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Information sharing and state revenue forecasting performance

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Abstract

This study evaluates whether intergovernmental information sharing enhances forecasting performance. This is accomplished by examining the accuracy of state revenue forecasts following the federal passage of the Tax Cuts and Jobs Act (TCJA) of 2017. The quantitative analysis suggests that states that shared information produced more accurate corporate income tax forecasts than nonsharing states. This result is consistent with surveys and interviews of federal and state officials that reported significant information-sharing activity arising from uncertainty about the TCJA's corporate income tax provisions. This study demonstrates that information sharing plays an important yet overlooked role in mitigating forecast uncertainty.

Applications For Practice

- Professional networks facilitate exchange of specialized knowledge between states and the federal government.
- Information sharing to mitigate uncertainty occurs between state actors or states and the federal government.
- Information exchange between state and federal revenue forecasters reduces uncertainty which can enhance forecast accuracy.
- Governments are encouraged to build and maintain professional networks that promote intergovernmental information sharing.

INTRODUCTION

Public officials often make critical decisions under time constraints and with incomplete information. This is routinely true of revenue forecasters, who are tasked with predicting future tax receipts with precision under tight timelines imposed by the budget process. Revenue

forecasts are premised on assumptions about future tax law and economic activity that often fail to transpire as expected. Uncertainty about these assumptions may grow in any one forecast year for idiosyncratic reasons, such as state-level tax reforms or declines in economic activity arising from localized natural disasters. Uncertainty can also arise from systematic changes that broadly affect state governments, such as a national recession. Economic and policy uncertainty increases the likelihood of forecast error, which creates challenges for state governments and their residents. A modest revenue overforecast can induce significant budgetary stress, requiring states to make midyear emergency budget cuts to meet balanced budget requirements.

State revenue forecasters possess considerable flexibility in selecting the assumptions, processes, and methods used to produce revenue forecasts. Previous research considers the effectiveness of various forecasting methods or budget institutions, such as consensus forecasting arrangements, on forecast accuracy. However, this literature devotes little attention to how professional networks influence forecasting assumptions or whether information sharing yields tangible performance benefits. We examine this research question by evaluating intergovernmental information-sharing activity following the federal passage of the Tax Cuts and Jobs Act (TCJA) of 2017. The changes to the federal income tax base enacted under the TCJA were the most significant since the Tax Reform Act of 1986 (Slemrod, 2018). At the time of adoption, 35 states conformed with some or all aspects of the federal definitions of individual or corporate income.[1] As a result, the TCJA automatically changed the revenue outlook of most U.S. states, which derived about 27% of their general revenues from income taxes in fiscal year (FY) 2016 (Walczak, 2019). Upon its adoption in December 2017, state forecasters were forced to rapidly update their forecasting assumptions and methodology in preparation for the FY 2019-20 budget process, which culminated in budget approval by June 2018 in most states (Dadayan, 2018).

We measure information sharing activity using a web survey of state forecasters conducted after the conclusion of FY19 state budget processes. Among the 25 states that participated in the survey, 19 reported sharing information with one or more external partners in the process of preparing their FY19 income tax forecasts. We pair these survey data with revenue forecast and subsequent tax receipts data compiled by the National Association of State Budget Officers over FY97 to FY19. Using a fixed effects model, we find that states that engaged in information sharing produced more accurate corporate income tax forecasts than nonsharing states. Subsequent interviews with state and federal officials reveal that the TCJA motivated increased information sharing intensity compared to prior years. Sharing was facilitated in large part by the Federation of Tax Administrators, a research and information exchange network comprised of state and local tax experts across the United States. Survey respondents and interviewees consistently stated that information sharing was helpful toward deciphering the impact of the TCJA on their respective state income tax bases and improving the quality of their forecasts, particularly those for the corporate income tax.

Based on our analytical and qualitative findings, we conceptualize information-sharing activities around the TCJA and revenue forecast practices broadly into a rational choice framework. A recent systematic review of the academic literature on public sector networks shows that rational choice theory helps explain how public officials analyze whether to cooperate with their peers (Siciliano et al., 2021). Our qualitative research suggests that while information sharing has limited net benefit in most years, the uncertainty arising from the TCJA substantially increased the expected benefit of information sharing. Prior studies on intergovernmental collaboration in the public administration literature typically focus on costs and barriers to collaboration but are unable to assess the subsequent benefit of collaborative

[1] Walczak (2019) reports that 29 states conform with the federal definition of adjusted gross income, while six states (Colorado, Idaho, Minnesota, North Dakota, Oregon, and South Carolina) use the federal definition of taxable income. Most states conform with the federal definition of corporate income but vary in the recognition of net operating losses or other deductions.

activities. A unique feature and contribution of this study is that we test the impact of information sharing on subsequent performance.

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

State revenue forecasting

The objective of state revenue forecasters is to generate timely and accurate estimates of future tax collections to inform lawmakers in preparation for the state budget. The forecasting process requires analysts to make informed predictions about state economic activity, its effect on the relevant tax base, and to use those assumptions to inform a methodological strategy (Shkurti, 1990). Willoughby and Guo (2008) and Boyd et al. (2011) survey the forecasting practices of state governments, reporting that forecasters use a variety of analytical techniques for forecasting revenues from different tax instruments. Forecasters often generate a range of predictions using multiple analytical techniques and make qualitative judgments to produce a final forecast. Prior research suggests that professional judgment can reduce forecast error, depending on the forecasters' knowledge and biases (Williams & Calabrese, 2016).

A large literature also considers the political motivations of forecasters themselves and the role of forecasting institutions. Prior research shows forecasters in the United States err on the side of caution by systematically underestimating revenues (Feenberg et al., 1988; Gentry, 1989; Rodgers & Joyce, 1996; Rose & Smith, 2012). These results appear to reflect a desire to cater to risk-averse politicians, who prefer to avoid midyear budget cuts owing to an overestimate of expected revenues.[2]

Recognizing the importance of the revenue forecast in the budget process, about half of the U.S. states employ consensus forecasting in generating their individual and corporate revenue forecasts. Under the consensus approach, the finalized revenue estimate must be agreed upon by representatives from both the executive and legislative branches of the state government. A large literature shows these arrangements result in smaller forecast errors compared to forecasts produced independently (Krause & Douglas, 2013; McNichol, 2014; Mikesell & Ross, 2014; Qiao, 2008; Voorhees, 2004).

Although prior research demonstrates that state budget institutions and politics can affect the quality of forecasts, many potential determinants of forecast error have yet to be formally evaluated. For example, Jonas et al. (1992) report that an evaluation by the Virginia General Assembly's oversight arm found that as much as 40% of the change from preliminary to final revenue forecasts potentially reflects professional judgments by forecasters, most of which were not formally documented. While we cannot directly assess the role of judgments in the forecasting process, we can evaluate whether the knowledge disseminated through information sharing was useful in informing forecaster judgments regarding the impact of the TCJA on state revenues.

Rational choice framework

We adopt a rational choice framework to explain information sharing in the revenue forecasting process. Rational choice is frequently employed in public administration research to understand the actions of public officials based on their costs and benefits (Hay, 2004; Heikkila & Isett, 2004;

[2]Boylan (2008) finds that state forecasters engage in the opposite behavior during gubernatorial election years, adopting overly optimistic economic growth assumptions that result in overestimation of revenue. Rose and Smith (2012) show the widespread adoption of state budget stabilization funds in the 1980s significantly reduced the propensity of state revenue forecasters to engage in strategic underforecasting.

Robertson & Tang, 1995). We believe a rational choice framework maps directly onto revenue forecasting as the prior research typically considers various methods, processes, or institutions in terms of their implementation costs and performance benefits (Williams & Calabrese, 2016). This literature suggests that forecasters favor less complicated forecasting methods and processes that yield forecasts of reasonable accuracy. New forecasting methods or processes should only be implemented if they are expected to offer a performance benefit net of the implementation cost.

An example of this tradeoff pertains to the selection of analytical techniques used to generate forecasts. As noted earlier, revenue forecasters report using a range of forecasting methodologies, ranging from deterministic methods, such as simple trend analysis, to complex econometric models. Thompson and Gates (2007) and Mikesell (2018) suggest that trend analysis often performs as well as sophisticated approaches, which usually require specialized expertise to prepare, interpret, and justify to politicians. A rational choice framework may inform why deterministic methods are still frequently used despite the advent of more sophisticated modeling alternatives. This framework can also be extended to consensus forecasting. Consensus forecasting arrangements add bargaining costs to the forecasting process compared to the alternative in which forecasts are produced independently or solely by the executive. Despite these added costs, many studies show consensus forecasting arrangements yield significant benefits in the form of smaller forecast errors compared to the alternative. Additional research suggests consensus forecasting also yields ancillary benefits by reducing political acrimony in the budget process more generally (Krause & Douglas, 2013; Krause et al., 2013).

Forecaster peer networks are a separate and little examined factor that may influence forecast error. From a rational choice perspective, public officials decide whether to engage in intergovernmental information sharing based on the expected benefits and costs of such collaboration. A recent systematic review of public sector networks shows that rational choice theory is also often used to explain why individuals engage in network formation (Siciliano et al., 2021). Through this lens, factors associated with costs and benefits of network formation include the level of expertise of network peers, the expected value of the information they will access, and the costs associated with trust building (Berardo & Lubell, 2016; Nisar & Maroulis, 2017; Siciliano, 2015; Yang & Maxwell, 2011).

The extant literature on public sector collaboration often emphasizes how the scope or context of a problem influences the costs and benefits of collaborating (Emerson et al., 2011; McGuire & Silvia, 2010). Collaboration in revenue forecasting typically takes the form of information sharing such as the sharing of methods or informational assumptions that inform forecasting methods. Information sharing imposes search and screen costs on forecasters as they must seek out peers to share with and then assess the validity and usefulness of that information to their states' forecasting process. When an economic activity or tax law is stable, information sharing has limited benefit as historical data is adequate to inform forecasting assumptions and make accurate projections of the future.

The expected value of information sharing rises following sharp policy changes or economic contractions where historical data is less valuable for informing forecasting assumptions. The federal adoption of the TCJA is one such example of a sharp policy change that is likely to motivate a widespread increase in information sharing among forecasters. The TCJA increased uncertainty around state tax law owing to the widespread conformity with federal tax law. State revenue forecasters had limited internal data and experience necessary to accurately forecast the revenue impact of the TCJA's novel provisions that applied to states. As such, the perceived benefit of engaging in information sharing with intergovernmental partners increased in the preparation of FY19 forecasts. Further, the cost of searching for information-sharing partners declined as most states were similarly affected by the reform.

We assess whether these information-sharing activities translated to forecasting performance improvements. We hypothesize that information sharing increased the volume and quality of information about the probable impact of the TCJA on state income taxes, spurring a reduction in forecaster error among information-sharing states. We also expect that exchanging information with a greater number of partners should facilitate greater performance improvements as forecasters gain access to additional relevant information about the TCJA and its specific impact on the tax law of their state.

THE TAX CUTS AND JOBS ACT OF 2017

The TCJA was signed into law on December 22, 2017, and its provisions became effective on January 1, 2018. With respect to the personal income tax, the law reduced marginal income tax rates, eliminated the personal exemption, doubled the standard deduction, and eliminated or substantially reduced several itemized and income exclusions. The TCJA also contained provisions related to the deductibility of state income taxes; notably, the creation of a $10,000 ceiling for itemized deductions of state and local taxes. The reforms aimed at broadening the income tax base had a large impact on state governments owing to their conformity with the federal income tax code.[3] One notable example is personal exemptions, where 21 states link the number of personal exemptions claimed on the state tax return directly to the number on the federal return. The elimination of personal exemptions and other provisions from the federal tax code resulted in their elimination from state tax codes, increasing state personal income tax revenues (Walczak, 2019).

The TCJA affected the corporate income tax base of several states. Overall, the TCJA significantly reduced corporate income tax revenue to the federal government due to the new 21% flat tax rate and a transition to a territorial tax regime (Auerbach, 2018). The TCJA also added new corporate taxes designed to mitigate the erosion of the corporate income tax base through corporate inversions.[4] Phillips and Wlodychak (2018) estimate that the corporate base provisions in the TCJA mechanically increased the state corporate tax base by 12%.

On net, the TCJA significantly increased state personal and corporate income tax receipts, increasing the likelihood of large underforecasts of both taxes. Based on a compilation of state revenue reports by the Tax Foundation (2018), the tax law was expected to generate about $7.1 billion in additional revenues for 19 states in FY19 alone. In some states the revenue impact of the law was dramatic; a report by the Michigan Department of Treasury estimated the TCJA provisions would generate $848 million in FY18 and $1.7 billion FY19, representing about 17% of estimated FY19 tax receipts (Michigan Department of Treasury, 2018).

DATA AND METHODS

This study relies upon quantitative analysis informed by qualitative information collected through a survey and interviews.[5] A web survey of state and federal officials was conducted in 2019 to assess the extent and the impact of intergovernmental collaboration and information

[3]Most state governments were slow to enact revenue-related legislation to counter the impact of the TCJA on state taxpayers. The National Association of State Budget Officers (2020) reports that one state enacted FY18 midyear changes that increased personal income tax collections and five took actions that reduced collections. However, at the start of FY19, nine states enacted personal income tax increases, and 16 adopted decreases.

[4]Corporate inversions refer to multinational companies domiciling in low-tax jurisdictions and leasing their intellectual property back to a corporate subsidiary operating in a high-tax country to realize larger operating expenses and incur less taxable income.

[5]A reproduction of the web survey instrument and interview script with state forecasters are available upon request.

sharing around the TCJA. The survey addressed revenue forecasters in the 45 state governments that collect personal and/or corporate income taxes, as well as economists at the Joint Committee on Taxation, the revenue forecasting arm of Congress. The survey was sent to 139 recipients in total, including one to three recipients in each state government and four staff economists at the Joint Committee on Taxation. The survey was completed by at least one recipient in 25 out of 45 (56%) eligible state governments and by all recipients at the Joint Committee on Taxation. The overall survey response rate was 22% which reflects the share of total state and federal officials contacted that responded to the web survey. Respondent and nonrespondent state governments were geographically disperse and proximate in terms of their total population, as well as the state domestic product and personal income per resident.[6] Although we cannot measure the underlying forecasting capacity of state governments, the similarity of respondents and nonrespondents along these observable characteristics suggests they are also similar in terms of unobservable characteristics. Table 1A shows respondent and nonrespondent states possess similar pre-TCJA forecast errors with respect to the personal income tax. However, Table 1B indicates nonrespondent states were generally more successful at forecasting corporate income tax revenue prior to the TCJA.

Given that the survey was sent to the universe of relevant respondents, it is unlikely to suffer from significant bias from coverage or sampling errors. Measurement error may be an issue in web surveys if respondents fail to understand some questions with no interviewer present to provide an explanation (Couper, 2008). We address this issue by following best practices from survey literature to increase respondents' understanding and the quality of their responses. For example, we follow Dillman et al. (1998) and their five principles for web surveys: inclusion of a purposeful welcome screen, starting with a simple question, following a simple and conventional format, limiting line length, and providing specific instructions. The survey protocol was also pretested with three survey and/or taxation experts who were asked to focus on the consistency and clarity of wording and instructions, questionnaire length, and questionnaire flow.

Two other potential sources of bias in the survey are measurement error due to recall error and nonresponse error. We address both concerns by surveying both the party providing technical assistance and those that received it. Surveying both parties increases the likelihood we receive report of collaboration (nonresponse error) and of receiving more complete information about the collaboration (measurement error). Other steps taken to improve response rate and accuracy include (1) limiting the length of the survey to ensure completion in under 15 min; (2) requesting respondents to access files to improve their recollection; and (3) sending follow-up emails to maximize survey response.

We make use of the survey data collected from state revenue forecasters to operationalize information sharing in a regression framework. Specifically, we produce a dichotomous variable equal to one if a state official reported that their state engaged in any information sharing with one or more outside entities during the preparation of their FY19 forecasts and equal to zero otherwise. Potential information sharing partners include the Congressional Joint Committee on Taxation, the U.S. Department of the Treasury, Congressional Budget Office, or state-to-state sharing facilitated by the Federation of Tax Administrators. This results in a binary measure of information sharing equal to one for 19 states, zero for 6 states, and missing for 20 other states that levy income taxes but did not participate in our study. Figure 1 shows a mapping of the states that engaged in information sharing grouped by the nine divisions used by the U.S. Census Bureau. The group of states that participated in our study includes at least one state in

[6]Two sample *t*-tests of the difference in means between respondent and nonrespondent states were not statistically significant along any of these characteristics. The average population of respondent states was 6.5 million compared to 6.2 million in nonresponding states ($p = 0.90$). Personal income per capita averages $54,900 in respondent states versus $53,400 among nonrespondents ($p = 0.60$), and state GDP per capita was $62,700 among respondents versus $57,900 among nonrespondents ($p = 0.18$).

TABLE 1A Variable descriptions and summary statistics for personal income tax states

Variable description	Variable name in estimation results	Shared information		No sharing		Nonrespondents	
		Mean	SD	Mean	SD	Mean	SD
Symmetric absolute percentage error of the personal income tax forecast of state *s* in FY19	PIT Forecast SAPE	3.40	2.71	5.99	4.96	4.56	2.80
Symmetric mean absolute percentage error of the personal income tax forecasts of state *s* over FY97-18	PIT Forecast SMAPE	6.24	9.58	7.38	10.28	6.10	5.48
Binary variable indicating state *s* engaged in information sharing activity with two external agencies in FY19	Info Sharing in FY19	1.00	0	0		NA	
Binary variable indicating state *s* engaged in information sharing activity with more than two external agencies in FY19	Additional Info Sharing in FY19	0.06	0.24	0		NA	
Binary variable indicating state *s* enacted a change in the state personal income tax base or rates in year *t*	State Tax Reform	0.51	0.50	0.46	0.50	0.44	0.50
Log-transformed state population in year *t*	Log(Pop)	15.21	1.11	14.79	0.72	15.28	0.69
Log-transformed state personal income in year *t*	Log(Personal Inc)	11.96	1.19	11.40	0.77	11.97	0.79
Absolute value of the annual percentage change in actual personal income tax receipts	Δ%|Tax Receipts|	7.49	5.32	7.67	7.12	7.32	5.25
Binary variable indicating conformity between the personal income tax base of state *s* and federal tax law in FY19	State-Federal Tax Conformity	0.04	0.19	0.04	0.20	0.03	0.17
Number of states		**18**		**6**		**17**	

Note: The data above excludes nine states that do not levy a personal income tax.

Source: Author's tabulations of forecast data from the National Association of State Budget Officers' *Fiscal Survey of the States*, economic data from the U.S. Bureau of Economic Analysis, and survey responses from state governments.

TABLE 1B Variable descriptions and summary statistics for corporate income tax states

Variable description	Variable name in estimation results	Shared information		No sharing		Nonrespondents	
		Mean	SD	Mean	SD	Mean	SD
Symmetric absolute percentage error of the corporate income tax forecast of state *s* in FY19	CIT Forecast SAPE	26.88	20.22	48.98	30.99	20.92	15.34
Symmetric mean absolute percentage error of the corporate income tax forecasts of state *s* over FY97-18	CIT Forecast SMAPE	18.9	21.65	23.61	24.47	17.06	16.21
Binary variable indicating state *s* engaged in information sharing activity with two external agencies in FY19	Info Sharing in FY19	1.00		0		NA	
Binary variable indicating state *s* engaged in information sharing activity with more than two external agencies in FY19	Additional Info Sharing in FY19	.05	0.23	0	0	-	-
Binary variable indicating state *s* enacted a change in the state corporate income tax base or rates in year *t*	State Tax Reform	0.48	0.50	0.46	0.50	0.37	0.48
Log-transformed state population in year *t*	Log(Pop)	15.12	1.15	14.80	0.72	15.26	0.75
Log-transformed state gross domestic product in year *t*	Log(GDP)	12.03	1.21	11.56	0.77	12.08	0.84
Absolute value of the annual percentage change in actual corporate income tax receipts	Δ%|Tax Receipts|	26.62	63.97	23.41	41.37	17.89	19.92
Binary variable indicating conformity between the corporate income tax base of state *s* and federal law in FY19	State-Federal Tax Conformity	.04	0.19	0.4	.20	0.03	0.16
Number of states		**19**		**6**		**19**	

Note: The data above excludes six states do not levy a corporate income tax or instead levy a gross receipts tax.

Source: Author's tabulations of forecast data from the National Association of State Budget Officers' *Fiscal Survey of the States*, economic data from the U.S. Bureau of Economic Analysis, and survey responses from state governments.

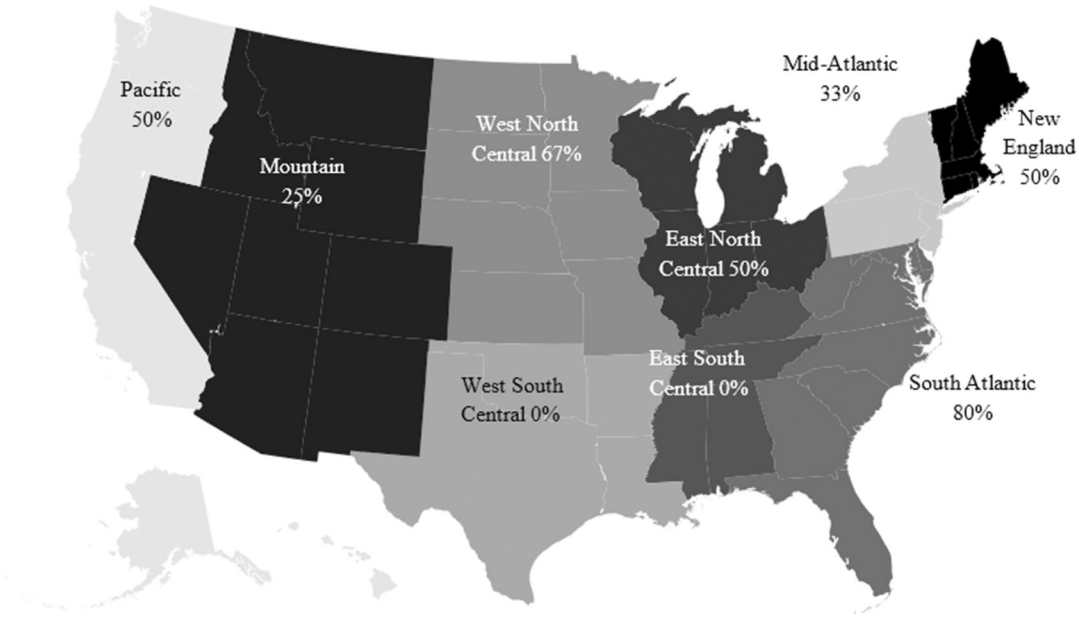

FIGURE 1 Percentage of respondent states that engaged in information sharing in fiscal year 2019 by U.S. census division. Regional values based on the 45 state governments that collect personal and/or corporate income taxes.

each of those nine divisions. All but one state self-reported sharing information with exactly two external entities. The remaining state indicated they engaged in sharing activities with four external partners.

The primary variable of interest in this analysis is the symmetric absolute percentage error (SAPE), which represents the absolute difference between the tax revenue forecast (*F*) in the adopted budget and actual collections (*A*), expressed as a percentage. Mikesell and Ross (2014) assert that absolute percentage error is a measure of technical accuracy that reflects state forecasting performance.[7] The calculation of SAPE is expressed in the equation below:

$$\text{SAPE} = \frac{2 \times |F - A|}{F + A} \times 100.$$

We separately assess personal and corporate income tax forecast error based on the FY19 adopted budget forecast, which was prepared in calendar year 2018 following the adoption of the TCJA in December 2017. Forecast data are drawn from the National Association of State Budget Officers' (NASBO) Fiscal Survey of the States reports from 1997 to 2020.

We estimate the effect of the TCJA on forecast error using a fixed effects model. An advantage of this research design is that changes to each state's tax base were unexpected and imposed exogenously by the federal government when the TCJA came into effect in 2018. However, a potential drawback to our analysis is that the decision to engage in information sharing with other states or federal agencies was made by the states themselves; in other words, they self-select into the information sharing "treatment." It is plausible that state forecasters that opt to share do so because they have greater unobserved professionalism than

[7] Mikesell and Ross (2014) also discuss percentage error (PE) as a measure of forecaster bias toward systematic overestimation or underestimation of revenues. The calculation of PE mirrors that of the APE without transformation through the absolute value function. They do not however find evidence of systematic forecaster bias using the PE in their case study of Indiana revenue forecasting practices.

noncollaborating states, which in turn enhances their forecast accuracy. While we cannot mitigate or even test for self-selection bias directly, we conduct one supplemental analysis to verify our results. Our methodological strategy may also partially pre-empt this concern, as Jung and Pirog (2014) show that fixed effect estimators reduce bias arising from self-selection.

The fixed effects regression model takes the following form:

$$y_{st} = \alpha + C_{st}\gamma + X_{st}\beta + \eta_s + \lambda_t + u_{st},$$

where y_{st} is the SAPE of each revenue forecast prepared by state s for fiscal year t. The variable C_{st} is a binary variable equal to one if state s engaged in information-sharing activity with external entities during the preparation of FY19 revenue forecasts and zero otherwise. This variable only takes non-zero values for FY19 observations. The vector X_{st} includes state-specific covariates for each state s in year t; η_s and λ_t are state and year fixed effects; and u_{st} is the idiosyncratic error term. The parameter estimate $\hat{\gamma}$ reports the average impact of information sharing activity on the SAPE of FY19 revenue forecasts.

The descriptions and summary statistics for all variables contained in the regression models are reported in Tables 1A and 1B. Log-transformed state population is included in the regression model both as a measure of state economic activity and as a proxy for the forecasting capacity of each state.[8] Log-transformed state personal income is also included in the regression model to capture changes in the size of the state personal income tax base, while state gross domestic product is used in the analysis of corporate income tax forecast error. All three series were obtained from the U.S. Bureau of Economic Analysis.

We also include additional covariates that reflect the underlying difficulty of forecasting tax receipts in each state over time and following the TCJA. One of these variables is the absolute value of the over-the-year percentage change in tax receipts.[9] This variable reflects annual volatility in tax receipts that increase the likelihood of forecast error. A binary variable is also incorporated into each model that is equal to one in each year that a state enacted a corporate or personal income tax policy change and zero otherwise. Finally, we include a binary variable equal to one if the state's corporate or personal income tax base conformed with the updated federal tax base in FY19 based on a review of state tax laws conducted by the Tax Foundation (Walczak, 2019). While we do not directly control for state budget institutions, such as the use of consensus forecasting, the inclusion of state fixed effects absorbs all time-invariant state-specific factors that may influence forecast error. We estimate the regression model using standard errors clustered at the state level.

We also estimate one additional model that builds on the specification above by adding one more binary interaction term. This term takes a value of one only for a single state that reported it engaged in information sharing with more than two external entities in FY19. This model accounts for the possibility that information-sharing activity with more external partners may yield additional reductions in the state's FY19 income tax forecast errors.

Finally, we conducted interviews with revenue forecasters from six different state governments. All interviews were conducted via telephone and followed a semi-structured conversational protocol. The objective of the interviews was to gather further information on open-ended questions that are challenging to assess via surveys. The interview questions focused on the protocols and processes that guide collaborative arrangements. All interviewees and survey respondents were guaranteed anonymity.

[8]The premise of this proxy is that larger states possess and devote more financial resources to revenue forecasting. While we cannot measure the forecasting capacity directly, our quantitative analysis indicates that state population is inversely related to forecast error.

[9]Calculation of this covariate requires both the current and prior year value which reduces the number of fiscal years included in the analysis by one fiscal year. This effectively restricts the analysis to the FY98 to FY19 period. The NASBO reports also contain a small number of missing observations in years prior to the Great Recession. This issue affects about 1.0% of state personal income tax forecasts and about 2.0% of corporate income tax forecasts.

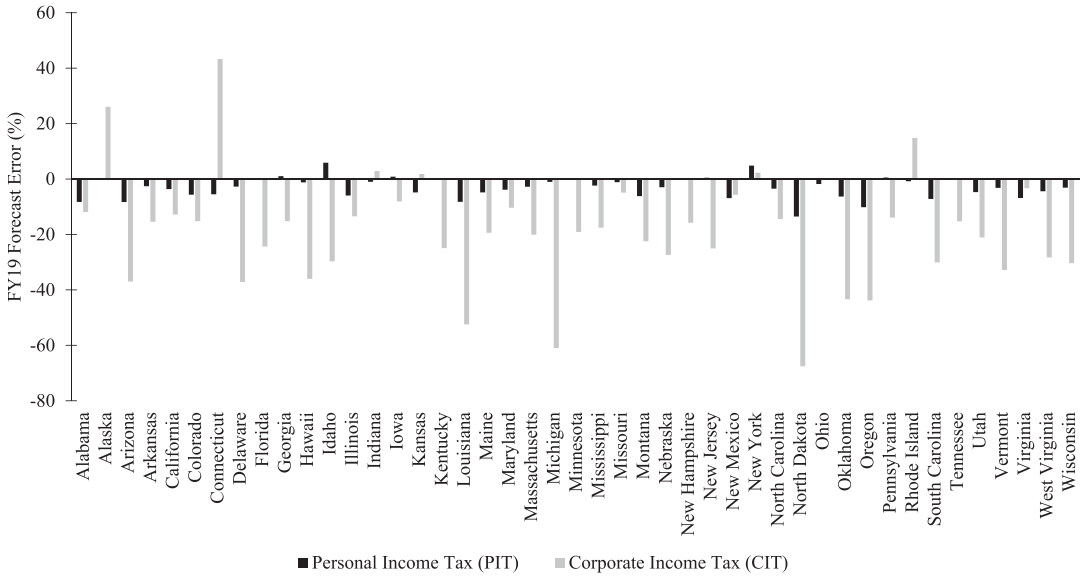

FIGURE 2 Fiscal year 2019 personal and corporate income tax forecast error. Forecast error reflects the difference between forecasted revenues for the FY19 state budget and actual collections determined at the end of FY19 measured as a percentage of actual collections. *Source*: Author's tabulations of data from the National Association of State Budget Officers' *Fiscal Survey of the States*.

RESULTS

Figure 2 reports each state's forecast error as a percentage of their actual collections in FY19. On average, states under-forecasted FY19 personal income tax collections by about 3.5% and corporate income tax collections by about 19%. This exceeds the historical average personal (−0.9%) and corporate (+2.9%) forecast errors over FY97-FY18, but this is a misleading comparison. In most years, a roughly equal number of states over- and under-forecast tax collections, which roughly offset one another when computing the mean error. By comparison, the SAPE of personal income tax forecasts across all states was 4.3% in FY19, compared to a historical average of 6.4%. The average error of the corporate income tax across all states was 27.3% in FY19 compared to an average of 18.7% historically. The large historical forecast error reflects a handful of very high error years. For example, the corporate income tax forecast SAPE across all states was as high as 24.4% in FY10, the first fiscal year following the 2008–09 financial crisis and the subsequent Great Recession.

As noted earlier, a significant concern towards evaluating the role of information sharing and subsequent forecast error is self-selection. While we cannot directly test whether information sharing is endogenous, Figure 3A,B provides some visual evidence that the historical average forecast error of sharing and nonsharing states was roughly comparable. The average historical personal income tax forecast error was 6.2% among states that engaged in information sharing in the preparation of their FY19 forecast, compared to 7.4% for states that did not engage in information sharing. States that engaged in information sharing in FY19 also demonstrated comparable corporate income tax forecast error (18.8%) relative to comparison states in that year (23.7%).[10] Both figures suggest that states that engaged in information sharing

[10] A two-sample *t*-test indicates the difference of means between information-sharing states and nonsharing states over the FY97 to FY18 period is not statistically significant at the 90% confidence level for both the personal ($p = 0.48$) and the corporate income tax ($p = 0.29$).

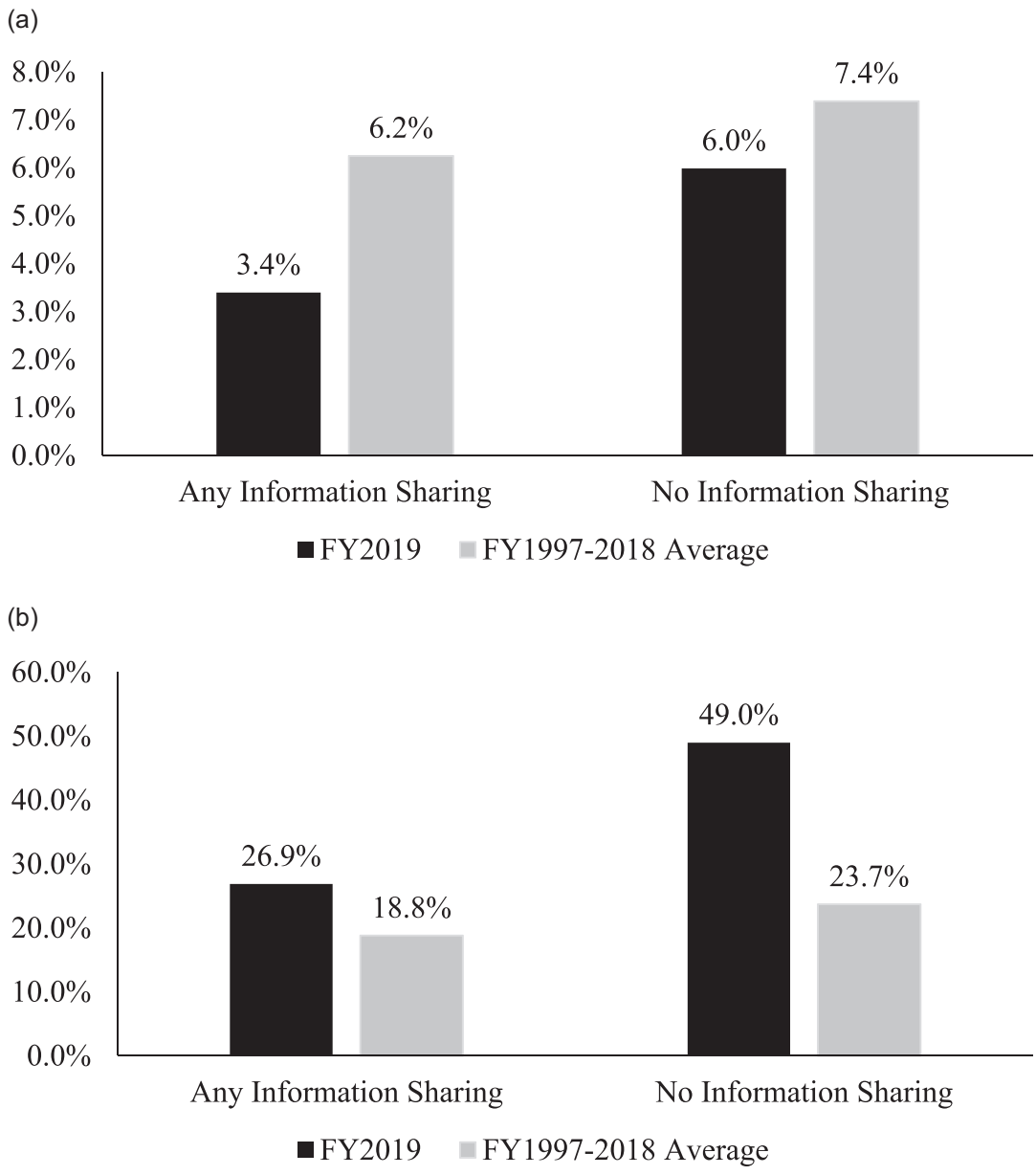

FIGURE 3 (a) Personal income tax forecast SAPE by use of information sharing in FY19 forecast. (b) Corporate income tax forecast SAPE by use of information sharing in FY19 forecast. $N = 25$ states. The forecast error shown in the figures reflects the difference between collections estimated during preparation of the state budget and actual collections determined at the end of the fiscal year measured as a percentage of actual collections. *Source*: Author's tabulations of data from the National Association of State Budget Officers' *Fiscal Survey of the States* and survey responses from state governments.

outperformed their peers in the accuracy of their personal and corporate income tax FY19 forecasts.

As a more rigorous test of information sharing on forecast performance, we estimate the impact of information sharing on FY19 personal income tax forecast error using a fixed effects model and report the results in Table 2. The first row of this table reports the estimated impact of engaging in information sharing during the preparation of FY19 personal income tax revenue

TABLE 2 Personal income tax symmetric absolute forecast error estimation results

	(1)	(2)	(3)
Information	−0.26	−0.16	−0.16
Sharing in FY19	(1.14)	(1.29)	(1.29)
Additional Info			−1.12
Sharing in FY19			(2.12)
FY19	−3.16	−26.66	−26.34
	(2.28)	(17.09)	(16.56)
State Tax Reform	0.35	0.65	0.66
	(1.00)	(0.59)	(0.59)
Log(Pop)	−18.60	−41.55*	−41.53*
	(12.86)	(21.22)	(21.22)
Log(Personal Inc)	2.59	33.26	33.32
	(4.11)	(21.13)	(21.24)
Δ%|Tax Receipts|	0.42***	0.32**	0.32*
	(0.08)	(0.15)	(0.15)
State-Federal	1.54	2.59**	2.21**
Tax Conformity	(1.17)	(1.19)	(1.02)
Constant	253.7*	248.9*	248.1*
	(147.3)	(128.4)	(128.4)
State Fixed Effects?	Yes	Yes	Yes
Year Fixed Effects?	No	Yes	Yes
Observations	520	520	520
Clusters (states)	24	24	24
R^2	0.07	0.19	0.19

Note: Standard errors clustered at the state level in parentheses.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

forecasts on subsequent forecast error. Column 1 of this table corresponds to a regression model with state-level covariates and state-fixed effects. The model in Column 2 adds year-fixed effects to the prior specification. The model in Column 3 similarly contains state-level controls and state and year fixed effects, but also incorporates an additional indicator for a single state that reported sharing forecast information with more external entities than all other states in the sample.

The estimation results of all three models indicate that the personal income tax forecast error of states that engaged in information-sharing activities was no different than nonsharing states. Specifically, the results indicate that the personal income tax forecast error of these states was 0.2 percentage points smaller than that of nonsharing states, but this point estimate is not statistically distinguishable from zero ($t = -0.12$; $p = 0.91$). The results in Column 3 also indicate that engaging with more external partners did not yield any statistically significant reduction in personal income tax forecast error in FY19.

TABLE 3 Corporate income tax symmetric absolute forecast error estimation results

	(1)	(2)	(3)
Information	−14.10*	−13.79*	−13.79*
Sharing in FY19	(8.13)	(7.77)	(7.77)
Additional Info			−9.60***
Sharing in FY19			(2.64)
FY19	19.11**	8.96	13.48
	(7.08)	(13.02)	(11.86)
State Tax Reform	−2.32*	−2.57**	−2.58**
	(1.27)	(1.20)	(1.20)
Log(Pop)	−63.17**	−51.86**	−51.73**
	(26.11)	(23.49)	(23.51)
Log(GDP)	16.07*	32.80*	33.09*
	(8.21)	(18.74)	(18.74)
Δ%|Tax Receipts|	0.20***	0.20***	0.20***
	(0.04)	(0.04)	(0.04)
State-Federal	3.36	3.56	−1.23
Tax Conformity	(4.44)	(5.53)	(4.75)
Constant	773.7**	406.8	401.4
	(303.4)	(357.4)	(359.3)
State Fixed Effects?	Yes	Yes	Yes
Year Fixed Effects?	No	Yes	Yes
Observations	535	535	535
Clusters (states)	25	25	25
R^2	0.35	0.44	0.44

Note: Standard errors clustered at the state level in parentheses.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

We repeat this analysis with corporate income tax forecast error serving as the dependent variable and report the results in Table 3. The results show that states that engaged in information sharing experienced a reduction in FY19 corporate income tax forecast error relative to nonsharing states. Specifically, the state-by-year fixed effects model indicates that information-sharing states outperformed the nonsharing states by about 13.8 percentage points ($t = -1.78$, $p = 0.88$). We also find that a state that engaged with more external information-sharing partners experienced an additional reduction in FY19 forecast error. Specifically, that state enjoyed an additional 9.6 percentage point ($t = 3.64$; $p = 0.001$) reduction in its forecast error. However, it is important to note this result reflects a performance improvement in a single state and as such should be interpreted with caution.

We perform one robustness check to verify the integrity of the quantitative analysis. Specifically, we execute a fixed effects model to test the impact of information sharing on sales tax revenue forecast error as the outcome variable. The goal of this falsification test is to

TABLE 4 Falsification test: Retail sales tax symmetric absolute forecast error estimation results

	(1)	(2)	(3)
Information	2.62*	2.73*	2.73*
Sharing in FY19	(1.49)	(1.56)	(1.56)
Additional Info			−0.45
Sharing in FY19			(3.05)
FY19	−5.08	−12.49	−12.36
	(3.42)	(22.43)	(21.72)
State Tax Reform	0.21	0.32	0.32
	(1.43)	(0.97)	(0.98)
Log(Pop)	−25.66	−33.96	−33.95
	(21.37)	(22.84)	(22.86)
Log(Personal Inc)	7.64	17.54	17.57
	(6.32)	(27.56)	(27.73)
Δ%|Tax Receipts|	0.04***	0.04***	0.04***
	(0.00)	(0.00)	(0.00)
State-Federal	0.71	1.00	0.85
Tax Conformity	(2.06)	(1.92)	(2.48)
Constant	253.7*	248.9*	313.8
	(147.3)	(128.4)	(278.0)
State Fixed Effects?	Yes	Yes	Yes
Year Fixed Effects?	No	Yes	No
Observations	469	469	469
Clusters (states)	21	21	21
R^2	0.16	0.20	0.20

Note: Standard errors clustered at the state level in parentheses.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

ascertain whether our methodology for identifying the impact of information sharing on personal and corporate income tax forecast error is yielding a "false positive" result. Given that the TCJA was an income tax reform, it has no clear and direct connection to state sales tax revenues. Further, the determinants of state sales tax revenues should generally reflect the same factors that influence income tax collections, as state residents spend a large share of their post-tax income to purchase consumptions goods. The estimation results in Table 4 indicate that states that engaged in information sharing in FY19 experienced greater sales tax revenue forecast error than nonsharing states. Given that this analysis shows no reduction in sales tax forecast error concurrent with income tax forecast error, we conclude the results presented above represent a valid estimate of the influence of information sharing activity on forecast error, rather than a false positive.

The analysis above provides quantitative evidence that states that engaged in information sharing produced more accurate corporate income tax forecasts in FY19 than nonsharing states.

We now discuss the findings of the qualitative portion of this study which aims to identify the mechanisms that drive these results. Survey and interview responses indicate that state revenue forecasters periodically engage in information sharing. Information sharing arrangements have existed for decades but the frequency and intensity of these activities change from year to year. Respondents uniformly reported that the two primary costs associated with information sharing are reputational consequences associated with breaches of confidentiality and the time and effort needed to develop trust among participants. Information sharing exclusively entails the exchange of data or other technical information. These discussions are perceived as less controversial than potentially sensitive topics such as politics. However, sharing only technical information does not fully eliminate potentially large reputational costs associated with breaches of confidentiality. This is because technical information might be based on sensitive assumptions about demographic or policy changes. One interviewee recalled a situation where a deputy, who was not properly aware of informal confidentiality rules, used sensitive information from other states in a presentation with local politicians leading to a significant impasse.

Survey and interview participants uniformly reported that the federal passage of the TCJA heightened uncertainty among state revenue forecasters. Multiple state revenue forecasters explained that the TJCA rendered their previous forecasting strategies largely unusable for FY19, particularly for the corporate income tax. One interviewee characterized the situation as "shooting in the dark" or "trying to produce estimates out of thin air." All interviewed forecasters indicated that information sharing was more frequent and widespread in the preparation of the FY19 forecasts than in previous years. This response lends support to the notion that the perceived benefit of information sharing rose following the passage of the TCJA.

Over two-thirds of the state governments that reported any information-sharing activity did so through channels provided by the Federation of Tax Administrators (FTA). Respondents that collaborate through the FTA reported that it significantly reduces the costs of information sharing by facilitating trust-building processes and providing a channel for communication. Our findings suggest that the FTA serves as a channel-producing, trust-building, and nonintrusive facilitator of information sharing between states. We also found no evidence of other networks of collaboration besides the one facilitated by the FTA.

In interview responses, multiple state forecasters also acknowledged the importance of the Congressional Joint Committee on Taxation (JCT). Interviewees indicated that they sporadically rely on modeling information supplied by the JCT, but those data became critical in the preparation of FY19 forecasts. One state revenue forecaster explained that "almost every year we use JCT data for the (tax) conformity bill. Some years there is very little to it, but some years like TCJA there are many many [*sic*] provisions." Most of the survey respondents that reported receiving assistance from the JCT do not maintain any formal network or sharing arrangement but instead connected through a phone conference facilitated by the FTA after the passage of the TCJA. The most cited collaborative partners following the implementation of the TCJA were state governments and the JCT; in sum, 93% of states that reported information sharing did so with one or both entities. A few respondents reported receiving information from the Congressional Budget Office, the National Association of State Budget Officers, and the U.S. Department of the Treasury.[11] Collaboration with these organizations appears sporadic and unstructured.

All instances of collaboration centered on information sharing. State revenue forecasters primarily shared preliminary projections to show how they were modeling the impact of specific

[11]We do not separately evaluate the impact of sharing with specific external partners because only two states reported information sharing activity with the U.S. Department of the Treasury or the Congressional Budget Office. Both states reported sharing with both external partners making it impossible to distinguish between the two entities. Similarly, given that the FTA facilitated information sharing with the JCT, all entities that reported information sharing with the JCT also engaged with the FTA.

provisions from the TCJA with other states. Many state officials interviewed for this study reported that impact estimates developed by the JCT were the most valuable information exchanged. Interviewees also explained that corporate income tax reforms posed the greatest uncertainty to state forecasters following the passage of the TCJA. This claim is support by the NASBO forecasting data which shows large increases in CIT forecast error in FY19. Web survey respondents also reported that the eight most common information sharing topics were related to the CIT. Three of those topics were mentioned by at least three-quarters of the respondents: provisions related to the tax treatment of international income, state-federal corporate taxable income conformity, and deductions for qualified pass-through business income. With respect to the personal income tax the two most mentioned topics related to state conformity with the federal definition of adjusted gross income and taxpayers' decision to itemize or use the standard deduction.

Our qualitative findings suggest that the FTA lowers the cost of information sharing, allowing for more of it to take place in the exceptional years when is perceived as most useful. Several studies note that technological barriers are often obstacles to information-sharing networks (Dawes, 1996; Gray et al., 2017; Park et al., 2019). Two technical factors that facilitated a fast collaborative response to the TCJA are that channels for communication were already in place and that the information is compatible among collaborators. The FTA listserv has operated for over a decade and has proven to be a simple technological solution that is easily accessible to state forecasters. Participation in the FTA is restricted to state revenue forecasters which ensures that all participants possess a common understanding of technical terminology and processes. Interviewees highlighted the importance of this established channel because "the TCJA was unique in how quickly [Congress] they ran it through, leaving no time for coalition building, academic studies, etcetera. Those factors made collaboration more intense than usual." Respondents reported high levels of satisfaction with the experience of sharing information during the preparation of both personal and corporate income tax forecasts, and all respondents agreed that information sharing was very or extremely useful.

Overall, our qualitative findings indicate that information sharing intensity increased because of heightened uncertainty arising from the TCJA, particularly about the corporate income tax. Reconciling these results with our quantitative analysis, we also find stronger evidence of improvement in corporate income tax forecast accuracy among information-sharing states. In surveys and interviews, state revenue forecasters emphasized the importance of the FTA, a professional network of state revenue forecasters, in facilitating information exchange.

DISCUSSION AND CONCLUSION

This paper aims to test whether information sharing yields performance benefits in the public sector. Rational choice theory suggests public officials will engage in information sharing only if the expected performance benefits exceed the search and screening costs of identifying trusted sharing partners and the time cost of transmitting, acquiring, and interpreting external information. We hypothesize the marked increase in state tax policy uncertainty arising from the federal passage of the Tax Cuts and Jobs Act of 2017 spurred greater information-sharing activity among state revenue forecasters. We test this hypothesis empirically by collecting data on information sharing activity after the passage of the TCJA among state revenue forecasters. We operationalize information sharing in a regression framework and evaluate its impact on subsequent forecast accuracy.

Our qualitative findings lend support to the notion that the TCJA motivated greater information sharing, particularly related to the corporate income tax where state-level uncertainty was the greatest. Consistent with rational choice theory, we find that information sharing flourished in a context of increased perceived value and diminished costs. The increase in perceived value was confirmed by multiple interview and survey participants that described heightened anxiety over the revenue forecasting uncertainties that arose from the TCJA. The scenario of diminished costs was an

unexpected finding uncovered through a detailed qualitative analysis of a complex decision-making process. As detailed in the results section, the FTA, a professional network of state revenue forecasters, played a major role toward reducing the cost of information exchange.

The detailed nature of our qualitative findings allows us to further explore the mechanisms through which information sharing resulted in enhanced forecasting performance. Our findings show that the TCJA led to a more intensive exchange of information between state revenue forecasters, particularly through the channels created by the FTA. Prior literature on group deliberations within the context of public finance shows that such exchanges of information within a group of individuals can lead to improved policy outcomes. For example, an experimental analysis in the field of monetary policy showed that groups made better decisions than individuals (Lombardelli et al., 2005). Consistent with that experiment, a more recent study found that monetary policy decisions governed by group dynamics were more adaptive to a shifting environment than those produced by organizations (Epp, 2017). The findings from the latter study are particularly relevant as they arise from the context of shifting external conditions which can be comparable to the environment following the passage of the TCJA. Overall, the contextualization of our findings within existing literature presents a credible mechanism through which information sharing results in improved revenue forecasting performance.

Our quantitative analysis complements our survey and interview results by showing that information-sharing states achieved improved corporate income tax forecasting performance compared to nonsharing states. Our quantitative analysis is also supported by a falsification exercise that shows information-sharing states underperformed nonsharing states in forecasting sales tax receipts. While we cannot rule out that there are other unobserved factors that may bias these quantitative results, we argue that our collective qualitative and quantitative findings strongly suggest that information sharing was a significant factor toward the mitigation of forecasting uncertainty and, therefore, resulted in improved corporate income tax forecasting performance.

The prior literature on state revenue forecasting largely focuses on technical and institutional factors that influence performance. This study is the first to consider the role of information sharing and professional networks. While this research has direct implications for tax administration, it also offers broader lessons to the public sector. State and local governments are encouraged to facilitate the formation and maintenance of professional networks for their employees, which fosters intergovernmental collaboration in tackling complex problems. Developing collaborative arrangements during "regular" years appears to prove most fruitful when external shocks such as national policy changes, epidemics, economic crises, or natural disasters increase the complexity of public management and the potential benefit of collaboration. Our study of state revenue forecasters demonstrates that simple arrangements that lower the cost of intergovernmental communication may be sufficient to foster collaboration. Collaboration between state and federal forecasters at the JCT was also facilitated in part by the FTA. This suggests that professional networks have the potential to play a coordinator role in promoting state-federal collaboration, though we do not test that hypothesis in this paper. Future research on collaborative governance should devote more effort toward measuring and empirically testing the benefits of collaborative arrangements so they may be weighed against their implementation costs. Future research should also study similar low-cost arrangements as the one examined in this paper in other functional areas. Consistent with rational choice expectations, uncertainty arising from the COVID-19 pandemic likely increased the perceived benefits of collaborative arrangements and may serve as a fruitful venue for further research.

This study has a few noteworthy shortcomings. First, we are only able to measure information sharing during the FY19 budget process. Survey respondents and interviewees indicated that information sharing occurred sporadically in years prior to FY19 but given the informal nature of the practice and the limitations on respondents' ability to recall sharing in prior years, we lack concrete data on the extent of information sharing prior to FY19. Second, the information-sharing measure utilized in the quantitative analysis reflects information shared between forecasters and external

entities but does not capture the volume or quality of that information. Third, only a single state engaged in information sharing with more than two external partners, which limits our ability to evaluate the impact of increased information sharing intensity on subsequent performance. Fourth, despite outreach efforts to improve the response rate, multiple states that levy either corporate or personal income taxes did not participate in our study. We expect that some information sharing occurred among many of the nonrespondent states, and we acknowledge that our results may differ with greater number of responses from eligible state governments.

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