State Tax Reforms in a Federalist System*

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Abstract

Federal grants represent one of the main sources of revenues for state governments and, hence, shape the way states conduct their fiscal policy. While literature on fiscal federalism and the flypaper effect had extensively studied how grants influence subnational spending, there is relatively few evidence on the responsiveness of state tax decisions to changes on intergovernmental revenues. This paper analyzes and characterizes long-term trends on personal income tax policy of US states and explores how it is influenced by state's reliance on federal grants as source of fiscal revenues. First, the empirical analysis shows there is a persistent trend on reductions on the top PIT rate across states. Results from our regression analysis suggest federal grants decrease the likelihood of states changing their taxes in the short-term, and in the long-term it increase (decrease) the likelihood of implementing policies that reduce (increase) the tax rate. These results shed some light on the implications of federal grants as a source of fiscal space for state governments, and provide some insights on the factors behind the long-term trends observed in state income taxation.

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1 Introduction

According to the data from the Annual Survey of State and Local Government Finance from the Census, federal grants passed from representing 20% of state revenues in 2000, to 30% in 2019, and jumped to 37% in 2020, while revenues from state tax instruments like the personal income tax (PIT, henceforth) or the sales tax remained relatively stable (see Figure 2).

The rise in federal intergovernmental (IG) revenues in 2020 as response to the COVID-19 crisis increased the amount of resources available to states, hence potentially changing the conditions that determine state's tax policies. In the aftermath of the COVID-19 pandemic there was an unprecedented increase in the number of states cutting their personal income tax (PIT, henceforth) rates. Between 2020 and 2024, states implemented 44 policy actions to reduce the top PIT rate. In a recent piece, we document this increase in PIT rate reductions is part of a long-term trend that has characterized state income tax reforms since 2002 (Johnson et al., 2024).

In this paper we study some of the potential mechanisms behind this this long-term trend on decreasing state income tax rates. In particular, we examine the influence of federal grants on state personal income tax policies. Fiscal federalism literature highlights federal grants could lead to either crowding-in or crowding-out effects on local spending (Lago et al., 2024). While the crowding-out effect on tax effort is often explained as a consequence of the political costs of taxation (Bradford and Oates, 1971a,b), crowding-in effects are commonly studied as part of the fly-

paper effect. Empirical evidence from this literature concurs there are asymmetric responses to federal grants where states are more likely to expand spending upon a grant increase, rather than cutting taxes (Wyckoff, 1988; Gramlich, 1987). This has arguably limited the literature looking at the influence of federal grants on sub-national tax policy. This paper aims to contribute to this literature by analyzing how intergovernmental revenues shape the type of income tax policy implemented by states.

To empirically study this relationship we estimate several regression models on a strongly balanced panel of 41 states (we exclude the 9 states that do not levy a personal income tax) from 2002 to 2019. The main dependent variable used for the empirical analysis is the top PIT rate levied by states. We use this variable as a proxy to characterize states income tax policies. The main independent variable used for all the analyses in this paper is the proportion that federal IG revenues represent of state's total revenues.

First, we study tax policy changes as a decision problem faced by states where each fiscal year they choose to change or keep the top PIT rate constant. We characterize this decision process as a function of the revenue structure of the states, the tax base, their political preferences, and the liquidity needs faced by the government. These decision models allow us to explore how the incentives to change tax rates respond to contemporaneous (short-term) variation on some of the variables we include as part of the decision process.

Estimates from binary and multinomial probability models suggest there is a negative association between the probability of changing the tax and federal IG revenues. That is, states with larger reliance on federal grants as source of revenues are less likely to change their top PIT rates. Furthermore, we document a larger effect for tax increases than tax cuts. A limitation of these results, however, is that they fail to account for the medium and long-term dynamics of state income tax policies. Governments often design tax reforms that involve paced changes on the tax schedule in order to prevent disruptions on economic activity and allow agents to update their long-term decision making accordingly.

To overcome this limitation we use the classification rule developed at Johnson et al. (2024) to categorize states according to the long-term trends observed in their income tax policy (see Definition 1). This categorization partitions into five categories the set of state governments that levy income taxes depending on the general direction and magnitude of the tax changes they had implemented since 2002. We identify governments with tax policies that had led to monotonic increases (decreases) on their top PIT rate (i.e. all tax changes followed the same direction). We define these as Tax Increasers (Decreasers). We define the governments with non-monotonic tax changes as Tax Switchers and distinguish between states that had observed a net increase or decrease on their top PIT rate. We define these as Tax Switchers - Net Increasers, and Tax Switchers - Net Decreasers, respectively. The reference category is keeping the tax rate constant during the analyzed period (i.e No Tax Change). This categorization allows us to classify state income tax policy using over 20 years of observed tax policy changes.

In this paper, we provide a slight generalization of the classification rules developed at Johnson et al. (2024) and compute the categorization with the path of income tax policies until each observed year. This time-varying classification (see Definition 2), unlike the long-term one at Definition 1, shows the path each state followed to be classified into one of the categories. In other words, it allows the states to change across income tax policy categories as they implement different changes on their top PIT rates.

Using both of these categorizations as dependent variables, we estimate a classification model using a multinomial logit regression in which we estimate the effect of federal IG revenues on the probability of each state being classified on the income tax categories defined above. Results from these models allow us to examine the effect of federal grants on long-term income tax policy by directly summarizing the trends of state policies into one dependent variable.

Results from these models show there is a positive relationship between federal IG revenues and the likelihood of being classified as a tax decreaser, and viceversa: an increase in federal grants is associated with a reduction in the probability of being classified as a tax increaser.[1] For instance, our preferred estimation on the model using the time-varying classification suggests that an increase in federal IG revenues equivalent to one percent of state's fiscal revenues is associated with a reduction of

[1]To ease the interpretation of these models, for all the multinomial logit regressions we report the average marginal effects instead of the raw regression coefficients. Statistical inference and hypothesis testing is done using a cluster-bootstrap algorithm with clusters at the state level. This allow us to report standard errors that account for the auto-correlation on each state's income tax policy.

8.9% of being a tax increaser. At the same time, it leads to a rise of 2.5% on the probability of being a classified as a tax decreaser.

As a robustness check, we define a simplified version of the time varying classification at Definition 2 that looks only at whether the states are characterized by a net tax increase (decrease) on their top PIT rate, relative to the level observed in 2002. Results from this exercise confirm the results from the previous model.

Altogether, these results lend some evidence for a negative relationship between federal grants and the probability of increasing taxes. The implication of these results aligns with the idea that federal grants have provided states with some fiscal space (Heller, 2005) to conduct tax policies that had led to an overall decrease in top PIT rates.

The rest of the paper is structured as follows. In section 2 we describe the relevant literature around the determination of state income tax policy and the role of federal grants. In Section 3 we provide some stylized facts on states income tax policies and revenue composition to motivate the empirical analysis. Sections 4 and 5 describe the results of the decision and tax policy classification models, respectively. Finally, Section 6 summarizes and discusses the main results.

2 Literature Review

The factors behind governments decision to change their tax policy is one of the central questions of the public finance literature, hence it has being explored from several angles and through different frameworks. In this section we review some relevant literatures that provide some insights on the determination of state income taxes and the role that federal grants play in this process.

2.1 Tax Setting

Tax competition literature characterizes the determination of tax policies as a result of strategic behavior across governments taxing a base with some degree of mobility. Theory from this literature generally agrees that local governments will strategically respond positively to a change in another government tax rate (Zodrow and Mieszkowski, 1986; Keen, 1998). These are the *race-to-the-bottom incentives* faced by local governments that lead to horizontal fiscal externalities (i.e. tax rates are set below their efficient level), which could further translate into underprovision of local public goods.

While this literature generally concurs on how tax competition leads to horizontal fiscal externalities, the effects when the competing jurisdictions share the tax base (i.e. overlapping governments, like the federal government and state governments) are ambiguous (Boadway and Keen, 1996; Keen, 1998; Hayashi and Boadway, 2001).

Higher federal tax rates restrict the space that state governments have to raise revenues from the same tax base. This could be thought as the crowding-out effect that federal taxes induce on states. States would need to reduce tax rates in order to compensate the reduction in revenues created by the federal tax increase. On the other hand, the size of the fiscal externality is increasing on the federal tax rate. Hence, as the federal tax rate rises, state governments have more incentives to raise their tax rates to compensate for the reduction in revenues.

Sobel (1997) formalizes the intuition behind this tragedy of the fiscal commons in an optimal taxation setting: when two different levels of government tax the same base it could lead to overtaxation (i.e the combined tax rates are higher than socially desired). This creates an intergovernmental fiscal externality where the deadweight loss of taxation is not minimized and could potentially lead to lower fiscal revenues if the change in the tax rate places the lower level of government on the wrong side of the Laffer curve. In sum, the determination of state tax rates is influenced both by the horizontal externalities created by tax competition, and the vertical externalities induced by the fiscal commons problem. The net effect that an increase in federal tax rates has on states tax policy will depend on the magnitude of each externality as well as the elasticity and mobility of the tax base (Hayashi and Boadway, 2001).

Empirical evidence from Hayashi and Boadway (2001), which looks at externalities from the federal government to provincial governments in Canada, suggests that vertical tax externalities are negative, consistent with a scenario where the crowding out effect created by federal taxes dominates the revenue incentives faced by state

governments to increase tax rates.

2.2 Fiscal Federalism

How decisions from the federal government influence state and local governments outcomes is one of the main interests on the fiscal federalism literature. Fiscal federalism theories highlight two main rationales for fiscal intervention of a higher level of government (Nechyba, 1996). On one hand, to internalize the fiscal externalities created by horizontal tax competition across states, either by promoting coordination across states or through tax-subsidies that correct the externalities (e.g. a matching grants program to address expenditure spillovers) (Keen, 1998). On other hand, federal fiscal intervention could have a redistributional role and address inter-jurisdictional inequities on the income distribution.

Under the presence of vertical fiscal externalities, intergovernmental transfers play a significant role on the equalization role of the federal government. To understand the magnitude of the externality and how federal tax instruments could alleviate its negative effects, Keen (1998) defines the *fiscal gap* as the *"excess of the federal government's revenue from own sources over its non transfer spending"*. Traditional fiscal federalism literature sees the fiscal gap as a residual (Buchanan, 1949; Albouy, 2012) induced by differences on the optimal degrees of centralization on taxation and spending. Positive fiscal gaps (i.e. where transfers go from the federal government to state governments) are consistent for scenarios where centralization of taxation is rel-

atively more efficient to centralization of expenditures. Keen (1998) argues the role of intergovernmental transfers is not to close the fiscal gap, but to alleviate the inefficiencies induced by concurrent taxation (i.e. sharing the tax base). Furthermore, under the presence of horizontal tax competition, it is not optimal to fully decentralize taxation powers to the states because the federal government should retain some tax instruments to address the efficiency loss induced by horizontal externalities.

Notwithstanding the rationale for federal grants, it is clear that IG transfers influence subnational fiscal revenues, spending behavior, and whether governments run balance budgets. Changes in grant levels potentially lead to adjustments on the components of the government budget constraint. Lago et al. (2024) decompose the behavioral response of subnational governments to changes in federal grants in terms of substitution and income effects. While the substitution effect reflects changes on the cost of subsidized public spending, the income effect captures the impact on the all the resources available to subnational government.[2]

Moreover, state and governments might react asymmetrically to changes in federal transfers (Gramlich, 1987; Wyckoff, 1988). Subnational governments might raise taxes upon a cutback on federal grants in order to preserve spending levels stable. At the same time, an increase in increase could be followed by an expansion of subnational spending. Empirical evidence suggests that, for a change of similar magnitude on federal grants, grants effects is larger for increases than for decreases. This commonly referred as the *fiscal replacement effect* (Gramlich, 1987; Martell and

[2]For example, Hines and Thaler (1995) argue that unconditional grants induced pure income effects.

Smith, 2004).

Lago et al. (2024) explains these asymmetric effects could lead to either crowding-out (decreasing) or crowding-in (increasing) effect on state and local tax revenues. Crowding-out effects are often explained by the political costs of rising taxes (Bradford and Oates, 1971a,b). State officials might find less politically costly to increase reliance on grant funding than increasing taxes.[3] Empirical evidence on this asymmetry finds that municipalities with left-leaning administrations are more likely to raise taxes when experiencing grant cuts (Lago-Peñas, 2008; Baekgaard and Kjaergaard, 2016) and expand spending when grants increase (Baekgaard and Kjaergaard, 2016).

Crowding-in effects are most commonly studied at the flypaper effect literature. The flypaper effect consists on *"the idea that grants stimulate government expenditures more than grants to individuals. Part of the federal resources stick to subnational governments"* (Henderson, 1968; Gramlich, 1969; Wyckoff, 1988; Martell and Smith, 2004).

Several explanations for the flypaper effect are presented on the literature. In this review, however, we focus on the research that explains it as a consequence of a fiscal illusion created by the imperfect information faced by voters (Wyckoff, 1991; Baekgaard et al., 2016; Cárdenas and Sharma, 2011) and recent literature building

[3]Empirical evidence reviewed by Lago et al. (2024) shows that crowding out effects are more pronounced on countries with weak fiscal institutions, high dependence on IG grants, and high costs of tax collection. Furthermore, these effects could be boosted if the grant design disincentives local revenue collection (e.g. government receive lower amounts when they increase the tax effort).

on (Hamilton, 1986) suggesting the flypaper effect is a consequence of the reduction in the marginal cost of public funds induced by grants (Aragon, 2013; Dahlby, 2011). The first strand of literature argues that information on intergovernmental aid is not as salient or processable to constituents, as oppose to local tax rates and public spending. The second strand, in contrast, argues it is a consequence of welfare maximizing behavior under the presence of costly tax collection (Lago et al., 2024).

An implication of the prevalence of the flypaper effect is that state and local governments are more likely to expand expenditures instead of reducing local taxes, upon an increase in federal grants (Wyckoff, 1988). This phenomenon has arguably limited the number of studies that only look at the taxation response to federal grants. In this sense, this paper provides a novel contribution to this side of the literature.

The characteristics of the grant also play a role on its effects on subnational fiscal policy. For instance, an increase in federal grants could create budgetary room for recipient governments if the latter has some degree of discretion on how to spend the grants. The fungible resources allow the recipient government to reduce taxes without changing the level of public output (i.e. the grant substitutes local tax revenue as a source of financing).

The idea of budgetary room is often found in the fiscal space literature. Fiscal space can be defined as *"the availability of budgetary room that allows a government to provide resources for a desired purpose without any prejudice to the sustainability*

of a government's financial position." (Heller, 2005). In general, governments can create budgetary room either by raising taxes, increase the efficiency of tax collection, cutback low-priority expenditures, or by issuing debt. The key part, however, is to carry out these strategies while preserving the sustainability of state's finances.

3 Descriptive Analysis

3.1 Data

For this analysis we rely primarily on data from the Tax Foundation on state income tax rates for state governments. We retrieved the information from the current update of state income tax rates that covers from 2015 to 2024, and the historic tables that trace back into 2002. From this data source we built a panel data set with the top PIT rates of state governments covering from 2002 to 2024. We use this data to compute the number tax changes, as well as to categorize states into income tax policy groups according to the classification rules described at Definitions 1-3 in Section 5.

For the relevant covariates, we use fiscal variables from states' Annual Comprehensive Financial Reports (ACFRs) and the Government Finance Database (Pierson et al., 2015), as well as economic covariates like the unemployment rate (retrieved from the Bureau of Labor Statistics). We also include data from the Book of States

on the political affiliation of the states governorship and majority on the state house.

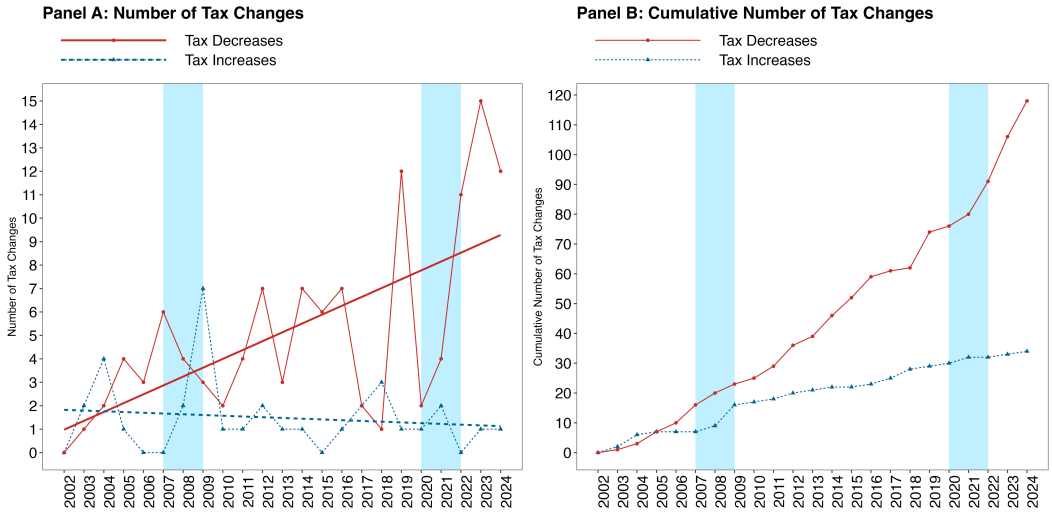
3.2 Stylized Facts about Income Tax Reforms

We analyze the Tax Foundation data to identify the number of times state governments changed their top PIT rates and classify them between tax increases and tax decreases. Figure 1 is reproduced from Johnson et al. (2024). Panels at Figure 1 show these results Panel A shows the annual count of increases and decreases on the top PIT rate. We document a positive trend on the number of tax decreases that has persisted since 2002 until 2024, where the number of decreases mounted after the pandemic period. At the same time, there has been a slightly decreasing trend on the number of tax increases. Panel B displays the cumulative number of tax changes (increases and decreases). Between 2002 and 2024, there were 118 tax decreases and only 34 tax increases. This trend on tax decreases has translated in a reduction of the average top PIT rate across states. Figure 5 depicts the trend on the average (and median) top PIT rate of state governments that levy a personal income tax. Between 2002 and 2024, we observe a decrease of 47.8 basis points on the average tax rate, and of 80 basis points on the median rate.

3.3 Revenue Structure

State revenue structure could play a relevant role explaining income tax reforms. Figure 2 shows the average revenue structure observed by state governments between 2000 and 2020. Tax revenues from sales and personal income taxes had observe some stability across time. For instance, PIT revenues had fluctuated around 12 and 15% of state's total fiscal revenues. Sales taxes represent approximately 20% of states revenues. In contrast, we observe increasing relevance of Federal IG revenues. While at 2000 this revenue source accounted for 21% of state's revenues, by the end 2019 the state's average rose to 31%.

Figure 1: Changes on top PIT rates

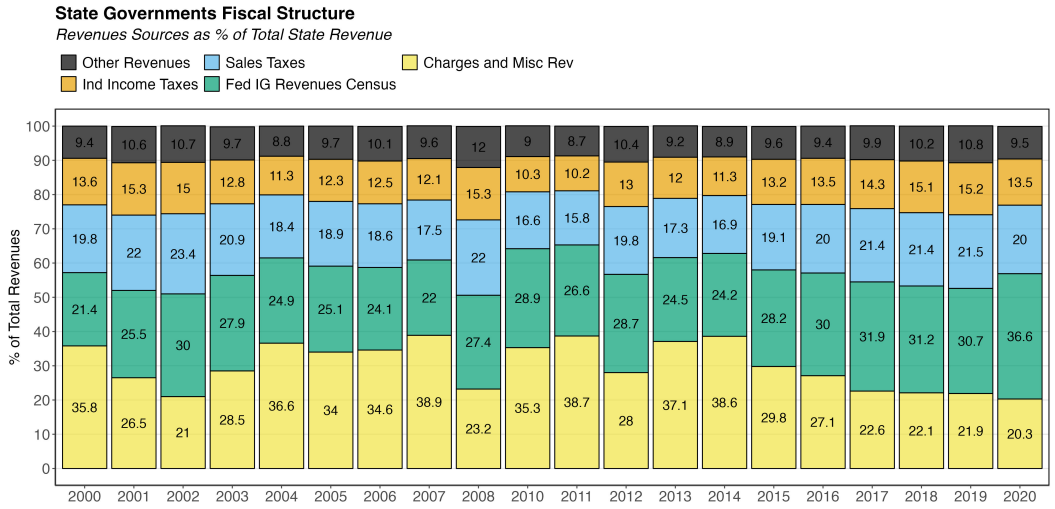


Source: Figure 1 at Johnson et al. (2024).**Note:** Calculations exclude states without a PIT rate. Tax changes for 2002 are not included since our analysis starts on this date. Panel A shows the number of tax changes observed in each year. Panel B shows the cumulative sum of the number of tax changes observed in each year. Both panels show individual lines according to the type of tax policy implemented (i.e., tax increase or tax decrease). Shaded areas correspond to the period of the Great Recession and the COVID-19 pandemic emergency.

Figure 6 provides a more nuanced view of state's fiscal structure. Each panel on this Figure shows the distribution of the main revenue sources (as a proportion of state's fiscal revenues). It stands out that during the Great Recession there was a large increase on the inflow of federal IG revenues to state governments. This is arguably explained by the relief programs bolstered by the federal government as response to the crisis.

Federal IG revenues are mainly distributed through the grant programs managed by the federal government. There are two general types of federal grants to state and local governments: categorical grants and block grants. Categorical grants for a specifically aided program (earmarked grants). Block grants can be used only for a

Figure 2: Fiscal Structure of State Governments



Note: This graph shows the composition of fiscal revenues of **all** state governments between 2000 and 2020 (i.e. this graph includes data from states that do not levy an income tax). Observations from 2009 are excluded due to inconsistency with the data (i.e. charges and miscellaneous revenues report negative figures, see Panel D at Figure 6 for further reference). Numbers expressed as percentage of total fiscal revenues.

more diverse set of programs (limited discretionary grants). [4]

Categorical grants could be allocated on a competitive basis (i.e. project categorical grants), characteristics of the state (i.e. formula categorical grants) like population, or poverty rate, a combination of both competitive application process and a formula within enabling legislation (formula-project categorical grants). Categorical grants include Supplemental Nutrition Assistance Program for Women, Infants, and Children (SNAP WIC) or grants limited to specific projects, like building a highway. Block grants include the Temporary Assistance for Needy Families (TANF) program. The majority of federal grants are dedicated to health care spending, including Medicaid. The rest are divided among income security programs, transportation, community and regional development, education, training, employment and social services.

The increasing role of federal IG revenues on state budgets could translate into a more centralized fiscal system as federal spending expands its influence to some areas that are previously viewed as responsibilities of state governments. In this sense, states with larger reliance on federal grants as a revenue source could have more incentives to decrease taxes as grants could translate into more fiscal space (Heller, 2005) to accommodate tax rates into lower levels without reducing the services output nor hindering the sustainability of public finances.

[4]Until 1986, the federal governments general revenue sharing program was used to distribute resources across states. The general revenue sharing program can be used for any purpose not expressly prohibited by federal or state law (discretionary grants).

4 Empirical Analysis: Tax Reforms as a Decision Model

To motivate the econometric analysis we model tax setting behavior as a decision problem faced by state governments each fiscal year. We model this problem through a couple approaches.

1. **Binary Probability Model**: we set is a binary decision problem in which the government each period chooses whether to change or keep the tax constant.
2. **Multinomial Probability Model**: we generalize this decision problem by expanding the set of alternatives that the government can choose from: i) increase the tax rate, ii) decrease the tax rate; or iii) keep the rate constant.

A benefit of both of these models is that they generate estimates on the probability of adopting a change in the tax rate (increase or decrease), relative to alternative of keeping it constant. To ensure comparability of the results, we preserve the same econometric specification across models. We only vary the dependent variable and, hence, the estimation approach (OLS/Logit and multinomial logit).

We regress the dependent variable on one-year lagged measures of the explanatory variables to account for the timing of the information available to the state government when setting the tax policy for each fiscal year. It should be mentioned

that a direct benefit of this approach is that also mitigates endogeneity bias on our estimates due to potential reverse causality with contemporaneous measures.

For all models, the main independent variable $FedIGRev_{it}$ measures federal IG revenues coming from categorical and block grants as a percentage of total fiscal revenues observed by the state on that fiscal year. We include a vector of control variables that could explain the decision to change taxes. We consider fiscal structure variables like the percentage of sales tax revenues to total revenues. We also include cash holdings (as percentage of fiscal revenues) to account for incentives for tax changes driven by liquidity needs. To control for movements on the income tax rate driven by changes on the tax base we include state's unemployment rate. We also include dummy variables on the political affiliation of the governor and the house majority (i.e. dummy equals one if the majority is republican). In other words, we model the decision to change taxes as a function of the state's fiscal structure, liquidity needs, and political affiliation. Altogether, these variables should account for the variation in the probability of tax change driven by state's fiscal, financial and political decisions. Hence, we aim to explain the remaining variation on the probability to change tax rates through the relevance of federal IG revenues on state's budget.

To address omitted variable bias concerns, we consider year fixed effects on the econometric specification. Year fixed effects account for factors that influence state's decision to change taxes in the same way, but could differ across time. Perhaps the main factors accounted by these parameters are changes in federal tax policy and

the overall stance of the US economy. The preferred specification of this paper does not considers state fixed effects. State fixed effects explain factors behind state tax reforms that are specific to each state and fixed across time. Thus, their inclusion on the model could wipe-out the variation that contains the effect of federal IG revenues on state income taxes.

4.1 Binary Decision Model

We first examine this problem through a binary probability model in which the outcome variable is a dummy equal to one if state i changes the tax rate on period $t+1$ and zero otherwise. Hence, we consider the following reduced-form statistical model.

$$Pr(TaxChange_{i,t+1}) = \alpha + \theta FedIGRev_{it} + X_{it}\beta + b_t + e_{it} \tag{1}$$

We estimate Equation 1 in three different samples that are associated with three different decision problems: i) probability of changing the top PIT rate (full panel of states), ii) probability of decreasing the top PIT rate (full panel excluding observations with tax increases); and iii) probability of increasing the top PIT rate (full panel excluding observations with tax decreases). Furthermore, we provide estimates of Equation 1 assuming a linear probability model (and hence using a fixed-effects estimator), as well as a logit model with dummy variables. To ease the comparison

of the results and the interpretation of the coefficients, for the logit model we report marginal effects. Statistical inference is done assuming clustered standard errors at the state level.

Estimation of all regression models in this paper is done in a strongly balanced panel of the 41 state governments that levy personal income taxes between 2002 and 2019. We exclude from the analysis the states that do not levy a personal income tax. The rationale for this assumption is straightforward since we are modeling the decision to change the income tax rate and these states do not face such problem. We exclude data from 2020 and onwards since we observed an increase in both the number of tax changes and the federal IG revenues to state governments, which add noise to coefficient estimates as they constitute outlier observations with respect to the rest of the panel. [5]

4.1.1 Estimation Results

We depart the analysis by showing the distribution of the main variables used for the analysis.Table 1 shows the descriptive statistics of the variables included in the regression models estimated in this paper. In this sample, the average state observes 30.25% of their fiscal revenues coming from federal IG revenues, 11.81% from sales tax revenues, and 15.86% from the personal income tax.

[5] As a robustness check, we estimate the models including data from 2020 and 2021. While the general direction of the coefficients persist, estimation is less precise (i.e. larger standard errors).

Table 1: Descriptive Statistics of Baseline Sample

	Mean	SD	Min	P25	P50	P75	Max	Obs
Federal IG Revenue	30.25	8.79	0.00	24.79	29.53	33.97	113.08	738
Sales Tax	11.81	5.26	0.00	9.38	11.66	14.59	47.94	738
Cash Reserves (% Revenue)	176.91	69.42	66.48	133.96	168.87	202.89	905.24	738
Unemployment Rate	5.64	2.01	2.10	4.20	5.20	6.70	13.10	738
Republican House	0.49	0.50	0.00	0.00	0.00	1.00	1.00	738
Republican Governor	0.53	0.50	0.00	0.00	1.00	1.00	1.00	738
Auxilary Variables								
Income Tax	15.86	6.20	4.09	11.88	14.88	19.48	70.10	738
Top PIT Rate	6.52	1.97	2.80	5.00	6.00	7.75	13.30	738
GF Balance (% Revenue)	54.73	89.60	-318.32	11.76	41.69	86.68	812.97	738

Note: This table shows the distribution of the main explanatory variables used for the analysis. Each column shows a moment or descriptive statistics on the distribution across the strongly balanced panel of state governments that levy a personal income tax from 2002 to 2019. P25, P50 and P75 denote the 25th, 50th (median), and 75th percentiles of the distribution.

Table 2 reports the results of the estimation of Equation 1. To ease comparison with OLS estimates, for the logit model we report average marginal effects. These coefficients show the marginal effect on the probability of changing taxes of an increase in federal IG revenues equivalent to one percentage point of fiscal revenues. In general, we document a negative association between federal IG revenues and the probability of changing the top PIT rate. For example, estimates from Panel A, column 4, imply a reduction on the probability of changing the top PIT rate of 0.7 percentage points. The probability of changing the tax rate for this sample (i.e. computed as the proportion of observed tax changes) is 13.96%. Hence, the estimates imply a reduction from 13.96% to 13.26% (i.e. about 5% of the mean of the dependent variable of this sample). Panels B and C on Table 2 shows results of this estimation under sub-samples of the data set that restrict for tax decreases and

increases, respectively.[6]

From these results it stands out that, while the coefficient estimates for the sample with tax increases suggest a stronger effect of federal transfers, when expressing the effect in terms of the in-sample probability of changing taxes, the implied reduction in the probability is larger for tax increases than tax decreases. For example, results at Panel B, Column (4), imply a reduction in the probability of decreasing taxes of 0.5 percentage points (i.e. equivalent to a 4.8% decrease on the probability of changing taxes). On the other hand, results from Panel C, Column (4) show a decrease of 0.4 percentage points, which represent a reduction of 9.1% on the in-sample probability of increasing the top PIT rate.

Altogether, the results from these models point towards a reduction on the incentives to change income tax rates upon an increase on federal IG revenues. This could be explained by the political costs of changing taxes (Bradford and Oates, 1971a,b). Furthermore, the effect on tax increases seems to be larger than the effect on tax decreases. While both results are statistically significant, the interpretation of this results should be done with caution. The implied effects suggest that larger reliance on federal IG revenues has a stronger dissuading effect on increasing taxes, relative to decreasing tax rates. However, this difference could be explained by the larger prevalence of tax decreases on the sample.

[6]To be clear, for Panel B we exclude all observations where there is a positive tax change. Similarly, for Panel C we exclude all observations with a negative tax change. Hence, the interpretation of Panel B (C) corresponds to a choice model where the decision to change taxes is restricted to choose between decreasing (increasing) or keeping constant the top PIT rate.

Table 2: Effect of Federal IG Revenues on Probability of Tax Change

	(1)	(2)	(3)	(4)
Panel A: All Tax Changes				
Federal IG Revenue	-0.003	-0.006**	-0.003	-0.007**
	(0.003)	(0.003)	(0.002)	(0.003)
N	738	738	738	738
Mean Dep Var	0.1396	0.1396	0.1396	0.1396
Panel B: Tax Decreases				
Federal IG Revenue	-0.002	-0.004*	-0.002	-0.005*
	(0.002)	(0.002)	(0.002)	(0.002)
N	709	709	709	709
Mean Dep Var	0.1044	0.1044	0.1044	0.1044
Panel C: Tax Increases				
Federal IG Revenue	-0.001	-0.003	-0.002**	-0.004***
	(0.001)	(0.002)	(0.001)	(0.001)
N	664	664	664	664
Mean Dep Var	0.0437	0.0437	0.0437	0.0437
Year FE	No	Yes	No	Yes
Estimator	Linear	Linear	Logit	Logit

Note: This table shows the marginal effects of an increase on Federal IG Revenues equivalent to 1% of state's fiscal revenues on the probability of changing their top PIT rate. Columns (1) and (2) show the coefficients from Equation 1 using an OLS estimator. Columns (3) and (4) show the results from a logistic regression. Panel A shows results from estimating the models on the full sample. Panel B and Panel C restrict this sample by excluding the observations with tax increases and tax decreases, respectively. Standard errors are clustered at the state level. A */**/*** indicates significance at the 10%, 5%, and 1% levels, respectively.

4.2 Multinomial Decision Model

A limitation on the results at Table 2 is that it does not allows to jointly compare differences on the effect of federal IG revenues on the probability to increase and decrease the top PIT rate. To overcome this limitation, we model the decision problem in terms of three alternatives that the state needs to choose each year: increase taxes, decrease taxes, or keep them constant. We estimate this decision process using a multinomial logit model, where we use the decision to keep taxes

constant as reference (omitted category). This implies that we obtain estimates on the probability to increase (decrease) taxes, relative to the probability of keeping them constant. We keep the same set of lagged independent variables, and fixed effects structure. To ease the interpretation of the results, we report the average marginal effects instead of the regression coefficients. Statistical inference on the marginal effects is done using a cluster bootstrap algorithm to obtain standard errors clustered at the state level.[7]

$$log\left(\frac{Pr(Decision_{i,t+1}=k)}{Pr(Decision_{i,t+1}=NoTaxChange)}\right)=\alpha+\theta FedIGRev_{it}+X_{it}\beta+b_t+e_{it} \quad (2)$$

4.2.1 Estimation Results

Table 3 shows the results of estimating Equation 2 on a strongly balanced panel of states from 2002 to 2019. This table shows two complementary transformations of the raw coefficients estimates from this model. Panel A reports the marginal effects of federal IG revenues on the probability of choosing a tax increase (or decrease) relative to the probability of keeping the PIT rate constant. Panel B, reports the exponential transformation of the coefficients such that they are expressed as log

[7]Statistical inference and hypothesis testing for all multinomial logit regression models is done through a cluster-bootstrap algorithm with 10,000 simulations. To be clear, in each round of the bootstrap we randomly pick a set of 41 states (with replacement), estimate the model on that bootstrap sample, and compute the marginal effects implied by those coefficient estimates. Then, we conduct hypothesis testing on the average marginal effect (our target parameter) using the bootstrap distribution of this parameter. We report two-tail rank-based p-values.

odds ratios, relative to the reference category of keeping the tax unchanged.

The results at Table 3 document similar findings to the ones at Table 2: we find a negative relationship between federal IG revenues and the probability of changing the top PIT rate. Estimates from the models including year fixed effects suggest that an increase in federal IG revenues equivalent to one percentage point of fiscal revenues leads to a reduction of 0.43 percentage points on the probability of decreasing the tax rate, and a reduction of 0.03 percentage points on the probability of increasing the tax rate. Both these coefficients are significant at the 5% level. When expressing these estimates in terms of the in-sample probability of tax change, the implied effect is larger for tax increases (i.e. reduction of 6.86%) than tax decreases (i.e. reduction of 4.11%). Table 10 on the Appendix shows the full results of this model.

Table 3: Multinomial Logit Models on Pr(Tax Change) - Effect of Federal IG Revenues

Variable	Tax Decrease (1)	Tax Decrease (2)	Tax Increase (1)	Tax Increase (2)
Federal IG Revenue	-0.0021	-0.0043**	-0.0016*	-0.003**
	(0.002)	(0.0025)	(0.001)	(0.0013)
Year FE	No	Yes	No	Yes
Pr(Tax Change)	0.1003	0.1003	0.0393	0.0393

Note: This table shows the results of estimating Equation 2. The excluded reference group is "No Tax Change". The table shows the marginal effects of states choosing to increase (or decrease) the top PIT rate, relative to keeping it constant. Standard errors computed using a cluster bootstrap algorithm (clusters by state). A */**/*** indicates significance at the 10%, 5%, and 1% levels, respectively.

Altogether, the results from these decision models point towards a negative relationship between federal IG revenues and the likelihood of changing income tax rates. This implies that states with larger reliance on this revenue source are more likely to pursue a more stable fiscal policy.

5 Income Tax Policy Classification

The results from the decision models presented above shed some light on the contemporaneous (short-term) determinants of state PIT rates. However, such models do not explicitly deal with long-term trends in state's fiscal policy. For example, if state's policies are driven by political factors, then to capture significant differences on the levels of income taxation we require a characterization of income tax policies that take into account the stickiness of tax policy.

To address this concern, we rely on the long-term characterization of income tax policy we developed and described at Johnson et al. (2024). This classification rule is based on the trends of the annual changes on the top PIT rate. We compute the cumulative change on the top PIT rate relative to the observed value in 2002 (i.e. the initial year of our analysis period). We build categories that allow to classify state's income tax policy both in terms of the direction and magnitude of the changes on the top PIT rate. Considering the characteristics of their income tax policy states are assigned into one of the following categories:

Definition 1 (Fixed (Long-term) Income Tax Policy Classification) *Considering the trajectory of each state's i top PIT rate τ_{it}, we assign the state to one of the following income tax policy categories. Define $\Delta\tau_{it} = \tau_{it} - \tau_{i,t-1}$.*

1. ***No PIT Rate:*** *states that do not levy a personal income tax.* $\tau_{it} = 0 \quad \forall t$
2. ***No Tax Change:*** *the PIT rate from 2002 remained constant through all*

periods. $\tau_{it} = \tau_{i,2002} \quad \forall t$.

3. ***Tax Decreasers:*** *The PIT rate is monotonically decreasing over time. All changes on the PIT rate were negative. The PIT rate is monotonically decreasing over time.* $\Delta\tau_{it} \leq 0 \quad \forall t$.

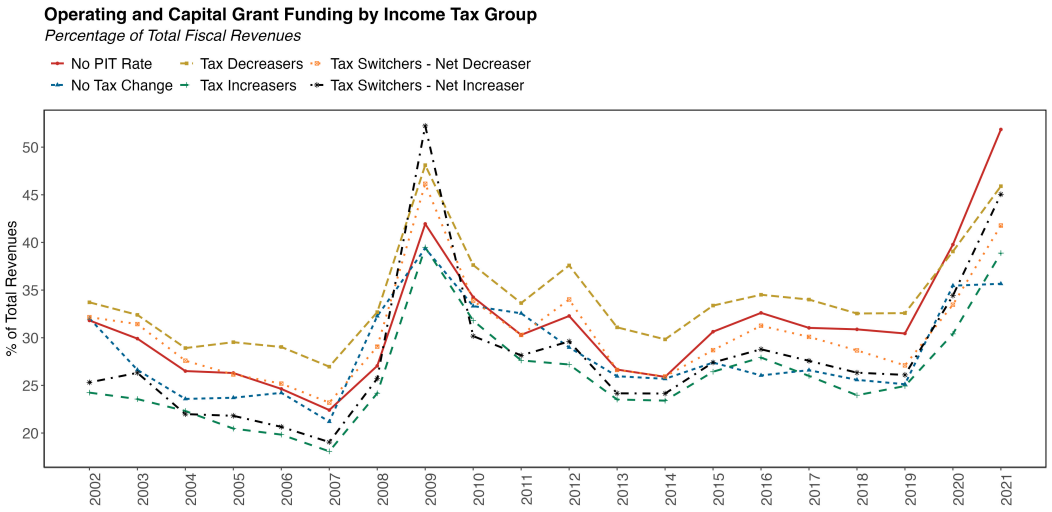
4. ***Tax Increasers:*** *The PIT rate is monotonically increasing over time. All changes on the PIT rate were positive.* $\Delta\tau_{it} \geq 0 \quad \forall t$

5. ***Tax Switchers - Net Decreasers:*** *changes on the PIT rate were either positive or negative, but the net change (cumulative sum of tax changes) is negative. Relative to 2002, the top PIT rate is lower in 2024.* $\Delta\tau_{it} \neq 0$ *for some* t *and* $\tau_{i,2024} < \tau_{i,2002}$

6. ***Tax Switchers - Net Increasers:*** *changes on the PIT rate were either positive or negative, but the net change (cumulative sum of tax changes) is positive. Relative to 2002, the top PIT rate is higher in 2024.* $\Delta\tau_{it} \neq 0$ *for some* t *and* $\tau_{i,2024} > \tau_{i,2002}$

Figure 7 shows the result of this classification. From this characterization it stands out that most state governments have undertaken tax policies that reduced the top PIT rate. In this 23-year period we identify 25 states that had observed a net decrease in the top PIT rate, where 19 states that have implemented monotonic decreases in the top PIT rate. On the other hand, we identify 14 states that observed a net increase in the top PIT rate, but only 2 out of the 14 implemented tax policies that consisted on monotonic increases.

Figure 3: Average Federal IG Revenues by Income Tax Policy Group



Note: This graph shows the average Federal IG Revenues (as percentage of total fiscal revenues) across the states belonging to each income tax category. Classification of income tax policy done using data from 2002 to 2024.

Using this classification of states, at Figure 3 we show the average percentage of Federal IG revenues to total revenues for each income tax policy category. From this graph it stands out that Tax Decreasers had consistently observed larger reliance on federal IG revenues than the other groups. At the same time, states with tax increasing trends are characterized by lower reliance on this source of revenues. This figure provides some suggestive evidence on the role that federal grants have on states personal income tax policy.

5.1 Dynamic Classification

While the classification described above captures the long-term trends on state's income tax policy, it obscures the path states followed to be characterized into one of the analytical groups we defined. To shed some light on this process, we provide a slight generalization of our categorization rule and classify the states into the defined groups taking the information up until the end of each fiscal year. This time-varying (dynamic) classification allows to examine the sorting process that led each state to be classified into one of the defined tax policy categories at Figure 7.

Definition 2 (Time Varying (Dynamic) Income Tax Policy Classification) *For each state i, considering the trajectory of their top PIT rate until period t we assign the state to one of the following income tax policy categories y_{it}.*

1. ***No PIT Rate:*** *states that do not levy a personal income tax.* $\tau_{it} = 0 \forall t$
2. ***No Tax Change:*** *the PIT rate from 2002 remained constant until period t.* $\tau_{it} = \tau_{i,2002}$.
3. ***Tax Decreasers:*** *up until period t, all changes on the PIT rate were negative. The PIT rate has been monotonically decreasing over time.* $\Delta\tau_{it} \leq 0$.
4. ***Tax Increasers:*** *up until period t, all changes on the PIT rate were positive. The PIT rate has been monotonically increasing over time.* $\Delta\tau_{it} \geq 0$
5. ***Tax Switchers - Net Decreasers:*** *up until period t, changes on the PIT rate were either positive or negative, but the net change (cumulative sum of tax changes) is negative. Relative to 2002, the top PIT rate is lower in period t.* $\Delta\tau_{it} \neq 0$ *for some t and* $\tau_{it} > \tau_{i,2002}$
6. ***Tax Switchers - Net Increasers:*** *up until period t, changes on the PIT rate were either positive or negative, but the net change (cumulative sum of tax changes) is positive. Relative to 2002, the top PIT rate is higher in period t.* $\Delta\tau_{it} \neq 0$ *for some t and* $\tau_{it} < \tau_{i,2002}$

Figure 4 shows the results of this classification. This diagram shows the results of the classification algorithm for all states across time. In the first year of the panel,

2002, all states start at the "No Tax Change" category. As states implement changes on their top PIT rates they are classified into a different category. Each change on the tax policy modifies the trajectory of their PIT rate, potentially classifying them into a different category. For example, Ohio is classified as Tax Decreaser in 2005 (the first year with a tax change since 2002). Since then, all the updates on their top PIT rate had been reductions. Therefore, the PIT rate of the state has observed monotonic decreases, leaving this state in this category. Michigan, on the other hand, began as a Tax Decreaser in 2003. In 2008, however, the state increased the tax rate above the level observed on 2002. Thus, the state moved from a Tax Decreaser to a Net Increaser. Under this classification, states can switch across categories depending on the cumulative direction and magnitude of their income tax policy. This flexibility allows to capture more accurately the effect of federal IG revenues on income tax policy, taken into consideration the trends on each states own fiscal policy.

As an alternative approach to analyze trends on income tax policy, we propose a simplified version of Definition 2. We relax the definition of tax increasers and decreasers to only encompass temporal differences on the top PIT rate, relative to the baseline level observed at 2002. This new definition basically groups tax decreasers and tax switchers-net decreasers together in the category "Net Tax Decreasers". Similarly, the category "Net Tax Increasers" groups the states at the Tax Increasers and Tax Swithchers - Net Increaser categories.

Definition 3 (Simplified Time Varying Income Tax Policy Classification) *For each state i, considering the trajectory of their top PIT rate until period t we*

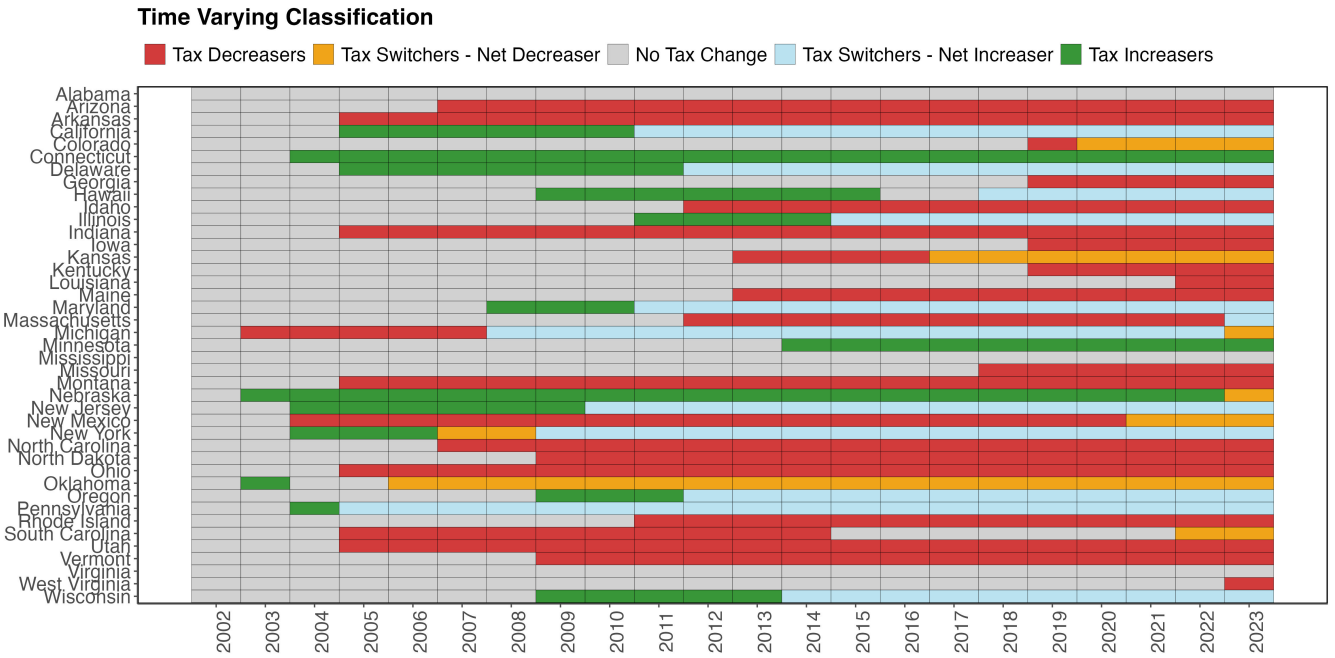
assign the state to one of the following income tax policy categories y_{it}.

1. ***No Tax Change:*** *the PIT rate from 2002 remained constant until period* t. $\tau_{it} = \tau_{i,2002}$.

2. ***Net Tax Decreasers:*** *up until period* t*, the net change on the top PIT rate (cumulative sum of tax changes) is negative. Relative to 2002, the top PIT rate is lower in period* t. $\Delta\tau_{it} \neq 0$ *for some* t *and* $\tau_{it} > \tau_{i,2002}$

3. ***Net Tax Increasers:*** *up until period* t*, the net change on the top PIT rate (cumulative sum of tax changes) is positive. Relative to 2002, the top PIT rate is higher in period* t. $\Delta\tau_{it} \neq 0$ *for some* t *and* $\tau_{it} < \tau_{i,2002}$

Figure 4: Time Varying Classification of Income Tax Policy



Note: This graph shows the results of applying the algorithm at Definition 2. The graph depicts the sorting process implied by the dynamic income tax policy classification. States without a PIT rate are excluded.

5.2 Empirical Analysis: Classification Models

We extend the model at Equation 1 to incorporate the long-term trends on state income tax policy by using long-term classification of state income tax policy as an categorical outcome variable, where the omitted reference category is being a state with no tax changes. In other words, we estimate several models on the probability of being classified into one of the categories (i.e. tax increaser, tax decreasers, tax switcher) relative to being classified as state with no tax change. Estimation is done using a multinomial logit regression.

We estimate this model using two different dependent variables: the long-term classification (Definition 1) and the dynamic classification (Definition 2). We provide estimates with and without year fixed effects (implemented via the inclusion of year dummy variables). The regression equation expressed as the log-odds of the probability of being assigned into each category k is the following:

$$log\left(\frac{Pr(y_{i,t+1}=k)}{Pr(y_{i,t+1}=NoTaxChange)}\right) = \alpha + \theta FedIGRev_{it} + X_{it}\beta + b_t + e_{it} \qquad (3)$$

For statistical inference we estimate a cluster bootstrap algorithm (10,000 simulations). To ensure precise estimation of the parameters of interest, we modify slightly the standard cluster bootstrap algorithm such that in each bootstrap simulation

there are the same number of states assigned into each category. [8]

5.2.1 Estimation Results

Table 4 shows the results from the classification models. Each row on this table displays the estimates on the probability of being classified into one of the categories, relative to the omitted group (no tax change). Estimates from the model on the fixed classification suggest a positive relationship between the probability of being classified as a tax decreaser and reliance on federal IG revenues. At the same time, there is a negative association between the probability of observing an income tax policy characterized by monotonic increases and dependence on federal grants as a revenue source. This relationship is also present on the classification model using the time-varying categorization, although the estimated marginal effects suggest a smaller effect of federal IG revenues on the classification probabilities. Implied effects at Table 6 make this point evident. An increase on federal IG revenues equivalent to one percent of state's fiscal revenues leads to an increase in the probability of being a tax decreaser of 2.48% and a reduction on the probability of being a tax increaser of 8.89%.

Table 5 show the results of classification model using the simplified classification

[8] The limitation of the standard cluster bootstrap algorithm for a multinomial logit model like the one we estimate is that in some bootstrap simulations, some categories do not draw states and hence are unable to obtain coefficient estimates. This creates a challenge for statistical inference as the effective number of observations used for each parameter differs. This slight modification of the re-sampling procedure is similar to the rationale used in placebo randomization where some placebo estimates are discarded from the empirical distribution due to poor goodness of fit.

Table 4: Effect of Federal IG Revenues on Income Tax Policy Classification

Model	Tax Decreasers	Tax Switchers Net Decreaser	Tax Switchers Net Increaser	Tax Increasers
Fixed Class.				
Controls	0.0279***	0.0012	-0.0221***	-0.0055
	(0.0049)	(0.0033)	(0.004)	(0.0034)
Controls + Year FE	0.0366***	0.0026	-0.0302***	-0.007*
	(0.0049)	(0.0045)	(0.0078)	(0.0067)
Pr(Tax Classification)	0.4634	0.1463	0.2927	0.0488
Time Varying Class.				
Controls	0.0078***	-0.0002	-0.0066**	-0.0083***
	(0.0047)	(0.0023)	(0.0031)	(0.0036)
Controls + Year FE	0.0072***	0.000	-0.0138***	-0.0106***
	(0.0062)	(0.0032)	(0.0066)	(0.0059)
Pr(Tax Classification)	0.2900	0.0298	0.1436	0.1192

Note: This table shows the results from Equation 3. Columns show the categories (alternatives) of the classification model. Rows show the results (average marginal effects) of the model under different dependent variables (fixed classification, time-varying classification) and econometric specifications (controls, controls and year fixed effects). Fixed classification corresponds to the model using as dependent variable the income tax policy categorization computed using data from 2002-2023. See Definition 1. Time Varying classification corresponds to the categorization updated annually. See Definition 2. Standard errors computed using a cluster bootstrap algorithm (clusters by state). A */**/*** indicates significance at the 10%, 5%, and 1% levels, respectively.

rules described at Definition 3. These results align with the estimates at Table 4 where we document a negative marginal effect of federal IG revenues on the probability of being characterized as a net increaser, and viceversa: a positive relationship between dependence on federal grants and the probability of being a net tax decreaser. When expressing these results in terms of the in-sample probability of being assigned to each of these categories, the implied effects suggest an increase of 1.8% on the probability of being characterized as a net tax decreaser and a reduction of 8.6% on the probability of being a net tax increaser.

Table 5: Effect of Federal IG Revenues on Simplified Income Tax Policy Classification

Variable	Net Tax Decreasers (1)	Net Tax Decreasers (2)	Net Tax Increasers (1)	Net Tax Increasers (2)
Federal IG Revenue	0.0078***	0.0059**	-0.0146***	-0.0228***
	(0.0062)	(0.0062)	(0.0054)	(0.0054)
Year FE	No	Yes	No	Yes
Pr(Tax Classification)	0.3198	0.3198	0.2629	0.2629

Note: This table shows the results from Equation 3 estimated using as dependent variable the simplified version of the time-varying classification. See Definition 3. Coefficients show the marginal effect on the probability of being classified into one of the categories (Net Tax Decreaser or Net Tax Increaser) of an increase of federal IG revenues equivalent to one percentage points of fiscal revenues. Standard errors computed using a cluster bootstrap algorithm (clusters by state). A */**/*** indicates significance at the 10%, 5%, and 1% levels, respectively.

6 Discussion and Conclusions

The examination of the long-term trends on income tax policies and the revenue distribution of state governments carried out in this paper reveals some key insights on the influence of federal transfers on state's incentives to increase and decrease personal income taxes. We summarize some of the main takeaways of the descriptive analysis in the following remarks.

Remark 1 (Trends in State top PIT rates) *We document an increase in the number of reductions on the top PIT rates. One way we can rationalize this trend is through the lens of the horizontal competition literature. A decrease on state tax rates could trigger the race-to-the-bottom incentives of tax competition, which could put downward pressures on state tax rates.*

Remark 2 (Role of Federal IG Revenues) *States that observe larger reliance on federal IG revenues had implemented income tax policies that decrease the top PIT rate and viceversa: states with lower reliance on federal IG revenues observe income tax policies that are characterized by tax increases. See Figure 6.*

The econometric models estimated on this paper shed some light both on the contemporaneous effects of federal IG revenues on the probability of tax reforms (i.e. choice models), as well on the long-term dynamics of income tax policies (i.e. classification models). Table 6 summarizes all the results from the regression models

by showing the marginal effects estimated on the specifications including year fixed effects and expresses them in terms of in-sample probability of observing a tax change (i.e. proportion of observations that correspond to tax increase or decrease).

Table 6: Summary of Results

Model	Tax Policy	Marginal Effect (A)	Mean Dep.Var. (B)	Implied Eff (%, C = A/B)
Decision.Mod:Binary Logit	All Tax Changes	-0.007**	0.1396	-5.0143
Decision.Mod:Binary Logit	Tax Decreases	-0.005*	0.1044	-4.7893
Decision.Mod:Binary Logit	Tax Increases	-0.004***	0.0437	-9.1533
Decision.Mod:Multinomial Logit	Tax Decreases	-0.0043**	0.1003	-4.2871
Decision.Mod:Multinomial Logit	Tax Increases	-0.003**	0.0393	-7.6336
Classif.Mod:Long Term	Tax Decreasers	0.0366***	0.4634	7.8979
Classif.Mod:Long Term	Tax Switchers - Net Decreaser	0.0026	0.1463	1.7767
Classif.Mod:Long Term	Tax Switchers - Net Increaser	-0.0302***	0.2927	-10.3183
Classif.Mod:Long Term	Tax Increasers	-0.007*	0.0488	-14.3500
Classif.Mod:Time Varying	Tax Decreasers	0.0072***	0.2900	2.4830
Classif.Mod:Time Varying	Tax Switchers - Net Decreaser	0.000	0.0298	0.0000
Classif.Mod:Time Varying	Tax Switchers - Net Increaser	-0.0138***	0.1436	-9.6079
Classif.Mod:Time Varying	Tax Increasers	-0.0106***	0.1192	-8.8895
Classif.Mod:Time Varying Simplified	Net Tax Decreasers (2)	0.0059**	0.3198	1.8449
Classif.Mod:Time Varying Simplified	Net Tax Increasers (2)	-0.0228***	0.2629	-8.6725

Note: This table summarizes the results of all econometric models. All reported models include year fixed effects. Reported implied effect is computed as the ratio of the marginal effect (A) and the in-sample probability of observing the outcome (mean of dependent variable, B), multiplied by 100 to express in percentage points. To be clear: C = 100*(A/B). Standard errors computed using a cluster bootstrap algorithm (clusters by state). A */**/*** indicates significance at the 10%, 5%, and 1% levels, respectively.

Results from the decision models suggest there is a negative relationship between reliance on federal IG revenues and the probability of changing taxes. In other words, governments are less likely to implement changes on their income tax rates if they draw a larger proportion of their revenues from federal grants. If state governments face some political costs (or transaction costs in general) by changing their income tax policy, then states whose revenues are more dependent on federal grants could be less inclined to undergo income tax reforms so they can avoid these costs.

Furthermore, results from the decision models suggest the negative association

between federal IG revenues and the probability of changing the top PIT rate is larger for tax increases than for tax decreases. For example, the results from the multinomial logit model at Equation 2 imply that an increase in federal IG revenues equivalent to one percentage point of fiscal revenues, lead to a reduction of 0.43 percentage points in the probability of decreasing taxes the next fiscal year. This is equivalent to a contraction of 6.8% of the in-sample probability of decreasing taxes, while the implied effect for tax increases is a reduction of 4.11%.

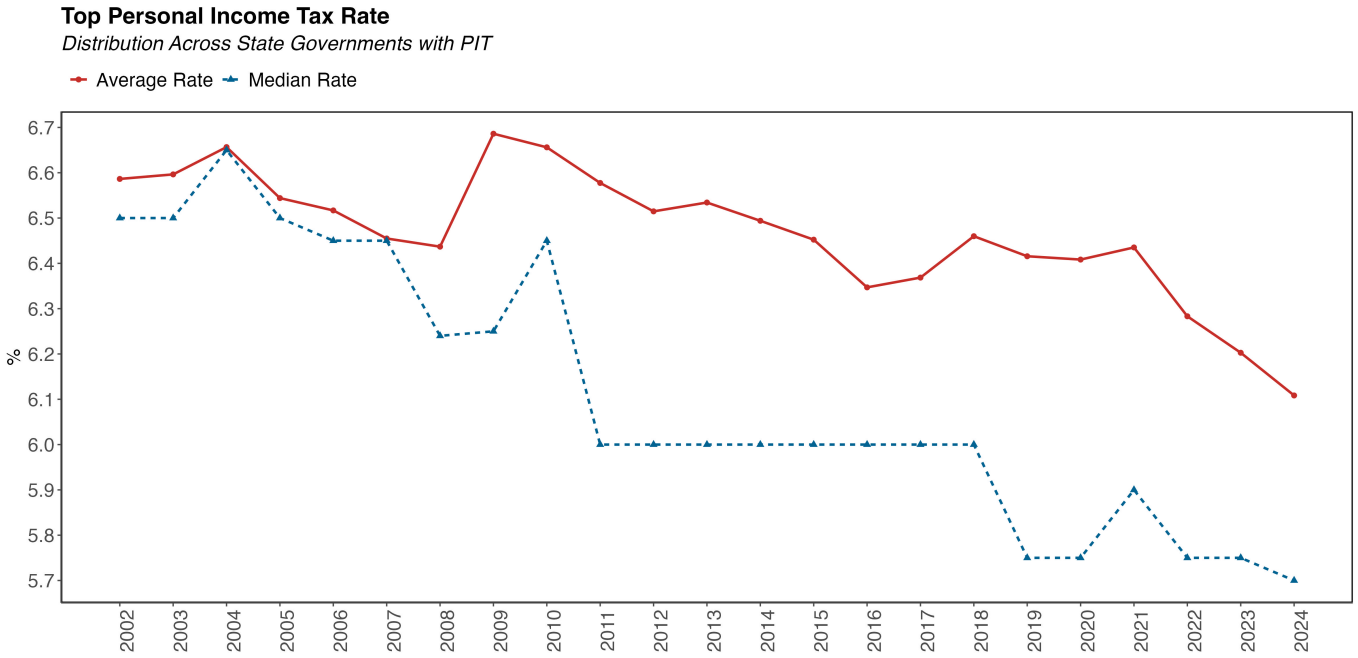
Results from the classification models provide some evidence on the long-term effects of federal IG revenues on state income tax policies. We document heterogeneity on the effect driven by the direction and magnitude of the changes on PIT rates. For example, estimates from the classification model on the time-varying categorization show that an increase on federal IG revenues equivalent to 1% of fiscal revenues, leads to an increase in the probability of being a tax decreaser of 0.72 percentage points (i.e. an implied effect of 2.5%). At the same time, it decreases the probability of being a tax increaser by 1.06% percentage points (i.e. implied effect of 8.9%). Estimates from the model on the long-term classification point in the same direction but suggest larger effects.

This paper provides descriptive evidence on the effect of federal grants to state governments on states incentives to change their income tax rates. While the econometric specification (i.e. lagged covariates and fixed effects structure) aim to address omitted variable concerns, the absence of exogenous variation on federal IG revenues limits the interpretation of our results as causal. Further steps of this research in-

clude exploring changes on specific federal grants that do not systematically affect all state governments. In addition, further research could undergo a more detailed examination of state tax policy reforms and analyze the extent to which changes in top PIT rates were accompanied by changes on the rates across the tax schedule. This could reveal whether these reduction on income taxes has led to improvements on the vertical equity of the tax system.

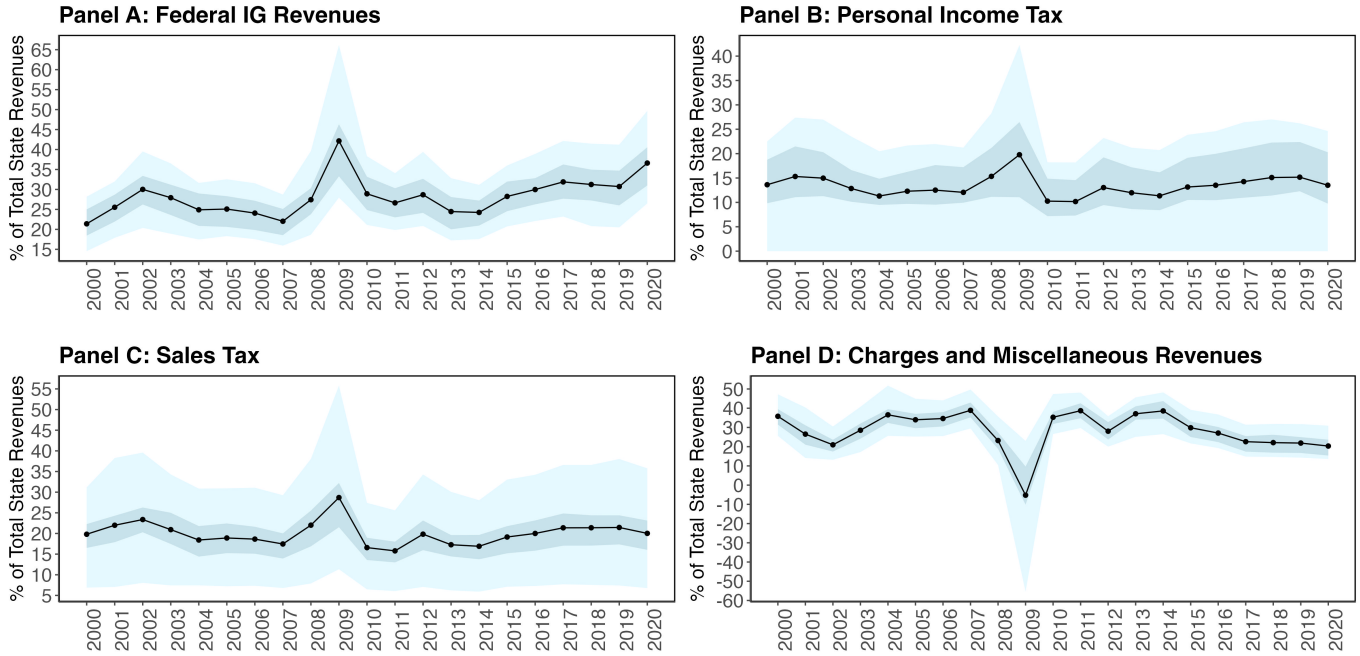
7 Appendix

Figure 5: Trends on the top PIT Rate



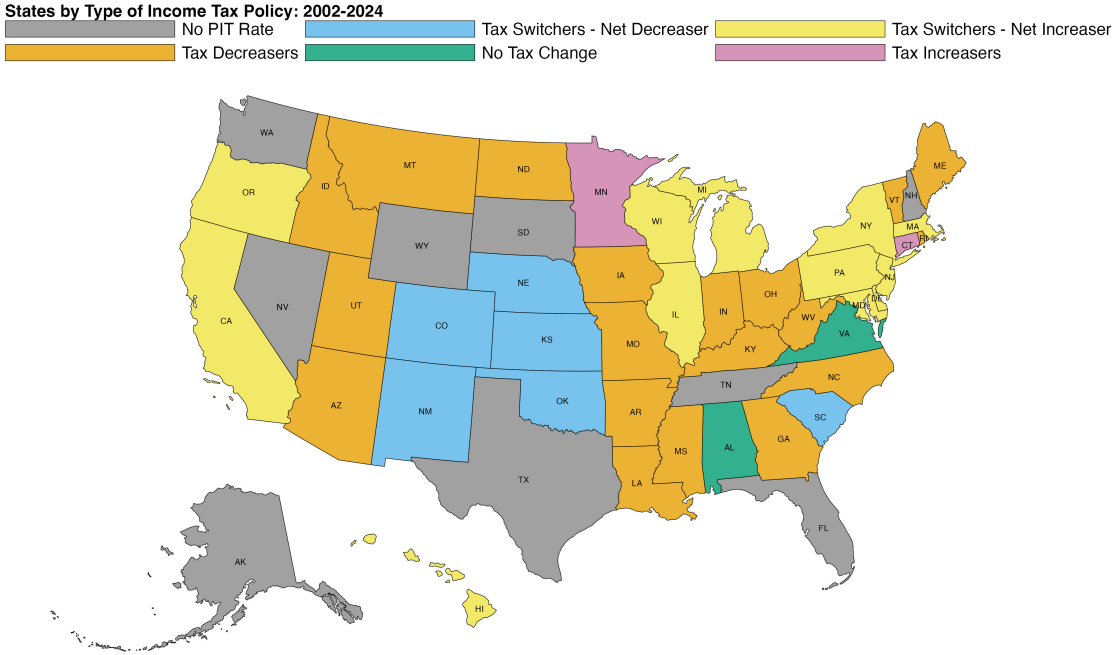
Note: This graph shows the average (red solid) and median (blue dashed) top PIT rate across all the state governments that levy an income tax.

Figure 6: Distribution of Federal IG Transfers and Personal Income Tax Revenues across states



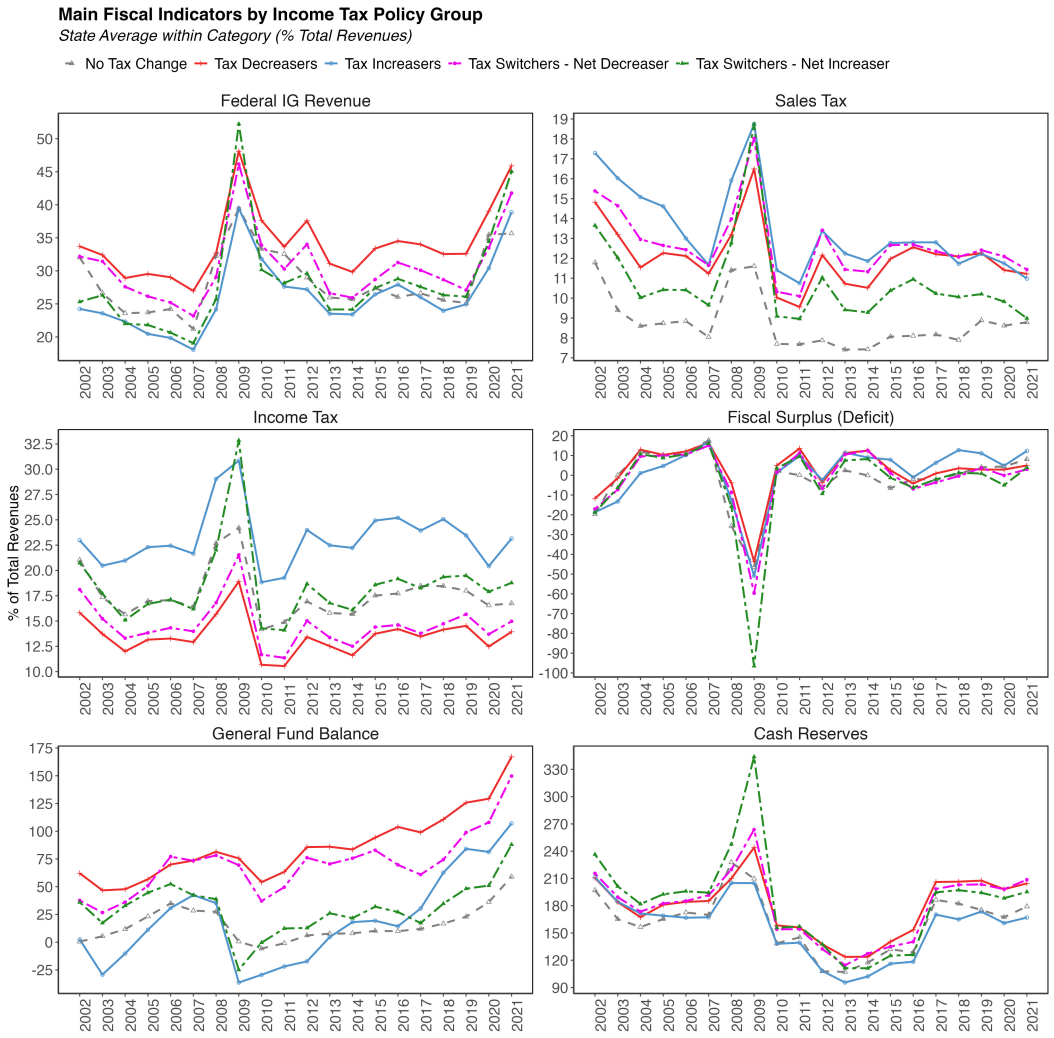
Note: These panels show the distribution of the main revenue categories of state governments. Each panel shows the distribution of a revenue variable across states and years. All variables are expressed as percentage of total fiscal revenues. The solid line represents the average of the variable across states on any given year. The darker shaded area shows the 25% and 75% percentiles of the distribution across states. The lighter shaded shows the area surrounding the 5% and 95% percentiles of distribution across states.

Figure 7: Long Term Income Tax Policy Classification



Note: this map shows the long-term classification of states income tax policy using the categorization algorithm described at Section 5.

Figure 8: Main Fiscal Indicators by Income Tax Policy Classification



Note: These panels show the average of the main fiscal indicators across the tax policy groups defined using Definition 1. All variables are expressed as percentage of state total revenues. States without a PIT rate are excluded.

7.1 Decision Models on the Probability of Tax Change

7.1.1 Binary Probability Model

Table 7: Coefficient Estimates on the Probability of Tax Change - Full Sample

Variable	(1)	(2)	(3)	(4)
Federal IG Revenue	-0.003	-0.006**	-0.003	-0.007**
	(0.003)	(0.003)	(0.002)	(0.003)
Sales Tax	0.004**	0.006**	0.004**	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)
Unemployment Rate	0.001	-0.001	0.001	0.002
	(0.009)	(0.012)	(0.009)	(0.012)
Cash Reserves (% Revenue)	0.001**	0.001***	0.000**	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Republican Governor	-0.003	0.002	-0.003	0.005
	(0.034)	(0.033)	(0.033)	(0.034)
Republican House	-0.008	-0.018	-0.008	-0.016
	(0.034)	(0.035)	(0.034)	(0.035)
N	738	738	738	738
Mean Dep Var	0.1396	0.1396	0.1396	0.1396
Year FE	No	Yes	No	Yes
Estimator	OLS	OLS	Logit	Logit

Note: This table shows the marginal effects of an increase on Federal IG Revenues equivalent to 1% of state's fiscal revenues on the probability of changing their top PIT rate. **Model estimated on the full panel of states from 2002-2019**. Columns (1)-(3) show the coefficients from Equation 1 using an OLS estimator. Columns (4)-(6) show the results from a logistic regression. Panel A shows results from estimating the models on the full sample. Standard errors are clustered at the state level. A */**/*** indicates significance at the 10%, 5%, and 1% levels, respectively.

Table 8: Coefficient Estimates on the Probability of Tax Change - Tax Increases

Variable	(1)	(2)	(3)	(4)
Federal IG Revenue	-0.001	-0.003	-0.002**	-0.004***
	(0.001)	(0.002)	(0.001)	(0.001)
Sales Tax	0.005***	0.005***	0.004***	0.003**
	(0.002)	(0.002)	(0.001)	(0.001)
Unemployment Rate	0.008*	0.007	0.007**	0.006
	(0.004)	(0.005)	(0.003)	(0.004)
Cash Reserves (% Revenue)	0.000**	0.000**	0.000**	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Republican Governor	-0.025	-0.024	-0.021	-0.021
	(0.017)	(0.015)	(0.015)	(0.014)
Republican House	-0.050***	-0.056***	-0.052***	-0.057***
	(0.016)	(0.017)	(0.016)	(0.016)
N	664	664	664	664
Mean Dep Var	0.0437	0.0437	0.0437	0.0437
Year FE	No	Yes	No	Yes
Estimator	OLS	OLS	Logit	Logit

Note: This table shows the marginal effects of an increase on Federal IG Revenues equivalent to 1% of state's fiscal revenues on the probability of changing their top PIT rate. **Model estimated on the full panel of states from 2002-2019, excluding observations with a negative tax change**. Columns (1)-(3) show the coefficients from Equation 1 using an OLS estimator. Columns (4)-(6) show the results from a logistic regression. Panel A shows results from estimating the models on the full sample. Standard errors are clustered at the state level. A */**/*** indicates significance at the 10%, 5%, and 1% levels, respectively.

Table 9: Coefficient Estimates on the Probability of Tax Change - Tax Decreases

Variable	(1)	(2)	(3)	(4)
Federal IG Revenue	-0.002	-0.004*	-0.002	-0.005*
	(0.002)	(0.002)	(0.002)	(0.002)
Sales Tax	0.000	0.001	0.000	0.001
	(0.002)	(0.003)	(0.002)	(0.003)
Unemployment Rate	-0.006	-0.008	-0.007	-0.004
	(0.008)	(0.012)	(0.009)	(0.012)
Cash Reserves (% Revenue)	0.000	0.001*	0.000	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)
Republican Governor	0.017	0.021	0.018	0.022
	(0.029)	(0.030)	(0.029)	(0.032)
Republican House	0.037	0.028	0.037	0.029
	(0.034)	(0.034)	(0.033)	(0.035)
N	709	709	709	709
Mean Dep Var	0.1044	0.1044	0.1044	0.1044
Year FE	No	Yes	No	Yes
Estimator	OLS	OLS	Logit	Logit

Note: This table shows the marginal effects of an increase on Federal IG Revenues equivalent to 1% of state's fiscal revenues on the probability of changing their top PIT rate. **Model estimated on the full panel of states from 2002-2019, excluding observations with a positive tax change**. Columns (1)-(3) show the coefficients from Equation 1 using an OLS estimator. Columns (4)-(6) show the results from a logistic regression. Panel A shows results from estimating the models on the full sample. Standard errors are clustered at the state level. A */**/*** indicates significance at the 10%, 5%, and 1% levels, respectively.

7.1.2 Multinomial Model Probability Model

Table 10: Multinomial Logit Model on Tax Changes - Marginal Effects on Explanatory Variables

Variable	Tax Decrease (1)	Tax Decrease (2)	Tax Increase (1)	Tax Increase (2)
Federal IG Revenue	-0.0021	-0.0043**	-0.0016*	-0.003**
	(0.002)	(0.0025)	(0.001)	(0.0013)
Cash Reserves (% Revenue)	0.0001	0.0006**	0.0002*	0.0003**
	(0.0003)	(0.0004)	(0.0001)	(0.0001)
Sales Tax	-0.0008	0.0003	0.0033**	0.0029**
	(0.0024)	(0.003)	(0.0019)	(0.002)
Unemployment Rate	-0.007	-0.0047	0.006*	0.0054
	(0.0088)	(0.0131)	(0.0026)	(0.0047)
Republican Governor	0.0193	0.0229	-0.0177	-0.0166
	(0.0288)	(0.0319)	(0.0143)	(0.0143)
Republican House	0.04*	0.0335	-0.0484***	-0.052***
	(0.0331)	(0.0353)	(0.0156)	(0.017)
Year FE	No	Yes	No	Yes
Pr(Tax Change)	0.1003	0.1003	0.0393	0.0393

Note: Columns Tax Dec and Tax Inc show the exponential-transformation of the coefficient estimates ($\exp \beta$) on the effect of Federal IG Revenues on the probability of choosing to decrease and increase the top PIT rate, respectively. In both cases, the probability is relative to keeping them constant (reference category). Tax Dec (1) and Tax Inc (1) show the results from estimating Equation 2 using a multinomial logit model. Tax Dec (2) and Tax Inc (2) add year dummy variables to the estimating equation. Standard errors are clustered at the state level and are computed using a cluster-bootstrap algorithm. Reported standard errors correspond to the raw coefficient estimates, not the reported exponential transformation. A */**/*** indicates significance at the 10%, 5%, and 1% levels, respectively. Pr(Tax Change) shows the in-sample proportion of tax changes.

7.2 Income Tax Policy Classification Models

Table 11: Income Tax Policy Classification - Marginal Effects on Explanatory Variables

Model	Tax Decreasers	Tax Switchers Net Decreaser	Tax Switchers Net Increaser	Tax Increasers
Fixed Class.				
Federal IG Revenue	0.0366***	0.0026	-0.0302***	-0.007*
	(0.0049)	(0.0045)	(0.0078)	(0.0067)
Cash Reserves (% Revenue)	-0.0012**	0.0001	0.0021***	-0.0005*
	(0.0011)	(0.0014)	(0.0013)	(0.001)
Sales Tax	-0.0012	0.0065	-0.0001	0.0033
	(0.0151)	(0.011)	(0.0204)	(0.0168)
Unemployment Rate	-0.0489***	-0.0358***	0.0794***	0.0028
	(0.0478)	(0.0489)	(0.0447)	(0.036)
Republican Governor	0.0602	0.0266	-0.1013***	-0.0113
	(0.0622)	(0.0528)	(0.0411)	(0.0349)
Republican House	0.1827***	0.0223	-0.2376***	-0.0211
	(0.0783)	(0.0965)	(0.095)	(0.0827)
Pr(Tax Classification)	0.4634	0.1463	0.2927	0.0488
Time Varying Class.				
Federal IG Revenue	0.0072***	0.000	-0.0138***	-0.0106***
	(0.0062)	(0.0032)	(0.0066)	(0.0059)
Cash Reserves (% Revenue)	0.0008**	-0.0005**	0	0.0011***
	(0.001)	(0.0005)	(0.0006)	(0.0008)
Sales Tax	0.0069*	-0.002	-0.0058**	0.0074*
	(0.0133)	(0.0041)	(0.0064)	(0.0122)
Unemployment Rate	-0.019	-0.0233**	0.0661***	-0.0202**
	(0.0365)	(0.0315)	(0.0241)	(0.0275)
Republican Governor	0.0718*	-0.0051	-0.0255	-0.0173
	(0.0496)	(0.0182)	(0.0475)	(0.0381)
Republican House	0.0899**	0.0479***	-0.0957***	-0.1573***
	(0.0729)	(0.0412)	(0.0557)	(0.0665)
Pr(Tax Classification)	0.29	0.0298	0.1436	0.1192

Note: This table shows the results from Equation 3. Columns show the categories (alternatives) of the classification model. Rows show the results (average marginal effects) of the model under two dep. variables (fixed classification, time-varying classification). Fixed classification corresponds to the model using as dependent variable the income tax policy categorization at Definition 1. Time Varying classification corresponds to the categorization updated annually under Definition 2. Reported results correspond to the models with year fixed effects in both cases. Standard errors computed using a cluster bootstrap algorithm (clusters by state). A */**/*** indicates significance at the 10%, 5%, and 1% levels, respectively.

7.3 Linear Model on the Tax Rate

As a robustness check, we estimate a linear regression model using a the top PIT rate as the main dependent variable. We preserve the econometric specification at Equation 1. Similarly, the model is estimated using a fixed effects estimator, considering both state and year fixed effects, and statistical inference is done assuming clustered standard errors at the state level.

$$taxrate_{i,t+1} = \alpha + \theta FedIGRev_{it} + X_{it}\beta + a_i + b_t + e_{it} \tag{4}$$

We estimate this model in the full sample of states and on independent sub-samples of states determined by the long-term categorization of income tax policy. This allow us to estimate the effect of federal IG revenues on top PIT rates across states that follow similar income tax policies. The rationale behind this approach is to analyze the correlation of federal IG revenues on top PIT rates across states with similar approaches to income tax policy. If there is heterogeneity driven by long-term trends on income taxes, then coefficients on these sub-samples should shed some light on these differences.

7.3.1 Estimation Results

Table 12 shows the results of this estimation. Each Panel on this table shows the coefficient estimates on the sub-sample of states within each tax policy category. While most coefficients suggest a negative association, these results are noisy and hence should be interpreted with caution.

Table 12: Effect of Federal IG Revenues on States top PIT rate

Category	(1)	(2)	(3)
No Tax Change	-0.010	-0.017***	0.000
	(0.010)	(0.000)	
N	36	36	36
Mean Dep Var	0	0	0
Tax Decreasers	-0.019	-0.019	0.007
	(0.027)	(0.043)	(0.011)
N	342	342	342
Mean Dep Var	0.1199	0.1199	0.1199
Tax Switchers - Net Increaser	-0.077	-0.141+	-0.048
	(0.051)	(0.069)	(0.032)
N	216	216	216
Mean Dep Var	0.1806	0.1806	0.1806
Tax Switchers - Net Decreaser	-0.002	0.027	-0.030*
	(0.022)	(0.041)	(0.008)
N	108	108	108
Mean Dep Var	0.1667	0.1667	0.1667
Tax Increasers	0.082	0.144***	0.097***
	(0.023)	(0.000)	(0.000)
N	36	36	36
Mean Dep Var	0.1389	0.1389	0.1389
Year FE	No	Yes	Yes
State FE	No	No	Yes

Note: This table shows the coefficient estimates on the effect that federal IG revenues have on the state top PIT rate. We present 5 sets of estimates of θ from Equation 4 using a fixed effects estimator. Each set of coefficients correspond to the estimation of the model on the subset of states according to the long-term classification of their income tax policy. Standard errors are clustered at the state level. A */**/*** indicates significance at the 10%, 5%, and 1% levels, respectively.

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