The Structure of State Corporate Taxation and its Impact on State Tax Revenues and Economic Activity*

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Abstract

This paper documents facts about the state corporate tax structure — tax rates, base rules, and credits — and investigates its consequences for state tax revenue and economic activity. We present three main findings. First, tax base rules and credits explain more of the variation in the state corporate tax revenue than tax rates. Second, although states typically do not offset tax rate changes with base and credit changes, the effects of tax rate changes on tax revenue and economic activity depend on the breadth of the base. Third, as states have narrowed their tax bases, the relationship between tax rates and tax revenues has diminished. Overall, changes in state tax bases have made the state corporate tax system more favorable for corporations and are reducing the extent to which tax rate increases raise corporate tax revenue.

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How states tax businesses has received renewed interest in both academic and policy circles. Recent work on state corporate tax rates has investigated their impacts on income growth, employment, and business location.[1] However, state policymakers compete to attract businesses not only by changing tax rates, but also by changing the tax base to enhance several investment incentives, loss provisions, and enforcement mechanisms.[2] There is a lack of basic facts about the state corporate tax structure, its evolution over recent years, and how it impacts tax revenue and economic activity. This paper describes the state corporate tax structure, documents how it has changed over time, and investigates the consequences of these changes for state tax collections and economic activity.

Our analysis proceeds in four steps. We first describe recent trends in tax rates and thirteen components of the corporate income tax structure.[3] While average state corporate tax rates have remained relatively stable, state corporate tax revenues as a share of economic activity have declined substantially. Some of this decline is due to other factors (e.g., the rise of pass-throughs (Cooper et al., 2015) and corporate losses (Auerbach and Poterba, 1987)), but we show that tax base and credit changes have substantial impacts on state corporate tax collections. Tax base and credit changes are much more frequent than tax rate changes. Contrary to the view that state tax rate changes are often accompanied by offsetting changes in the tax base, we find that the vast majority of tax base changes are not associated with tax rate changes. Some provisions, such as R&D credits, investment tax credits, and loss carry forward rules, have become more favorable for corporations and others (e.g., throwback rules and combined reporting) have lead to broader bases.

Second, we estimate the importance of each of these tax base and credit rules for state corporate tax collections from 1980 and 2010. We perform analysis of variance decompositions every 5-years and document the importance of tax base rules and credits, relative to tax rates, in explaining the variation in corporate tax revenue across states. Overall, tax base components account for more than 75% of the explained variation in tax revenues. This fraction remains relatively stable during most of our sample, with only a slight increase in the fraction explained by tax rates in 2010. The importance of different tax base controls in explaining tax revenues has evolved over our sample. In particular, payroll apportionment weights and loss carry-back provisions have waned in importance, while franchise taxes, different depreciation rules, and interactions with federal tax policies, such as adopting the federal tax base or allowing for the deductibility of federal taxes, have increased their share of explained variance.

Third, we explore the degree to which controlling for these tax base provisions affects the relationship between tax rates and revenue and state GDP. We find that, while tax base controls explain a large portion of the variation in revenues, the relationships between tax rates and our outcomes of interest are not fundamentally affected by controlling for these tax base measures. This result may be due to the lack of a temporal coincidence

[1] Recent papers include Heider and Ljungqvist (2014), Giroud and Rauh (2015), Suárez Serrato and Zidar (2016), Fajgelbaum et al. (2015), Ohrn (2016), and Ljungqvist and Smolyansky (2014).

[2] These tax base rules are important determinants of measures of state business climate indexes. For instance, Tax Foundation (2016). ALEC (2014) reports that 14 states changed taxes in 2014 with many of the changes affecting both tax rates as well as tax base determinants.

[3] The thirteen determinants of the corporate income tax structure that we analyze include tax credits, such as the investment tax credit and the R&D tax credit. For simplicity, we refer to these credits as determinants of the tax base, along with our other tax base measures.

between changes to tax rates and determinants of the tax base.

Fourth, we allow for the effects of tax rates to depend on the tax base and credits. We find that states with narrower tax bases collect less revenue from marginal increases in tax rates. Not accounting for tax-base-driven-heterogeneity results in biased estimates of the effects of tax rate changes on state corporate tax revenue. While some states broadened the base (e.g., Michigan, Ohio, Illinois), we observe narrower tax bases on average. We find that tax-base-driven-heterogeneity has diminished the relationship between tax rates and tax revenues in a way that varies substantially across states and over time. Specifically, despite the increased adoption of combined reporting and throwback rules in some states, several provisions, such as R&D credits and depreciation rules, have reduced the effect of state corporate tax rate increases on state corporate tax revenue as a share of state GDP. Overall, changes in state tax bases have made the state corporate tax system more generous towards corporations, and are reducing the extent to which tax rate increases raise corporate tax revenue.

This paper contributes to three literatures. First, relative to recent work on the effects of changes in state business tax rates on economic activity (Heider and Ljungqvist (2014), Giroud and Rauh (2015), Suárez Serrato and Zidar (2016), Fajgelbaum et al. (2015), Ohrn (2016), and Ljungqvist and Smolyansky (2014)), we explore how the relationships between tax rates and revenues and economic activity depend on the structure of the corporate tax system. A contribution of this paper is the collection and description of comprehensive set of variables that describe the structure of the corporate tax system across all U.S. states since 1980, which we hope will aid future researchers in this literature. In a contemporaneous contribution, Bartik (2017) simulates the tax consequences of locating a new plant in 32 states and 45 industries that cover roughly 90% of the US economic activity since 1990. These simulations are highly detailed and capture complex interactions between several rules. We view this paper as highly complementary to ours, which takes a reduced-form empirical approach. Specifically, we do not conduct similar simulations at the plant level, but do variance decompositions of observed state corporate tax revenue as a share of state GDP to understand the quantitative importance of different base provisions for state tax revenue. Bartik (2017) also documents several facts about changes in incentives and finds that business incentives are large, vary substantially across states, and have become increasingly generous. Consistent with these results, we document substantial variation across states and a general narrowing of the base on average in the full panel of 50 states since 1980.

Second, this paper is also related to a set of papers that explore whether tax base changes affect the relationship between corporate tax rates and corporate income tax revenues. In particular, Clausing (2007), Devereux (2007), and Kawano and Slemrod (2015) study this relationship across 29 OECD member countries, and Dahlby and Ferede (2012) perform a similar analysis across Canadian provinces. We follow Kawano and Slemrod (2015) by collecting a comprehensive set of variables that describe the breadth of the tax base and by controlling for this tax base vector in our estimations. In contrast to Kawano and Slemrod (2015), who focus on the international corporate tax structure, we find that state tax rate changes are not often offset by base and credit changes.

Finally, we find that the relationship between tax rates and economic activity depends on the structure

of the tax base. This point is related to work by Kopczuk (2005), who finds that the elasticity of reported taxable income for individuals depends on the availability of deductions. In our setting, this dependence on the tax base is important for revenue forecasts and assessments of the incidence and efficiency of state corporate taxation.

The paper is organized as follows. Section 1 describes the dataset of tax base determinants, and Section 2 describes trends in the structure of the state corporate tax system. Section 3 performs the variance decomposition analysis, and Section 4 explores the effects of controlling for tax base determinants on various outcomes of economic interest. Section 5 explores effect heterogeneity across states and over time, and Section 6 discusses policy implications.

1 Measuring the State Corporate Tax Structure

Most of the data used in this paper were digitized from a variety of sources including CCH (1980-2010) and CSG (1976-2011) but we also rely on data collected and generously provided by Chirinko and Wilson (2008), Wilson (2009), and Bernthal et al. (2012). Details of each of the variables, sources, and coverage are available in Appendix A. The following variables comprise our state-year panel dataset of tax base measures: an indicator of having throwback rules, an indicator of having combined reporting rules, investment tax credit rates, research and development tax credit rates, number of years for loss carry backs, number of years for loss carry forwards, an indicator for franchise taxes, an indicator for federal income tax deductibility, an indicator for federal income tax base as the state tax base, an indicator for follows federal accelerated depreciation, an indicator for follows accelerated cost recovery system (ACRS) depreciation, and an indicator for federal bonus depreciation.

Most of the variables are indicators of whether a state allows a particular policy. Loss rules specify the number of years prior to the loss that a corporation may carry back net operating loss as well as the number of years a corporation may carry forward any excess loss following the loss year. Throwback and combined reporting rules come from Bernthal et al. (2012) and describe whether a state requires a unitary business to submit combined reporting and, in the case of throwback rules, whether a state eliminates "nowhere income" that would be untaxed by either the state with the corporation's nexus or the state in which the relevant sales were being made. Finally, data on state investment tax credits and R&D tax credits come from Chirinko and Wilson (2008), and Wilson (2009) and provides the rate of each of these credits. In the case of the R&D credit, the rate we use is the statutory credit rate adjusted for recapture and type of credit.

In addition to our data on tax base measures, we rely on the statutory corporate income tax rate and apportionment weights for payroll, property, and sales that were digitized from CSG (1976-2011). We also use data on additional tax base and credits for a subset of states and years from Bartik (2017), such as property taxes and job creation tax credits.[4] Finally, we use data from Census Bureau (2011) on reported revenues for each state.

We have data on all thirteen of these indicators from 1980, but end dates vary. For eight of the thirteen

[4]See Figures A19, A20, and A21 for variance decomposition results that take Bartik (2017) controls into account for the subset of states and years for which these controls are available.

indicators, data end in 2014. Data on investment tax credits end in 2013; data on sales apportionment weights end in 2012; data on R&D credit rates end in 2011; and data on both throwback and combined reporting rules end in 2010.

2 Trends and Changes in the State Corporate Tax Structure

The structure of state corporate taxation varies widely across states and over time. Figure 1 shows that the statutory corporate income tax rate has varied between 0 and 12%. Five states (Nevada, South Dakota, Texas, Washington, and Wyoming) currently have no taxes on corporate income. As of 2012, another five states (Alaska, Illinois, Iowa, Minnesota, and Pennsylvania) had tax rates above 9%. Figure 1 shows that over the past few decades, very modest increases in the state corporate tax rate distribution across states have been accompanied by substantial declines in the share of total state revenue from state corporate tax revenue. Panel A of Figure 2 shows this pattern directly – average state corporate tax rates are quite stable, but the average state corporate tax revenue of GDP has declined from nearly 0.5% to 0.3%. While part of this decline arises from the shift away from the traditional corporate form (Cooper et al. (2015)), losses and other factors (Auerbach and Poterba (1987)), part of this decline is due to changes in the state corporate tax base.[5]

Table 1 describes the number of changes to each of our tax base measures. Overall, this table shows that there are more changes categorized as narrowing of tax bases than broadening of tax bases, which suggests that an aggregate trend towards narrower bases is partly responsible for the patterns in Figures 1–2. Of these changes, the increase in the number of years allowed for loss carry forwards and the increased reliance on sales as a factor for apportionment are the most active measures in our data.

Table 2 compares changes in the tax base with changes in the tax rate. As the resurgent literature studying the effects of states corporate taxes on economic activity has noted, there have been a considerable number of changes to states' tax rates. This table shows that states have decreased rates in 76 occasions, while increasing rates 205 times, for a total of 281 changes. However, this considerable policy activity pales in comparison to changes to the states' tax bases. Table 2 shows that states have adopted changes that narrow the tax base in 293 occasions, while increasing the base 153 times, for a total of 446 tax base changes.

A widespread belief among economists and policy analysts is that increases in tax rates have relatively small effects on firms' tax obligations, since legislatures often change tax rates and tax bases simultaneously. In particular, if tax increases are accompanied by narrowing of tax bases, firms' effective tax rates will be less susceptible to changes in the statutory rate. Panel B of Figure 2 shows for each year the number of states that change their corporate tax rates and base provisions. Most points fall below the red 45 degree line, illustrating that in almost all years in which states are change their tax base, most of them do not change their tax rates.[6]

Table 2 provides additional evidence that tax rates and tax bases are not temporally related, by showing the number of times that states changed rates and tax bases. This table shows that when states lowered tax

[5] See Bartik (2017) for a detailed industry-state level analysis of business tax incentives since 1990.

[6] Figure A18 shows that this finding is also consistent in recent years and states that coincide with the analysis sample in Bartik (2017).

rates, there was no accompanying change in the tax base in most occasions (49 out of 76). Similarly, when states increased tax rates, there were relatively few occasions when states also changed the tax base (only 24 out of 205). Conversely, Table 2 also finds that when states changed tax bases, these changes were very seldom accompanied by changes in the tax rates (24 out of 293 for base-narrowing changes, and 17 out of 153 for base-broadening changes).[7]

Table 3 formalizes this inference by presenting the results of probit models that estimate the likelihood of a coincidence in base and rate changes. The first panel estimates the probability of a change in tax base as a function of a rate change. This panel shows that changes in tax rates are not predictive of changes in tax bases, and that this pattern is robust to splitting the dependent variable by base-narrowing and broadening events. Panel B estimates the converse relation using changes in tax bases to predict changes in tax rates, which also shows a lack of statistically robust relation. In particular, when we estimate the likelihood of a tax increase, we observe that there is no statistical relation with a state also narrowing the tax base. In all of these estimates, we only find weak evidence of a correlation between a tax decrease and a base narrowing. These results contrast with those of Kawano and Slemrod (2015), who estimate similar models for OECD countries and find statistically significant relations in all categories.

We now describe trends in specific tax base and credit provisions. Figure 3 shows how tax credits, loss rules, other base provisions and apportionment weights have evolved overtime. Panel A of Figure 3 shows that tax credits, especially R&D credits, have become much more generous. Panel B shows that loss carry forward provisions have become more favorable, and loss carry back provisions have remained relatively stable. Figure 4 shows how the distributions of many of these provisions have tended to become more generous over the past four decades. In 1980, research and development credits were rare. Beginning in 1990, some states introduced credits, but the vast majority of these were small – below 5%. R&D tax credits have become more common in the twenty-first century. Many states have increased the size of the credit; as of 2010, a large share of states offer credits even more generous than the most generous provisions in 1990. The data reveal similar patterns for the investment tax credit and loss carry forward provisions, which have on aggregate changed with the result of narrowing the tax base.[8]

In contrast, other dimensions of the tax base have expanded over the past few decades. Panel C of Figure 3 shows an increasing number of states have adopted the federal definition of the state tax base for state tax purposes. This policy choice limits the extent to which state lawmakers can tinker with the tax base, but also puts states at risk of changes in federal policy that may have adverse effects on state tax revenues. The panel also shows a slight increase in the number of states adopting throwback rules that limit the ability of companies to have "nowhere income" under state apportionment rules, especially in later years. Similarly, many states adopted combined reporting rules that strengthen the reporting requirements for unitary businesses. This panel also shows that states have moved away from allowing federal income taxes to be deducted from state taxation. The most notable change is the reduction in the number of states adopting bonus depreciation in the early 2000s, which is likely due in part to the substantial fiscal cost of these provisions in a period of reduced tax

[7] Table A1 provides more detail by describing the co-movement of tax rates and each individual tax base measure.
[8] Figures A1–A15 provide additional detail behind changes in individual tax base measures by state.

revenues (Ohrn, 2016).

Finally, Panel D of Figure 3 shows that states have continued to increase the apportionment weight on sales, and decrease the weights on property and payroll. In 1980, the majority of states placed less than half of the apportionment weight on sales. This share declined steadily until 2010, leaving only 12 states with sales apportionment shares below 50%. Figure 4 depicts this shift and the implications for the payroll apportioned corporate tax rate, which is the product of the statutory corporate tax rate and the payroll weight. Given the secular decline in payroll and property weights, it is not surprising that the range of this distribution is more compressed than the distribution of sales-apportioned corporate rate. However, it is striking that the distribution of the sales-apportioned corporate rate is skewed to the right and has, if anything, become more dispersed in recent years by increasing the density of states with higher sales-apportioned corporate rates.

The structure of the corporate tax system has been an active area for state policymakers. Contrary to conventional wisdom, we do not find evidence of a temporal concomitance in tax rate and tax base changes. While some aspects of the tax base have become more generous for corporations (*e.g.*, loss carry forward provisions and R&D and investment tax credits), changes in other rules have broadened the tax base (*e.g.* throwback and combined reporting rules). The following section explores the degree to which these changes to states' corporate tax systems explain changes in tax revenue.

3 Decomposing Variation in Corporate Tax Revenue

To explore the relationship between state corporate tax revenues as a share state GDP, we decompose R_{st}, state corporate tax revenue as a share of state GDP, into components related to state corporate tax rates, the state corporate tax base, and a residual component.

$$R_{st} = \alpha + \gamma \tau_{st}^{c} + \mathbf{X}_{st}' \mathbf{\Psi}_{st}^{BASE} + u_{st}, \tag{1}$$

where $\mathbf{X}_{st}$ is a vector of tax base and credit controls including the number of years of losses can be carried forward and backward, research and development credits, the payroll apportionment weight, an indicator for federal income deductibility, the investment tax credit, conformity with MACRS depreciation guidelines, federal bonus depreciation rules, federal income as the state tax base, and other tax base rules, as described in Section 1. We can then study the variation in state corporate tax revenue shares by decomposing the variation in these components.

$$Var(R_{st}) = Var(\alpha + \gamma \tau_{st}^{c} + \mathbf{X}_{st}' \mathbf{\Psi}_{st}^{BASE} + u_{st}) \tag{2}$$

where R_{st} is corporate tax revenue as a share of state GDP, and $\mathbf{X}_{st}$ includes state tax rates and several aspects of the state tax base. We begin by estimating the share of the variance in R_{st} which can be explained by these independent variables. We then break this share down into the proportions which can be attributed to each of these variables, to discover whether variation R_{st} is better explained by variation in the tax base and credits or in the tax rate. Finally, we investigate which components of the tax base hold the greatest explanatory power

over variation in R_{st}.

Figure 5 presents the results.[9] Panel A shows that roughly half the variation in corporate tax revenue as a share of GDP across states and overtime can be explained by the state corporate tax structure. Of this explained variation, state corporate tax base and credits explain more of the variation than state corporate tax rates. Panel B and C examine this result further by showing the importance of variation from specific tax base and credit rules. The contribution to the variance from a given base provision j is $Var(x^j_{st}\Psi^j_{st})$, which depends on the variance of the rule x^j_{st} and the magnitude of it's relationship with corporate tax revenue as a share of GDP Ψ^j_{st}. Panel B shows the overall contribution from each rule, i.e., $\frac{Var(x^j_{st}\Psi^j_{st})}{\sum_j Var(x^j_{st}\Psi^j_{st})}$. The five most important rule provisions are using the federal income tax as state base (19%), payroll apportionment weights (15%), throwback rules (11%), the deductibility of the federal income tax (10%), and loss carry forwards (8%). To isolate the importance of variation in the effects of base rules Ψ^j_{st}, we standardize the rules $\tilde{x}^j_{st} = \frac{x^j_{st} - \bar{x}^j_{st}}{\sigma_{x_j}}$ and then regress each standardized rule on revenue as a share of GDP. Panel C shows the results. Each row shows the point estimate of $\tilde{\Psi}^j_{st}$, which is the effect of a one standard deviation increase in the mean zero standardize deviation one tax base measure $\tilde{x}^j_{st}$. Two features of this figure are interesting: the direction and magnitude of each effect. First, Panel C shows, for example, that a one standard deviation increase in payroll apportionment is associated with a 0.3 standard deviation in state corporate tax revenue as a share of GDP. This impact is positive and relatively large compared the overall contribution to the variance shown in Panel B. Most of the base and credit provisions listed are positively related to revenue as a share of GDP, but making the federal income tax liability deductible, loss provisions, and depreciation provisions reduce corporate tax revenue as a share of GDP. Overall, these figures show that tax base and credit rules explain the majority of variation in corporate tax revenues as a share of GDP that can be explained by the state corporate tax structure.

Figure 6 shows that the explanatory power of base and credit rules has evolved over time. Specifically, it shows the share of variation for each 5 year interval from 1980-2010 that can be explained by the state corporate tax structure in Panel A, rates versus base and credit rules in Panel B, and for each base rule in Panel C. The upper left panel shows that the state tax policy parameters explain roughly half of the variation in state corporate tax revenues as a share of state GDP. The upper right panel shows that a larger share of the explained variance is accounted for by state corporate tax base rules. Payroll apportionment weights and loss carry-back provisions were quite important in the first half of the sample period, but more recently federal provisions (such as adopting the federal tax base or allowing for the deductibility of federal taxes have grown in importance), franchise taxes, and loss carry forwards have increased their share of explained variance.

[9] Each decomposition is weighted by mean state GDP across the full period (1980-2010). See Figures A19, A20, and A21 for analogous results that take Bartik controls into account, as well as for unweighted decompositions.

4 Impacts on State Tax Revenue and Economic Activity

We begin with an analysis of the typical path of state outcomes preceding and following a change in the state corporate tax structure. We use an event study specification of the form:

$$Y_{st} = \alpha_s + \gamma_t + \sum_{k \in \{-4,-3,-2,0,1,2,3,4,5\}} \beta_k D_{st}^k + \underline{\beta} \sum_{k<-4} D_{st}^k + \overline{\beta} \sum_{k>5} D_{st}^k + \varepsilon_{st} \quad (3)$$

where D_{st}^k is an indicator for state s having changed the state tax rate k periods in the past, α_s is a state fixed effect, and γ_t is a time fixed effect. The coefficients β_k provide the impact on the time path of mean outcomes relative to the period before the tax rate change (which has been normalized to zero). Additionally, we address imbalance issues by "binning" periods greater than 5 or less than -4, which is reflected in the $\bar{\beta}$ and $\underline{\beta}$ coefficients that are assumed to be stable within end point bins. To address serial correlation in ε_{it}, all standard errors are clustered by state. We consider three main outcomes: log state corporate tax revenue as a share of state GDP, log state corporate tax revenue, and log state GDP.

We fit specifications of this type on our state panel data using data from 1980 to 2010. We also consider specifications that also control for the leads and lags of key components of the tax base. Specifically, we control for leads and lags of the six most important tax base controls in terms of variance shares of corporate tax revenue: federal income tax treated as state base, payroll apportionment weight, throwback rules, federal income tax deductibility, loss carry forward, and investment tax credit.

Figure 7 shows the results for corporate tax cuts and corporate tax increases that exceed a 0.5 percentage point change in the rate in absolute value on log state corporate tax revenue as a share of state GDP, log corporate tax revenue, and log state GDP. Panel A shows that corporate tax decreases that exceed 0.5 percentage point cuts in the rate tend to reduce state corporate tax revenue as a share of state GDP by roughly 10% cumulatively over a 5 year period. Panel B and C show the importance of the numerator and denominator separately. Despite modestly higher economic activity, corporate tax cuts decrease state tax revenue by roughly 10%. The increases in state GDP are imprecise and not statistically different than zero, though the point estimate is roughly 2%. Controlling for the tax base in does not alter these general patterns. The most noticeable impact is in Panel C, which shows less of an impact on economic activity when conditioning on state tax base provisions. Panel D, E, and F show that tax increases have symmetric impacts, though pre-trends are a bit more noticeable prior to state corporate tax increases. Specifically, the event studies in D and E show that tax revenues were also higher preceding the tax increase events by roughly a similar magnitude, so it is not clear that corporate tax revenues actually increase following tax increases. Overall, these point estimates are imprecise but the key finding for our purposes is how they do not depend strongly on base controls on average.

5 Heterogeneous Effects of Tax Rate Changes

The previous section shows that controlling for determinants of the corporate income tax base does not affect the estimated relationship between state taxes and both state GDP and corporate tax revenue. One reason for this result is that, contrary to common belief, states do not seem to adjust the determinants of the state tax base in years when they change tax rates, as discussed in Section 2. This section explores the extent to which tax base determinants lead to heterogeneous effects of tax rate changes.

Economic intuition suggests that changes in corporate tax rates may have differential effects on tax revenue and economic activity depending on the breadth of the tax base. In particular, we would expect that a tax increase will raise less revenue whenever the tax base is relatively narrow. This intuition holds for mechanical effects, since narrow bases by definition tax a smaller share of profits, for reporting responses, since firms in states with narrow bases may respond by adopting new deduction strategies, and for behavioral responses, since firms are less likely to have real responses to a tax increase whenever the tax affects a smaller share of their profits. As a hypothetical example, suppose that California and New York both increase their state corporate tax rates, but suppose further that California has a much more lenient treatment of loss carry-forwards. Firms in California with past losses will face a smaller increase in their effective tax liability as firms in New York, since the tax base in California is narrower. Any behavioral response by firms, such as investment, employment, or relocation, will therefore be more muted in California than in New York. While this example only mentions loss carry forwards, the treatment of other aspects of the tax base, such as depreciation allowances or investment tax credits, may have similar effects in how they modulate the degree to which tax changes affect tax revenue.

The potential of heterogeneous treatment effects raises the specter that estimation approaches that do not allow for this heterogeneity will result in biased estimates of the average effect of taxes on a given outcome. The intuition for this bias is as follows. If states with relatively narrow bases experience a larger number of tax changes than states with broader bases, an OLS estimator will give disproportionate weight to the states with narrow tax bases. Under the hypothesis of homogeneous effects, this is an efficient strategy, since the variance in tax rates in narrow-base states is information that the OLS estimator uses to minimize the sum of least-squares. However, if, as described above, states with narrow bases experience smaller declines in revenues following a tax cut, the OLS estimator will result in an estimate that is more representative of the experience of narrow-base states and, in particular, will not be a consistent estimator for the average effect across states. This type of bias is well known in the econometrics literature (*e.g.*, Wooldridge (2005)), and has been shown to be empirically important across several fields of applied economics (Gibbons, Suárez Serrato and Urbancic, 2014).

We explore the potential for this type of heterogeneity by estimating models of the form:

$$Y_{st} = \alpha_s + \gamma_t + \beta_0 \ln(1 - \tau^c_{st}) + \sum_{k=1}^{13} \beta_k \ln(1 - \tau^c_{st}) \times X^k_{st} + \mathbf{X}'_{st} \mathbf{\Psi}^{BASE}_{st} + u_{st}, \tag{4}$$

where Y_{st} is a given outcome, where we control for determinants of the tax base and for state and year fixed effects, and where we interact the log-corporate tax keep-rate with the determinants of the tax base. We first

standardize the tax base determinants across the estimation sample to facilitate the interpretation of β_0 as the mean effect of $\ln(1-\tau^c)$ on Y.

Table 4 presents our estimations for three outcomes: the revenue-to-GDP ratio, log-GDP, and log-corporate tax revenue. In these estimations we weight observations by the mean GDP in the state over our sample, and the standard errors allow for arbitrary correlation between observations from a given state. We multiply the coefficients in the regression of the revenue-to-GDP ratio by 100 in order to ease the interpretation. Column (1) in the first panel shows that increasing the log-corporate keep-rate by 1% lowers revenue by 1.6 basis points of GDP. Column (2) shows that including our 13 base controls results in a very similar estimate. This result aligns with those of the previous sections, and dispels the notion that the main concern in estimating these models is one of omitted variable bias. Nonetheless, given the explanatory power of the base controls, including them in the regression increases the precision of the estimated effect of taxes on the revenue-to-GDP ratio. Column (3) reports results from the full model with interactions in Equation 4. The mean effect β_0 is estimated to be -2.5, and is statistically significant at the 1%-level. This effect is more than 60% larger in absolute magnitude than the estimate that does not allow for heterogeneous effects, which is strong evidence that the OLS estimator is not a consistent estimator for the average effect across states. A second interpretation of this quantity is that, given a mean value of the revenue-to-GDP ratio of 3.5 basis points, this coefficient represents an elasticity of the revenue-to-GDP ratio to the corporate keep-rate of $-0.7(\approx \frac{-2.456}{3.5})$.

For a given state with a tax base described by $\mathbf{X}_{st}$, the total effect of $\ln(1-\tau^c)$ on Y is given by:

$$\beta_Y(\mathbf{X}_{st}) = \beta_0 + \sigma \underbrace{\sum_{k=1}^{13} \frac{\beta_k}{\sigma} X_{st}^k}_{\text{Joint Interactions}}, \tag{5}$$

where σ equals the standard deviation of $\sum_{k=1}^{13} \beta_k X_{st}^k$. The joint interaction term has mean zero, following the normalization of the X_{st}^k's, and the term σ ensures that the joint interaction term has a unit-standard deviation.[10] The specification in Equation 5 has two main advantages. First, the joint interaction term is a useful data-reduction measure that captures the variation across 13 bases in a single index. Second, the statistical significance of the the total effect $\beta_Y(\mathbf{X}_{st})$ for a given state depends on the covariance matrix of the individual β_k terms. While it is hard to evaluate the joint statistical importance of these interactions from individual coefficients, the joint interaction term collapses the covariance structure and allows for a simple univariate statistical analysis.

Column (3) of Table 4 reports the coefficient on the joint interactions, and shows that that these interactions are statistically significant. To interpret the magnitude of this effect, note that, in a corporate tax structure with a joint interaction that is two standard deviations from the mean, the total effect on revenue-to-GDP from increasing $\ln(1-\tau^c)$ is close to zero. Conversely, a state with a joint interaction term that is two standard deviations below the mean would see a fall in revenue that is approximately twice as large as the effect at the

[10] We estimate the β_k parameters in a first stage to generate the joint interaction term, and we report the individual interactions between each of the tax base controls and $\ln(1-\tau^c)$ in Tables A2-A3. By construction, the estimate of β_0 is not affected by this procedure. Note also that, without the standardization of the joint interaction term, we would obtain a coefficient of unity on this variable.

mean.[11]

The second and third panels in Table 4 report the effects of $\ln(1-\tau^c)$ on log-GDP and log-revenue. These panels show that controlling for the tax base does not have large effects on our estimates of β_0. While an increase in $\ln(1-\tau^c)$ both reduces revenue and increases GDP, we find that the effects on revenue are a larger driver of the net effect on the revenue-to-GDP ratio. In addition, these panels also show that both state GDP and state tax revenue are subject to statistically significant joint interactions between $\ln(1-\tau^c)$ and the tax base.

Figure 8 describes how each of the interaction terms contributes to the joint interaction term for each outcome. Panel A plots the fraction of the variation in the total effect $\beta_Y(\mathbf{X}_{st})$ for each outcome that is driven by each of the base controls. Each contribution in this graph is driven by the coefficient of each interaction term, as well as by the number of tax bases changes for each control. This figure shows that the heterogeneous effects for the revenue-to-GDP ratio are driven mostly by the R&D tax credit, the presence of a franchise tax, the allowance for federal accelerated depreciation, and the deduction of federal taxes. Of these four policies, this figure shows that the contribution of the franchise tax and the allowance for federal depreciation are driven by heterogeneous effects on corporate revenue, while the allowance for the deductibility of federal taxes has a larger effect on GDP. Panel B splits this decomposition by 5-year intervals, and shows that the importance of the franchise tax and the deductibility of federal taxes has waned over time, while the importance of the allowance for federal accelerated depreciation and the R&D tax credit has grown in importance over time.

We now evaluate how these heterogeneous effects modulate the revenue response to changes in the corporate tax rate across states and time periods. Figure 9 plots the average value of $\beta_Y(\mathbf{X}_{st})$ across states in a given year t, and shows that changes in tax bases between 1980 and 2000 diminished the effect of taxes on revenue. Consistent with the descriptive evidence in favor of narrowing tax bases in Section 2, this figure shows that tax cuts lead to smaller reductions in 2000 than in 1980. This figure also shows that this pattern is slightly reversed during the 2000's. The adoption of combined reporting, that tighten the reporting requirements for unitary businesses, and of throwback rules, that limit the extent to which firms can have "nowhere income" under the apportionment system, may be partly due to the reversal, as the increased adoption during the 2000's represented a shift towards a broader tax base.

The patterns in Figure 9 may represent average trends across states, but they may also represent different experience across states with expanding or contracting bases. Figure 10 plots the estimated total effect $\beta_Y(\mathbf{X}_{st})$ for four selected states during our sample period. Delaware is an example of a state that saw a decrease in the tax base, which is reflected by a decrease in the effect of a tax cut on revenue over time. This pattern is due to changes to the Delaware corporate tax base in the late 1990's that led to an increase in the number of years allowed for loss carry-forwards, and by the adoption of a generous R&D tax credit. In contrast, Michigan is an example of state that saw a broadening of the tax base as it disallowed the MACRS depreciation rule, as well as the allowance of federal accelerated and bonus depreciation rules. In addition, the adoption of throwback and combined reporting rules in the late 2000's further broadened the tax base. As a result, the second panel in

[11] Table A4 shows that these results are robust to including lagged values of the tax, base controls, and interaction terms.

Figure 10 shows that revenue became more responsive to changes in tax rates in the later years of our sample. Pennsylvania and Rhode Island are examples of states whose experience mirrors the reversal pattern observed on average across states. Pennsylvania saw a narrowing of the tax base in the 1990's following increases in the number of years allowed for loss carry-forwards, as well as the introduction of R&D and investment tax credits. The reversal in this trend was due to a reduction in the investment tax credit and the introduction of throwback and combined reporting rules in the 2000's. In the case of Rhode Island, the narrowing of the base was due to the introduction of R&D and investment tax credits, and the reversal was due to the disallowance of federal bonus depreciation.[12]

Figure 11 compares the estimated effect across all states in 1985 and 2005. These maps are consistent with the trends in Figure 9, as the map in 2005 has more states with effects closer to zero. However, this average effect masks considerable heterogeneity in experiences across states. In addition to Michigan, other mid-western states including Wisconsin, Ohio, and Illinois saw a broadening of the tax base between 1985 and 2000. In contrast several other states including California, Oregon, Florida, and Massachusetts saw a narrowing of the tax base, as evidenced by the diminished effects of taxes on corporate tax revenue.

The results of this section have important implications for both policy analysts and empirical economists. For policy analysts, these results show that the effects of taxes depend on the structure of the corporate tax base. In particular, revenue predictions that do not take into account changes in the tax base may provide misleading guidance. For empirical economists, this section reinforces the result that tax bases are not a source of omitted variable bias in empirical studies. Instead, the results point to a different bias that arises when estimators do not account for the heterogeneous effects of tax changes with respect to the tax base. In our case, we find an average effect that is more than 60% different from standard OLS estimates.

6 Discussion of Policy Implications

This paper has established several facts detailing how tax rates, base rules, and credits determine the structure of the state corporate tax system. We find that changes to tax base rules and credits are more common than changes in tax rates, and that changes in tax base rules are not enacted to temporally offset changes to tax rates. Further, we show that changes in tax base rules and credits play a more important role in explaining patterns in the revenue-to-GDP ratio across states than do changes in tax rates. We document trends in individual tax base rules over time and provide evidence that, while some states have narrowed their tax bases by adopting combined reporting and throwback rules in recent years, most other measures of the tax base point toward a narrowing of the tax base. We analyze the role that tax base rules play in the estimation of the effects of tax rates on tax revenues and economic activity, and find that controlling for these rules does not affect the estimated effects. Instead, we show that accounting for heterogeneous effects of tax changes that depend on the structure of the corporate tax system is important both to obtain consistent estimates of the average effect of changing taxes, and to more precisely forecast the revenue response of individual states with different

[12] Further insight can be gained by comparing the estimated effects in Figure A24 with the base changes by state in Figures A3-A15.

corporate tax systems.

These findings have important implications for policy analysis. First, it is worth pointing out that, while changes in tax rates receive public and media attention, changes in state tax bases may have larger effects on revenue and may also modulate the effects of state corporate tax rates on revenue and economic activity. For this reason, the public debate should place relatively more attention to policy changes that affect the structure of state corporate taxation, and not only the statutory tax rate.

Second, given the large effects of the structural of the tax base on corporate tax revenue, state policymakers should be careful to use these policies to accomplish particular goals. States that are able to attract businesses for non-tax reasons may prefer to have a lower tax rate and a broader base by, for instance, adopting the federal income tax base as their own. States wishing to increase investment may depart from this strategy by using tax credits or generous depreciation allowances to encourage investment, but they may see substantial declines in revenue. Finally, states wishing to attract or retain businesses at any cost may craft a treatment of loss carry forwards that is very favorable to existing businesses. Policymakers would likely benefit from further research outlining the relative success of these strategies.

Third, as states structure the taxation of corporate income for their particular needs and objectives, state policymakers should bear in mind that changes to the structure of state corporate taxation will influence the distortionary costs of increasing the state corporate tax rate. In particular, we find that when states narrow the tax base, they also diminish the relation between tax rates and corporate tax revenue. By making it harder to raise tax revenue from corporations, it is also likely that state policymakers will be forced to raise revenue from other sources including sales taxes, property taxes, or personal income taxes, or to reduce spending in public goods.

Future work can explore the degree to which tax base determinants affect the incidence of the state corporate income tax by extending the framework in Suárez Serrato and Zidar (2016) to allow for deductions that may affect the response of firms to tax rate changes. Intuitively, a narrower tax base lowers the benefits of a tax cut to business owners as they only pay taxes on a smaller fraction of profits. As there is a smaller benefit from the tax cut, firms are less likely to enter a particular location, which will also mute the effect of the tax cut on employment, wages, and costs of living. Whether the decrease in firm entry is larger than the decrease in the real wage and employment will determine whether the incidence of a state income tax cut is borne by workers of by firm owners.

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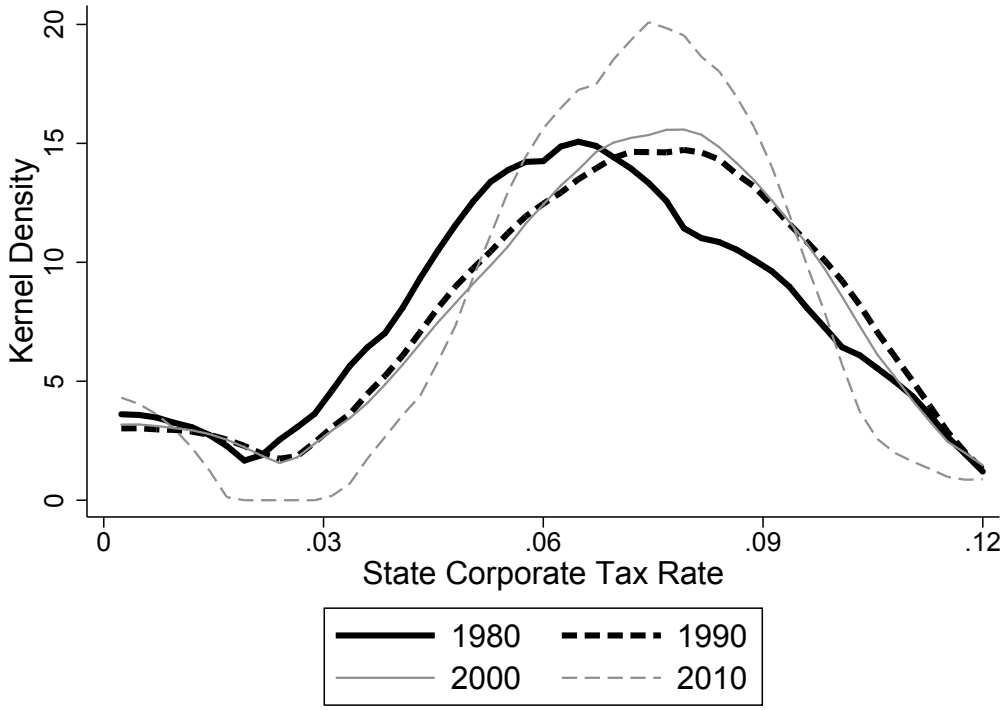
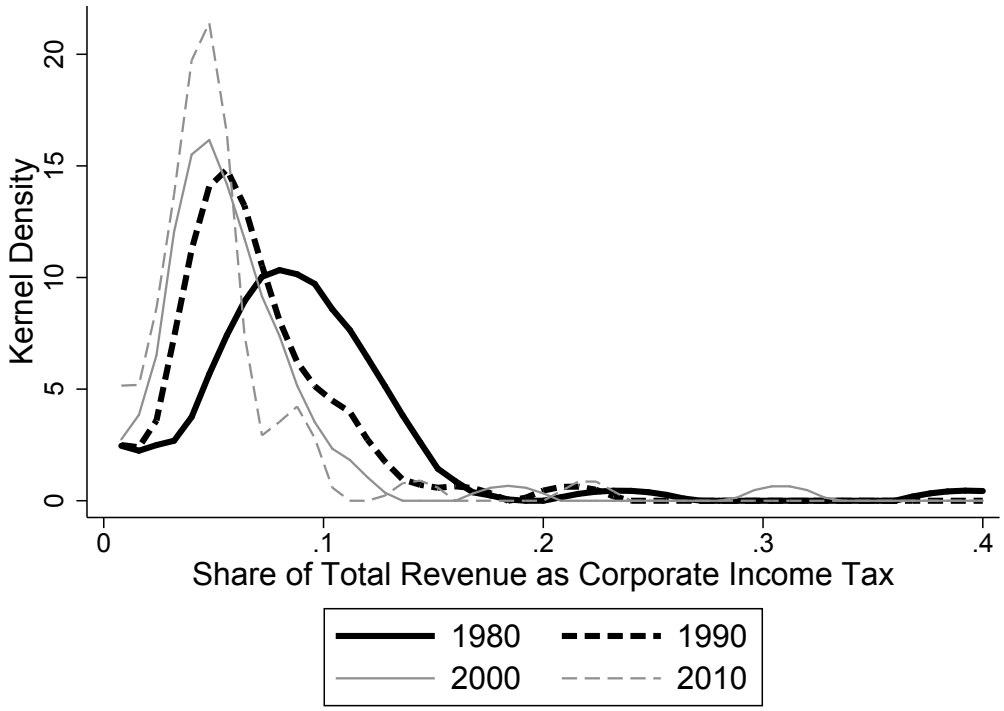
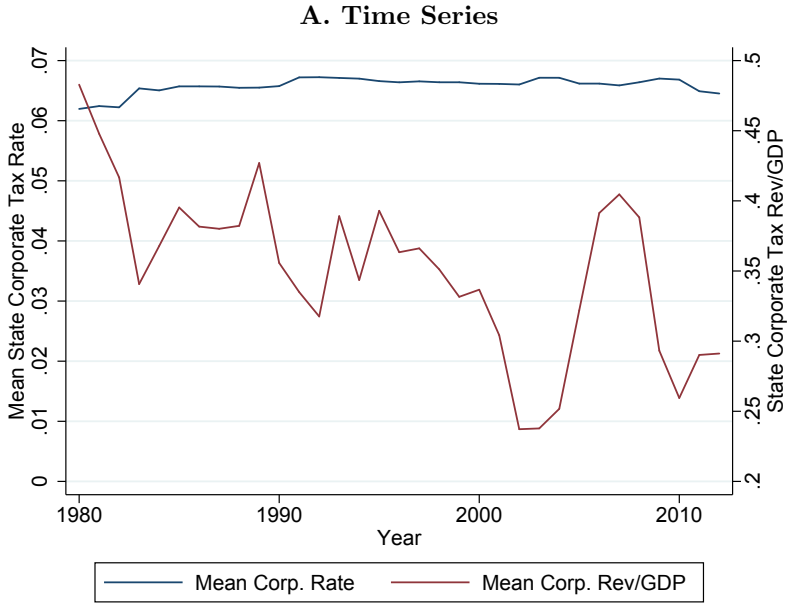
Figure 1: State Corporate Tax Rate Densities By Decade

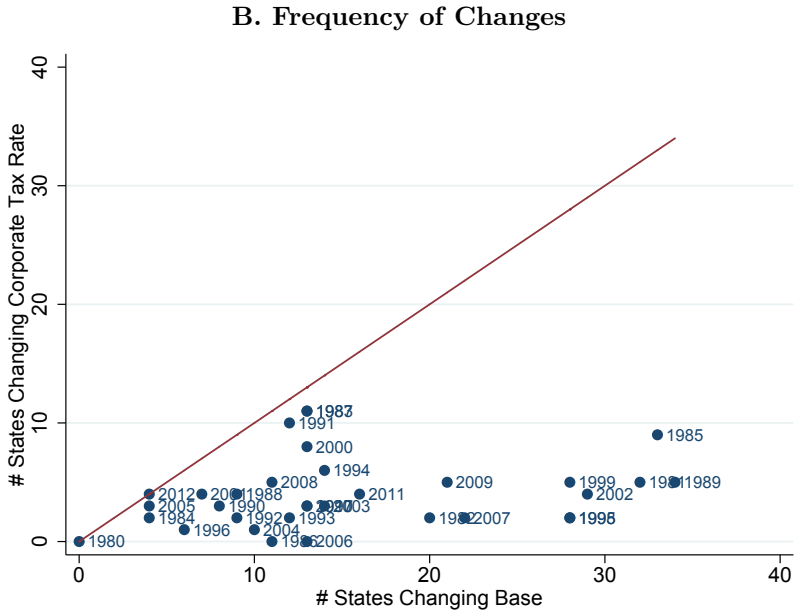




NOTES: These figures present kernel density functions for the state corporate tax rate and the share of total state tax revenue as corporate income tax by decade. The District of Columbia is excluded from the density calculation.

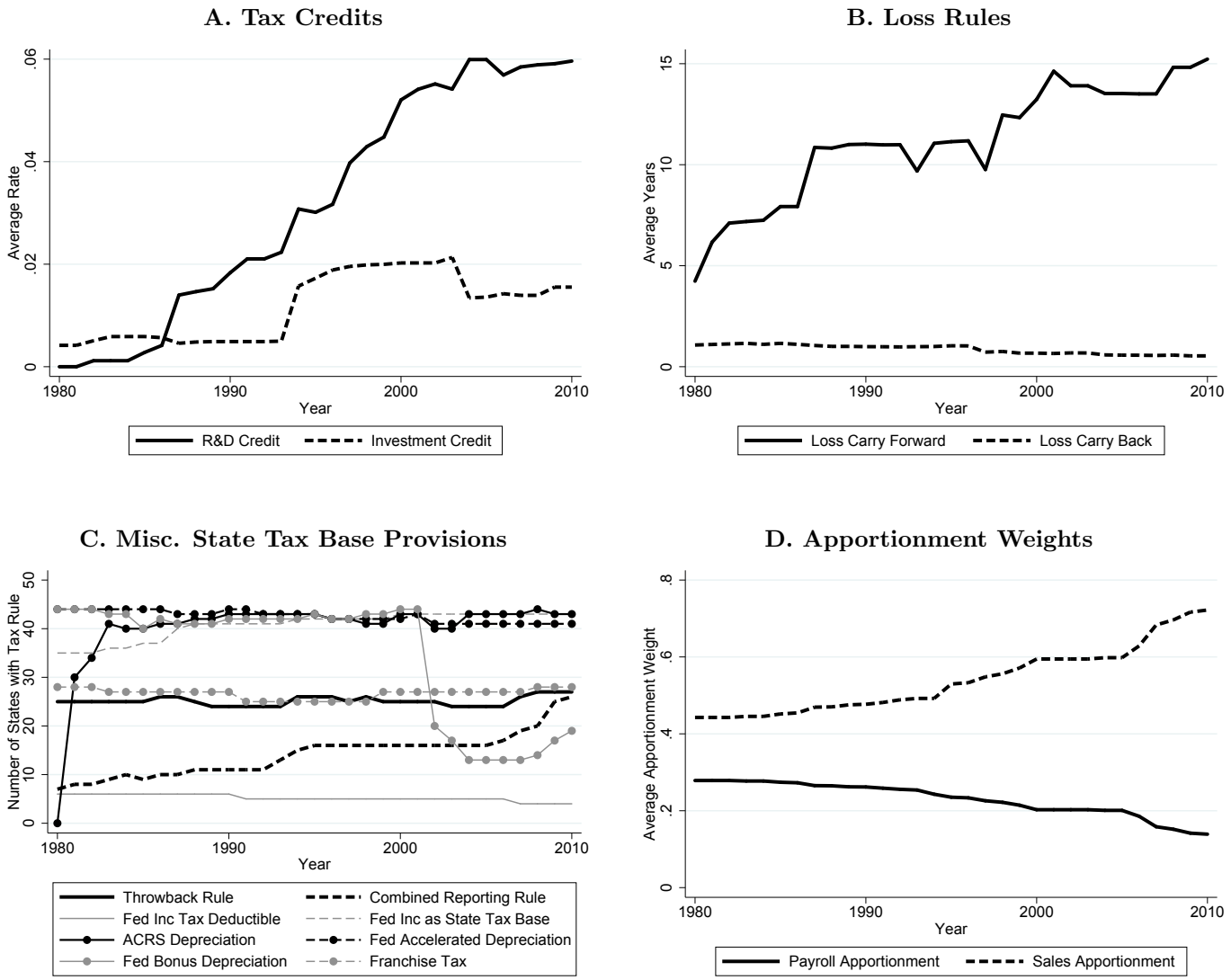
Figure 2: Changes in State Corporate Tax Structure





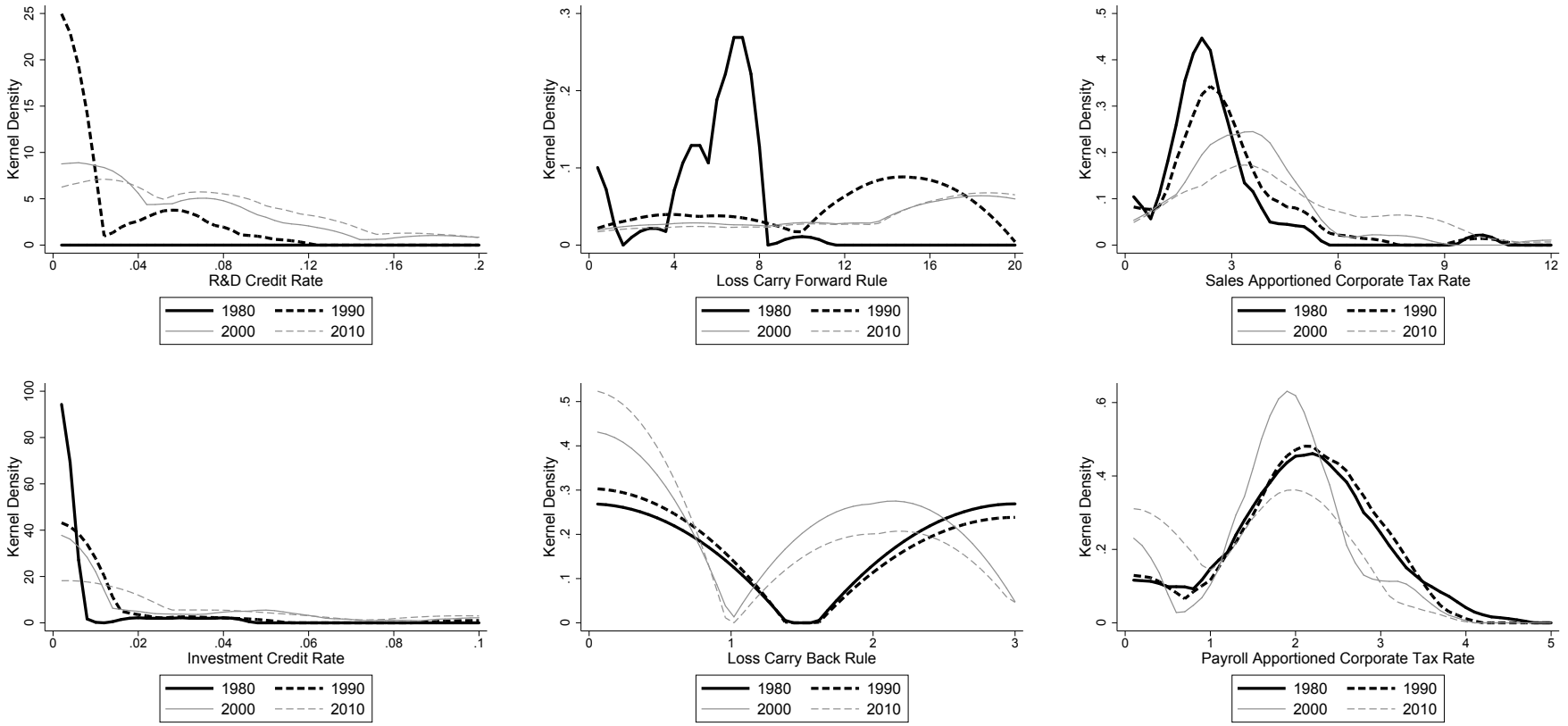
Notes: These figures show annual trends in both the mean corporate tax rate across states and corporate tax revenue as a share of GDP in panel A. Panel B shows by year the number of states that changed rates and tax base provisions. It illustrates that these pairs are not on a 45 degree line, so most years in which many states change base provisions are not years in which many states also change rates.

Figure 3: Base Rules and Credits Over Time



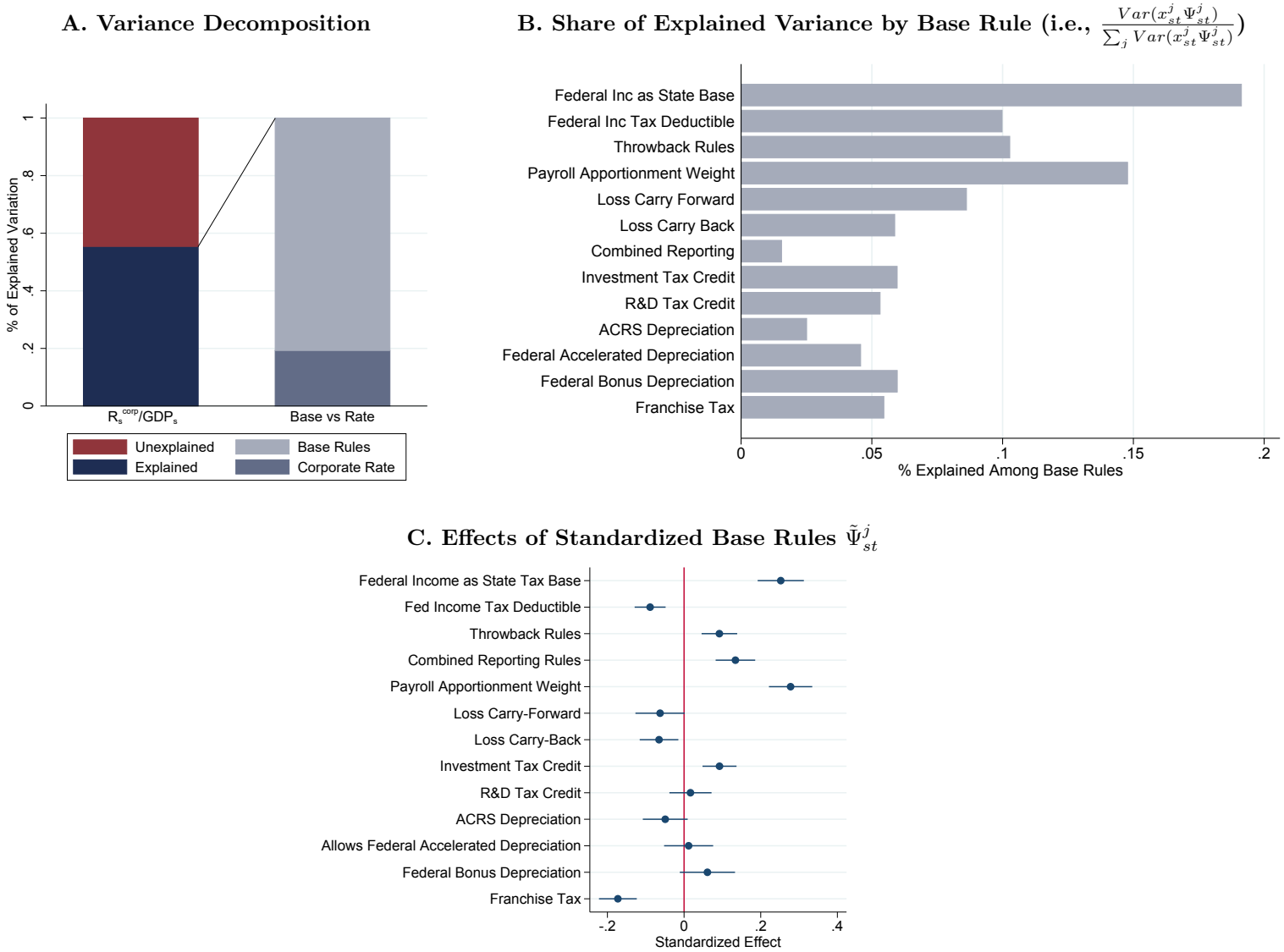
NOTES: These figures show annual trends in various base rules between 1980 and 2010. Panels A,B, and D use the mean tax credit rate, loss carry allowance, and apportionment weights across all states, respectively. The value is weighted by mean state GDP across the sample period.

Figure 4: Corporate Tax Base and Credit Densities By Decade



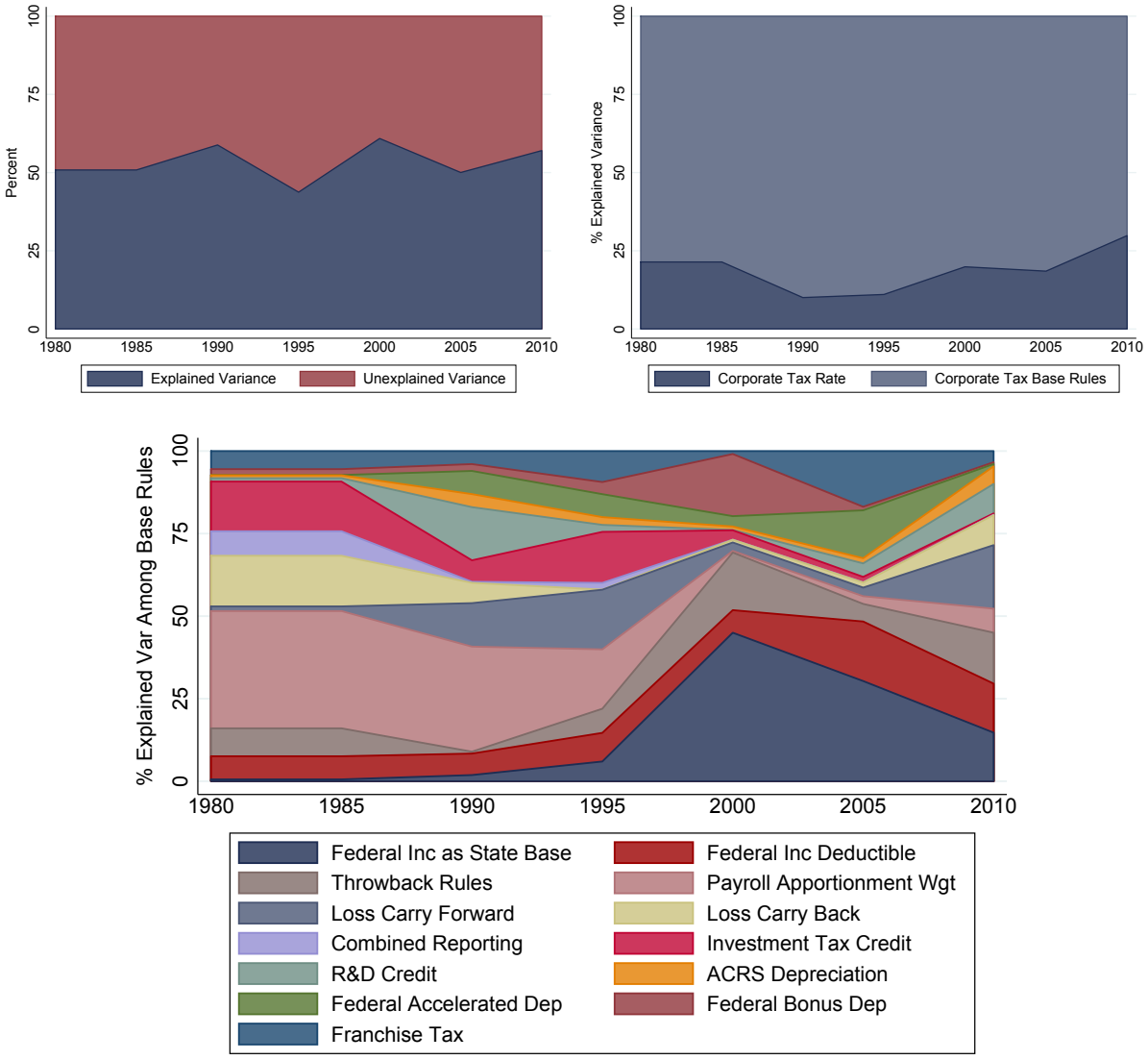
NOTES: These figures present kernel density functions for various tax base rules by decade. Loss carry forward and loss carry back are measured in years allotted by the respective rule. The District of Columbia is excluded from the density calculation. See Appendix A.1 for details on each tax base rule and data sources.

Figure 5: Variance of State Corporate Tax Revenue as a Share of GDP



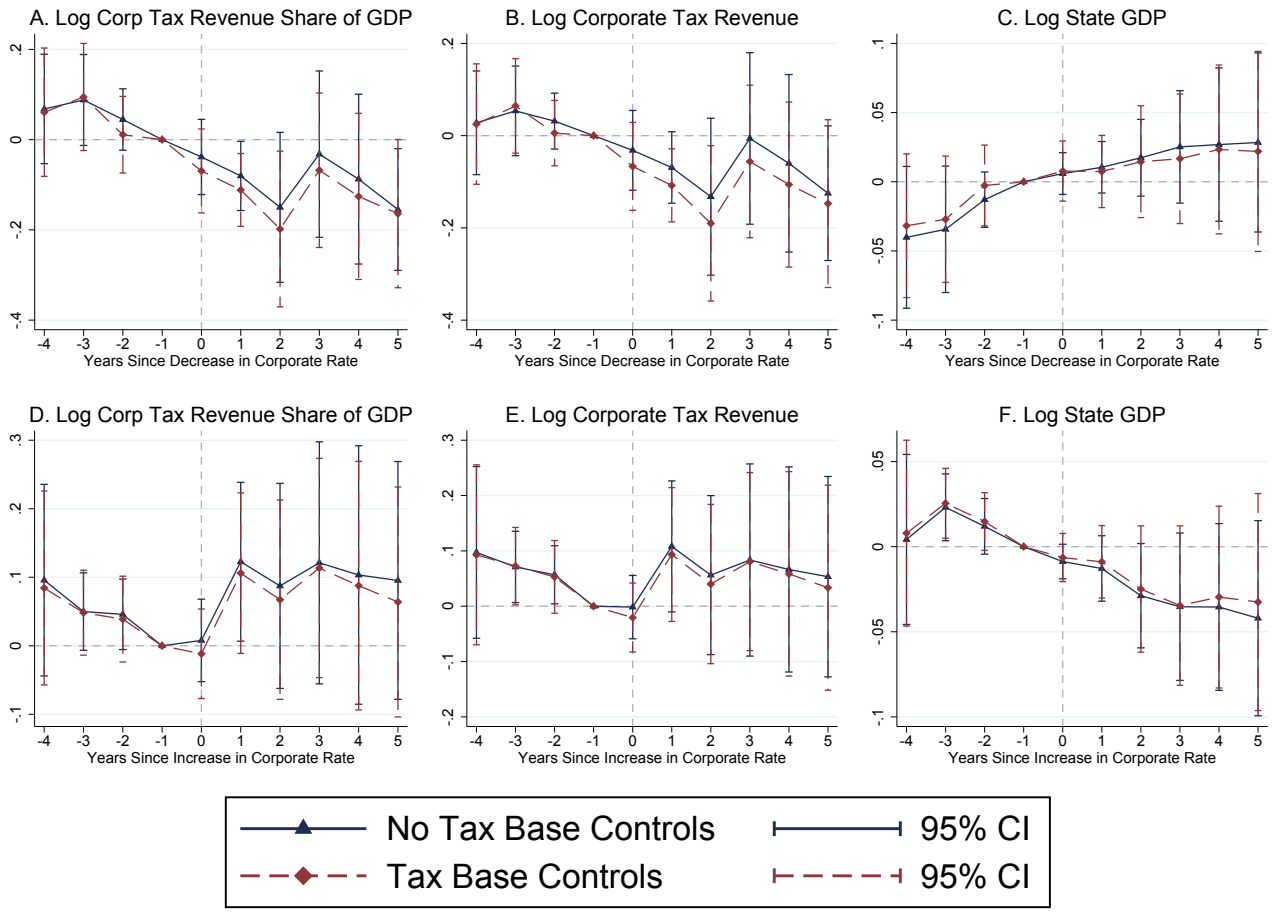
NOTES: Panel A decomposes the variation in state corporate tax revenue share of state GDP from 1980-2010 using equation 2. Panel B displays the contribution to base variation from each base rule. Panel C plots the effect of each base rule on the state corporate tax revenue share of state GDP from 1980-2010. We standardize each base rule prior to determining the coefficients to facilitate comparisons across base rules with different variances. See section 3 for details. The decomposition is weighted by mean state GDP across our sample period.

Figure 6: Corporate Tax Revenue Share of GDP - Variance Decomposition - 5-Year Splits



NOTES: These figures show the general explanatory power for the corporate tax rate and base rules. The first figure shows the explained versus unexplained variance in the specified model. The second figure shows the shares of explained variance for the corporate tax rate versus the corporate tax base rules. The third shows the shares of explained variance only among the corporate tax base rules. Equation 1 presents the expression for state corporate tax revenue as a share of state GDP. Each figure has 6 point estimates that correspond to 5-year periods between 1980 and 2010. We include the following base rules and credit: loss carry forward, loss carry back, R&D credit, investment credit, throwback rule, combined reporting rule, federal income tax deductibility, federal bonus depreciation, federal income as state tax base, federal accelerated depreciation, ACRS depreciation, payroll apportionment weight, and franchise tax. Each decomposition is weighted by mean state GDP across the full period (1980-2010). See figures A19, A20, and A21 for analogous results that take Bartik (2017) controls into account, as well as for unweighted decompositions.

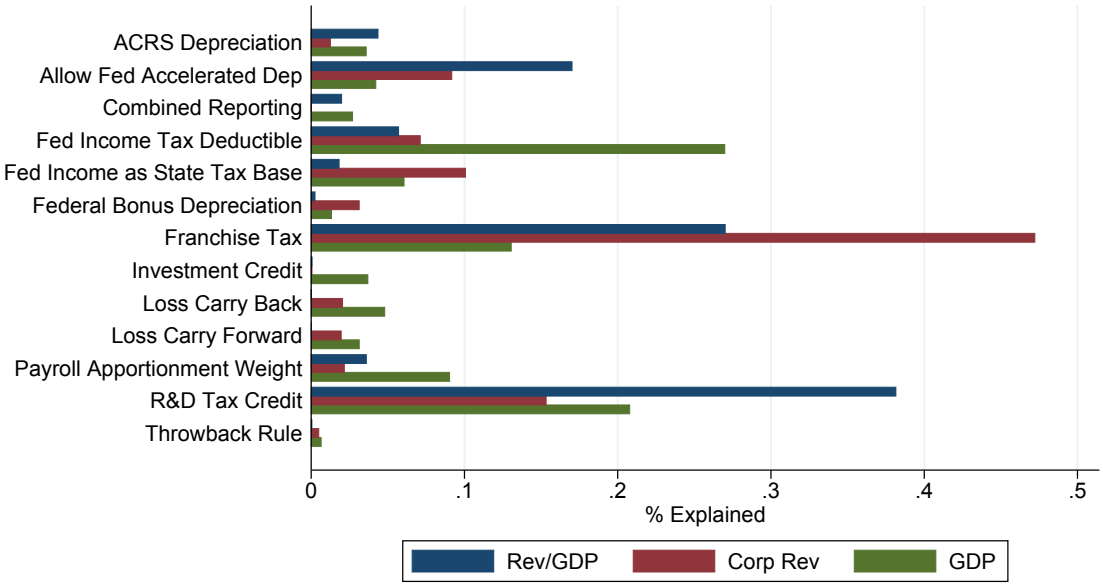
Figure 7: Event Analysis: Impacts on State Corporate Tax Revenue and GDP



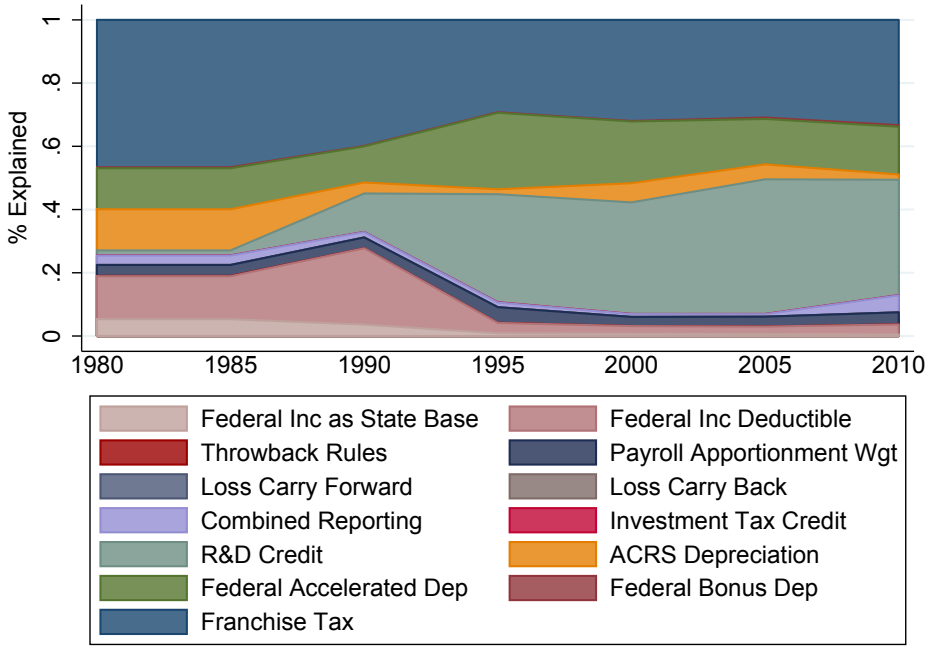
NOTES: This figure shows the effect of increases and decreases in the state corporate rate of at least .5pp on log state GDP and corporate tax revenue, respectively. Year and state fixed effects are utilized. Where specified, we additionally control for the following tax base rules: federal income tax treated as state base, payroll apportionment weight, throwback rules, federal income tax deductibility, loss carry forward, and investment tax credit. Standard errors are clustered by state. The construction of these event studies follows the form of equation 3.

Figure 8: Decomposing the Total Effect of the Log-Net-of-Corporate Tax Rate on Corporate Tax Revenue

A. Full Decomposition of Total Effect on Revenue to GDP

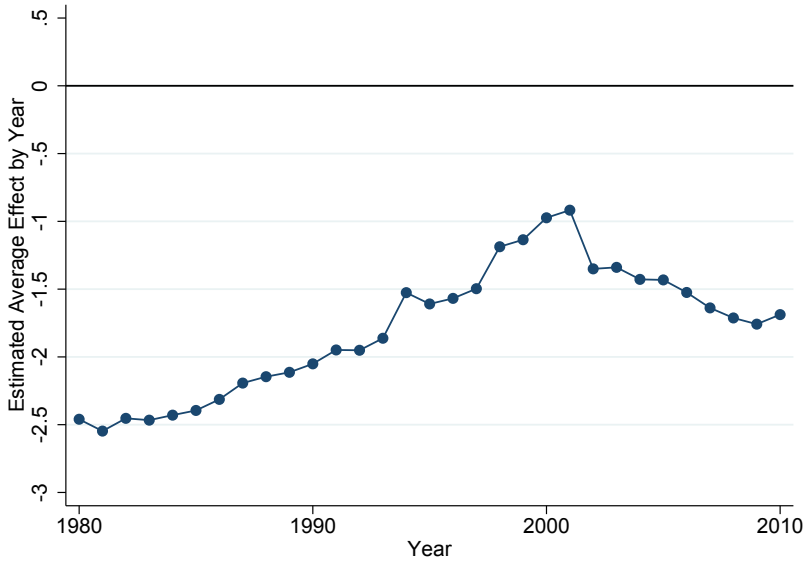


B. Decomposition of Total Effect on Revenue to GDP over Time



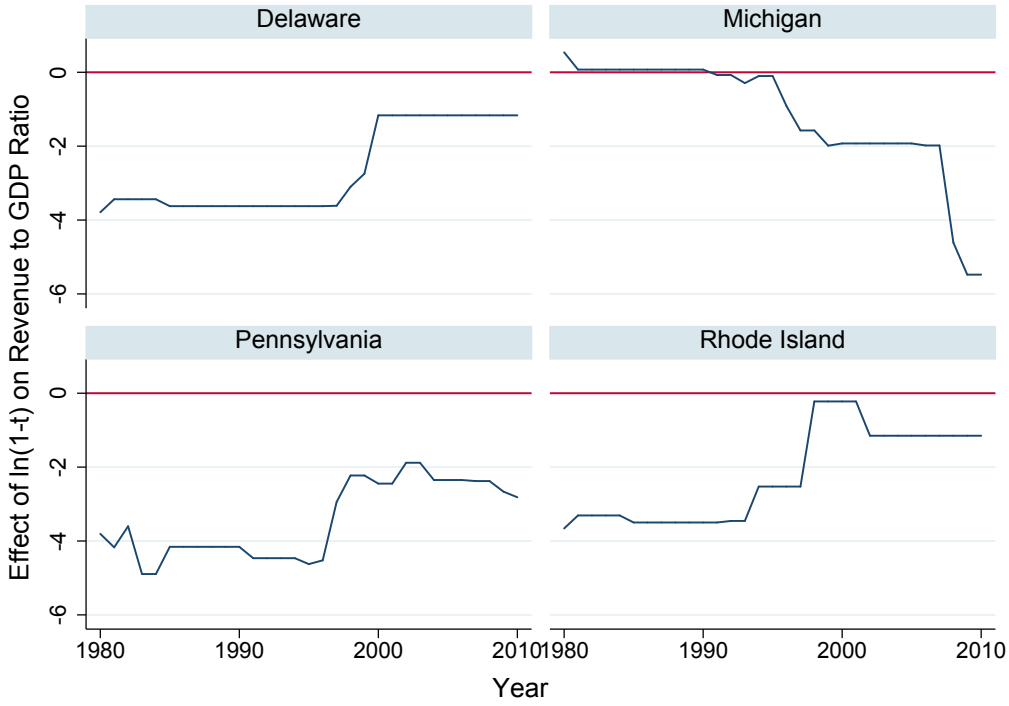
NOTES: These figures decompose the variance in the estimated total effects of $\ln(1-\tau^c)$ on the revenue-to-GDP ratio, and on log-GDP and log-revenue. The total effect is defined in Equation 5 as a result of estimating Equation 4, which is reported in column (3) of Table 4. By construction, the variance in the model is equal to the total variance. The bars report the fraction of the total variance that is due to changes in each of the tax base parameters. Data used for this estimation is discussed in Section 1, and details of the estimation can be found in Section 5. Overall, this figure describes the relative importance of different tax base controls for the joint interaction term, as well as how this importance evolves over time.

Figure 9: Average Estimated Total Effect of $\ln(1-\tau^c)$ on the Revenue-to-GDP Ratio by Year



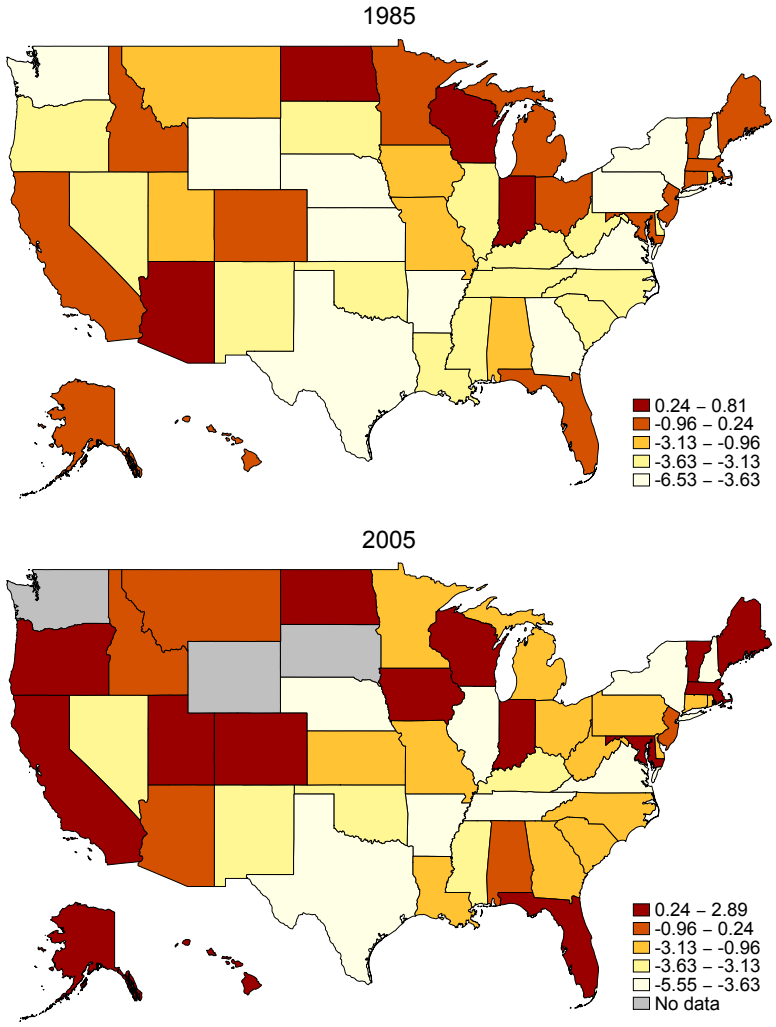
NOTES: This figure plots the state-average of the estimated total effects of $\ln(1-\tau^c)$ on the revenue-to-GDP ratio for every year. The total effect is defined in Equation 5 as a result of estimating Equation 4, which is reported in column (3) of Table 4. Data used for this estimation is discussed in Section 1, and details of the estimation can be found in Section 5. The coefficients on the terms $\ln(1-\tau)$ and interactions are multiplied by 100 to ease interpretation. Overall, this figure shows an aggregate pattern of contracting tax bases from 1980-2000, with a slight reversal of this pattern in the 2000's.

Figure 10: Estimated Total Effect of $\ln(1-\tau^c)$ on the Revenue-to-GDP Ratio by Year For Selected States



NOTES: This figure plots estimated total effects of $\ln(1-\tau^c)$ on the revenue-to-GDP ratio for every state-year. The total effect is defined in Equation 5 as a result of estimating Equation 4, which is reported in column (3) of Table 4. Data used for this estimation is discussed in Section 1, and details of the estimation can be found in Section 5. The coefficients on the terms $\ln(1-\tau)$ and interactions are multiplied by 100 to ease interpretation. Figure A24 presents similar plots for the rest of the states. Overall, these plots show that the aggregate pattern described in Figure 9 is a result of states that have a mirror experience to the national average (such as Pennsylvania and Rhode Island), as well as of states that have contracting (Delaware) and expanding (Michigan) bases.

Figure 11: Maps of the Estimated Total Effect of $\ln(1-\tau^c)$ on the Revenue-to-GDP Ratio



NOTES: These maps plot total effects of $\ln(1-\tau^c)$ on the revenue-to-GDP ratio for every state in 1985 and 2005. The category (color) ranges are held constant across time except for the maximum and minimum values. The total effect is defined in Equation 5 as a result of estimating Equation 4, which is reported in column (3) of Table 4. Data used for this estimation is discussed in Section 1, and details of the estimation can be found in Section 5. The coefficients on the terms $\ln(1-\tau)$ and interactions are multiplied by 100 to ease interpretation. Overall, these maps show a decrease in the absolute value of the total effect of $\ln(1-\tau^c)$ on the revenue-to-GDP ratio, while showcasing considerable heterogeneity across states.

Table 1: Summary of Base Changes

Base narrowing/broadening:	-1	+1	Total Changes	No Change
Sales Apportionment Weight	92	33	125	1375
Loss Carry Back	23	42	65	1435
Loss Carry Forward	85	15	100	1400
Franchise Tax	3	3	6	1494
Federal Income Tax Deductible	2	4	6	1494
Federal Income Tax as State Tax Base	8	0	8	1492
Federal Accelerated Depreciation	2	5	7	1493
ACRS Depreciation	57	14	71	1429
Federal Bonus Depreciation	18	43	61	1439
Throwback	23	24	47	1411
Combined Reporting	21	2	23	1446
Investment Credit	34	9	43	1457
R&D Credit	51	8	59	1441

NOTES: The data used for these table are described in Section 1. This table reports the number of state-year observations from 1980-2010 where there was a change in tax base and tax rate. A change that represents a narrowing of the base is counted in the -1 column, while a year that represents a broadening of the base is counted as $+1$. An increase in the rate of investment credits, R&D credits, or sales apportionment corresponds to a narrowing of the base, while a decrease corresponds to a broadening. An increase in the number of years allowed for both loss carry forward and loss carry back correspond to a narrowing of the base, while a decrease corresponds to a broadening. For all other rules (which are indicators), the rule being turned off corresponds to a narrowing of the base, while it being turned on corresponds to a broadening. For instance, if a state adopts combined reporting, then we say that the tax base has narrowed. If that state gets rid of combined reporting, then the tax base has broadened. See Section A for definitions of broadening and narrowing for each measure. Table A1 provides a more detailed breakdown along with the co-movement of tax rates.

Table 2: Frequency of State Tax Rate and Base Changes

Base Change	Rate Decrease	No Change	Rate Increase	Total
Narrowing	25.00	19.47	7.59	18.13
	(19)	(286)	(18)	(323)
No Change	61.84	71.48	89.45	73.46
	(47)	(1050)	(212)	(1309)
Broadening	13.16	9.05	2.95	8.42
	(10)	(133)	(7)	(150)
Total	100.00	100.00	100.00	100.00
	(76)	(1469)	(237)	(1782)

NOTES: The data used for these table are described in Section 1. This table reports the fraction of state-year observations that saw a simultaneous change in tax base and in tax rate. Numbers in parenthesis report the number of state-year observations that correspond to a given cell. See Section A for definitions of broadening and narrowing for each measure. Overall, this table shows that the majority of times when there is a change in the tax base (either a narrowing or a broadening) there is no accompanying change in the tax rate.

Table 3: Probit Estimates of the Coincidence of Base and Rate Changes

Panel A: Base Change

	Any Base Change	Base Broadening	Base Narrowing
Rate decrease	0.2120	0.1527	0.1713
	(0.2241)	(0.3591)	(0.2512)
No rate change	-0.0814	-0.1712	-0.0365
	(0.1791)	(0.2933)	(0.1774)

Panel B: Tax Rate Change

	Any Tax Change	Tax Increase	Tax Decrease
Base narrowed	0.1598	0.0201	0.2046
	(0.0995)	(0.1473)	(0.1271)
Base broadened	0.2148	0.0541	0.2637
	(0.1731)	(0.2618)	(0.1876)

NOTES: The data used for these table are described in Section 1. Panel A reports coefficients from a probit model estimating the probability of a change in the tax base using changes in tax rates. Panel B reports coefficients from a probit model estimating the probability of a change in the tax rate using changes in the tax base. See Section A for definitions of broadening and narrowing for each measure. Year fixed effects are included in each panel. Standard errors are clustered by state. Overall, this table shows that tax rate changes and tax base changes do not occur simultaneously.

Table 4: Effects of Corporate Tax Rate Changes on Tax Revenues and Economic Activity

	(1)	(2)	(3)
Revenue to GDP Ratio			
$\ln(1-\tau)$	-1.639*	-1.512**	-2.456***
	(0.955)	(0.734)	(0.569)
$\ln(1-\tau)\times$ Joint Interactions			1.317***
			(0.228)
Log Revenue			
$\ln(1-\tau)$	-2.293	-2.513	-4.150***
	(2.674)	(1.868)	(1.231)
$\ln(1-\tau)\times$ Joint Interactions			3.432***
			(0.597)
Log GDP			
$\ln(1-\tau)$	1.134	0.871	0.915
	(1.286)	(0.956)	(0.793)
$\ln(1-\tau)\times$ Joint Interactions			1.383***
			(0.285)
Observations	1,413	1,413	1,413
Base Controls	N	Y	Y

NOTES: This table reports the results of regressions that estimate the effects of changes in tax rates on tax revenues and economic activity. Each specification weights observations by the mean state GDP in our sample and includes state and year fixed effects. Standard errors are clustered by state. The 13 base controls included in columns (2)-(3) are described in Section 1. Details of the specification and the definition of the joint interaction can be found in Section 5. In the regression of the revenue-to-GDP ratio, the coefficients on the terms $\ln(1-\tau)$ and interactions are multiplied by 100 to ease interpretation. Tables A2-A4 present the full set of interaction terms. Overall this table shows that, while including tax base controls does not have significant effects on the average effect of taxes on revenues and economic activity, estimators that do not allow for heterogeneous effects of taxes that depend on the structure of the state corporate tax system result in inconsistent estimates of the average partial effect of taxes on revenues and economic activity.

Appendices for Online Publication

This appendix contains several sections.

A Data

A.1 Tax Base Rules

1. Throwback Rules
   - Variable: throwback
   - Source: Bernthal et al. (2012)
   - Definition: Indicator for whether state eliminates "nowhere income" that would be untaxed by either the state with the corporation's nexus or the state in which the relevant sales were being made.
2. Combined Reporting Rules
   - Variable: combined
   - Source: Bernthal et al. (2012)
   - Definition: Indicator for whether a state requires a unitary business to submit combined reporting.
3. Investment Tax Credit
   - Variable: investment_credit
   - Source: Chirinko and Wilson (2008)
   - Definition: Rate of investment tax credit for a given state-year.
4. Research and Development Tax Credit
   - Variable: rec_val
   - Source: Dan Wilson (2009)
   - Definition: Statutory credit rate adjusted for recapture and type of credit.
5. Loss Carry Back Rules
   - Variable: Losscarryback
   - Source: CCH (1980 - 2010)
   - Definition: Number of years prior to the loss year that a corporation may carry back net operating loss.
6. Loss Carry Forward Rules
   - Variable: Losscarryforward
   - Source: CCH (1980 - 2010)
   - Definition: Number of years a corporation may carry forward any excess loss following the loss year.
7. Franchise Tax (indicator)
   - Variable: FranchiseTax
   - Source: CCH (1980 - 2010)
   - Definition: An indicator for whether or not a Franchise tax is levied on corporations in a given state-year.
8. Federal Income Tax Deductible
   - Variable: FedIncomeTaxDeductible

- Source: CCH (1980 - 2010)
- Definition: An indicator for whether or not federal income tax is deductible in a given state-year.

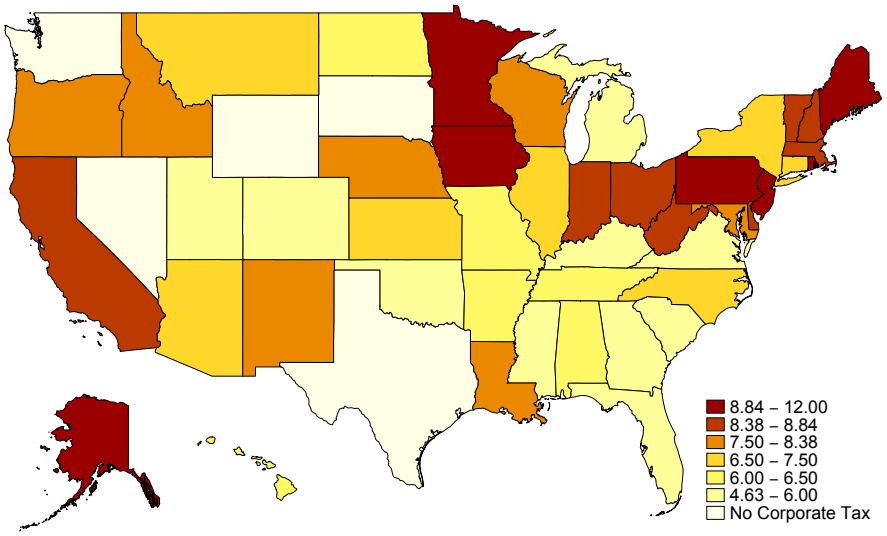
9. Federal Income as State Tax Base
   - Variable: FederalIncomeasStateTaxBase
   - Source: CCH (1980 - 2010)
   - Definition: An indicator for whether or not federal income in used as the state tax base in a given state-year.
10. Federal Accelerated Depreciation
    - Variable: AllowFedAccDep
    - Source: CCH (1980 - 2010)
    - Definition: An indicator for whether or not federal accelerated depreciation is allowed in a given state-year.
11. Accelerated Cost Recovery System (ACRS) Depreciation
    - Variable: ACRSDepreciation
    - Source: CCH (1980 - 2010)
    - Definition: An indicator for whether or not ACRS is allowed in a given state-year.
12. Federal Bonus Depreciation
    - Variable: FederalBonusDepreciation
    - Source: CCH (1980 - 2010)
    - Definition: An indicator for whether or not federal bonus depreciation is allowed in a given state-year.
13. Payroll Apportionment Weight
    - Variable: payroll_wgt
    - Source: Bernthal et al. (2012)
    - Definition: The share of national profits of multi-state firms that are allocated to payroll (for tax purposes) in a given state.

In Tables 1-3 and A1 we analyze changes in base rules and code changes as narrowing or broadening as follows:

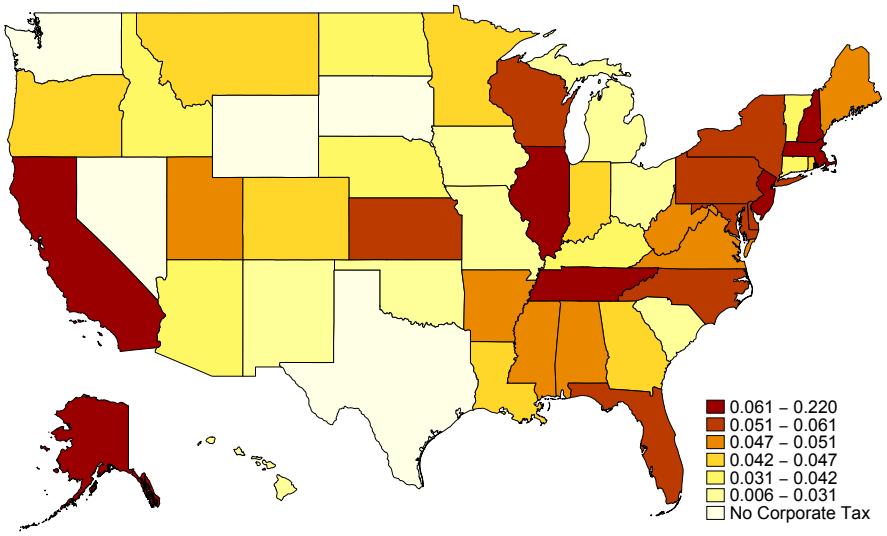
- Throwback Rules: "no" to "yes" is base narrowing
- Combined Reporting Rules: "no" to "yes" is base narrowing
- Investment Tax Credit: increase in credit is base narrowing
- Research and Development Tax Credit: increase in credit is base narrowing
- Loss Carry Back Rules: increase in years is base narrowing
- Loss Carry Forward Rules: increase in years is base narrowing
- Franchise Tax (indicator): "no" to "yes" is base broadening
- Federal Income Tax Deductible: "no" to "yes" is base narrowing, "yes" to "no" is base broadening
- Federal Income as State Tax Base: "no" to "yes" is base narrowing, "yes" to "no" is base broadening
- Federal Accelerated Depreciation: "no" to "yes" is base narrowing
- Accelerated Cost Recovery System (ACRS) Depreciation: "no" to "yes" is base narrowing
- Federal Bonus Depreciation: "no" to "yes" is base narrowing
- Sales Apportionment Weight: increase in sales weight is base narrowing

Figure A1: Rates & Revenue

Corporate Tax Rate - 2012



Corporate Revenue Share - 2012



Sales Apportionment Weight - 2012

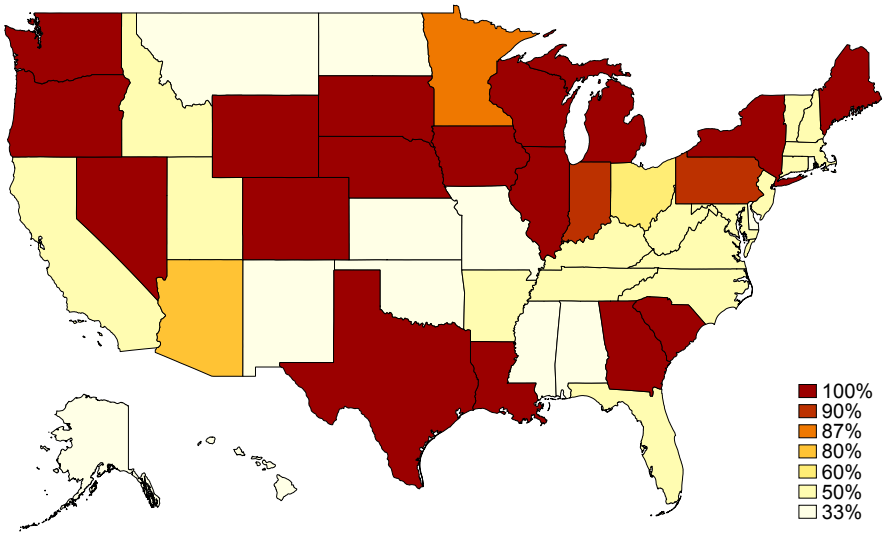


Figure A2: Corporate Tax Base Rules

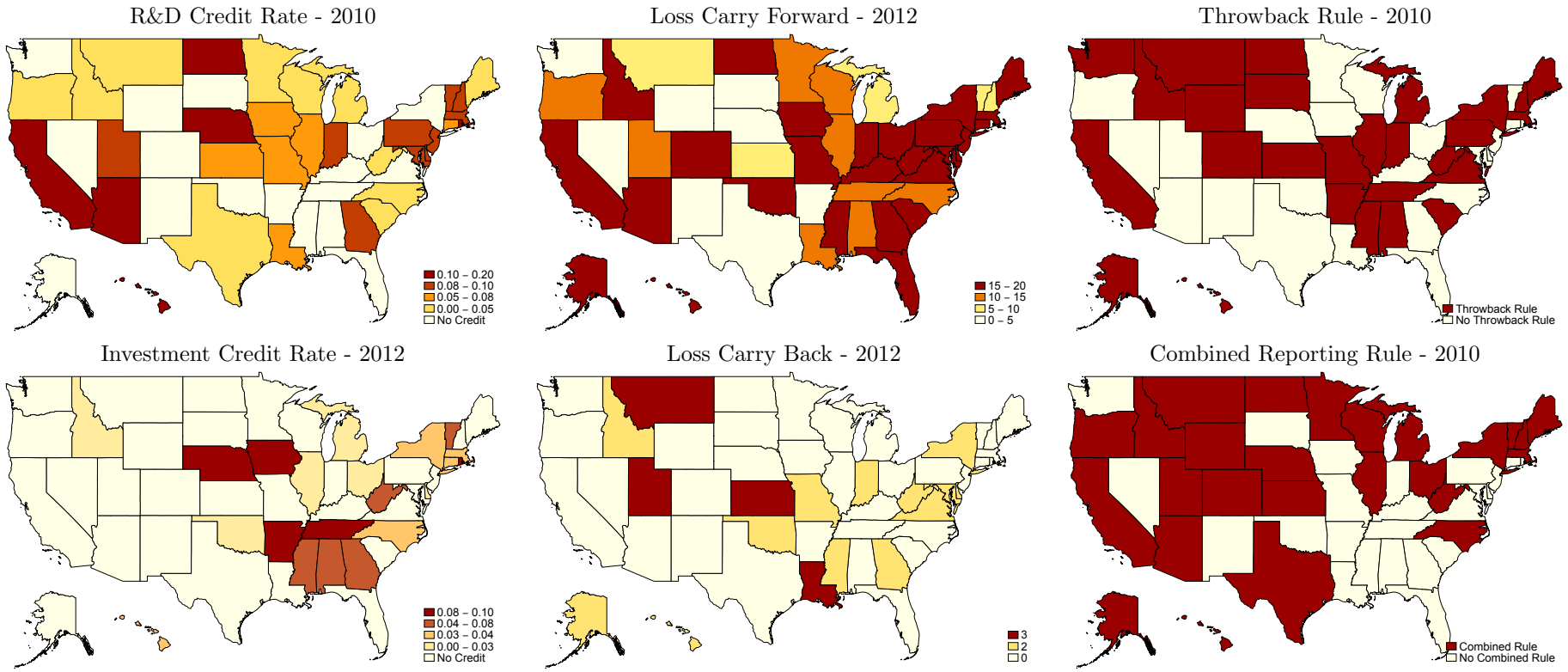
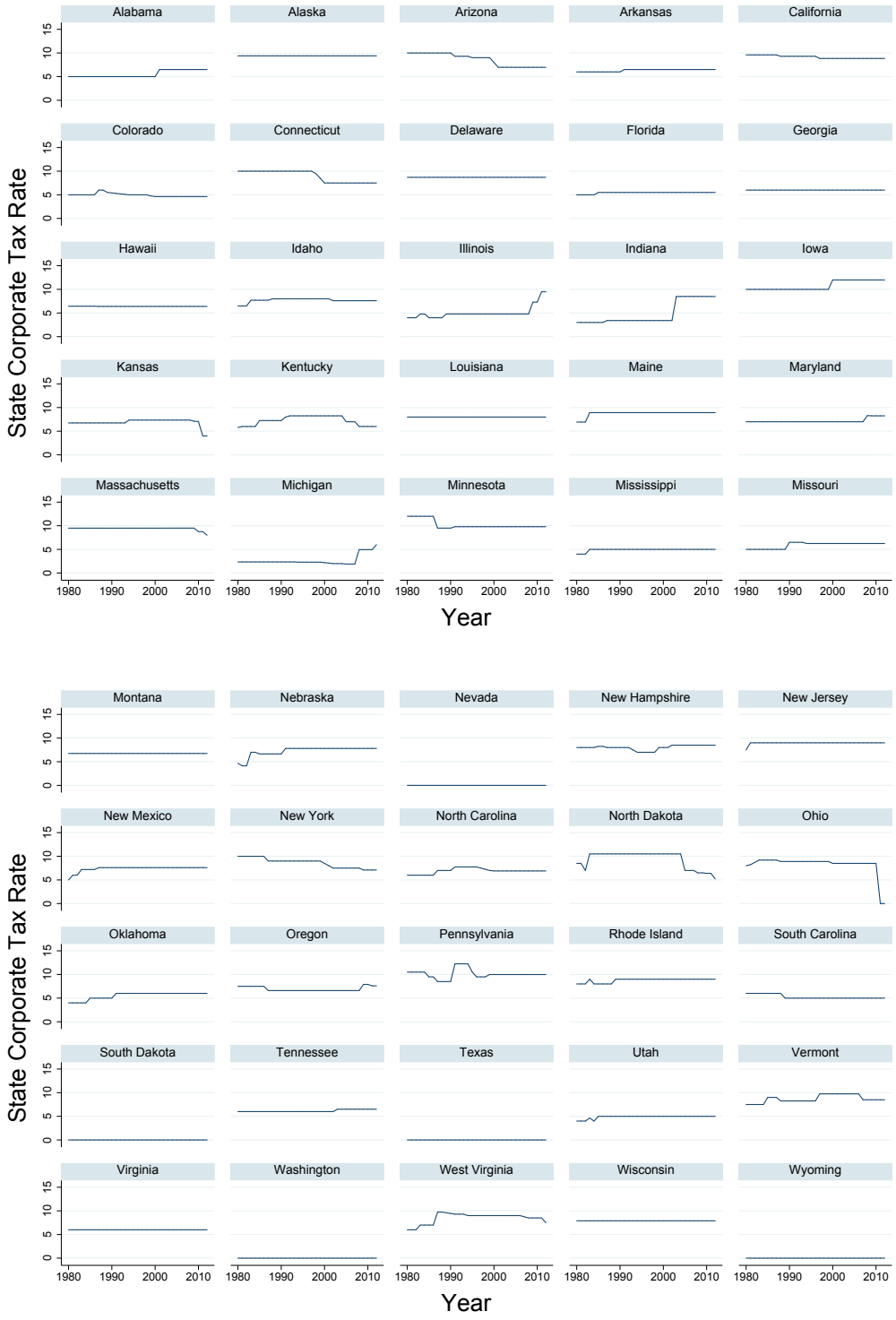
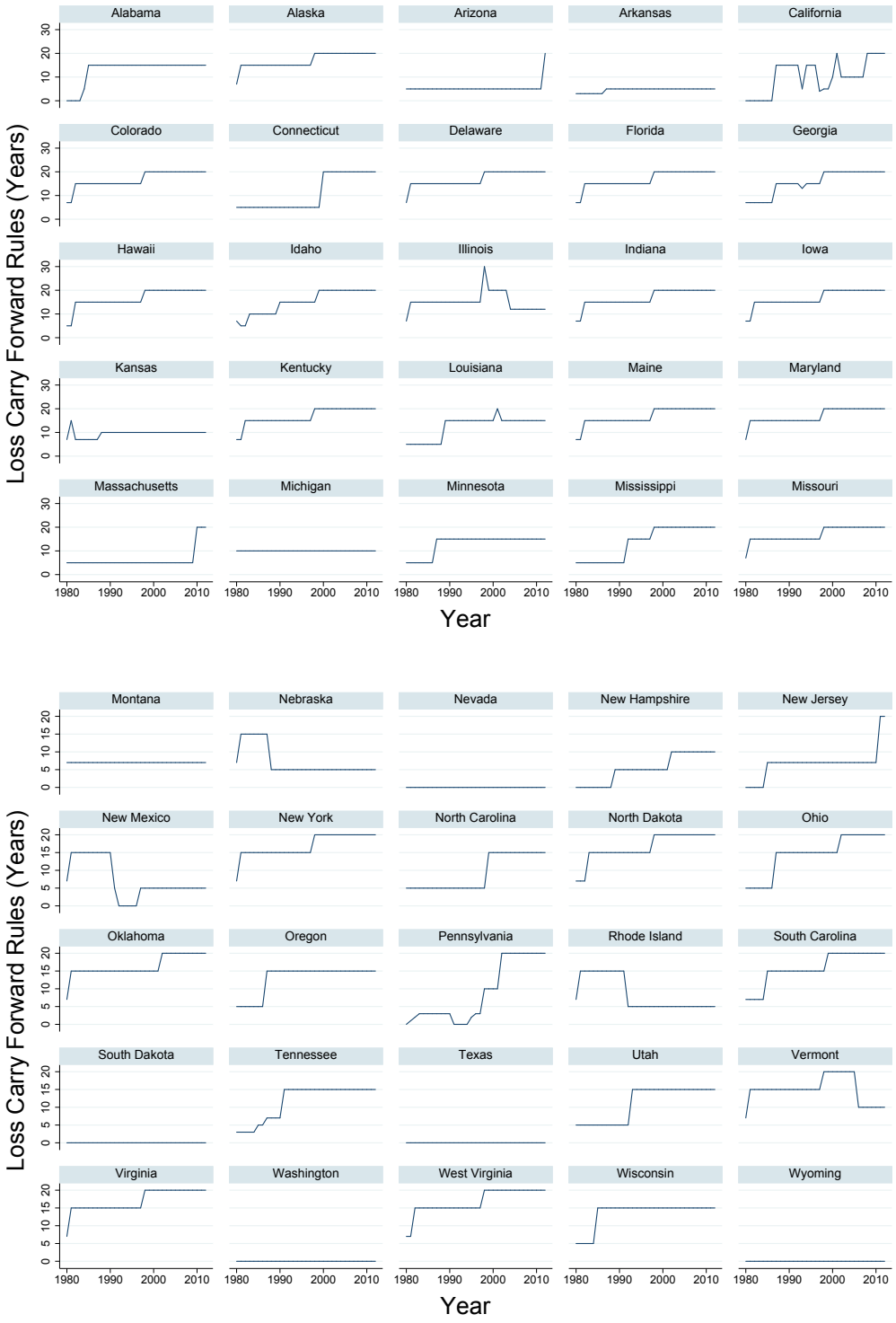


Figure A3: Corporate Tax Rate By State-Year



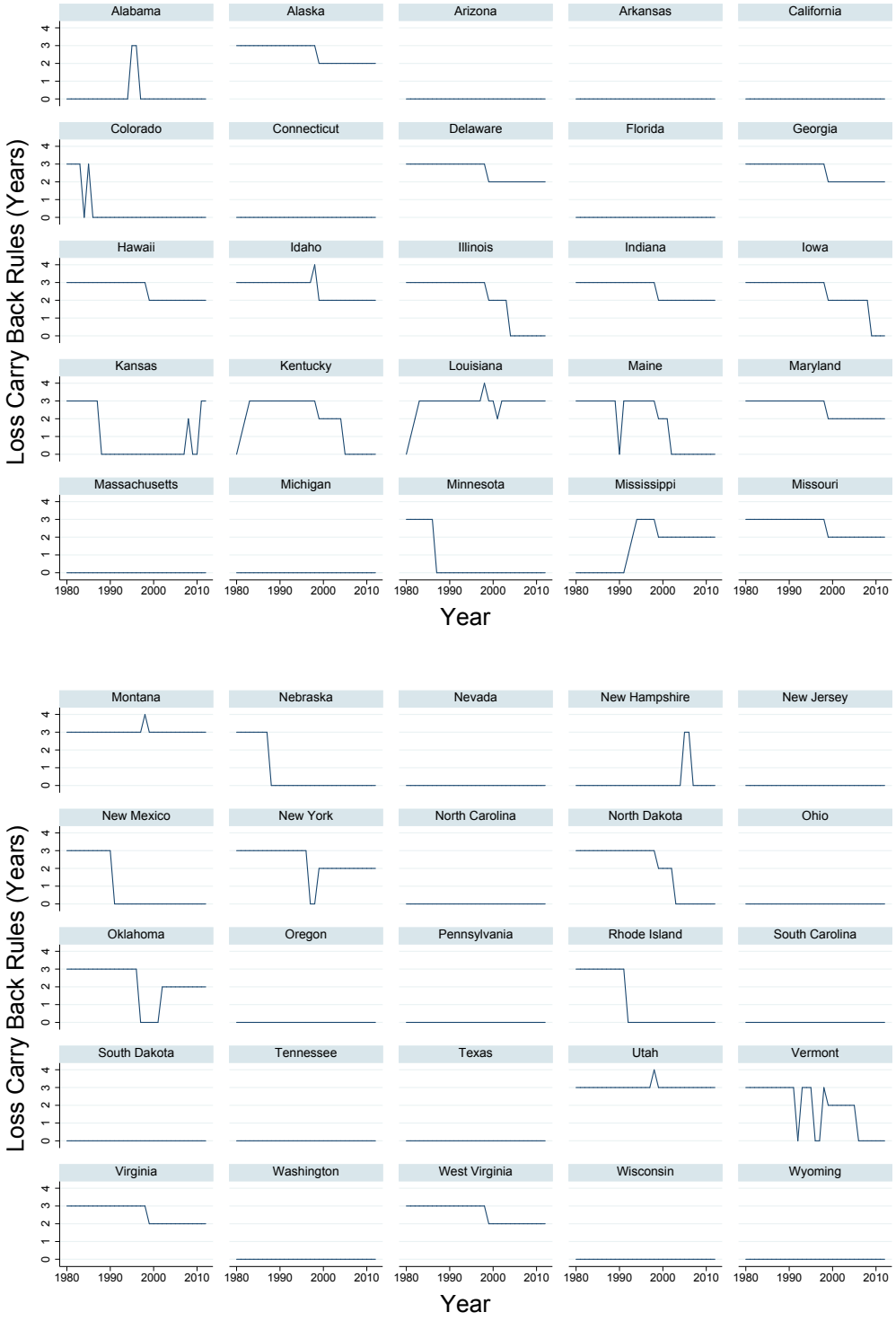
NOTES: Sample spans 1980-2012.

Figure A4: Loss Carry Forward Rule By State-Year



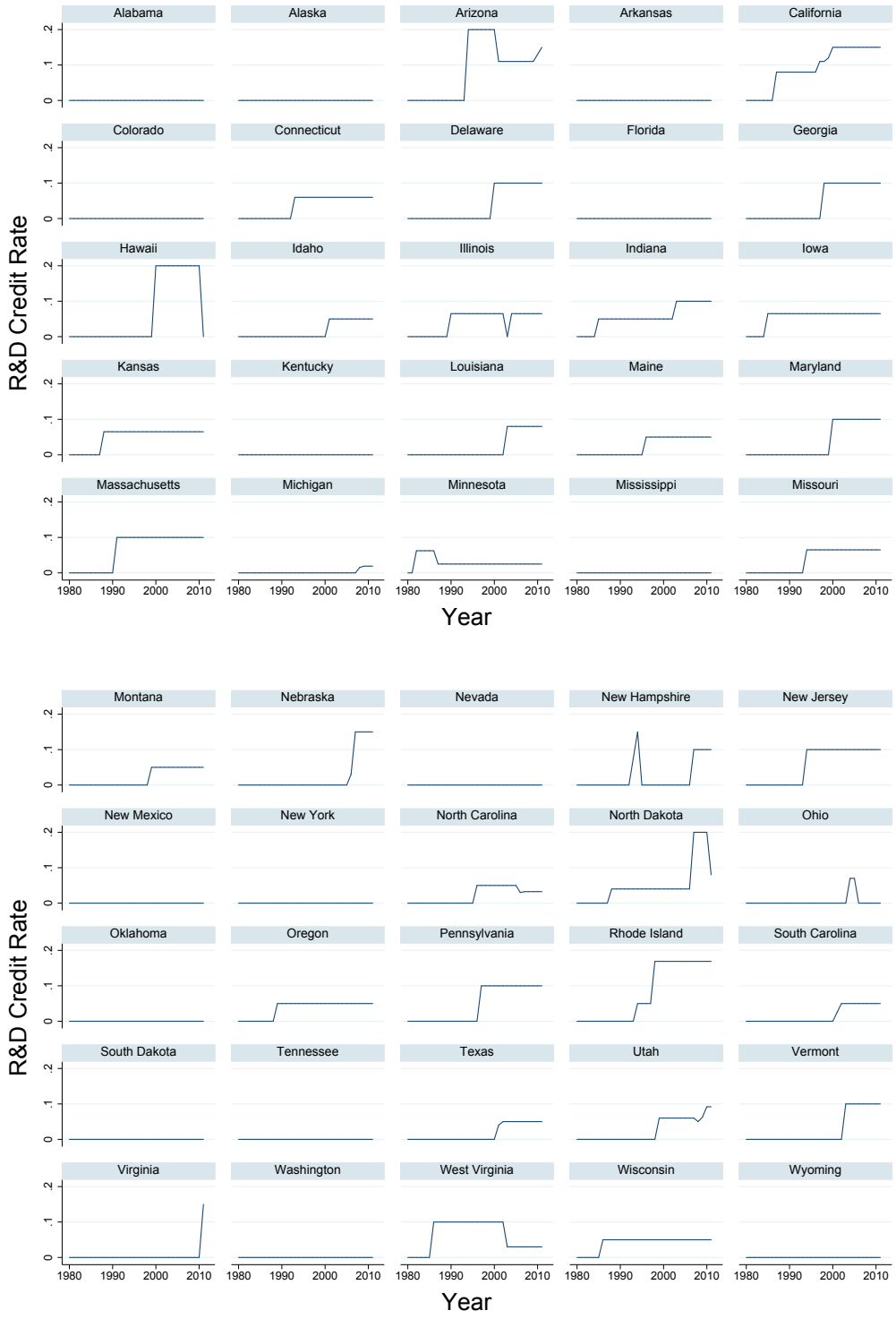
NOTES: Sample spans 1980-2012.

Figure A5: Loss Carry Back Rule By State-Year



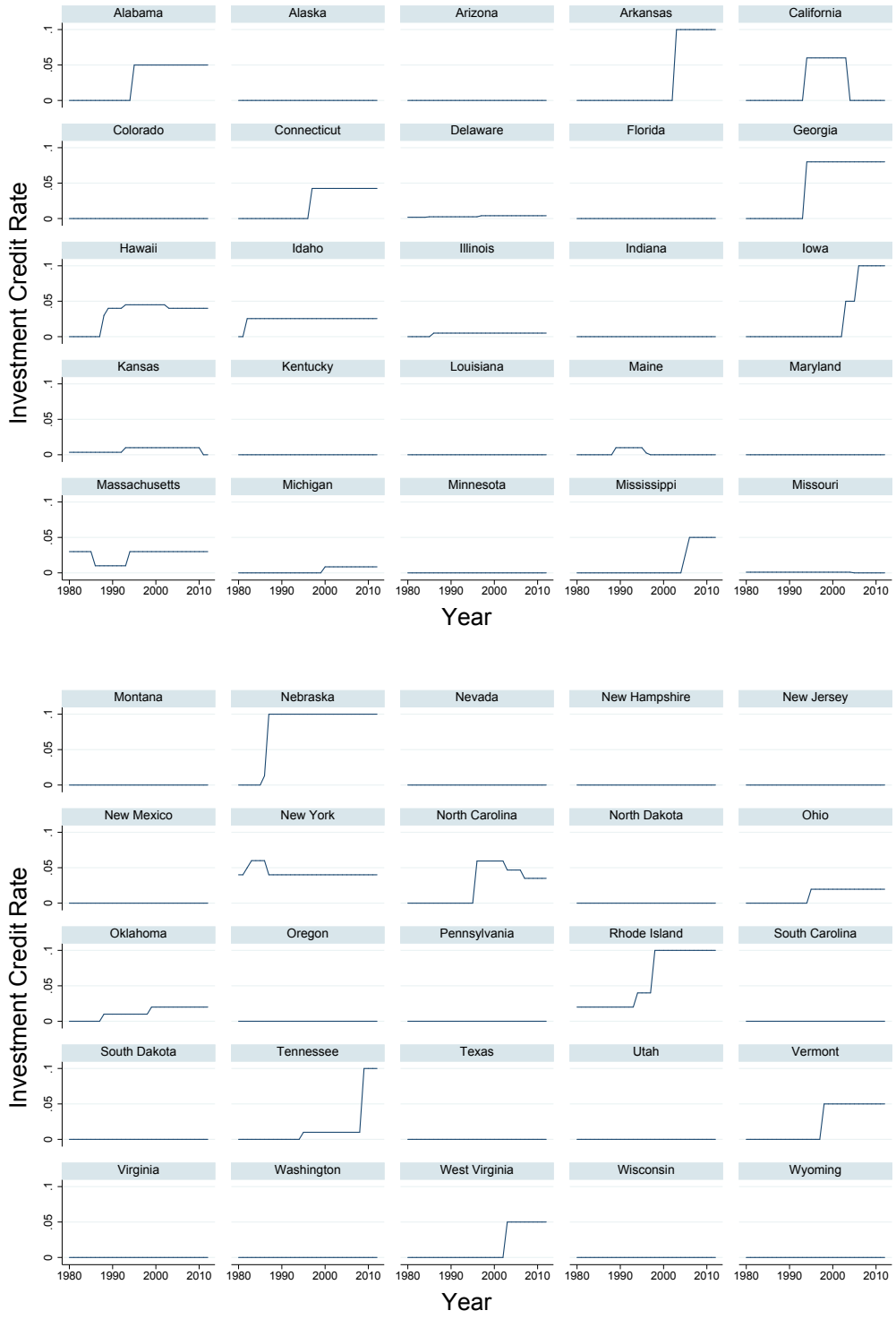
NOTES: Sample spans 1980-2012.

Figure A6: R&D Credit Rate By State-Year



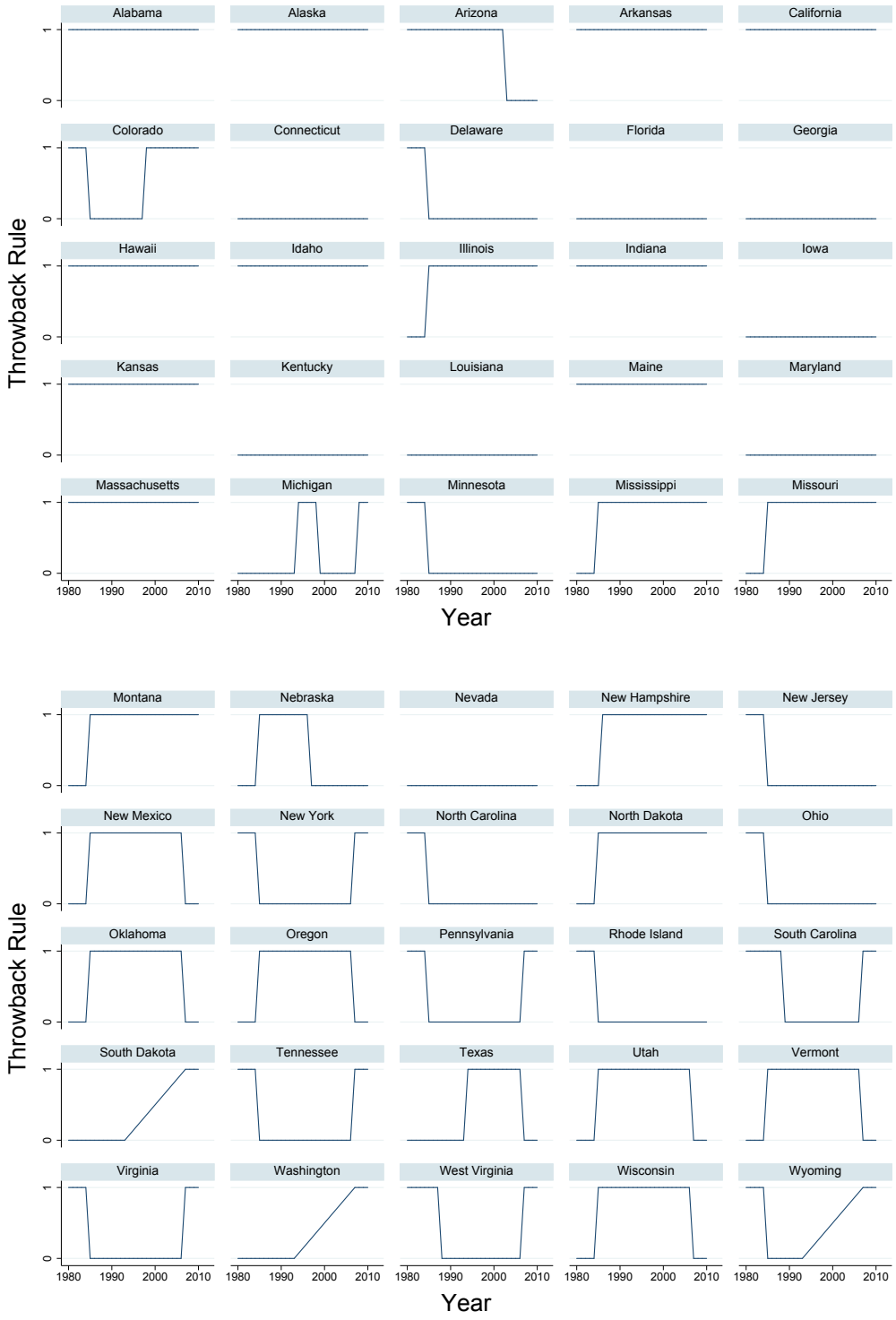
NOTES: Sample spans 1980-2011.

Figure A7: Investment Credit Rate By State-Year



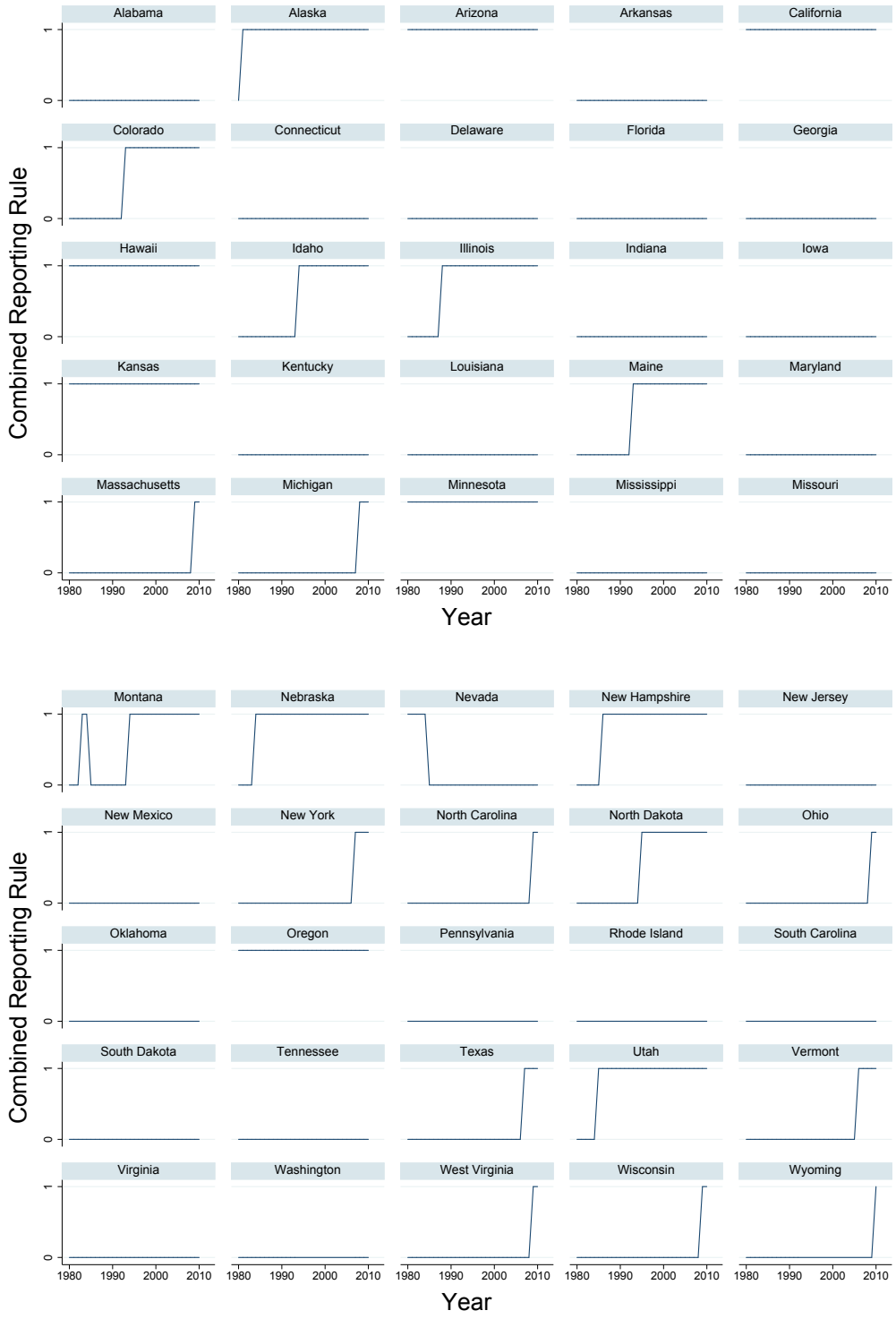
NOTES: Sample spans 1980-2012.

Figure A8: Throwback Rule By State-Year



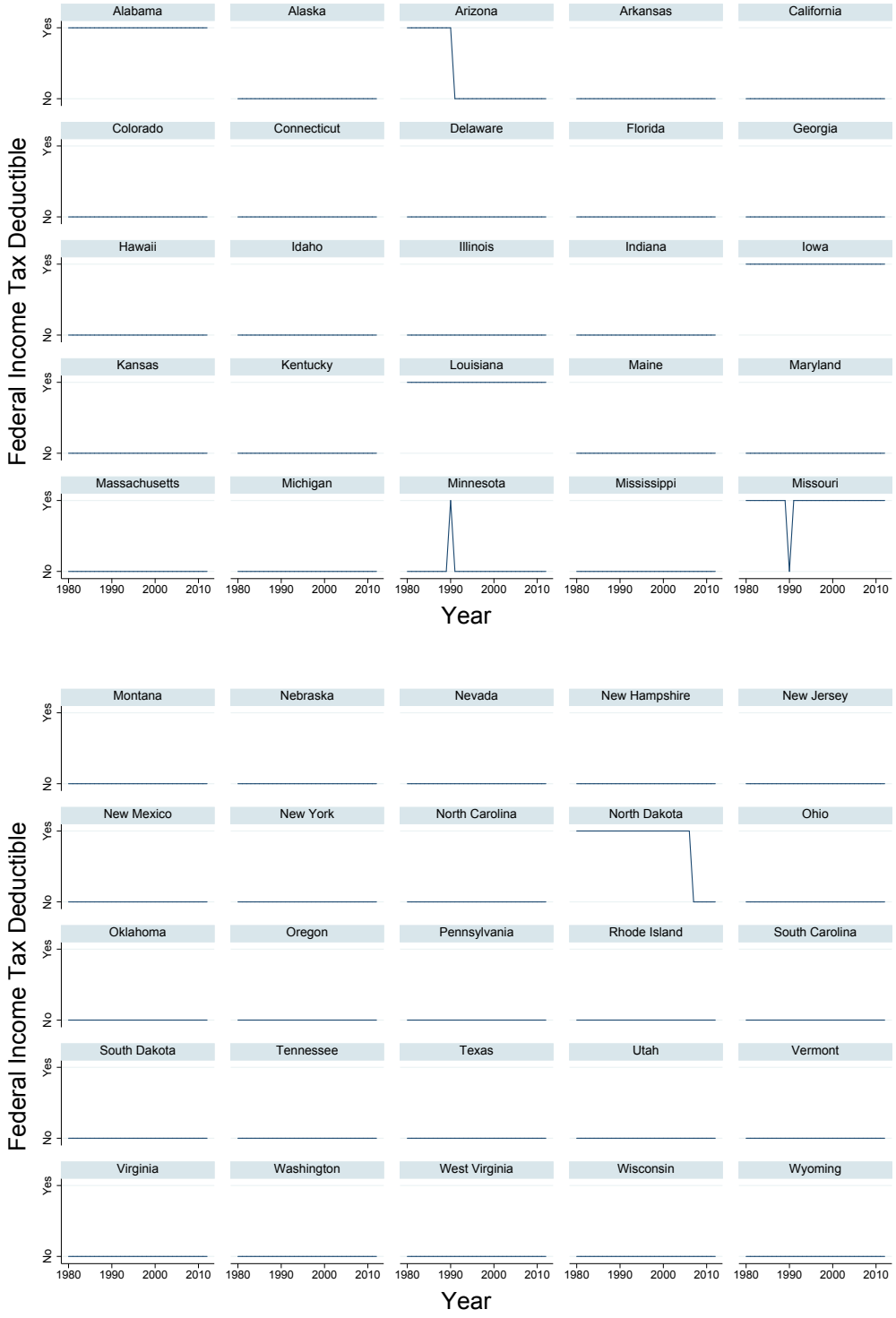
NOTES: Sample spans 1980-2010.

Figure A9: Combined Reporting Rule By State-Year



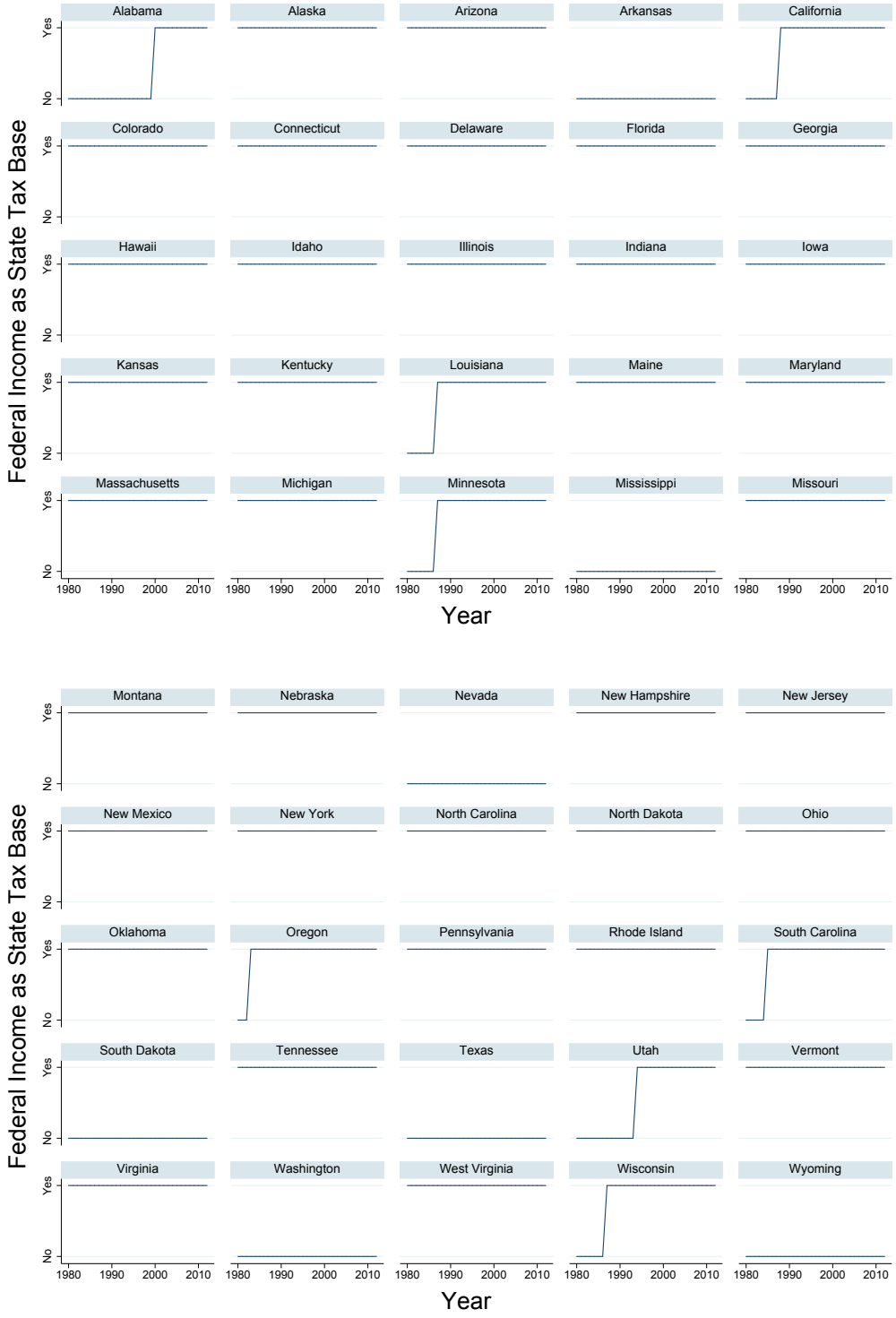
NOTES: Sample spans 1980-2010.

Figure A10: Federal Income Tax Deductible By State-Year



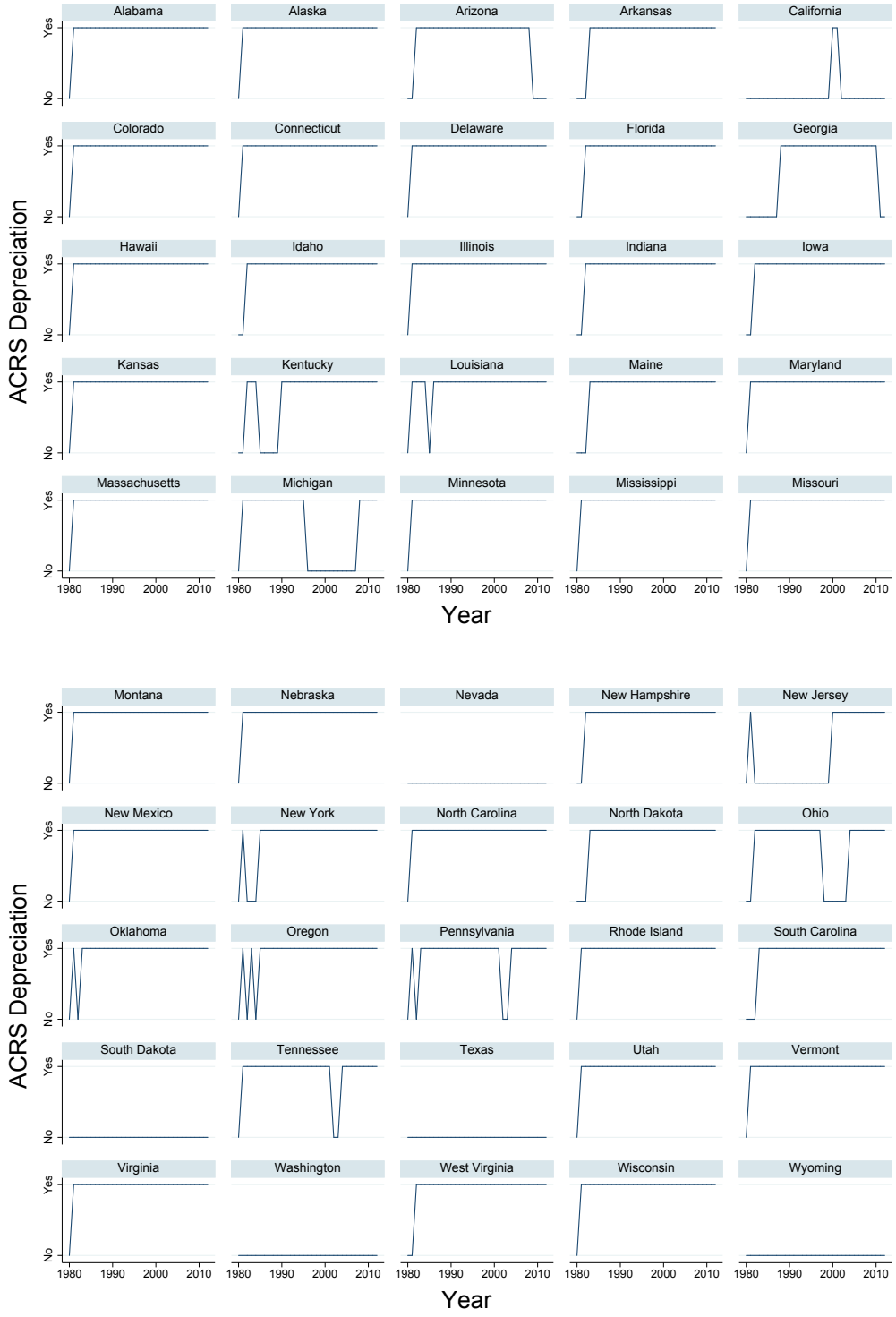
NOTES: Sample spans 1980-2012.

Figure A11: Federal Income as State Tax Base By State-Year



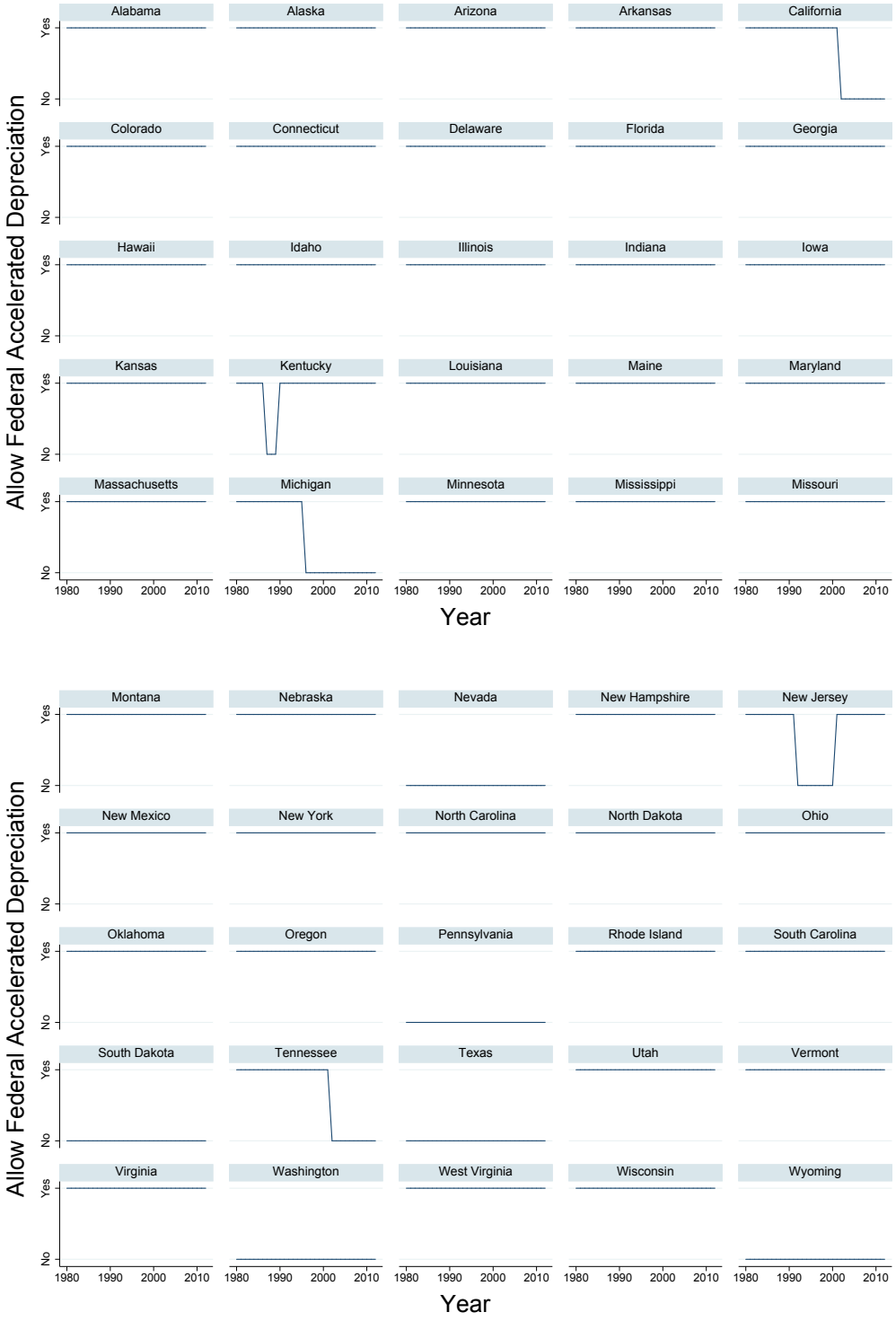
NOTES: Sample spans 1980-2012.

Figure A12: ACRS Depreciation Rule By State-Year



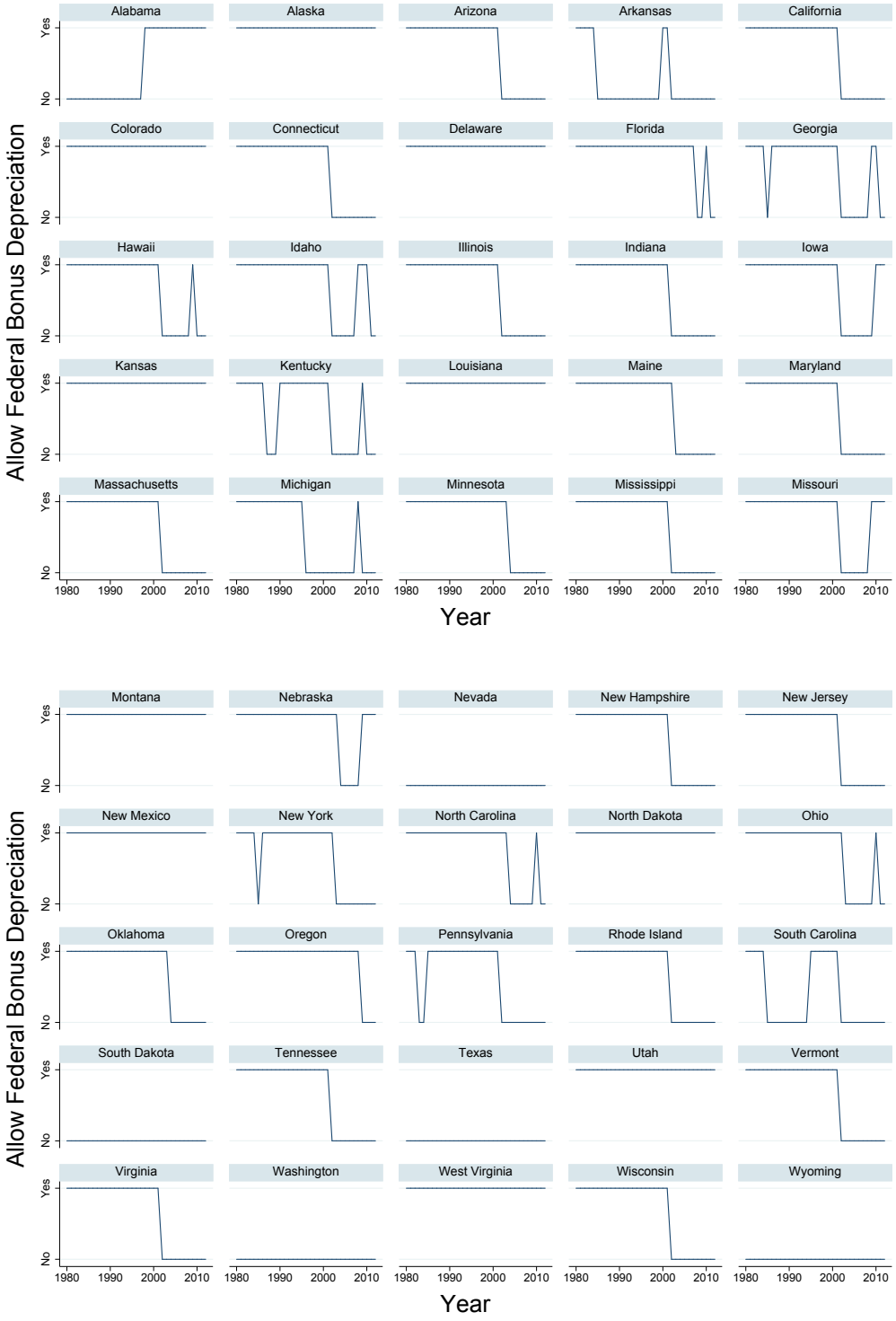
NOTES: Sample spans 1980-2012.

Figure A13: Federal Accelerated Depreciation Rule By State-Year



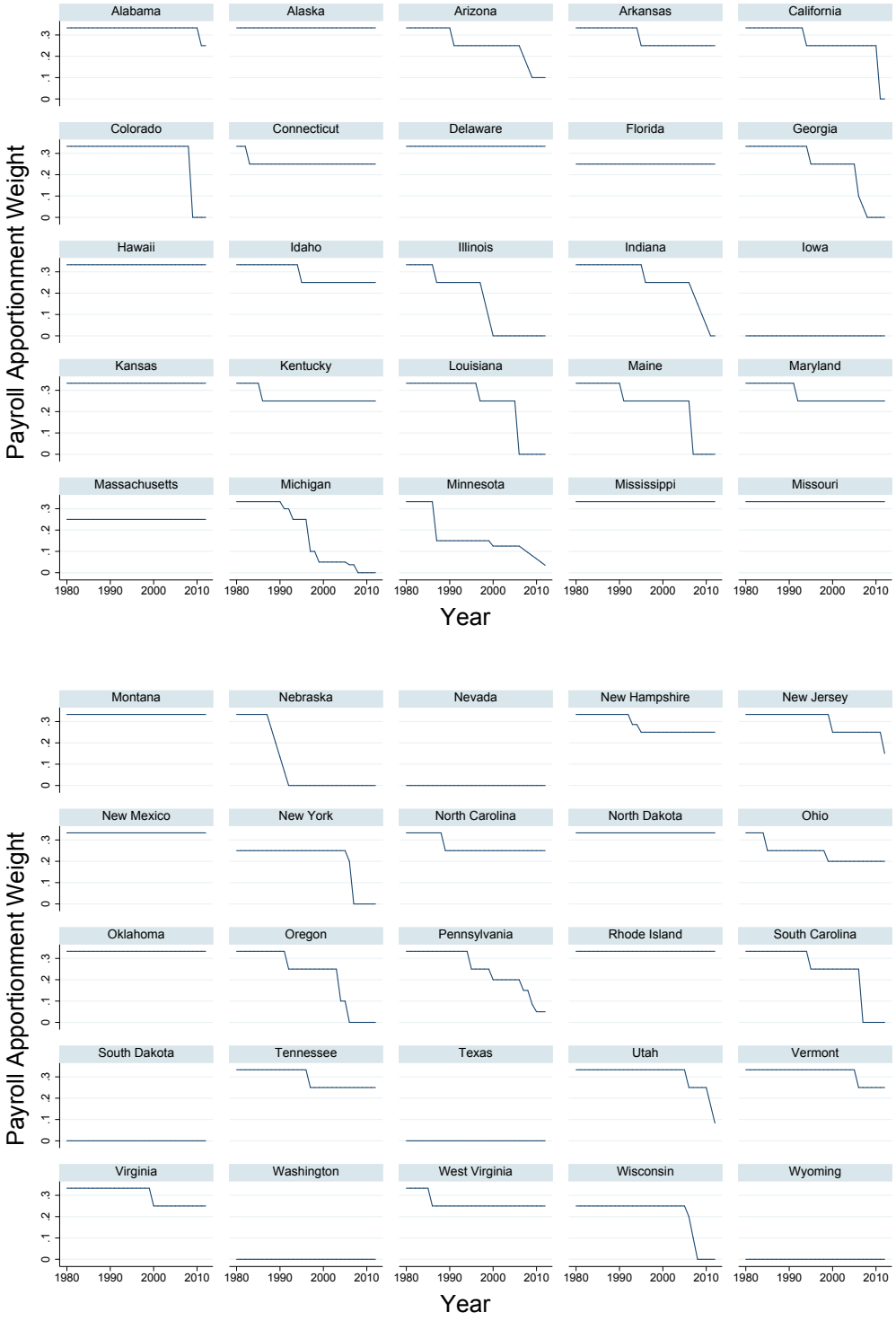
NOTES: Sample spans 1980-2012.

Figure A14: Federal Bonus Depreciation Rule By State-Year



NOTES: Sample spans 1980-2012.

Figure A15: Payroll Apportionment Weight By State-Year



NOTES: Sample spans 1980-2012.

Figure A16: Corporate Tax Revenue Share by Region

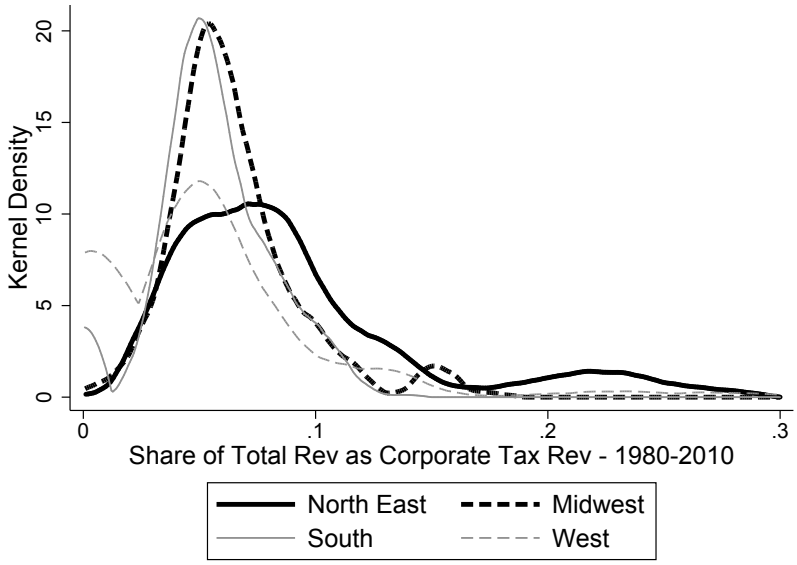
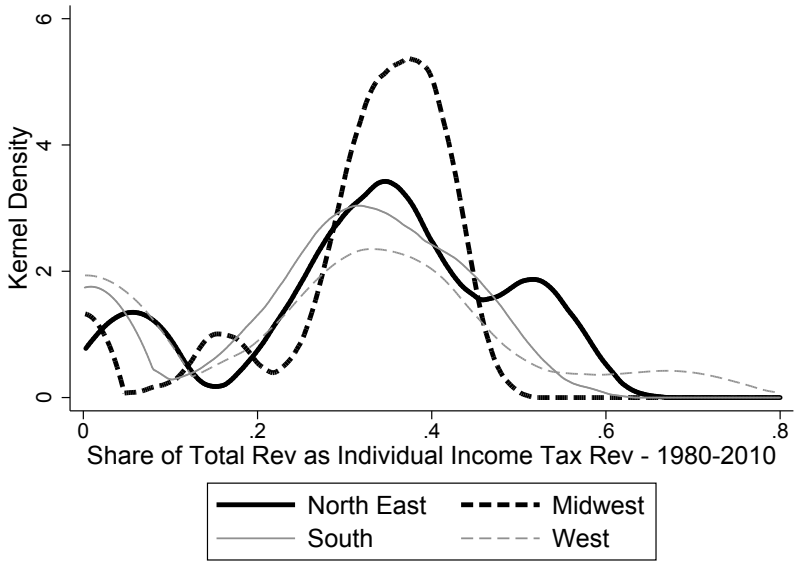
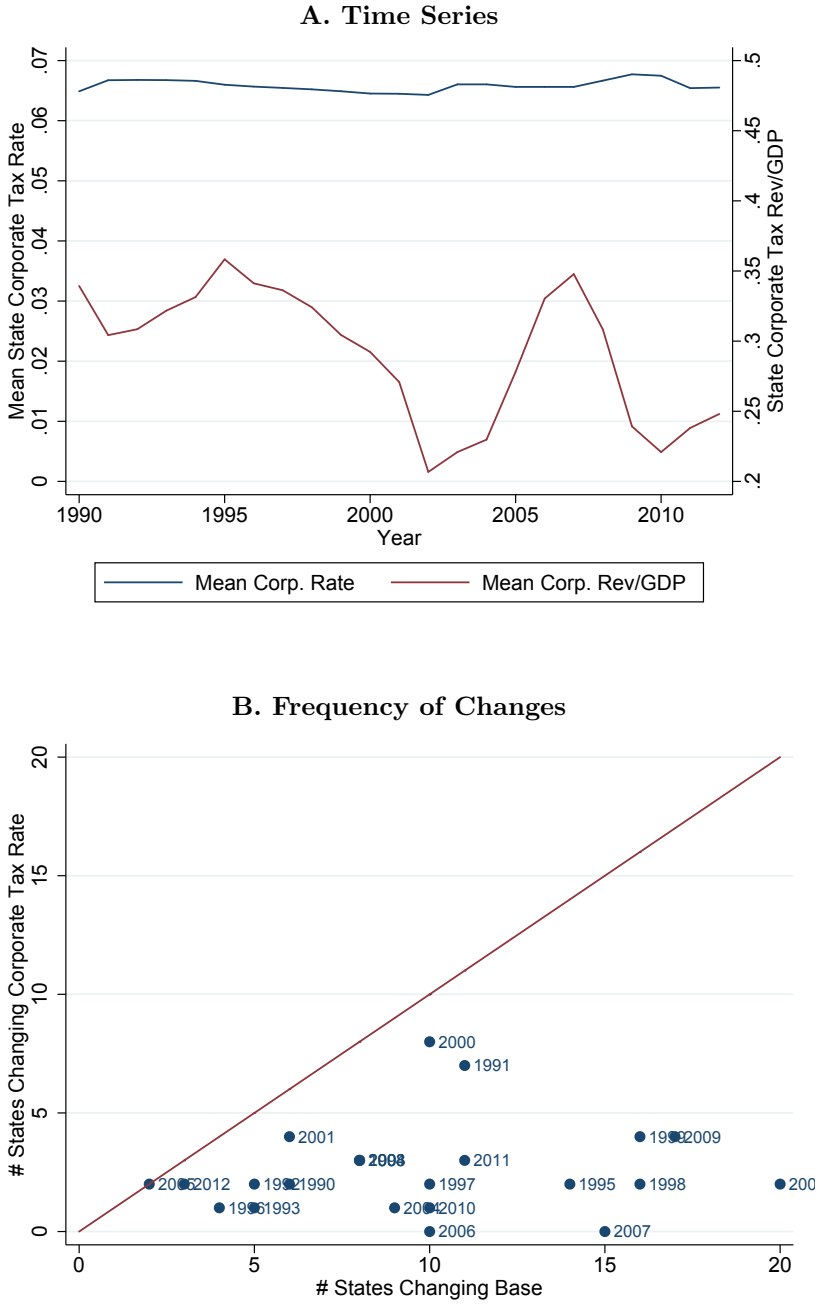


Figure A17: Individual Income Tax Revenue Share by Region



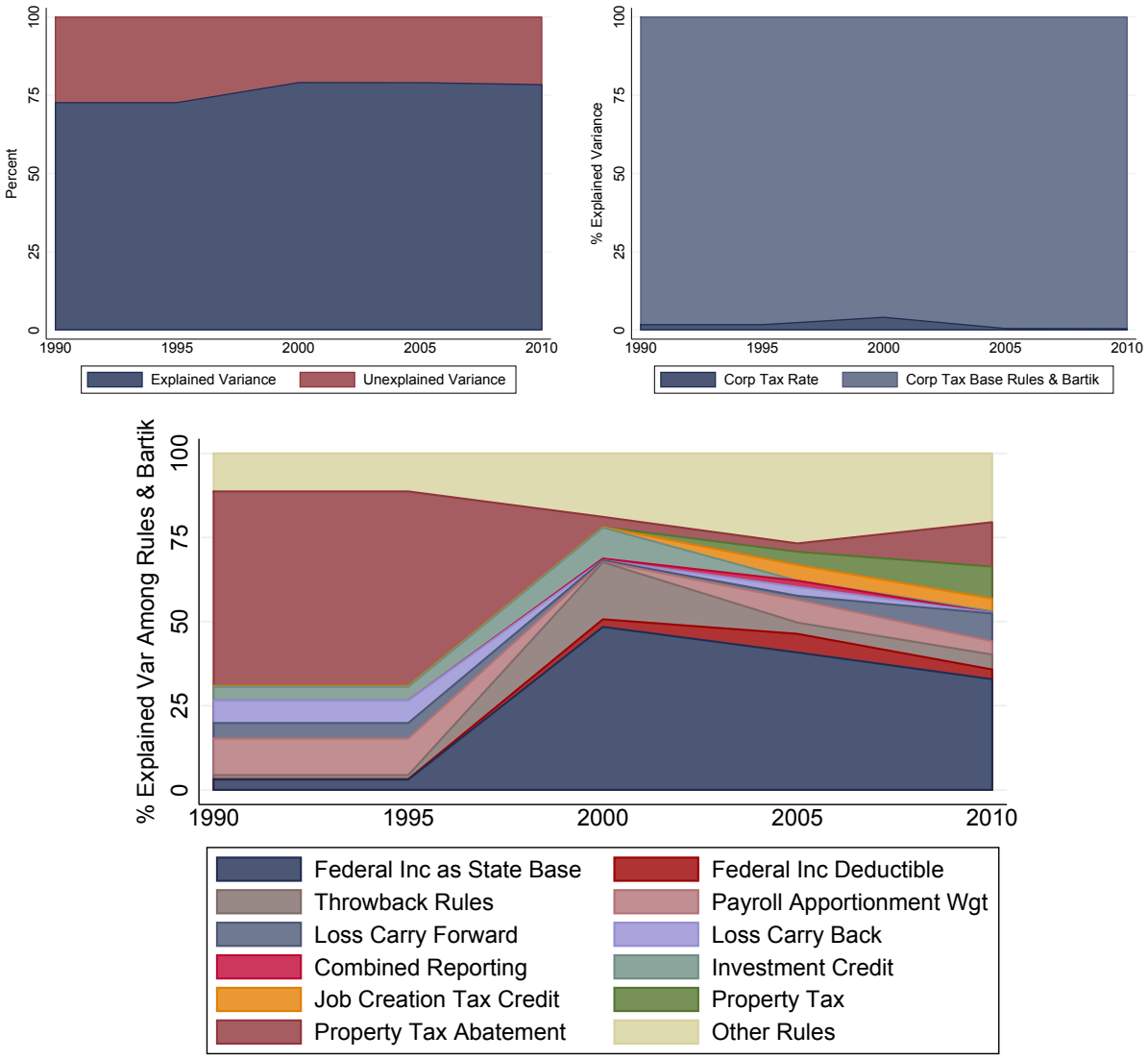
Notes: Sample spans 1980-2010. Regions are based on standard U.S. Census regions. Note that the kernel density is equally weighted by state-year observation. That is, a single observation is one state-year (within a single region). The alternative would be to take the total single tax revenue for a given state over the sample period (1980-2010) and divide it by the total tax revenue for that state over the sample period. Both produce similar results.

Figure A18: Changes in State Corporate Tax Structure - Bartik Sample



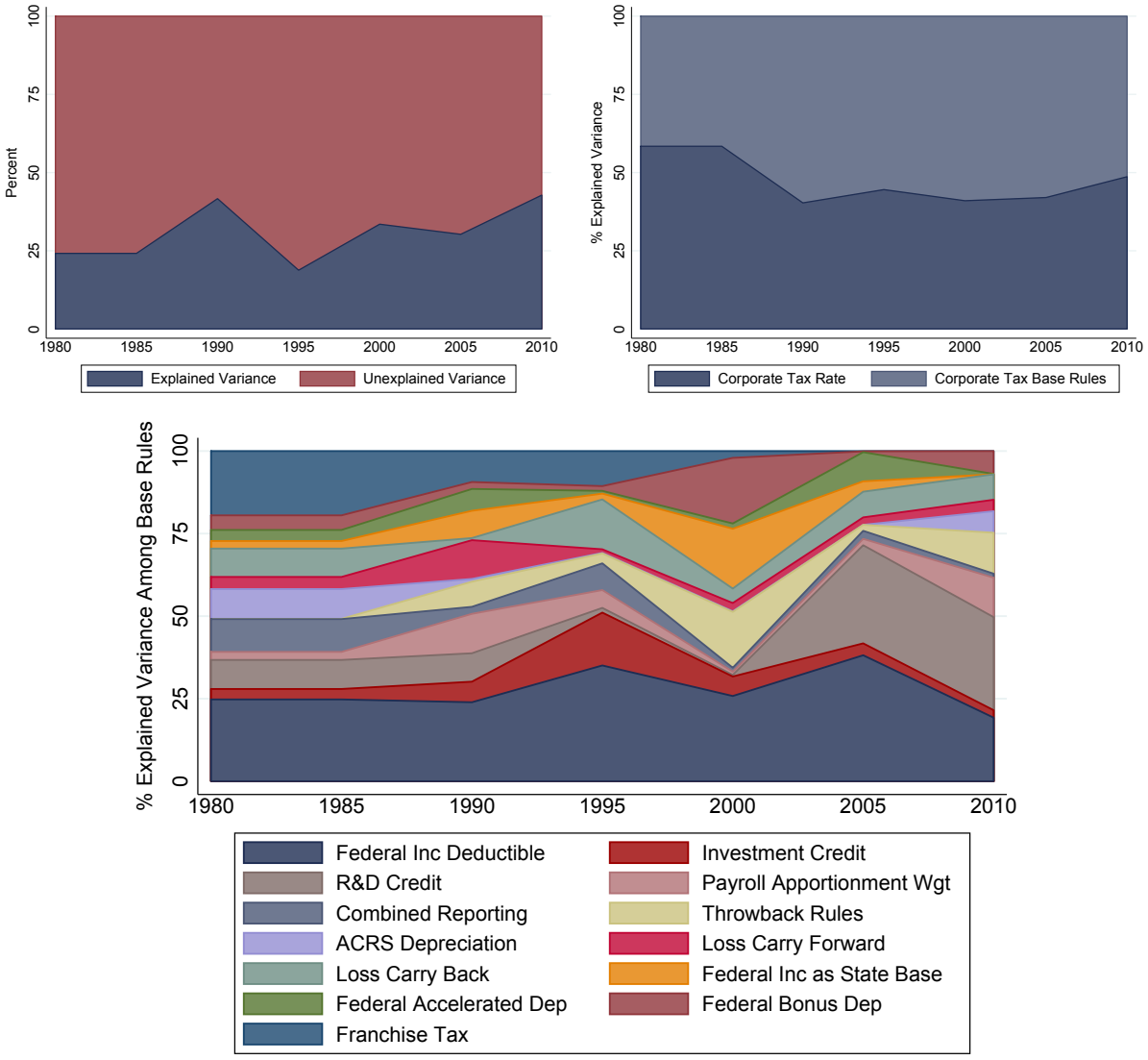
NOTES: These figures show annual trends in both the mean corporate tax rate across states and corporate tax revenue as a share of GDP in panel A. Panel B shows by year the number of states that changed rates and tax base provisions. It illustrates that these pairs are not on a 45 degree line, so most years in which many states change base provisions are not years in which many states also change rates. Note that this figure is analogous to figure 2, but only on 33 states from 1990-2010 (i.e. availability along the Bartik controls dimension).

Figure A19: Corp Tax Rev Share of GDP - Variance Decomp - w/ Bartik



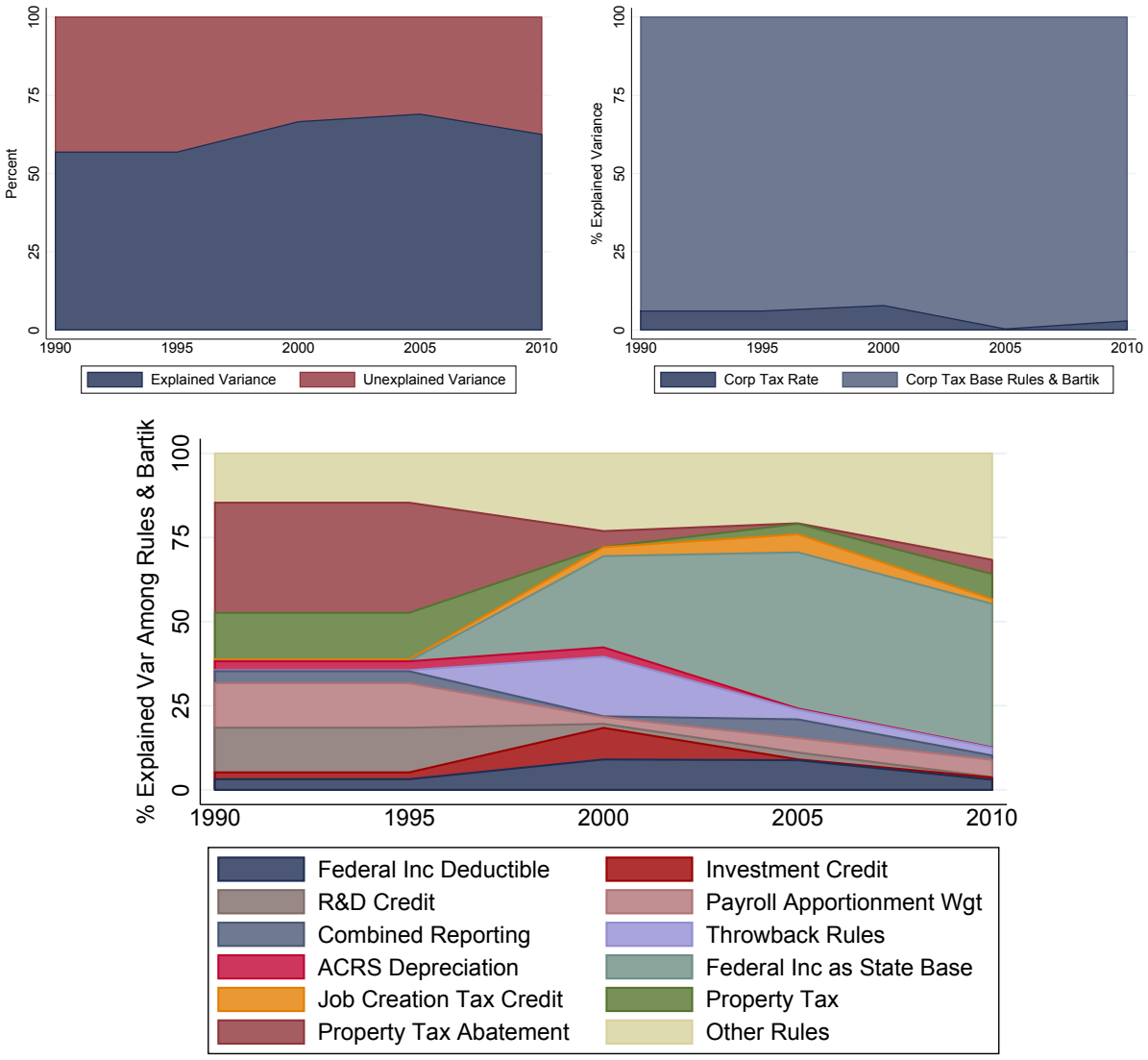
NOTES: These figures show the general explanatory power for the corporate tax rate, base rules, and additional bartik controls. The first figure shows the explained vs. unexplained variance in the specified model. The second figure shows the ratio of explained variance for the corporate tax rate vs. the corporate tax base rules and bartik controls. The third shows the ratio of explained variance only among the corporate tax base rules and bartik controls. Each figure has 4 point estimates that correspond to 5-year spans between 1990 and 2010. The following tax base rules encompass those included in the model: loss carry forward, loss carry back, R&D credit, investment credit, throwback rule, combined reporting rule, federal income tax deductibility, federal bonus depreciation, federal income as state tax base, federal accelerated depreciation, ACRS depreciation, and the payroll apportionment weight. In addition, we include the job creation tax credit rate, property tax rate, and property tax abatement as part of the "Bartik" controls. Note that each variance decomposition shown in this figure is only performed on 33 states due to data limitations along the "Bartik" dimension. In addition, we weight each decomposition by the mean GDP in each state across the sample period.

Figure A20: Corp Tax Rev Share of GDP - Variance Decomp - Unweighted



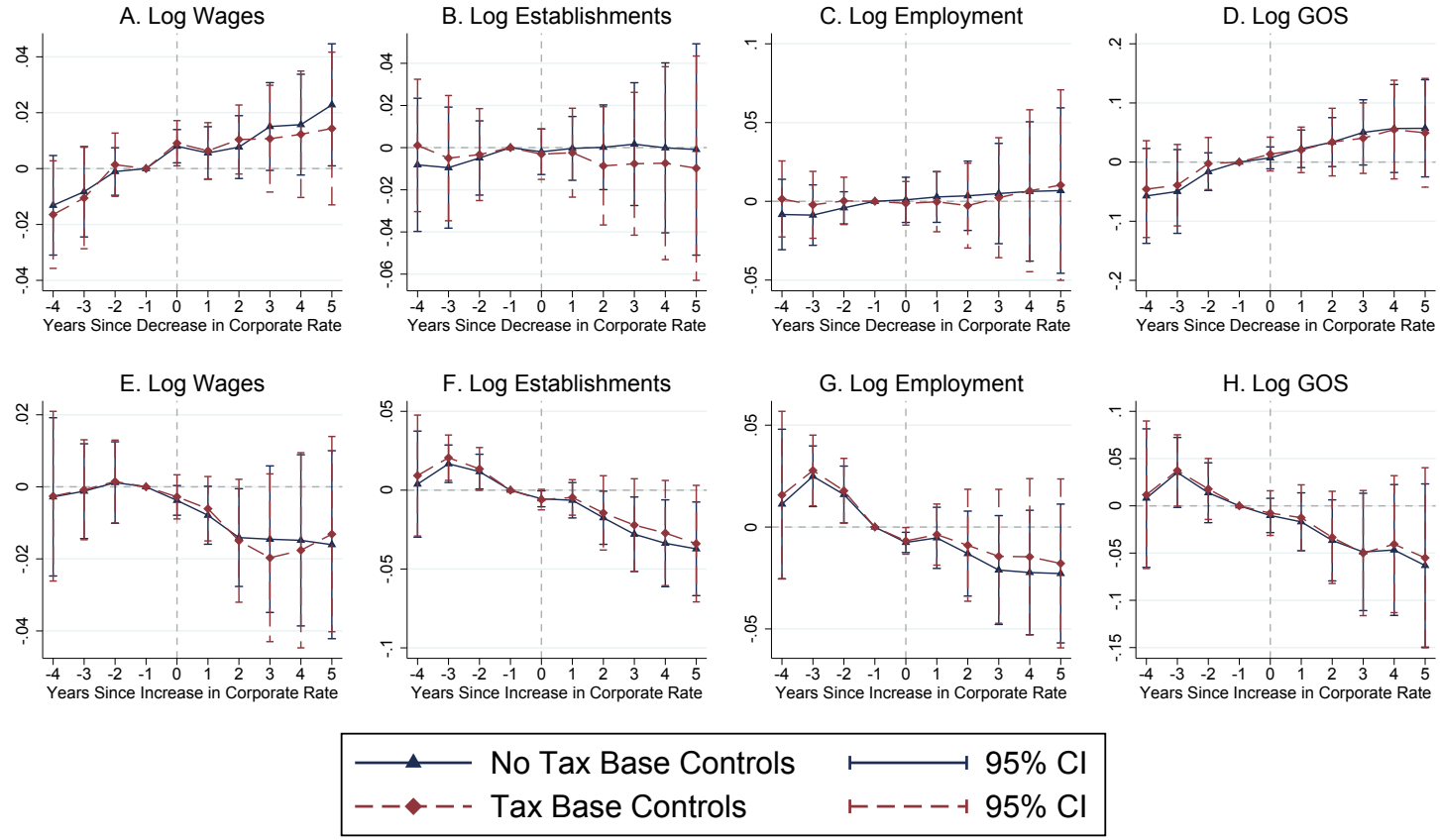
NOTES: These figures show the general explanatory power for the corporate tax rate and base rules. The first figure shows the explained vs. unexplained variance in the specified model. The second figure shows the ratio of explained variance for the corporate tax rate vs. the corporate tax base rules. The third shows the ratio of explained variance only among the corporate tax base rules. Equation 1 presents the expression for state corporate tax revenue as a share of state GDP. Each figure has 6 point estimates that correspond to 5-year spans between 1980 and 2010. The following tax base rules encompass those included in the model: loss carry forward, loss carry back, R&D credit, investment credit, throwback rule, combined reporting rule, federal income tax deductibility, federal bonus depreciation, federal income as state tax base, federal accelerated depreciation, ACRS depreciation, and the payroll apportionment weight. Note that this figure is analogous to figure 6, but does *not* weight each decomposition by State GDP.

Figure A21: Corp Tax Rev Share of GDP - Variance Decomp - w/ Bartik - Unweighted



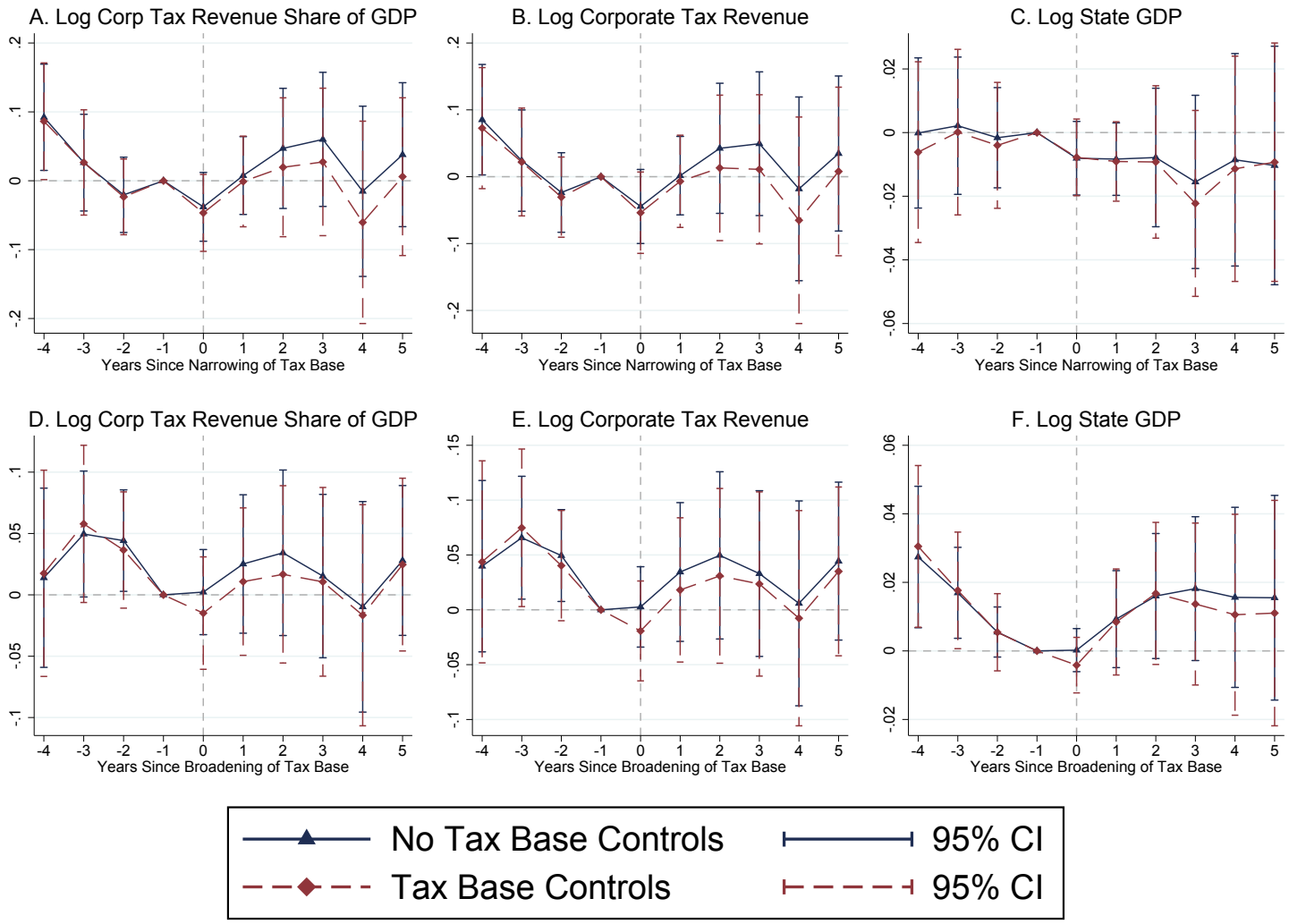
NOTES: These figures show the general explanatory power for the corporate tax rate, base rules, and additional bartik controls. The first figure shows the explained vs. unexplained variance in the specified model. The second figure shows the ratio of explained variance for the corporate tax rate vs. the corporate tax base rules and bartik controls. The third shows the ratio of explained variance only among the corporate tax base rules and bartik controls. Each figure has 4 point estimates that correspond to 5-year spans between 1990 and 2010. The following tax base rules encompass those included in the model: loss carry forward, loss carry back, R&D credit, investment credit, throwback rule, combined reporting rule, federal income tax deductibility, federal bonus depreciation, federal income as state tax base, federal accelerated depreciation, ACRS depreciation, and the payroll apportionment weight. In addition, we include the job creation tax credit rate, property tax rate, and property tax abatement as part of the "Bartik" controls. Note that the variance decomposition shown in this figure is only performed on 33 states due to data limitations along the "Bartik" dimension. Note that this figure is analogous to figure A19, but does *not* weight each decomposition by State GDP.

Figure A22: Event Analysis: Impacts on State Wages, Establishments, Employment, and GOS



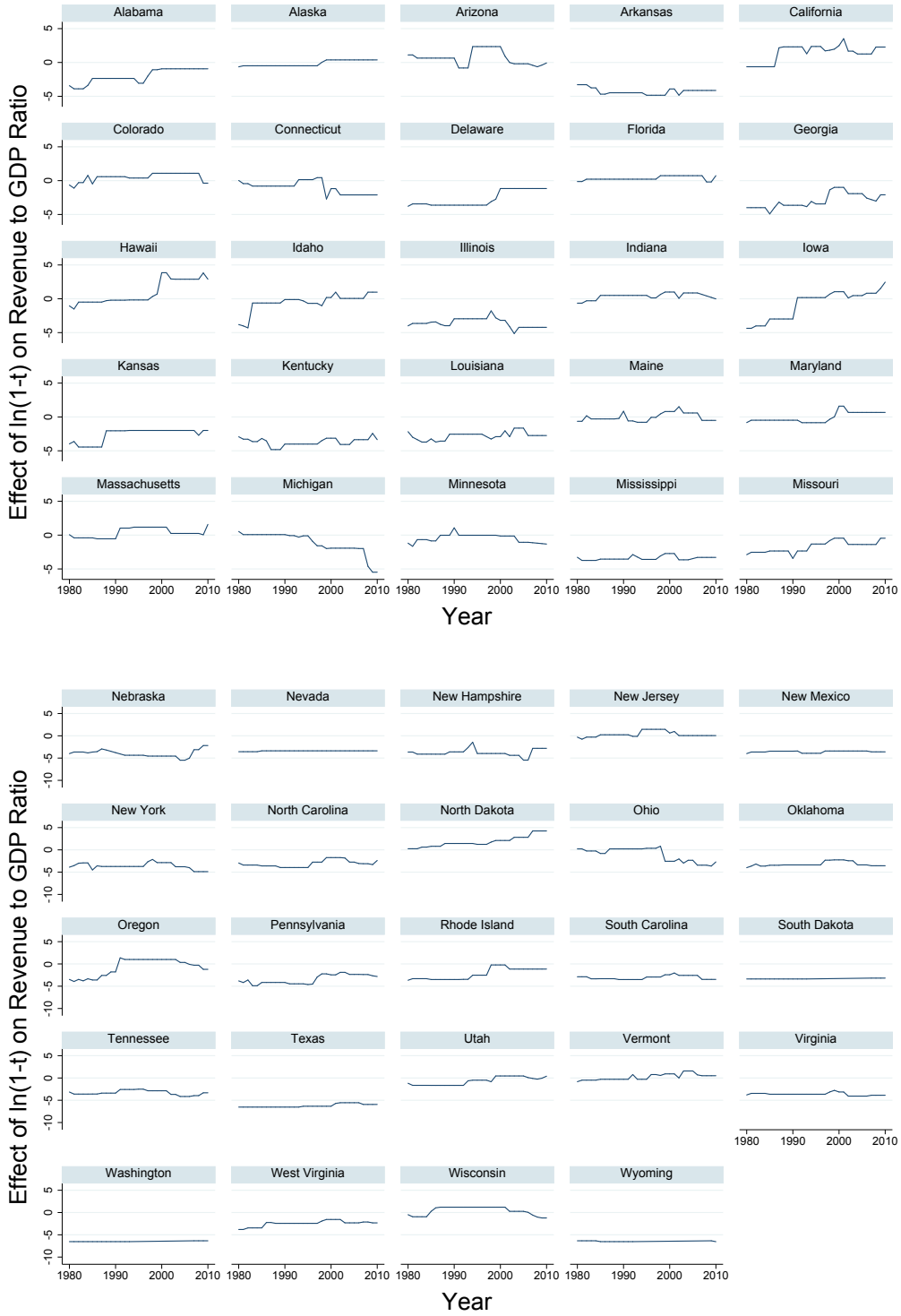
NOTES: This figure shows the effect of increases and decreases in the state corporate rate of at least .5pp on log state average wages, establishments, and employment. Year and state fixed effects are utilized. Where specified, we additionally control for the following tax base rules: federal income tax treated as state base, payroll apportionment weight, throwback rules, federal income tax deductibility, loss carry forward, and investment tax credit. Note that "wages" are the average earnings among workers in a state. Standard errors are clustered by state. The construction of these event studies follows the form of equation 3.

Figure A23: Event Analysis: Impacts of Tax Base Changes on Revenue and GDP



Notes: This figure shows the effect of increases and decreases in the tax base. We use the joint interaction term in Table 2 as a measure of base broadening/narrowing and define a change in the top/bottom 25th percentile of the distribution as a narrowing/broadening. Where specified, we additionally control for the tax rate and the following tax base rules: federal income tax treated as state base, payroll apportionment weight, throwback rules, federal income tax deductibility, loss carry forward, and investment tax credit. Standard errors are clustered by state. The construction of these event studies follows the form of Equation 3.

Figure A24: Estimated Total Effect of $\ln(1-\tau^c)$ on the Revenue-to-GDP Ratio By State-Year



NOTES: This figure plots estimated total effects of $\ln(1-\tau^c)$ on the revenue-to-GDP ratio for every state-year. The total effect is defined in Equation 5 as a result of estimating Equation 4, which is reported in column (3) of Table 4. Data used for this estimation is discussed in Section 1, and details of the estimation can be found in Section 5. The coefficients on the terms $\ln(1-\tau)$ and interactions are multiplied by 100 to ease interpretation.

Table A1: Frequency of tax base changes accompanying rate changes

Tax Rate Change:	Dec.	Dec.	Inc.	Inc.	None	None	Total	Total
Total Rate Changes:	76		237		1469		313	
Base narrowing/broadening:	-1	+1	-1	+1	-1	+1	-1	+1
Sales Apportionment Weight	4	2	2	1	94	30	100	33
Loss Carry Back	1	3	2	1	22	39	25	43
Loss Carry Forward	8	1	6	1	75	13	89	15
Francise Tax	1	1	1	1	2	1	4	3
Federal Income Tax Deductible	0	1	0	2	2	1	2	4
Federal Income Tax as State Tax Base	2	0	0	0	6	0	8	0
Federal Accelerated Depreciation	0	0	0	0	2	5	2	5
ACRS Depreciation	1	0	6	1	50	14	57	15
Federal Bonus Depreciation	1	2	2	2	16	44	19	48
Throwback	4	3	4	0	15	21	23	24
Combined Reporting	1	0	2	0	18	2	21	2
Investment Credit	1	2	1	0	33	8	35	10
R&D Credit	4	2	2	0	47	8	53	10

NOTES: The data used for these table are described in Section 1. This table reports the number of state-year observations where there was a change in tax base and tax rate. A change that represents a narrowing of the base is counted in the -1 column, while a year that represents a broadening of the base is counted as $+1$. See Section A for detailed definitions of broadening and narrowing for each measure.

Table A2: Heterogeneous Effects of Corporate Tax Rates on R_s^{corp}/GDP_s

	(1)	(2)	(3)	(4)
$\ln(1-t)$	-1.639*	-1.512**	-2.456***	-2.456***
	(0.955)	(0.734)	(0.785)	(0.388)
$\ln(1-t) \times$ R&D Tax Credit			0.800***	0.800***
			(0.274)	(0.137)
$\ln(1-t) \times$ Payroll Apportionment Weight			0.289	0.289
			(0.511)	(0.257)
$\ln(1-t) \times$ Loss carry-back			0.016	0.016
			(0.144)	(0.096)
$\ln(1-t) \times$ Loss carry-forward			0.002	0.002
			(0.169)	(0.117)
$\ln(1-t) \times$ Franchise Tax			-0.792**	-0.792***
			(0.323)	(0.205)
$\ln(1-t) \times$ Fed Income Tax Deductible			0.327**	0.327***
			(0.138)	(0.121)
$\ln(1-t) \times$ Federal Income as State Tax Base			-0.198	-0.198*
			(0.248)	(0.119)
$\ln(1-t) \times$ Allow Fed Acc Dep			0.694**	0.694***
			(0.291)	(0.148)
$\ln(1-t) \times$ ACRS Depreciation			-0.305***	-0.305***
			(0.103)	(0.078)
$\ln(1-t) \times$ Federal Bonus Depreciation			-0.080	-0.080
			(0.164)	(0.108)
$\ln(1-t) \times$ Apportionment throwback rules			-0.032	-0.032
			(0.096)	(0.067)
$\ln(1-t) \times$ Apportionment combined reporting rules			-0.208*	-0.208**
			(0.122)	(0.097)
$\ln(1-t) \times$ Investment tax credit			0.030	0.030
			(0.165)	(0.088)
Observations	1,508	1,508	1,508	1,508
Base Controls	N	Y	Y	Y

NOTES: The data used for these table are described in Section 1. This table reports the coefficients of regressions of the revenue-to-GDP ratio on the log-corporate keep rate. The specifications are described in detail in Equation 4 of Section 5. Each specification includes state and year fixed effects. Columns (1)-(3) cluster standard errors at the state level and column (4) reports robust standard errors. The interacted regressions in columns (3) and (4) first normalized the tax base parameters so that the coefficient on $\ln(1-\tau^c)$ can be interpreted as the mean marginal elasticity, and so the coefficients on the interaction terms are interpreted in terms of standard deviations.. Table 4 presents the same estimates where the interaction terms are collapsed into a single joint interaction term. The coefficients on the terms $\ln(1-\tau)$ and interactions are multiplied by 100 to ease interpretation.

Table A3: Heterogeneous Effects of Corporate Tax Rates on Corporate Revenue

	(1)	(2)	(3)	(4)
$\ln(1-t)$	-2.293	-2.513	-4.150**	-4.150***
	(2.674)	(1.868)	(1.837)	(1.226)
$\ln(1-t) \times$ R&D Tax Credit			1.334	1.334***
			(1.096)	(0.506)
$\ln(1-t) \times$ Payroll Apportionment Weight			-0.789	-0.789
			(1.397)	(0.789)
$\ln(1-t) \times$ Loss carry-back			0.563	0.563*
			(0.563)	(0.327)
$\ln(1-t) \times$ Loss carry-forward			0.574	0.574
			(0.624)	(0.387)
$\ln(1-t) \times$ Franchise Tax			-2.632**	-2.632***
			(1.068)	(0.605)
$\ln(1-t) \times$ Fed Income Tax Deductible			0.924*	0.924**
			(0.533)	(0.361)
$\ln(1-t) \times$ Federal Income as State Tax Base			-1.169	-1.169***
			(0.991)	(0.345)
$\ln(1-t) \times$ Allow Fed Acc Dep			1.290	1.290**
			(1.012)	(0.514)
$\ln(1-t) \times$ ACRS Depreciation			-0.424	-0.424
			(0.563)	(0.395)
$\ln(1-t) \times$ Federal Bonus Depreciation			0.733	0.733
			(0.670)	(0.523)
$\ln(1-t) \times$ Apportionment throwback rules			-0.290	-0.290
			(0.452)	(0.285)
$\ln(1-t) \times$ Apportionment combined reporting rules			0.044	0.044
			(1.074)	(0.679)
$\ln(1-t) \times$ Investment tax credit			-0.087	-0.087
			(0.598)	(0.291)
Observations	1,413	1,413	1,413	1,413
Base Controls	N	Y	Y	Y

NOTES: The data used for these table are described in Section 1. This table reports the coefficients of regressions of log-revenue on the log-corporate keep rate. The specifications are described in detail in Equation 4 of Section 5. Each specification includes state and year fixed effects. Columns (1)-(3) cluster standard errors at the state level and column (4) reports robust standard errors. The interacted regressions in columns (3) and (4) first normalized the tax base parameters so that the coefficient on $\ln(1-\tau^c)$ can be interpreted as the mean marginal elasticity, and so the coefficients on the interaction terms are interpreted in terms of standard deviations.. Table 4 presents the same estimates where the interaction terms are collapsed into a single joint interaction term.

Table A4: Heterogeneous Effects of Corporate Tax Rates on GDP

	(1)	(2)	(3)	(4)
$\ln(1-t)$	1.134	0.871	0.915	0.915***
	(1.286)	(0.956)	(0.951)	(0.321)
$\ln(1-t) \times$ R&D Tax Credit			0.658	0.658***
			(0.470)	(0.153)
$\ln(1-t) \times$ Payroll Apportionment Weight			-0.316	-0.316
			(0.493)	(0.242)
$\ln(1-t) \times$ Loss carry-back			0.216	0.216*
			(0.262)	(0.112)
$\ln(1-t) \times$ Loss carry-forward			0.578**	0.578***
			(0.220)	(0.140)
$\ln(1-t) \times$ Franchise Tax			-0.570**	-0.570***
			(0.270)	(0.139)
$\ln(1-t) \times$ Fed Income Tax Deductible			0.553*	0.553***
			(0.292)	(0.143)
$\ln(1-t) \times$ Federal Income as State Tax Base			-0.444	-0.444***
			(0.426)	(0.122)
$\ln(1-t) \times$ Allow Fed Acc Dep			0.197	0.197
			(0.251)	(0.199)
$\ln(1-t) \times$ ACRS Depreciation			0.328*	0.328*
			(0.193)	(0.193)
$\ln(1-t) \times$ Federal Bonus Depreciation			0.038	0.038
			(0.267)	(0.143)
$\ln(1-t) \times$ Apportionment throwback rules			-0.280	-0.280**
			(0.291)	(0.131)
$\ln(1-t) \times$ Apportionment combined reporting rules			0.077	0.077
			(0.319)	(0.127)
$\ln(1-t) \times$ Investment tax credit			-0.095	-0.095
			(0.371)	(0.115)
Observations	1,413	1,413	1,413	1,413
Base Controls	N	Y	Y	Y

NOTES: The data used for these table are described in Section 1. This table reports the coefficients of regressions of log-GDP on the log-corporate keep rate. The specifications are described in detail in Equation 4 of Section 5. Each specification includes state and year fixed effects. Columns (1)-(3) cluster standard errors at the state level and column (4) reports robust standard errors. The interacted regressions in columns (3) and (4) first normalized the tax base parameters so that the coefficient on $\ln(1-\tau^c)$ can be interpreted as the mean marginal elasticity, and so the coefficients on the interaction terms are interpreted in terms of standard deviations.. Table 4 presents the same estimates where the interaction terms are collapsed into a single joint interaction term.

Table A5: Heterogeneous Effects of Corp Tax Rates on R_s^{corp}/GDP_s: Robustness to Including Lagged Values

	(1)	(2)	(3)	(4)
$\ln(1-\tau)$	-0.439	0.121	-1.030	-0.258
	(0.915)	(0.469)	(0.682)	(0.499)
Lagged $\ln(1-\tau)$	-1.323*	-1.846**	-1.644*	-2.714***
	(0.721)	(0.749)	(0.917)	(0.774)
$\ln(1-\tau)\times$ Joint Interactions From Table 4			1.308***	
			(0.281)	
Lagged $\ln(1-\tau)\times$ Lagged Joint Interactions From Table 4			0.041	
			(0.071)	
$\ln(1-\tau)$ + $\ln(1-\tau)_{t-1}$	-1.762	-1.725	-2.675	-2.972
	(0.985)	(0.841)	(0.671)	(0.941)
	0.074	0.040	0.000	0.002
Base and Lagged Base Controls	N	Y	Y	Y
Base Interaction and Lagged Base Interaction	N	N	N	Y

NOTES: The data used for these table are described in Section 1. This table reports the coefficients of regressions of the revenue-to-GDP ratio on the log-corporate keep rate. The models in this table expand those of Table 4 by including lagged values of $\ln(1-\tau)$, the tax base measures, and the interactions. Each specification includes state and year fixed effects. Column (3) uses the joint interaction term from Table 4, while column (4) includes unreported interactions between each base control and $\ln(1-\tau)$, as well as interactions for lagged values of the base and the tax rate. The last line in the table reports the linear combination of the coefficient for $\ln(1-\tau)$ plus its lagged value, along with standard errors and p-value. The sum of these terms is quantitatively close to the estimates reported in Table 4. Standard errors are clustered at the state level. The coefficients on the terms $\ln(1-\tau)$ and interactions are multiplied by 100 to ease interpretation.