Corporate Tax Shocks as Drivers of Vertical Tax Externalities: Evidence from Narrative Federal Tax Shocks

Yaniv Reingewertz[a], Ohad Raveh[b]

Abstract:

What are the sources of vertical tax externalities? The empirical aspects of vertical common pool issues have been studied extensively in the literature; however, very little attention, if any, has been given to studying their sources. In this paper we point at a new determinant: *Corporate federal tax shocks*. Adopting the case of the U.S., and using narrative-based tax shocks (Romer and Romer 2010), we study the separate vertical effects of corporate and non-corporate federal tax shocks. We find that vertical tax externalities work exclusively through the former. In particular, we estimate that a 1 billion dollar increase in federal corporate tax revenues reduce states' corporate tax revenues by approximately 20 million dollars; non-corporate federal tax shocks, on the other hand, do not seem to affect state tax revenues. Taking a state micro-level approach and using firm-level business activity data we show this distinction is a result of the erosion of states' corporate tax bases.

JEL codes: E62, H20, H71, H77

Keywords: Vertical tax externality, narrative tax shocks, federal taxes, state taxes.

[a] Division of Public Administration and Policy, School of Political Science, The University of Haifa, yanivrein@poli.haifa.ac.il, corresponding author. [b] Hebrew University of Jerusalem.

I. Introduction

The rivalry between the federal level and the state level over the same tax base, also known as vertical tax externality, or vertical tax competition, is a relatively new topic in the fiscal federalism literature. Most theoretical and empirical studies focus on vertical tax competition and provide conflicting results regarding the effects of chnagers in federal tax rates on state tax rates. We focus on the vertical tax externality, namely the effect of federal tax shocks on state tax revenues. We disaggregate the effect of federal tax shocks to corporate and non-corporate taxes, using the methodology proposed by Romer and Romer (2010) (henceforth RR), and find that federal corporate tax shocks drive vertical tax externalities.

We find that federal tax shocks decrease state corporate tax revenues, while they hardly affect non-corporate state tax revenues. A one billion dollar increase in federal tax revenues leads to a 16.5 million dollars decrease in total state corporate tax revenues. We also demonstrate that the decrease in tax revenue is a result of a smaller tax base by showing a negative association between federal tax shocks and the number of firms and establishments operating in the state, as well as an adverse effect on labor market outcomes like unemployment and household income. Federal tax shocks do not seem to significantly affect state corporate tax rates.

Our paper provides a novel identification strategy, based on narrative federal tax shocks (Romer and Romer 2010), which are used to identify the effect of federal tax shocks on state tax revenues. While parts of the literature ignore simultaneity and endogeneity issues in tax setting, we focus on a plausibly exogenous component of federal tax changes. The difficulty in identifying exogenous changes to the tax code might be one of the reasons for the disagreement in the literature regarding the magnitude, and even the sign of the effect of federal taxes on state taxes.

II. Literature review

Keen (1998) was probably the first to present a complete model of vertical tax externalities. He showed that if the federal and state levels share the same tax base, an increase in federal tax rates might erode the state tax base. In the case of unit taxes and log convexity of demand, a smaller tax base decreases state tax revenues, creating a negative vertical tax externality. Dahlby and Wilson (2003) provide a similar model, giving potentially opposite results. They show that in the case of ad-valorem taxes (as opposed to unit taxes) and inelastic demand, the vertical tax externality will be *positive*.

To understand the applicability of these models to the case of the US states, note that the main taxes which finance state budgets are income, corporate and sales taxes.[1] Most of these taxes are ad-valorem, hence the model of Dahlby and Wilson (2003) is more appropriate. Therefore, the sign of the vertical tax externality depends on the elasticity of demand. The demand for labor, capital and most consumer goods is probably elastic (see Murphy and Welch 1992, Borjas 2003 regarding labor demand; Papke 1991, Serrato and Zidar 2014 regarding capital; and Tellis 1988 regarding consumer goods). In other words, we would expect federal tax hikes to reduce state tax revenues due to a negative vertical tax externality.

Having a vertical tax externality requires that when setting federal (state) tax rates, the adverse effects of these taxes on the tax base of the state (federal) level is not taken into account. However, vertical tax externalities (as well as horizontal tax externalities) can be corrected by the federal government through transfers (Dahlby 1996, Boadway and Keen 1996, Boadway et al. 1998, Hoyt 2001), or even taxes, if the

[1] While the empirical literature provides evidence on cigarette tax and fuel tax, we do not include them in the analysis since their contribution to state tax revenue is minute. Property taxes are usually levied at the local level which is beyond the scope of this paper.

federal government takes into account the effect of its tax changes on state tax revenues (Hoyt 2001).

The empirical literature mainly deals with vertical tax competition, i.e. the effect of federal tax rate changes on state tax rates. Evidence showing the existence of vertical tax competition can be interpreted as evidence of vertical tax externalities – states increase their tax rates as a result of federal tax rate hikes because their tax revenues declined. The results of the literature, however, are different. For the case of business income tax, Hayashi and Boadway (2001) find that provincial tax rates respond negatively to federal tax rates, in Canada.

The literature on vertical tax competition mainly deals with non-corporate state taxes and does not reach a unanimous conclusion regarding the sign and magnitude of vertical tax competition. First, dealing with excise taxes, some suggest that an increase in the federal tax rate on cigarettes and gasoline leads to an increase in state tax rates on these items (Besley and Rosen 1998, Devereux et al. 2007). However, others suggest that state cigarette tax rates *decline* when federal cigarette tax rates increase (Fredriksson and Mamun 2008). The results regarding gasoline taxes are also mixed: state gasoline tax revenues are adversely affected by past increases in federal gasoline tax rates, but positively affected by current tax rates (Devereux et al. 2007). The divergence in this literature stems from different samples as well as different specifications, and is hard to settle without additional findings.

The empirical literature also deals with income taxes. Esteller-More and Solle-Olle (2001) find that state income tax rates are positively correlated with federal income tax rates. A related paper finds virtually the same result for Canada (Esteller-Moré and Solé-Ollé 2002). However, Goodspeed (2000) suggests that an increase in federal tax

rates decreases state tax rates, in the US. Therefore, the literature seems to suggest no conclusive result regarding vertical tax competition in income taxes.

Vertical tax competition might also prevail at the sub-national level. For example, Brett and Pinkse (2000) find that municipal business property tax rates are negatively correlated with provincial tax rates in Canada. Agrawal (2015a) finds similar results for the US. Burge and Rogers (2011) show that county tax rates negatively affect municipal tax revenues. Revelli (2003) estimates sub national vertical fiscal externalities from the spending side. He finds that an increase in county spending from own sources (which he calls a tax burden, since this spending has to be financed from county taxes) reduces district spending in the UK. These result suggest that local governments might be trying to internalize the vertical tax externality, therefore reducing local tax rates.

The literature on vertical tax externalities is also related to the literature on fiscal and tax multiplier. An increase in federal tax rates can have an indirect effect on state tax revenues (and hence on state tax rates) due to the tax multiplier and its effect on state tax bases. For example, an increase in federal tax rates would have a contracting effect on the economy (Romer and Romer 2010, Mertens and Ravn 2014).[2] This contraction would reduce employment and consumption at the state level, causing a reduction in the tax base of either of the state taxes. Therefore, vertical tax externalities might have macroeconomic implications.

Our paper is also related to the corporate tax literature, dealing with the effect of corporate taxation on business activity. This vast literature documents how corporate taxation shifts production, capital, income and profits between countries and within

[2] See also Ramey (2011) for a literature review on fiscal multipliers, which also covers issues related to tax multipliers.

countries (see, for example, Hall and Jorgensen 1967, Harris 1993, Devereux and Griffith 1998).[3] Contemporary studies, using more sophisticated empirical models, show a similar picture. For example, Serrato and Zidar (2014) estimate the effect of corporate tax changes at the county level in the US. They show that a 1% tax cut leads to an increase of 3-4% in establishment growth. Giroud and Rauh (2015) provide similar results using state-level tax changes. Aus dem Moore (2014) finds that corporate tax adversely affect investment activity by Belgian firms. Fossen and Steiner (2014) find an adverse effect of corporate taxes on business activity at the municipal level. Mertens and Ravn (2013, 2014) provide a macro-level analysis and show the effect of corporate and non-corporate tax shocks on economic activity.

Lastly, an issue related to the vertical tax externality is the horizontal tax externality: a possible negative effect of state tax rates on tax revenues in other states. While this effect has theoretical foundations (Bucovetsky 1991, Kanbur and Keen 1993), the empirical literature mainly deals with horizontal tax competition at the local level and is highly divided. Some suggest that horizontal tax competition exists (Büttner 2003, Heyndels and Vuchelen 1998, Feld and Kirchgässner 2001, Agrawal 2015b), while others offer opposing results (Lyytikäinen 2012, Baskaran 2014, Isen 2014). Devereux et al. (2007) explore state excise taxes and do find evidence for horizontal tax competition.

II. Data

Following RR, we define changes to the federal tax code as exogenous or endogenous federal tax shocks (more details are given in Section III, see also Romer and Romer 2010). We aggregate the RR tax shocks from the quarterly to the annual frequency and

[3] See Deveroux and Maffini (2007) for a survey of this literature.

use only the exogenous tax shocks, which are -2.29 billion dollars per year on average (Table 1). Federal tax shocks range from a tax decrease of 126.4 billion dollars to a tax hike of 68.1 billion dollar. These tax shocks are the projected changes in federal tax revenues as a result of the changes in the tax code.

In order to understand the effect of different federal taxes, we separate the RR tax shocks to corporate and non-corporate taxes, based on the detailed description of each change to the tax code provided by Romer and Romer (2009). We classified every tax shock to be corporate-related or non-corporate related. For example, changes to social security were classified as non-corporate, while changes in corporate tax rates and changes in depreciation rules were classified as corporate. Figures 1a and 1b present the variation upon time in these corporate and non-corporate federal tax shocks, respectively.

We collected data on state tax revenues from the US Census survey: *State Government Tax Collections*, which limits our sample period to 1963-2007. We look at total tax revenues and also at their division to corporate taxes and non-corporate taxes. [4] We also control for Gross State Product (GSP), taken from the BEA. We also collected data on business activity from the Business Dynamics Statistics. Finally, we collected data on employment and earnings from the IPUMS-CPS dataset (King et al. 2010). We aggregated this dataset to the state level using the weights provided in the dataset. Descriptive statistics for the main variables is given in Appendix Table A1, and a complete list of our data sources is provided in Appendix Table A2.

III. Methodology

[4] We define sales tax and individual income tax revenues, which are the majority of state tax revenues, as non-corporate state tax revenues. We do not include property taxation which is mostly relevant at the local level, and also do not include other taxes which represent a negligible part of state tax revenues.

We use narrative federal tax changes, based on Romer and Romer (2010), and assess their effect on state tax revenue, as well as other state level data.[5] Following RR, a distinction is made between "exogenous" tax changes and "endogenous" ones. "Exogenous" tax changes are defined as tax changes that were not designed to offset other (short-term) macroeconomic shocks. In other words, exogenous tax changes had motivations which were not related to immediate economic fluctuations, but rather were based on long run considerations and ideological or philosophical considerations. RR assess the magnitude of the tax shock based on projections done by the CBO and other government agencies. A more complete description of their methodology is provided in Romer and Romer (2009) and Romer and Romer (2010).

We start the analysis with equation 1, which is a variant of equation 5 in Romer and Romer (2010):

$$(1)\ \Delta t_t = \alpha + \beta T_t + \varepsilon_t$$

Where Δt_t is the first difference of log state tax revenues in time *t*, T_t is an exogenous tax changes in time *t* and ε_t is the residual. The only difference between equation 1 here and equation 5 in RR is that we explore the effect of federal tax shocks on tax revenues whereas RR estimate their effect on GDP. While RR use a quarterly time series for the US, we use a yearly panel data of 50 states for the period 1963-2007.[6] This difference leads to several changes to the specification, as is evident in Equation (2):[7]

$$(2)\ \Delta t_{it} = \beta \sum_{i=1}^{3} T_{t-i} + \gamma \sum_{i=1}^{3} t_{t-i} + \delta \sum_{i=1}^{3} t_{t-i}^{j} + \theta \sum_{i=1}^{3} X_{it} + F_i + \nu_{it}$$

[5] Other papers which use the Romer & Romer methodology to study state level activity include Zidar (2015), Hayo and Uhl (2015) and Perez-Sebastian et al. (2015). These papers are mainly dedicated to exploring heterogeneous effects of the RR tax shocks.

[6] Data for state taxes exists starting 1950, but data on GSP is only available since 1963.

[7] Moving from the national level to the state level comes at the expense of moving from the quarterly frequency to the yearly frequency, due to data limitations at the state level.

Where Δt_{it} is the first difference of log state tax revenues per capita in state *i* at time *t*, T_t is the federal tax shock in year *t*, t_{it}^J represents the spatial component and is the log of the weighted average of neighboring states' tax revenue.[8] We control for spatial effects due to the possibility of horizontal tax competition. X_{it} is a vector of control variables which includes gross state product per capita and a time trend. F_i is state fixed effects and ν_{it} is the residual. We follow RR and use lags to allow for continuous effects. We use 3 yearly lags which is consistent with Romer and Romer (2010) who use 12 quarterly lags.

Our specification is done using the fixed-effects estimator, since we assume that the narrative tax changes are exogenous to economic activity and to state tax revenues. GSP is added in order to control for economic fluctuations and spatial effects are added to conform with the literature, which is sometimes analyzing vertical and horizontal tax externalities simultaneously. Unfortunately, since federal tax shocks are the same for all states in a specific year, we cannot use year fixed-effects, hence we use a time trend. In the robustness checks we introduce quinquennial fixed effects (i.e. dummy variables for every 5-year period).

IV. Results

Table 1 presents the results of estimating equation 2, with three lags of federal tax shocks as the main explanatory variables. Following RR, we focus on the accumulated effect of federal tax shocks, while discussing the effect of specific lags when necessary. Column 1 displays the effect of federal tax shocks on total state tax revenues. While the

[8] We follow Devereux et al. (2007) and compute an average of neighbouring states' tax revenues, weighted by population. A similar computation is made for other dependent variables.

third lag is marginally statistically significant, the accumulated effect, which is negative and equal to -0.00005, is not statistically significant at the 5% level.

In order to further explore the effects of federal tax shocks, we make a distinction between state corporate tax revenues and state non-corporate tax revenues (columns 2 and 3, respectively). As can be seen in column 2, federal tax shocks negatively affect state corporate tax revenues, with an accumulated effect of -0.00069, or 19.2 million dollars for every 1 billion dollars of federal tax increase.[9] State non-corporate tax shocks don't seem to be much affected by federal tax shocks.

Columns 4 through 7 (Table 1) use the full decomposition of federal and state taxes to their corporate and non-corporate components. Column 4 (5) analyzes the effect of federal corporate tax shocks on state corporate (non-corporate) tax revenue. Column 6 (7) analyzes the effect of federal non corporate tax shocks on state non-corporate (corporate) tax revenue. We can see that corporate taxes are more influential, as well as more responsive. The accumulated effect of corporate federal tax shocks on state corporate tax revenue is -0.00059, or 16.5 million dollars (column 4).[10] The accumulated effect of non-corporate federal tax shocks on state corporate tax revenue is not statistically significantly different from zero, though it is still negative (column 5). Moving to state non-corporate tax revenues, we see insignificant results, for both federal corporate and non-corporate tax shocks (columns 6 and 7, respectively). Summing up our baseline results, we show that federal corporate tax shocks negatively affect state corporate tax revenues.

b.3. Firm-level effects of federal tax shocks

[9] 0.00069 multiplied by mean state corporate taxes per capita ($116), multiplied by mean state population (4.826 million), and aggregated through the 50 states.
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After establishing a negative association between federal tax shocks and state corporate tax revenues we continue to explore the reasons for this link. Specifically, we assess whether the reduction in state corporate tax revenues is a result of lower tax rates (Table 2), or a result of having a smaller tax base (tables 3 and 4). First, Table 2 looks on the effect of federal tax shocks on corporate tax rates. We use data on the highest bracket of state corporate tax rates, taken from the University of Michigan World Tax Database.[11] Column 1 looks on the effect of total federal tax shocks while columns 2 and 3 differentiate between federal corporate and non-corporate tax shocks, respectively. The effect of total federal tax shocks, as well as federal corporate tax shocks, is statistically insignificant. However, federal non-corporate tax shocks seem to increase state corporate tax rates, or at least their highest bracket. Therefore, we can conclude that the decline in state corporate tax revenues is not a result of lower tax rates.

Table 3 looks on business activity in order to understand how federal tax shocks affect the tax base. We use total federal tax shocks, though the results hold if we use only federal corporate tax shocks. Column 1 and 2 look on the number of establishments and firms operating in a specific state, respectively. Columns 3 and 4 look on firm entrance and exit rates, respectively. Both the number of establishments and the number of firms are adversely affected by an increase in federal taxes, with coefficients of -0.0006 and -0.0008, respectively. This means that a 1 billion dollar increase in federal taxes reduces the number of establishments and firms by 330 and 379, respectively.[12] Firms' entrance and exit rates show a similar picture. The negative effect of federal tax

[11] Data on other state corporate tax rates was unavailable for our sample period.
[12] 0.00006*110,028 (average state establishments), multiplied by 50 states. 0.00008* 94,776 (average state firms), multiplied by 50 states.

shocks on firm level activity suggests that a reduction in the tax base is the reason for lower state tax revenues.

In Table 4 we further explore the effect of federal tax shocks on firm-level activity, trying to understand which firms are affected the most. Therefore, we divide establishments to small and large, where establishments with less than 10 workers are considered small, and those with 10 workers or more are considered medium or large.[13] Column 1 displays the effect of federal tax shocks on small establishments, and we can see a negative effect with similar magnitude to those reported in Table 3. However, large establishments are hardly affected by federal tax shocks (column 2). We therefore conclude that federal tax shocks affect small businesses much more than they affect large ones.

b.4. Household sector effects of federal tax shocks

A final step in our analysis is to explore the effect of federal tax shocks on households. Following our prior findings, we would expect households to have lower income levels and to have higher unemployment levels due to the reduction in business activity. We use the IPUMS-CPS dataset which includes household-level surveys of the entire US. We focus on the following variables: unemployment, hours worked, wage income and household income. The last variable, household income, is at the household level, while the others are at the respondent level. We aggregate the data to the state level using the weights provided in the survey, and compute state-level averages of the aforementioned variables. Table 5 presents the effect of federal tax shocks on labor market outcomes and household income. First, column 1 presents the effect of federal tax shocks on

[13] The US Small Business Administration classifies small businesses by industry, with thresholds varying between 100 and 1,500 employees. This classification is not informative to our sample since the analysis is done at the establishment level and not the firm level. The results hold if we use other thresholds for firm size.

unemployment. We can see that unemployment rises in the two years after a federal tax hike, though the accumulated effect is not statistically significant. In terms of magnitude, the coefficient for the second lag, which is statistically significant, equals 0.00002, while the accumulated effect equals 0.00001. Both coefficients are small in terms of economic magnitude, suggesting that a 1 billion dollars increase in federal taxes would lead to an increase of 0.00002 (or 0.00001) percentage points in unemployment levels.

Column 2 tests the effect of federal tax shocks on hours worked. The results suggest an increase in hours worked, by 0.00099, though this effect is only marginally statistically significant. Judging from columns 1 and 2, it seems like federal tax shocks push workers out of employment, with remaining workers somewhat compensate the loss of workers by working more hours.

Columns 3 and 4 (Table 5) examine the effect of federal tax shocks on wages and income. First, we can see that wage income tends to increase after a federal tax shock, at least in the second lag, though the accumulated effect is not statistically significant. This positive association might be a result of at least two things. First, as shown in column 2, hours worked tend to rise after a federal tax shock. Second, since unemployment is rising, the composition of remaining workers might change. If unemployment is concentrated in low-income workers, then average wage would increase. In order to better understand what happened to the actual income of households, we examine the effect of federal tax shocks on household income (column 4). Here we see a decrease in income levels, equals to -0.00006, which is roughly $4 per household.

Summing up the effects of federal tax shocks on labor market outcomes, we can observe an increase in unemployment, an increase in hours worked, and a possible

increase in average wage. Household income at the state level, however, decreases after a federal tax shock.

b.5. Robustness checks

Table 6 offers several robustness checks for the main results. We test the baseline specification of Table 1, column 2. Columns 1 and 2 of Table 6 examine whether the results are sensitive to the lag structure of the federal tax shocks. Our baseline specification, following RR, uses three yearly lags of federal tax shocks. Here we use two lags and four lags, in columns 1 and 2, respectively. The results show that federal tax shocks adversely affect state corporate tax revenues starting the second year (column 1), and up to the fourth year (column 2). The accumulated effect of federal tax shocks increases when more lags are added to the analysis.

Column 3 of Table 6 explores whether the results are sensitive to the estimation strategy. Specifically, column 3 uses a dynamic panel-data model which is estimated using GMM (Arellano and Bond 1991). Nickel (1981) showed that using fixed effects models to estimate short panels with lagged dependent variables might yield biased estimates. Since our panel is relatively long, we use the Arellano Bond estimator only as a robustness check. Looking at the results of column 3 we can see that the accumulated effect of federal tax shocks, which is equal to -0.00132, is statistically significant, and is actually larger than that of the baseline specification.

Column 4 of Table 6 adds quinquennial (5-year) dummies to the specification. These dummies take the value of one for every 5-year period, starting 1960, onward (and zero otherwise). The 5-year dummies are serving as year (or more exactly 5-year) fixed effects, and are used since we cannot use year fixed effects. The results of Column

4 show an accumulated effect of -0.00099, which is somewhat larger than our baseline estimate.

Column 5 of Table 6 uses an alternative measure for federal tax shocks - total federal corporate tax revenues, taken from the BEA, instead of the narrative measure of Romer and Romer (2010). While federal corporate tax revenues are possibly endogenous to state corporate tax revenues, it is interesting to examine the direction of the bias which is caused by using endogenous tax data. The results of Column 5 are fairly consistent with our baseline results, showing a negative effect in the second and third lags, but a positive effect in the first lag. While the magnitudes of these effects is large comparted with our baseline results, the accumulated effect is smaller in magnitude and is not statistically significant. It looks like endogenous federal tax shocks show a larger association with state tax revenues, but that much of this association can be attributed to yearly macroeconomic fluctuations, which wash away in the long run.

Finally, Column 6 of Table 6 introduces another control variable to the baseline specification – federal transfers. An increase in federal transfers will increase state revenues, and therefore might lead to lower tax revenues, for example by creating an incentive to lower tax rates. However, adding federal transfers as a control variable hardly affects the results, both qualitatively and quantitatively.

V. Conclusions

This paper provides evidence on the magnitude of vertical tax externalities - the influence of federal tax shocks on state tax revenues. Our estimates suggest that a 1 billion dollar increase in federal taxes leads to a decrease of 19 million dollars in state

corporate tax revenues. We further explore the effect of federal tax shocks by looking on business activity and labor market outcomes. We show that federal tax shocks reduce firms' activity and lead to unemployment and reductions in total household income.

The results suggest that corporate taxes drive vertical tax externalities: state corporate tax revenues diminish when federal corporate taxes rise. A possible solution to this loss in revenue would be to increase tax rates or cut state spending. Another solution would include federal transfers to the states that would compensate for the loss in state tax revenue.

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Table 1: The effect of federal tax shocks on state tax revenues: direct and indirect channels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	first difference of log real state tax revenue per capita	first difference of log real state corporate tax revenue per capita	first difference of log real state non-corporate tax revenue per capita	first difference of log real state corporate tax revenue per capita		first difference of log real state non-corporate tax revenue per capita	
Federal tax shocks, t-1	0.00002	0.00037***	-0.00000				
	(0.00002)	(0.00013)	(0.00004)				
Federal tax shocks, t-2	-0.00002	-0.00058***	-0.00004				
	(0.00003)	(0.00014)	(0.00003)				
Federal tax shocks, t-3	-0.00005*	-0.00048***	-0.00003				
	(0.00003)	(0.00010)	(0.00003)				
Federal corporate tax shocks, t-1				0.00049***		0.00002	
				(0.00013)		(0.00004)	
Federal corporate tax shocks, t-2				-0.00050***		-0.00005	
				(0.00014)		(0.00003)	
Federal corporate tax shocks, t-3				-0.00057***		-0.00006**	
				(0.00010)		(0.00003)	
Federal non-corporate tax shocks, t-1					-0.00031		-0.00028**
					(0.00038)		(0.00011)
Federal non-corporate tax shocks, t-2					-0.00139***		0.00009
					(0.00045)		(0.00012)
Federal non-corporate tax shocks, t-3					0.00109**		0.00042***
					(0.00054)		(0.00013)
accumulated effect, federal tax shocks	-0.00005	-0.00069***	-0.00007	-0.00059***	-0.00061	-0.00009	0.00022
	(0.00005)	(0.00017)	(0.00006)	(0.00017)	(0.00055)	(0.00006)	(0.00015)
R-squared, within	0.226	0.191	0.166	0.192	0.174	0.167	0.171
Observations	2150	1918	2150	1918	1918	2150	2150
State fixed effects, Time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors are robust, clustered by state, and appear in parentheses for independent variables. Superscripts *, **, *** correspond to a 10, 5 and 1% level of significance. All regressions estimate equation 2, i.e. they include as independent variables the log of real GSP per capita, spatial effects, state fixed effects and a time trend. `Federal tax shocks' are the narrative-based exogenous federal tax shocks taken from Romer and Romer (2010). For further information on variables see data Appendix.

Table 2: Tax rates

Dependent variable: Tax rate of corporate taxes	(1)	(2)	(3)
Federal tax shocks, t-1	-0.00039		
	(0.00038)		
Federal tax shocks, t-2	0.00060**		
	(0.00026)		
Federal tax shocks, t-3	0.00032		
	(0.00029)		
accumulated effect, federal tax shocks	0.00053		
	(0.00045)		
Federal corporate tax shocks, t-1		-0.00097*	
		(0.00051)	
Federal corporate tax shocks, t-2		0.00047**	
		(0.00021)	
Federal corporate tax shocks, t-3		0.00029	
		(0.00034)	
accumulated effect		-0.00020	
		(0.00042)	
Federal non-corporate tax shocks, t-1			0.00151**
			(0.00058)
Federal non-corporate tax shocks, t-2			0.00163
			(0.00105)
Federal non-corporate tax shocks, t-3			0.00029
			(0.00058)
accumulated effect			0.00343**
			(0.00135)
R-squared, within	0.089	0.090	0.090
Observations	1686	1686	1686
States fixed effects	YES	YES	YES
Time trend	YES	YES	YES

Note: Standard errors are robust, clustered by state, and appear in parentheses for independent variables. Superscripts *, **, *** correspond to a 10, 5 and 1% level of significance. All regressions estimate equation 2, i.e. they include as independent variables the log of real GSP per capita, spatial effects, state fixed effects and a time trend. `Federal tax shocks' are the narrative-based exogenous federal tax shocks taken from Romer and Romer (2010).

Table 3: Firm level data

	establishments	firms	firm entrance rate	firm exit rate
Dependent variable: first difference of log number of establishments	(1)	(2)	(3)	(4)
Federal tax shocks, t-1	-0.00002*	-0.00004***	0.00303***	0.00496***
	(0.00001)	(0.00001)	(0.00111)	(0.00076)
Federal tax shocks, t-2	0.00001	-0.00000	-0.00068	-0.00177*
	(0.00001)	(0.00001)	(0.00085)	(0.00102)
Federal tax shocks, t-3	-0.00005***	-0.00005**	-0.00672***	0.00114
	(0.00002)	(0.00002)	(0.00105)	(0.00089)
accumulated effect, federal tax shocks	-0.00006***	-0.00008***	-0.00437***	0.00432***
	(0.00002)	(0.00002)	(0.00141)	(0.00096)
R-squared, within	0.130	0.134	0.474	0.513
Observations	1400	1400	1400	1400
States fixed effects	YES	YES	YES	YES
Time trend	YES	YES	YES	YES

Note: Standard errors are robust, clustered by state, and appear in parentheses for independent variables. Superscripts *, **, *** correspond to a 10, 5 and 1% level of significance. `Federal tax shocks' are the narrative-based exogenous federal tax shocks taken from Romer and Romer (2010). All regressions estimate equation 2, i.e. they include as independent variables the log of real GSP per capita, spatial effects, state fixed effects and a time trend.

Table 4: Firm size data

	establishments - small firms	establishments - large firms
Dependent variable: first difference of log number of establishments	(1)	(2)
Federal tax shocks, t-1	-0.00002*	0.00001
	(0.00001)	(0.00001)
Federal tax shocks, t-2	0.00001	0.00002**
	(0.00001)	(0.00001)
Federal tax shocks, t-3	-0.00005***	-0.00003**
	(0.00002)	(0.00001)
accumulated effect, federal tax shocks	-0.00006***	0.00001
	(0.00002)	(0.00002)
R-squared, within	0.102	0.420
Observations	1400	1400
States fixed effects	YES	YES
Time trend	YES	YES

Note: Standard errors are robust, clustered by state, and appear in parentheses for independent variables. Superscripts *, **, *** correspond to a 10, 5 and 1% level of significance. All regressions estimate equation 2, i.e. they include as independent variables the log of real GSP per capita, spatial effects, state fixed effects and a time trend. `Federal tax shocks' are the narrative-based exogenous federal tax shocks taken from Romer and Romer (2010).

Table 5: Household Sector data

	Unemployment	Hours worked	wage income	household income
	(1)	(2)	(3)	(4)
Federal tax shocks, t-1	0.00001*	0.00086**	0.00001	-0.00006**
	(0.00000)	(0.00040)	(0.00003)	(0.00003)
Federal tax shocks, t-2	0.00002**	-0.00185***	0.00005**	0.00009***
	(0.00001)	(0.00042)	(0.00002)	(0.00003)
Federal tax shocks, t-3	-0.00002**	0.00198***	-0.00001	-0.00009***
	(0.00001)	(0.00053)	(0.00004)	(0.00003)
accumulated effect, federal tax shocks	0.00001	0.00099*	0.00004	-0.00006*
	(0.000007)	(0.00057)	(0.00004)	(0.00004)
R-squared, within	0.154	0.148	0.117	0.119
Observations	1668	1668	1668	1514
States fixed effects	YES	YES	YES	YES
Time trend	YES	YES	YES	YES

Note: Standard errors are robust, clustered by state, and appear in parentheses for independent variables. Superscripts *, **, *** correspond to a 10, 5 and 1% level of significance. All regressions estimate equation 2, i.e. they include as independent variables the log of real GSP per capita, spatial effects, state fixed effects and a time trend. `Federal tax shocks' are the narrative-based exogenous federal tax shocks taken from Romer and Romer (2010).

Table 6: Robustness checks

	2 lags	4 lags	Arellano-Bond	5-year FE	Endogenous tax revenues	Federal transfers
	(1)	(2)	(3)	(4)	(5)	(6)
Federal tax shocks, t-1	0.00026**	0.00046***	0.00003	-0.00012	0.00241***	0.00039***
	(0.00012)	(0.00012)	(0.00013)	(0.00015)	(0.00023)	(0.00012)
Federal tax shocks, t-2	-0.00077***	-0.00067***	-0.00077***	-0.00049***	-0.00181***	-0.00069***
	(0.00013)	(0.00014)	(0.00015)	(0.00014)	(0.00036)	(0.00013)
Federal tax shocks, t-3		-0.00029**	-0.00057***	-0.00038**	-0.00068**	-0.00047***
		(0.00012)	(0.00012)	(0.00010)	(0.00026)	(0.00010)
Federal tax shocks, t-4		-0.00061***				
		(0.00013)				
accumulated effect, federal tax shocks	-0.00052***	-0.00112***	-0.00132***	-0.00099***	-0.00009	-0.00067***
	(0.00015)	(0.00021)	(0.00016)	(0.00023)	(0.00012)	(0.00017)
R-squared, within	0.139	0.201		0.251	0.260	0.191
Observations	1964	1872	1937	1918	1918	1918
State fixed effects	YES	YES	YES	YES	YES	YES
Time trend	YES	YES	YES	NO	YES	YES

Note: The dependent variable in columns 1 through 5 is log state corporate tax revenues per capita. The dependent variable in Column 6 is log investment per capita. Standard errors are robust, clustered by state, and appear in parentheses for independent variables. Superscripts *, **, *** correspond to a 10, 5 and 1% level of significance. All regressions include state fixed effects. `Federal tax shocks' are the narrative-based exogenous federal tax shocks taken from Romer and Romer (2010). 'GSP per capita' is the log of real Gross State Product divided by state population. Columns 1 and 2 include two and four lags of the main independent variable, respectively. Column 3 uses the Arellano-Bond estimator. Column 4 introduces 5-year dummy variables to the baseline specification. Column 5 uses total federal tax revenues as the independent variable instead of the RR narrative measure. Column 6 controls for federal transfers.

Appendix Table 1: Descriptive Statistics

	N	Mean	Std. Dev.	Min.	Max.
federal tax shocks	2250	-6.21857	38.71	-148.37	75.667
federal corporate tax shocks	2250	-10.6578	37.0625	-148.37	75.667
federal non-corporate tax shocks	2250	4.438619	11.3258	-21.51249	46.632
state tax revenues per capita (log)	2250	14.2436	0.4387	12.8631	16.312
state corporate tax revenues per capita (log)	2010	11.49402	0.70573	7.581053	15.36
state non-corporate tax revenues per capita (log)	2250	13.95133	0.49176	12.23099	15.189
GSP per capita (log)	2250	10.29389	0.33576	9.337104	11.616
Highest corporate tax rate	1948	5.854492	2.98388	0	12.25
Establishments per capita (log)	1550	3.093647	0.14159	2.735135	3.5669
Firms per capita (log)	1550	2.959774	0.15409	2.603918	3.4707
establishment entry rate	1550	13.08716	2.47857	8.5	28.8
establishment exit rate	1550	10.92594	1.86538	5.9	25.8
Small establishments (log)	1550	2.773343	0.15188	2.441955	3.285
Large establishments (log)	1550	1.793341	0.15403	1.271924	2.1839
Unemployment	1938	0.0492	0.01868	0	0.1705
hours worked	1938	17.70197	2.09183	11.05032	28.014
log household income	1688	11.22497	0.82198	10.49127	15.762

Note: The sample includes 2250 annual observations of the 50 U.S. states, over the period of 1963-2007. 'Federal tax shocks' are the narrative-based exogenous federal tax shocks taken from Romer and Romer (2010); 'corporate related' are those changes related to corporate tax, whereas 'non-corporate related' pertain to the remaining changes. 'GSP per capita' is real Gross State Product divided by state population. For further information on variables see Appendix Table 2.

Appendix Table 2: Data sources

variable name	definition	data source
federal tax shocks	Romer and Romer narrative federal tax shocks (billion dollars)	Romer and Romer (2010)
federal corporate tax shocks	Romer and Romer narrative federal tax shocks - corporate related (billion dollars)	Romer and Romer (2010)
federal non-corporate tax shocks	Romer and Romer narrative federal tax shocks - non-corporate related (billion dollars)	Romer and Romer (2010)
state tax revenues	total state tax revenues per capita (log)	Annual Survey of State Government Tax Collections
state corporate tax revenues	state corporate tax revenues per capita (log)	Annual Survey of State Government Tax Collections
state non-corporate tax revenues	state non-corporate tax revenues per capita (log)	Annual Survey of State Government Tax Collections
GSP per capita	gross state product per capita (log)	Bureau of Economic Analysis (BEA)
state corporate tax rates	highest corporate tax rate	World tax database (University of Michigan)
establishments	number of establishments per capita (log)	US Census Bureau - Business Dynamics Statistics
firms	number of firms per capita (log)	US Census Bureau - Business Dynamics Statistics
firms entrance rate	firms entrance rate	US Census Bureau - Business Dynamics Statistics
firms exit rate	firms exit rate	US Census Bureau - Business Dynamics Statistics
establishments - small firms	number of establishments with less than 10 workers, per capita (log)	US Census Bureau - Business Dynamics Statistics
establishments - large firms	number of establishments with more than 10 workers, per capita (log)	US Census Bureau - Business Dynamics Statistics
Unemployment	percent of unemployed	IPUMS-CPS
Hours worked	weekly working hours	IPUMS-CPS
Household income	annual household income (log)	IPUMS-CPS

Note: all monetary variables are in real 2010 Dollars.

Figure 1.a Federal corporate tax shocks

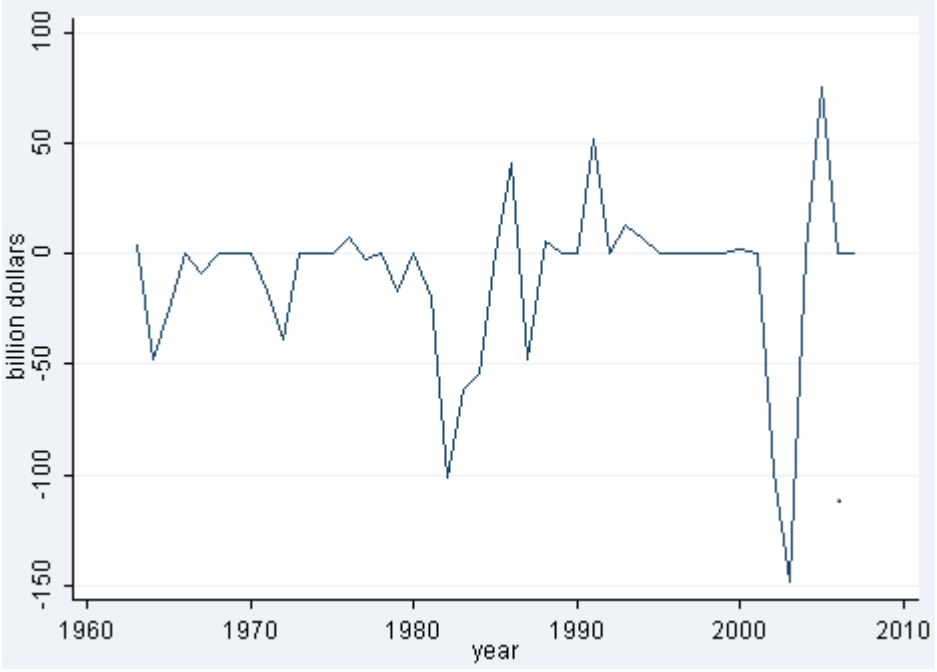

Figure 1.b Federal non-corporate tax shocks