CROSS-STATES HETEROGENEITIES IN THE TRANSMISSION OF THE U.S. NARRATIVE TAX CHANGES

Poster Presentation
ASSA 2021 Annual Meeting

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Introduction

- This study investigates:

  -The effects of federal tax changes on the U.S. state-level economic activity

  -The assumption of homogeneous effects of federal tax cuts across states and identifies where and why that assumption may not be valid.

  -What factors within the state economies impacted the transmission mechanism of tax cut shock and how

- Main objective

  -To examine the effects of federal tax changes on the state-level real GDP, personal income, employment, and price levels.

Motivation of the study

- Existing literature assume that tax shocks affect all states the same way, which does not seem realistic.
- Previous empirical literature use narrative tax shocks to estimate aggregate tax multiplier (Romer and Romer, 2010; Mertens and Ravn, 2013)
- Also, a small-scale structural VAR model employs to examine the heterogeneous responsiveness of federal tax policy changes at the state level(Hussain and Malik, 2016; Liu and Williams, 2019)
- However, this aggregate estimate does not consider the importance of state-level characteristics/heterogeneities in the transmission of federal tax shocks.
- Moreover, the issue of omitted variable bias and limited information set are also associated with the small-scale structural VAR models
- Therefore, the estimation of federal tax policy changes is likely to be biased if the additional regional and aggregate information not included in the VAR system.

About this study

- This study employs

  -Exogenous personal and corporate income tax changes using narrative identification method (Romer and Romer, 2010; Mertens and Ravn, 2013).

  - Narrative tax changes are combined with factor augmented vector autoregressive (FAVAR) models

  -The cross-state regression analysis incorporates various microeconomic channels about how the state's economic structures interact with the transmission of federal tax changes

Contribution of the study

- This study considers a broader set of regional and aggregate variables than typically considered in small-scale VAR models.
- Estimates a factor augmented vector autoregressive (FAVAR) model, where narrative tax shocks are identified by using sign restrictions with Uhlig's (2005) penalty function.
- The FAVAR model includes U.S. regional (BEA) and aggregate factors from an extensive panel data set of 126 output, prices, employment, and monetary and financial variables.
- Extends the narrative dataset up to 2018 using the narrative approach (Romer and Romer, 2009; Mertens and Ravn, 2013)

Main findings
The FAVAR estimates

- The magnitude and persistence of state's responses are heterogeneous, and, in most states, these responses are statistically and economically significant
- A one percent cut in personal income tax increases real GDP by about 1.2 percent on impact and a maximum of 1.9 percent after four years.
- A one percent cut in corporate income tax cut raises real GDP on impact by 0.52 percent on impact and by 0.83 percent after two years.
- Cuts in personal income tax increases real GDP in 33 states, raises personal income in 39 states, and drives the price level up in 46 states.
- The corporate tax cuts show a significant rise in real GDP and personal income for around 40 states, while price level rises in 48 states
- The direction of state employment response is significantly homogenous across the U.S. states; with employment rising by a maximum of about 1.6 percent after the personal income tax cut, and 0.8 percent for the corporate tax cut.

Main findings
The role of state-level characteristics

- States with a higher financial and manufacturing concentration in their industry share appear to be the more responsive states in real GDP and personal income
- Lower tax burdens, smaller degree of labor market rigidities and economic policy uncertainty are also related to higher responses of state's real GDP and personal income
- The response in price levels and employment to a corporate tax cut is relatively higher in states with a broader credit channels, a smaller degree of financial friction, and a smaller degree of labor market rigidities.
- States with no personal and corporate income taxes or moderate state tax rates (TX, FL, WY, CA, and CO) show relatively a higher response to either tax changes
- The estimated cumulative response is higher for a personal income tax cut than the same amount of cut in personal income tax.

Data and Econometric model

- The state-level analysis includes three sets of information:

  -The first set of factors comes from federal-level data,

  -The second set of factors is related to the regional data, which represents the economic characteristics for a specific Bureau of Economic Analysis (BEA) region, and

  -The state-level economic characteristics.

- The state-level macroeconomic variables in the panel FAVAR include real GDP, personal income, consumer price index, and non-farm employment

Data

Table 1: Summary statistics of state-level macroeconomic variables

Summary statistics of state-level key macroeconomic variables

Variable	States	Mean	Std.dev	Max	Min	CI of mean (95%)	Corr with U.S. aggregates
Real GDP growth	**U.S.**	**2.6**	**1.85**	**7.13**	**-2.54**	**0.59**	**1**
	1st (CA)	3.31	2.6	8.06	-4.01	0.83	0.82
	Median (AL)	2.17	2.26	6.42	-3.93	0.83	0.81
	50th (VT)	2.88	2.80	10.00	-2.71	0.90	0.67
Disp. Pers. Inc	**U.S.**	**5.08**	**1.81**	**8.82**	**-0.30**	**0.63**	**1**
	1st (CA)	5.38	2.17	9.69	-0.15	0.76	0.88
	Median (AL)	4.77	1.89	8.41	0.25	0.66	0.83
	50th (WY)	4.99	3.76	8.43	-4.22	1.31	0.43
Employment	**U.S.**	**1.63**	**1.41**	**4.42**	**-3.11**	**0.45**	**1**
	1st (CA)	1.98	2.06	6.27	-3.95	0.65	0.89
	Median (KY)	1.25	1.50	4.16	-3.22	0.47	0.87
	50th (WY)	1.56	2.74	8.34	-4.66	0.87	0.39
Inflation (% change in CPI)	**U.S.**	**2.92**	**1.51**	**7.63**	**-0.32**	**0.50**	**1**
	1st (CA)	3.42	1.9	10.03	-0.02	0.62	0.74
	Median (CO)	3.20	1.9	9.39	-0.65	0.64	0.74
	50th (AK)	2.81	1.3	5.94	-0.48	0.43	0.95

Econometric model

Following Bernanke, Boivin, and Eliasz (2013), the measurement equation:

$$X_t = \Lambda_F^a F_t^a + \Lambda_F^r F_t^r + \Lambda^T T_t + \omega_t \qquad (1)$$

X_t denote a $S\,x1$ vector of stationary macroeconomic variables for S states.

F_t^a and F_t^r are the $f\,x1$ vector of unobserved factors at the aggregate and regional level.

T_t is a vector of narrative tax changes that is considered as an exogenous observable variable,

ω_t is an $S\,x1$ vector follows Gaussian distribution with an $S\,x\,S$ variance-covariance matrix

$$\Sigma_\omega = diag(\sigma_1^2,...,\sigma_S^2)\,.$$

Λ_F is a coefficient matrix of factor loadings

Λ^T is coefficient matrix of narrative tax series T_t

Econometric model

The dynamics of the factors $Z_t = (F'_{a,t}, T'_t)'$ is governed by a VAR process of order L and is given by the following state equation,

$$Z_t = B(Z'_{t-1}, \ldots, Z'_{t-L}) + \varepsilon_t \qquad (2)$$

With $(f\ x\ k)\ x\ L(f\ x\ k)$ dimensional coefficient matrix B and ε_t are each $f\ x\ k$ dimensional vectors of shocks

Table 2: Sign restriction on the variables of the FAVAR model

	Sign restriction							
Variable	**GDP**	**DPI**	**CPI**	**EMP**	**Tax (PI)**	**Tax (CI)**	**Fa**	**Fr**
Personal income tax cut shocks	**> 0**	**> 0**	**> 0**	**> 0**	**> 0**	**≅ 0**	**≅ 0**	**≅ 0**
Corporate income tax cut shocks	**> 0**	**> 0**	**> 0**	**> 0**	**≅ 0**	**> 0**	**≅ 0**	**≅ 0**

≅ 0 indicates no restriction

Model estimation

(1) Estimate the unrestricted FAVAR in order to get $\hat{B}$ and the variance-covariance matrix $\hat{\Sigma}$

(2) Apply a Cholesky decomposition to the model to orthogonalize narrative tax shocks and extract the orthogonal innovations

(3) Estimate impulse responses of the variable of interest or all the variables in the model

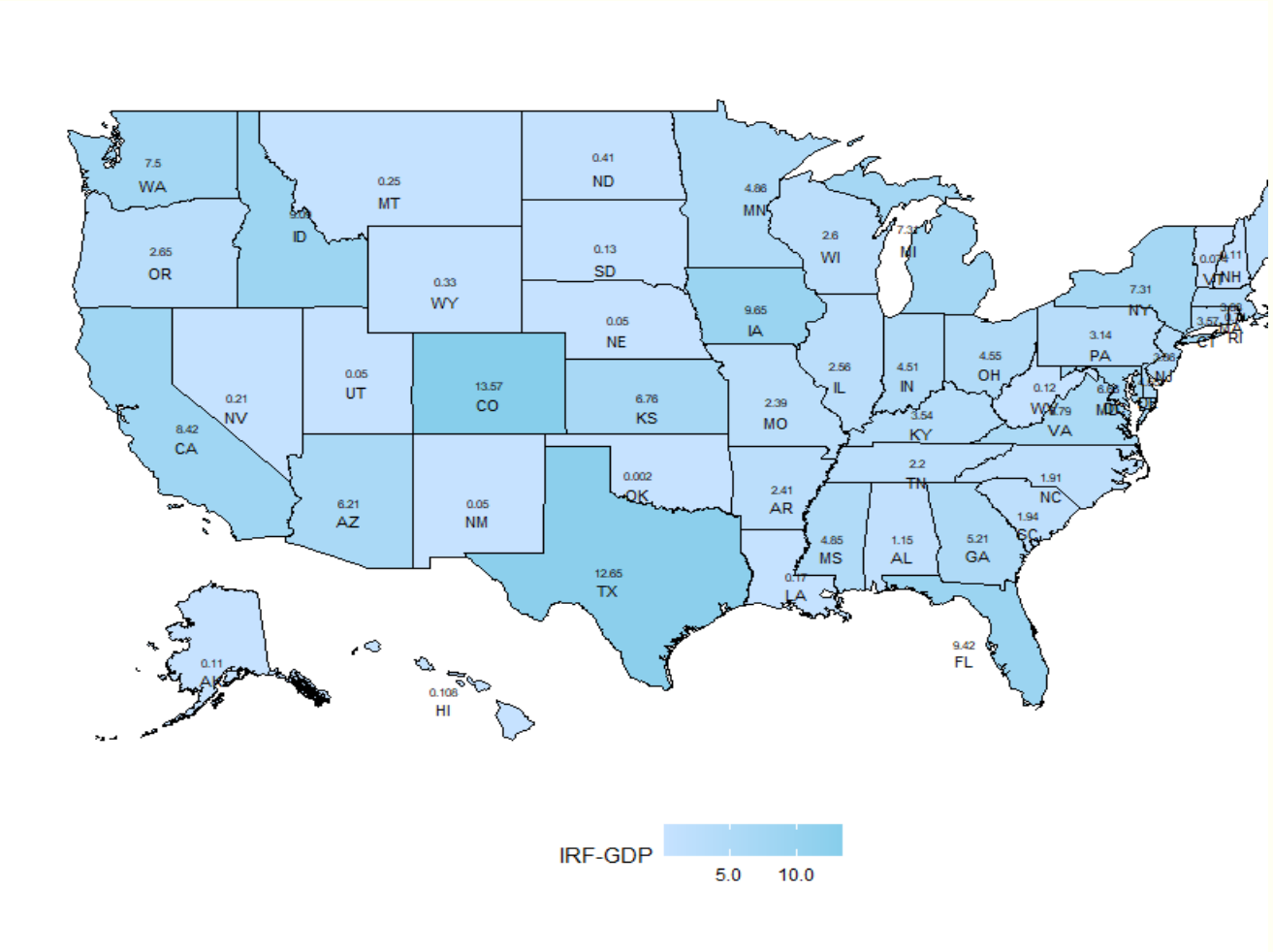
(4) Given $\hat{B}$ and $\hat{\Sigma}$, and impulse responses, an orthogonal impulse vector δ (which is based on the factor rotation) can be drawn using a standard random draw where $\delta = \tilde{B}a$. The n -dimensional vector $\|a\| = 1$ comes from $(n-1)x1$ standard normal draw, and $\tilde{B}\tilde{B}' = \Sigma'$

(5) Impulse responses of the variables are multiplied by α and examine if the prior sign restrictions are satisfied. This step identifies an impulse response function which exactly satisfies *a priori* sign restrictions by minimizing penalty function

(6) If *a priori* sign restrictions hold, the model keeps the impulse responses; otherwise, the system drops the draw

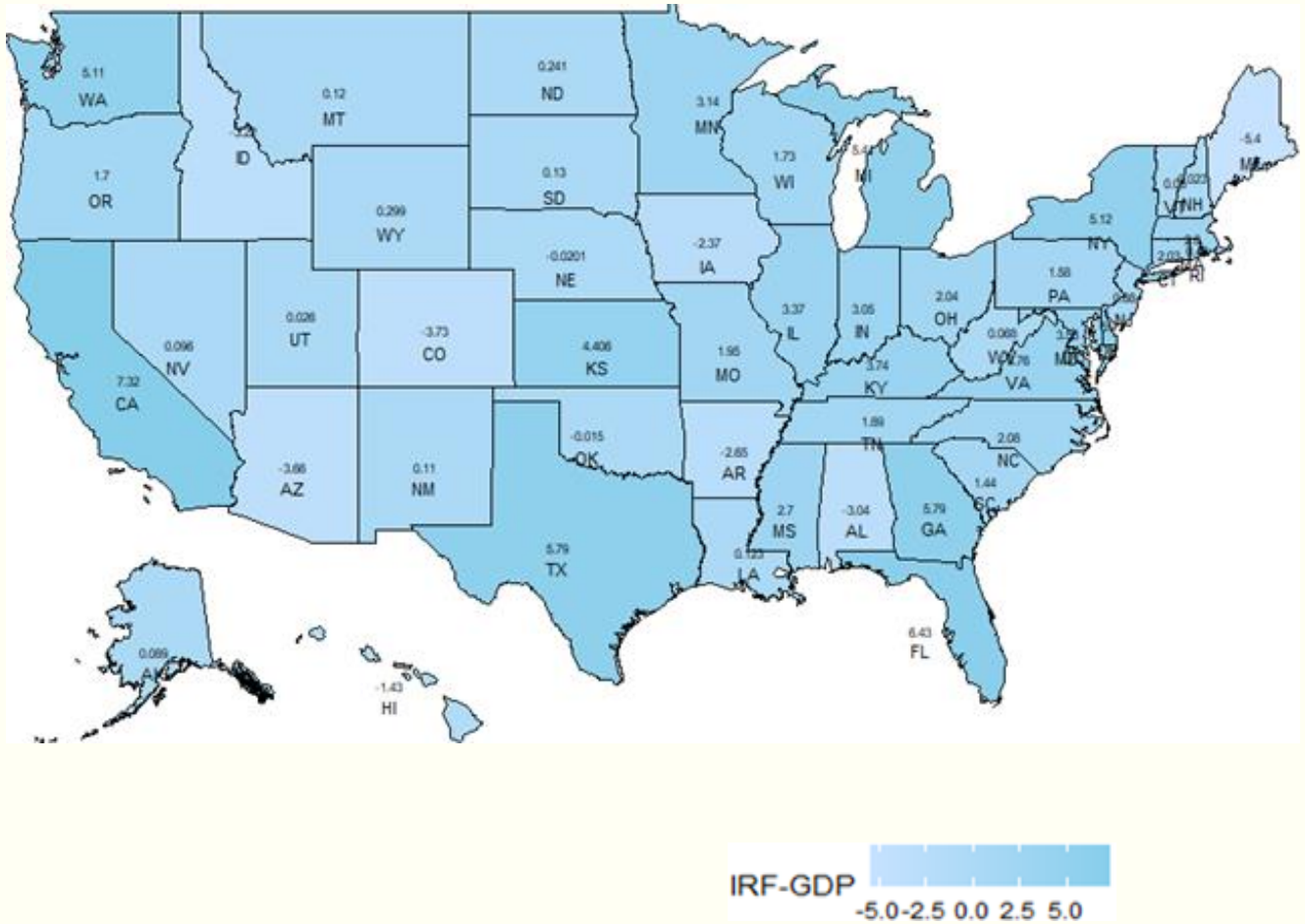
Dynamic response of the states (personal income tax)

Cumulative responses of state's GDP to a one standard deviation cut in federal personal income tax at the 10-year horizon



Dynamic response of the states (corporate income tax)

Cumulative responses of state's GDP to a one standard deviation cut in federal corporate income tax at the 10-year horizon



Dynamic response of the states (personal income tax)

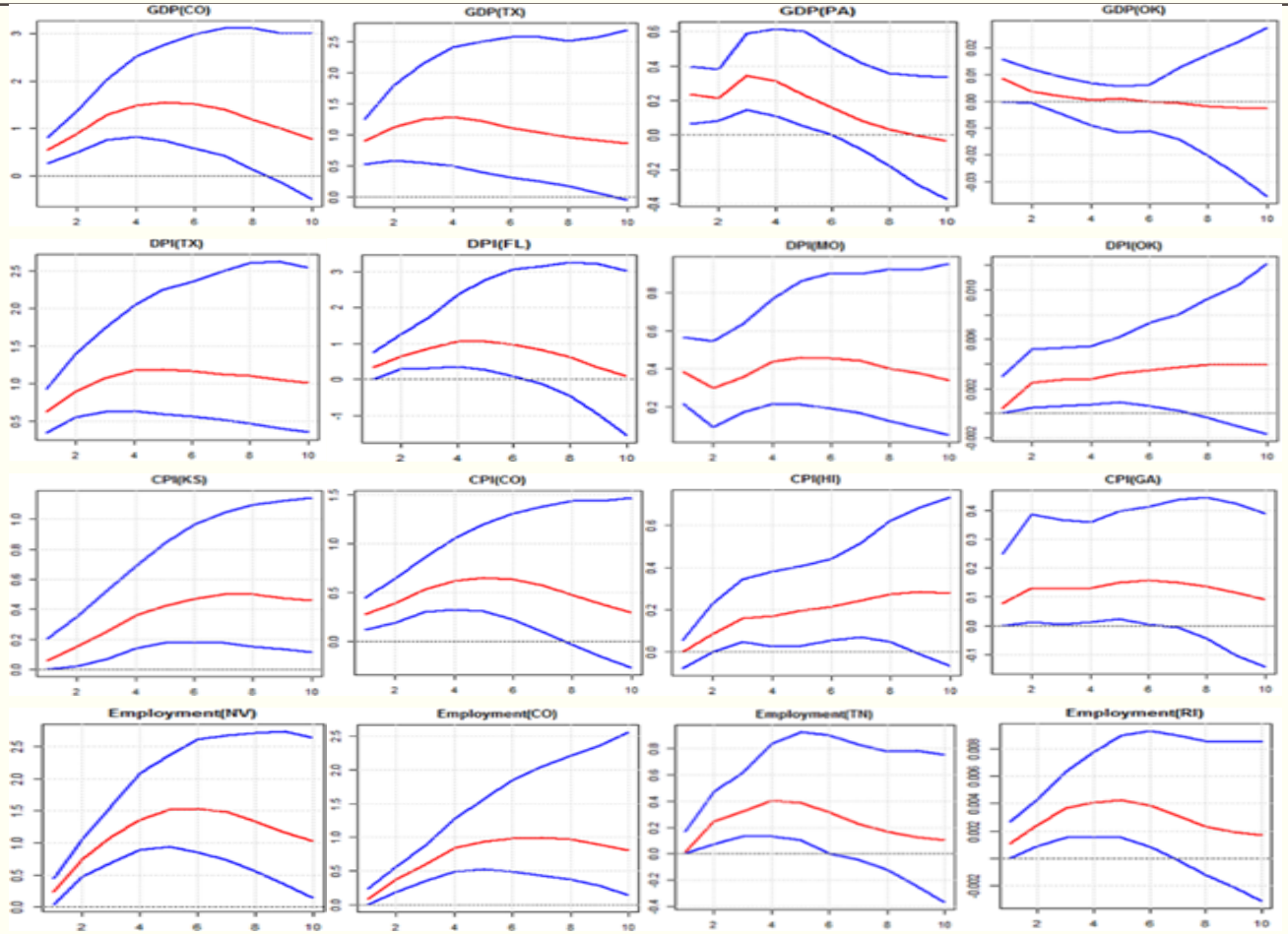


Figure 1: Impulses responses of state's GDP, disposable personal income, CPI and employment to a 1 percent cut to the federal personal income tax rate. The responses of 1st, 2nd, 25th and 50th states are presented here where states are ordered by their cumulative impulse responses over a 10-year horizon.

Dynamic response of the states (corporate income tax)

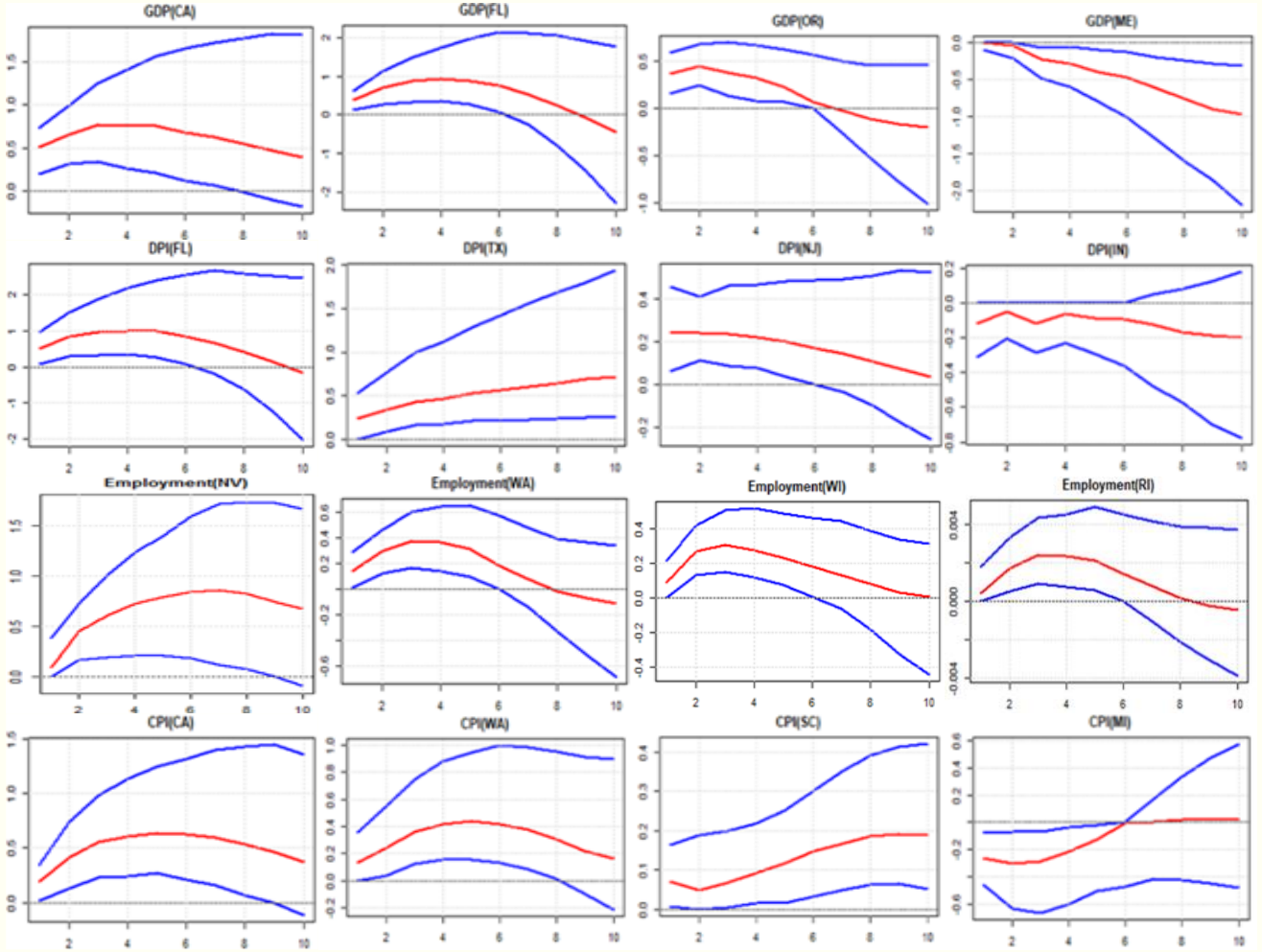


Figure 2: Impulses responses of state's GDP, disposable personal income, CPI, and employment to a 1 percent cut to the federal corporate income tax rate. The responses of 1st, 2nd, 25th and 50th states are presented here where states are ordered by their cumulative impulse responses over a 10-year horizon.

Reliability of the FAVAR estimates

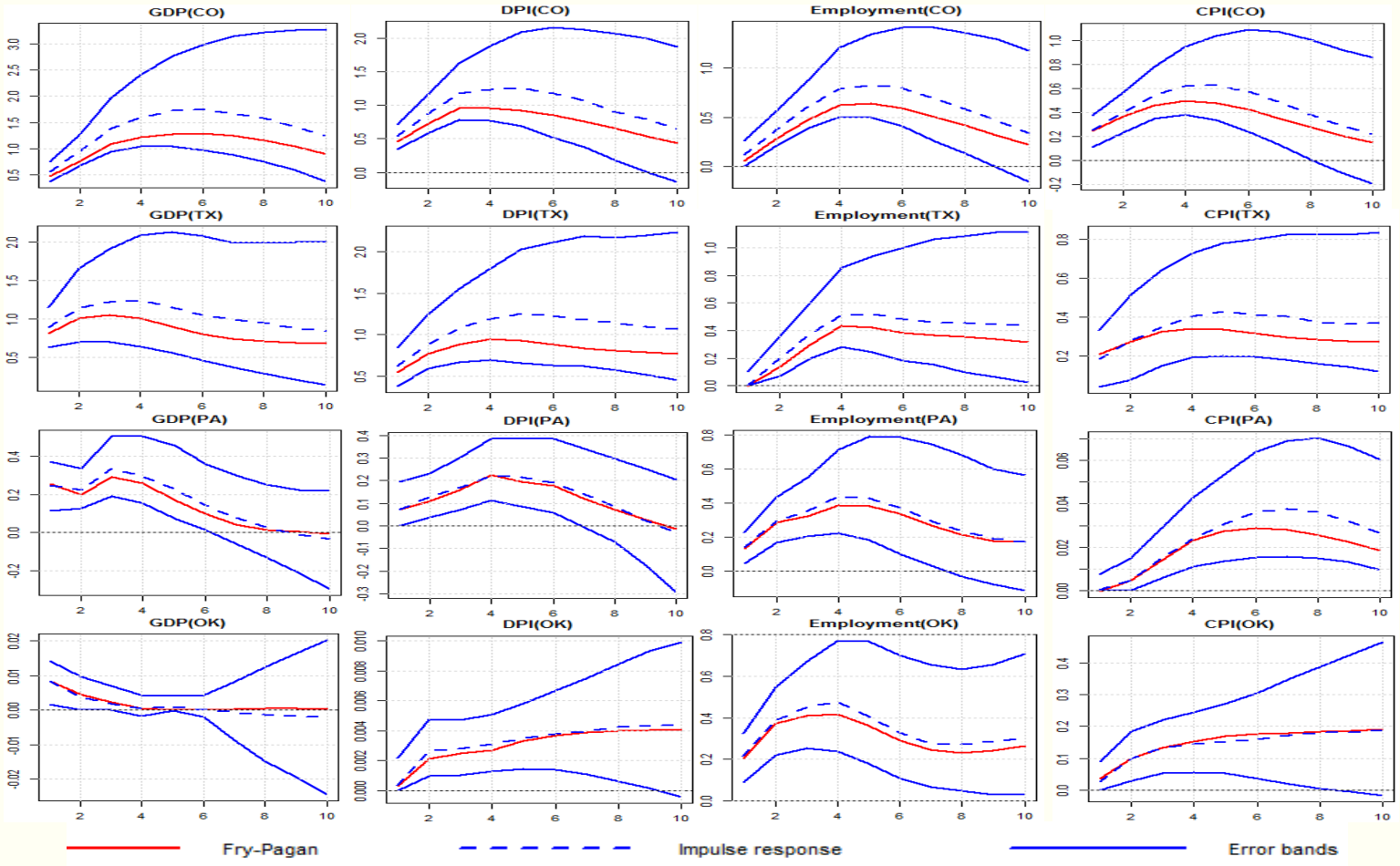


Figure 3: Comparison of impulses responses of 1st (CO), 2nd (TX), 25th (PA) and 50th (OK) state's GDP with those state's disposable personal income, CPI and employment responses are drawn from Fry and Pagan's (2011) M-T method (red solid line) and from sign restricted FAVAR models (dashed blue line). The GDP responses of 1st (CO), 2nd (TX), 25th (PA) and 50th (OK) states are ordered by their cumulative impulse responses over a 10-year horizon.

Economic significance of the FAVAR estimates

- The FAVAR estimates imply a maximum personal income tax's output multiplier is 1.9, and the corporate income tax's output multiplier is 0.83.
- At the state level, the value of output multiplier starts rising two years after the personal income tax cut for most states and reaches a maximum of 1.6 for Colorado, 1.2 for Texas, and 0.38 for Pennsylvania at five years.
- The total personal income multiplier is higher for CO, TX, FL, and MD, followed by KS, AZ, CA, IA, MN, MA, and WA.
- Looking at the labor market, a one percent cut in personal income tax increases employment by a maximum of 1.6 percent (non-farm employment elasticity) compared to 0.92 percent for the corporate income tax cut.

Consistency with the existing studies

- The magnitude of the impulse response functions (IRFs) is consistent with the aggregate-level analysis of Blanchard and Perotti (2002) and Mertens and Ravn (2013).
- The findings of the FAVAR model are moderately consistent in directions and persistence with the conclusions of Liu and Williams (2019), and Marten and Ravn (2013), and Romer and Romer (2009).
- For example, the maximum per capita GDP response to a personal income tax cut in Mertens and Ravn (2013) is 1.8 percent, while the maximum response of this study is 1.9 percent.
- On the sources of heterogeneity and the transmission mechanism of federal tax policy changes, this study is similar to disaggregated empirical fiscal policy literature (Liu and Williams, 2019; Owyang and Zubairy, 2013)

States' characteristics in the transmission of tax shocks

$$Cum\,\mathrm{Re}_{i,m}^{t} = \varphi + \beta X_i + \varepsilon_i \qquad (3)$$

$Cum\,\mathrm{Re}_{i,m}^{t}$: $t-year$ horizon cumulative impulse responses of state $i's$ macroeconomic variable $m \in [real\,GDP, personal\,income, CPI, employment]$.

X_i : a set of covariates that attempt to explain the cross-state heterogeneities

Table 3: Baseline Regression (Personal income tax shock)

	Dependent variable				
	(1) IRF-GDP10 yr	(2) IRF-GDP10 yr	(3) IRF-GDP10 yr	(4) IRF-GDP10 yr	(5) IRF-GDP2 yr
Financial	0.36**	0.59***	0.56***	0.59***	0.65***
	(0.15)	(0.16)	(0.15)	(0.16)	(0.16)
State Govt. debt	-0.307*	-0.41**	-0.39**	-0.34**	-0.39**
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
State uncertainty	-0.32**	-0.27**	-0.23*	-0.27**	-0.19
	(0.13)	(0.13)	(0.12)	(0.13)	(0.13)
Manufacturing		0.17*	0.33**	0.38**	0.49***
		(0.12)	(0.14)	(0.14)	(0.14)
State job creation		0.23*	0.30**	0.32**	0.32**
		(0.12)	(0.12)	(0.12)	(0.12)
Loans to small firms		0.25*	0.29**	0.26*	0.21*
		(0.13)	(0.12)	(0.13)	(0.13)
Elasticity of income tax		-0.26**	-0.28**	-0.31**	-0.30**
		(0.12)	(0.12)	(0.14)	(0.14)
Home ownership rate			-0.29*	-0.36**	-0.35**
			(0.14)	(0.15)	(0.15)
State Avg Corp.Inc. Tax				0.001	-0.014
				(0.15)	(0.15)
Labor market regulation				-0.24*	-0.24*
				(0.13)	(0.13)
Observations	50	50	50	50	50
Adjusted R^2	0.25	0.33	0.39	0.39	0.39

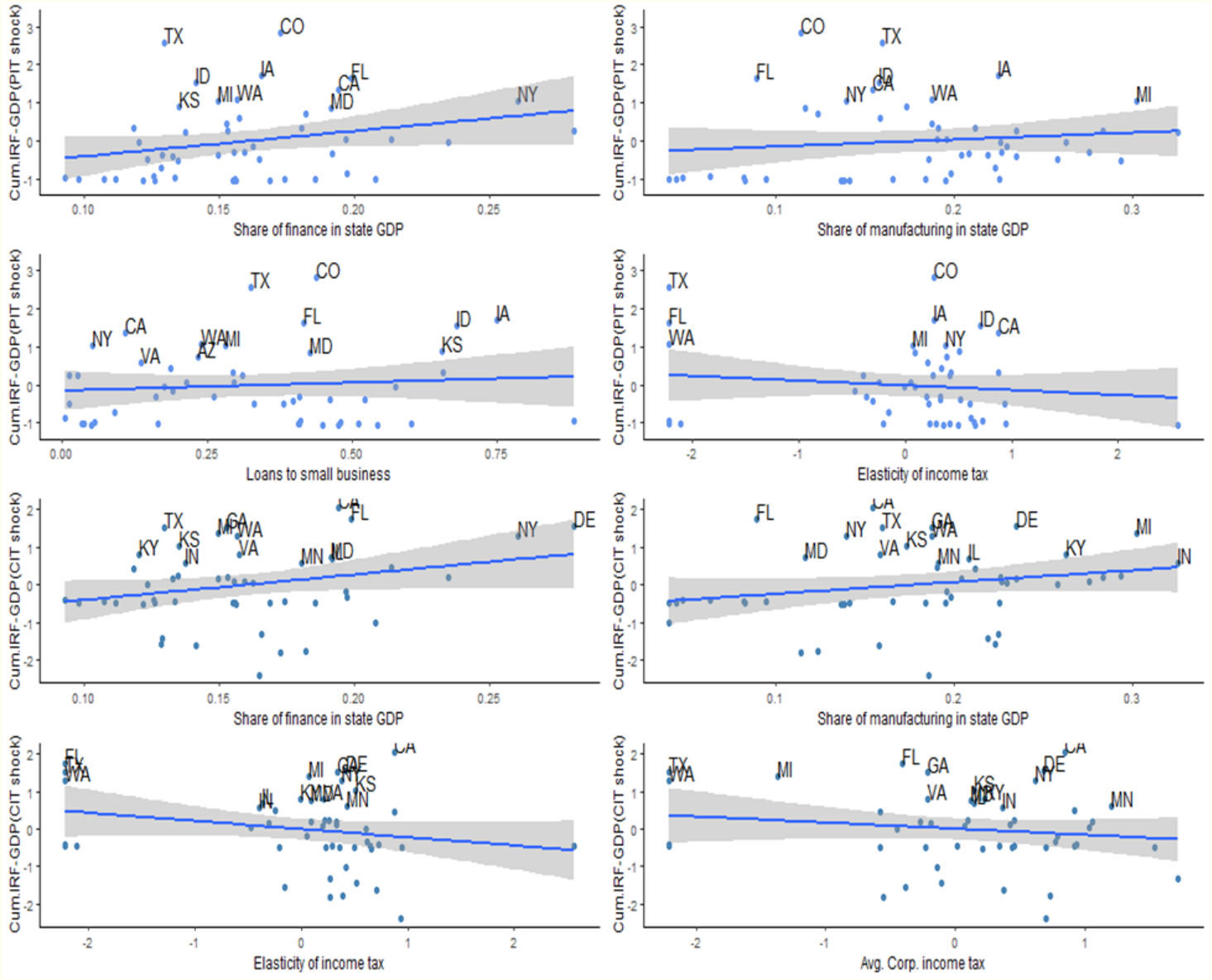
Note: *p<0.1; **p<0.05; ***p<0.01

Table 4: Baseline Regression (Corporate income tax shock)

	Dependent variable				
	(1) IRF-GDP10 yr	(2) IRF-GDP10 yr	(3) IRF-GDP10 yr	(4) IRF-GDP10 yr	(5) IRF-GDP2 yr
Financial	0.29**	0.27***	0.48**	0.53**	0.42***
	(0.13)	(0.13)	(0.22)	(0.23)	(0.27)
Manufacturing	0.23*	0.24*	0.41**	0.41**	0.48***
	(0.13)	(0.13)	(0.16)	(0.16)	(0.16)
State uncertainty	-0.22	-0.22*	-0.26*	-0.22	-0.13
	(0.13)	(0.13)	(0.14)	(0.15)	(0.14)
State Avg Corp.Inc. Tax	-0.30**	-0.20	-0.11	-0.10	-0.09
	(0.14)	(0.16)	(0.17)	(0.17)	(0.17)
Elasticity of income tax		-0.17	-0.23	-0.25*	-0.28*
		(0.15)	(0.16)	(0.16)	(0.16)
Loans to small firms		0.25*	0.01	0.01	0.005
		(0.13)	(0.14)	(0.15)	(0.14)
State job creation			0.24	0.26*	0.20
			(0.14)	(0.15)	(0.14)
Home ownership rate			-0.41**	-0.40**	-0.32*
			(0.17)	(0.17)	(0.17)
Labor market regulation			-0.03	-0.02	-0.04
			(0.15)	(0.15)	(0.15)
Housing			-0.32	-0.30	-0.18
			(0.21)	(0.22)	(0.21)
State Govt. debt				-0.11	0.18
				(0.17)	(0.17)
Observations	50	50	50	50	50
Adjusted R^2	0.17	0.17	0.21	0.20	0.22

Note: *p<0.1; **p<0.05; ***p<0.01

Figure: The left panel (right panel) shows the correlation between cumulative impulse responses of states GDP to a personal income tax shock (a corporate income tax shock). Points with state acronyms indicate states with highest responses.



Conclusion

- The findings uncover a substantial heterogeneity on the impact of personal and corporate income tax cuts on state-level macroeconomic variables.
- The FAVAR results highlight the significance of the New-Classical and the Keynesian models that link federal tax cuts with state-level real GDP and income growth.
- Cross-states regression analysis suggests that real GDP, personal income, and employment rise in states with a larger share of finance and manufacturing industries, higher nonfarm employment, and flexible supply of loans to small firms.
- States characterized by a higher amount of government debt, strict labor market regulations, a higher degree of economic policy uncertainty, and a higher tax burden appear to be negatively affected by federal tax changes.