Tax Competition Among U.S. States:
Racing to the Bottom or Riding on a Seesaw?

Formerly Titled

Tax Competition and Capital Mobility: Evidence from the U.S. States

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Abstract

This paper provides an empirical analysis of the determination of capital tax policy by U.S. states based on new panel data, a new econometric technique, and a new theoretical model. The analysis is undertaken with a panel dataset covering all 48 contiguous states for the period 1969 to 2004 and is guided by the theory of strategic tax competition. The latter suggests that capital tax policy is a function of out-of-state tax policy, in-state and out-of-state economic conditions and, perhaps most importantly, preferences for government services. Using the Common Correlated Effects Pooled estimator to account for cross-section dependence and time lags to account for delayed responses, we estimate this reaction function for three state capital tax instruments: the investment tax credit rate, the corporate income tax rate, and the state's capital weight in its multi-state income apportionment formula. We find the slope of the reaction function – i.e., the equilibrium response of in-state to out-of-state tax policy – is *negative*, contrary to many prior empirical results. We document that a positive slope is obtained when either aggregate time effects or time-lags are omitted. We show that the positive slope found in misspecified models is the result of synchronous responses among states to common shocks rather than competitive responses to out-of-state tax policy. While striking given prior findings in the literature, these results are not surprising. The negative sign is fully consistent with qualitative and quantitative implications of the theoretical model developed in this paper. Rather than "racing to the bottom," our findings suggest that states are "riding on a seesaw."

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I. Introduction

This paper provides an empirical analysis of the determination of capital tax policy by U.S. states based on new panel data, a new econometric technique, and a new theoretical model. The analysis is guided by the theory of strategic tax competition and motivated in part by the substantial variation in state tax instruments. In 1968, no state had an investment tax credit (ITC). Since then, adoptions have grown steadily; by 2004, 21 states had adopted an ITC (Figure 1). An equally dramatic change has occurred in the capital apportionment weight (CAW) in the income apportionment formula, which has fallen substantially over the past 15 years. Less dramatic variation has occurred with state corporate income tax (CIT) rates (Figure 2). These common movements suggest that states are engaged in a "race to the bottom." However, we find that the slope of the reaction function – i.e., the equilibrium response of in-state tax policy to out-of-state tax policy – is *negative*. To varying degrees, this finding holds for all three capital tax policy instruments. This result runs contrary to the casual empirical evidence in Figures 1 and 2, the findings in many prior empirical results, and the implications in most theoretical models. We document that this seeming paradox is due to common time effects affecting all states in a similar manner and time lags. While these results are striking, they are not surprising and are fully consistent with the qualitative and quantitative implications of the theoretical model developed in this paper. The negative slope is inconsistent with the leading alternative model of strategic interaction, -- the yardstick competition model studied in Besley and Case [1995]. [1] Rather than "racing to the bottom," our findings suggest that states are "riding on a seesaw."

Our paper proceeds as follows. Section II develops a theoretical model whose key element is the relative preference for private vs. public goods. We show that the sign of the slope of the reaction function of in-state to out-of-state tax policy depends on the income elasticity of the preference of private to public goods. Section III presents the estimating

[1] Yardstick competition is a model in which the influence of out-of-state tax policy comes from an information asymmetry between policymakers and voters regarding the cost of government services provision. Voters look to the level of taxes and government services in other states in order to evaluate this cost. Holding services constant, tax increases (decreases) in other states signal to voters that costs have increased (decreased) and allow own-state policymakers to increase (decrease) tax rates without suffering in terms of re-electibility, which is assumed to be the objective of policymakers.

equation. The effects of aggregate shocks prove critical in evaluating the reaction function, and we rely on the Common Correlated Effects Pooled (CCEP) estimator that allows for heterogeneous responses across states. Section IV discusses our panel dataset for 48 U.S. states for the period 1969 to 2004. Section V presents our empirical results that document the importance of allowing for aggregate time effects and time-lags. Section VI offers a brief discussion of some of the relevant literature. Section VII summarizes.

II. The Strategic Tax Competition Model

Perhaps the most widely known theoretical result in the tax competition literature is that strategic interactions among independent, benevolent jurisdictions leads to tax rates and public good provision that are inefficiently low (Oates, 1972). This "race to the bottom" is driven by a fiscal externality among jurisdiction competing for a mobile tax base. Thus, in the face of a change in a tax rate by a neighboring state, a given state will react with a commensurate change in its tax rate. While such a positively sloped reaction function is possible, it is not the only implication of strategic tax competition. This section presents a new model demonstrating that, under plausible circumstances, the slope of the reaction function can be negative and states may well be "riding a seesaw." As shown by Brueckner and Saavedra (2001) and Mintz and Tulkens (1986) in different models, the key element is the relative preference for private vs. public goods.

Our model relies largely on the state's budget constraint and is based on five relations. First, we define the GDP expenditure identity linking income (y) and expenditures on public (g) and private (c) goods,

$$y = g + c. \qquad (1)$$

Second, income in a given state is measured by production in that state. The latter is determined by a neoclassical production function that depends on the mobile capital stock (k) and a fixed factor of production, that is strongly separable in the factors (e.g., the CES and Cobb-Douglas production functions), and that is subject to constant returns. We state the production function ($f[k]$) in the following intensive form relative to the fixed factor,

$$y = f[k]. \qquad (2)$$

Third, the government's budget constraint (stated per unit of the fixed factor) equates public goods expenditure to the product of the capital income tax rate (τ) and capital income, the latter defined as the marginal product of capital ($f'[k]$) multiplied by the capital stock,

$$g = \tau * f'[k] * k = \tau * \chi^{-1} * y. \tag{3}$$

Given the characteristics of the production function, capital income is a proportion ($\chi > 0$) of output. Fourth, we recognize that, as long as the supply of aggregate capital is not perfectly elastic, the capital stock in a given state depends negatively on its own tax rate and positively on the out-of-state tax rate ($\tau^{\#}$), as well as on a set of controls reflecting in-state and out-of-state demographic and economic variables (x_k and $x_k^{\#}$, respectively),

$$k = k[\tau, \tau^{\#} : x_k, x_k^{\#}]. \tag{4}$$

We enter capital mobility into the model by assuming that the derivatives of k with respect to in-state or out-of state tax rates are nonzero; it proves expositionally convenient to further assume that these derivatives are equal and opposite in sign, though the qualitative results do not require this assumption. Fifth, the preference between private and public goods is a key element in this model and is parameterized in a parsimonious manner as follows,

$$\zeta[y : x_{\zeta}] = c / g, \tag{5}$$

where the preference depends explicitly on income and implicitly on, among other control variables (labeled x_{ζ}), population size, economic conditions, and voter preferences all at the local level.[2] The derivative of $\zeta[.]$ with respect to income will loom large in the results below.

To derive the relation between in-state and out-of-state tax rates, we divide the right-side of equation (1) by g, use equation (5) to eliminate the ratio, and equation (3) to eliminate g. We then recognize the dependence of ζ on income that, in turn, depends on the production function (equation (2)), that, in turn, depends on tax rates through the mobility of capital (equation (4)),

[2] ζ can be thought of as the marginal rate of substitution between public and private goods for the representative state resident.

$$\begin{aligned}\chi &= \tau * (1+\zeta[y : x_\zeta]) \\ &= \tau * (1+\zeta[f[k[\tau,\tau^{\#} : x_k, x_k^{\#}]] : x_\zeta]) \\ &= g[\tau,\tau^{\#} : x], \qquad \text{where} \qquad x = \{x_\zeta, x_k, x_k^{\#}\}.\end{aligned} \tag{6}$$

Equation (6) implicitly defines a relation between in-state and out-of-state tax rates, and thus can be used to compute the reaction function for τ with respect to changes in $\tau^{\#}$. Following the standard Nash assumption used in the literature, we assume residents treat out-of-state tax policy as given. Differentiating equation (6) with respect to τ and $\tau^{\#}$ using the chain rule and rearranging yields the following reaction function,

$$\frac{d\tau}{d\tau^{\#}} = \frac{\eta_{\zeta,y} * \eta_{y,k} * (-\eta_{k,\tau}) * \zeta}{\left(\eta_{\zeta,y} * \eta_{y,k} * (-\eta_{k,\tau}) * \zeta - (1+\zeta)\right)}, \tag{7}$$

where the η's are elasticities, $\eta_{y,k}$, $-\eta_{k,\tau}$, and ζ are all positive. The slope of the reaction function depends on $\eta_{\zeta,y}$ and is evaluated in the following three cases where $\eta_{\zeta,y}$ is zero, negative, or positive.

To develop intuition for the slope of the reaction function under alternative values of $\eta_{\zeta,y}$ we assume that the out-of-state tax rate ($\tau^{\#}$) rises and, ceteris paribus, mobile capital flows into the state and capital income and tax revenues rise. The key decision is how this "windfall" is allocated to private and public goods and the subsequent impact on financing public goods through taxation.

Case I: $\eta_{\zeta,y} = 0$, $d\tau / d\tau^{\#} = 0$

The assumption that the division of resources between private and public goods remains unaltered ($\eta_{\zeta,y} = 0$) implies that there is no need to change the in-state tax rate to alter the mix. Note that the capital income tax base is proportional to income.

Case II: $\eta_{\zeta,y} < 0$, $d\tau / d\tau^{\#} > 0$

Under this assumption, the one term in the numerator and the two terms in the denominator of equation (7) are each negative; hence the overall derivative is positive. The negative value for $\eta_{\zeta,y}$ represents a preference for disproportionately diverting the windfall toward the public good. Since public goods need to be financed by tax revenues, this preference dictates an increase in τ.

<u>Case III</u>: $\eta_{\zeta,y} > 0, \; d\tau / d\tau^{\#} < 0$

Under this assumption, the numerator is unambiguously positive; the slope of the reaction function depends on the relative magnitudes of elasticities in the denominator. A sufficient condition for the denominator to be negative is as follows,

$$\left(\eta_{\zeta,y} * \eta_{y,k} * (-\eta_{k,\tau})\right) < 1. \qquad (8)$$

Upper bounds on $\eta_{y,k}$ and $(-\eta_{k,\tau})$ are 0.33 and 1.00, respectively. Thus, an income elasticity of the ratio of private to public goods less than 3.00 implies that the slope of the reaction function is negative. In this case, the windfall is directed toward a relative increase in private goods. The windfall relaxes the budget constraint and allows the state to lower tax rates and public good consumption.

The above analysis highlights that the slope of the reaction function is indeterminate *a priori* and depends crucially on the elasticity of the preferred private/public good mix with respect to income. This sensitivity is documented in Figure 3, which plots the slope of the reaction function (equation (7)) against values of $\eta_{\zeta,y}$ ranging from -2.00 to +2.00 in increments of 0.10.[3] The ζ and $\eta_{\zeta,y}$ parameters represent residents' preferences if the government is perfectly benevolent or might partially reflect the political ideology of government policymakers, as represented by political factors such as the political party of the governor and the majority of the state legislature. Our empirical analysis will include a variety of political variables. These key insights from the theory of strategic tax competition guide our empirical analyses below and

[3] These computations are based on the following assumptions about the other elasticities and parameter entering equation (7): $\eta_{y,k} = 0.33$, $-\eta_{k,\tau} = 1.00$, and $\zeta = 0.13^{-1}$. The latter parameter is based on the assumption that the ratio of state & local spending to GDP less state & local spending is 13%, a number in accord with figures presented in the National Income and Product Accounts.

will help us interpret the results.

The model developed in this Section has two further testable implications. First, the slope should vary systematically depending on whether the tax instrument applies to highly mobile new capital or less mobile old capital. Intuitively, the more responsive capital is to tax stimuli, the greater should be the response. Capital mobility is measured by the absolute value of the elasticity of capital with respect to the tax instrument, $(-\eta_{k,\tau})$. Differentiating equation (7) with respect to this elasticity, we obtain the following result,

$$d\frac{d\tau}{d\tau^{\#}}\Big/d(-\eta_{k,\tau}) < 0. \tag{9}$$

In the empirical work, we thus expect that the slope of the reaction function will be lower (or more negative) for the investment tax credit affecting new capital versus the corporate income tax rate that affects both new and old capital.

A further implication is that we would expect the slope to again be more negative the greater the relative preference for private goods. Differentiating equation (7) with respect to ζ, we obtain,

$$d\frac{d\tau}{d\tau^{\#}}\Big/d\zeta < 0. \tag{10}$$

In the empirical work, we thus expect that the slope of the reaction function will be lower (or more negative) for those states that have a relative preference for private goods. We assume that such a preference is revealed in those states in which Republicans hold the governorship and/or control both legislative houses.

In sum, the model developed and analyzed in this section carries three empirical implications:

Implication I: The slope of the reaction function is ambiguous;

Implication II: The slope of the reaction function will be lower for the investment tax credit than that for the corporate income tax rate.

Implication III: The slope of the reaction function will be lower for those states with a preference for private goods.

III. Estimation Issues

A. The Estimating Equation

The objective of our empirical work is to identify the slope of the reaction function for three state capital tax variables – the investment tax credit rate (ITC), the corporate income tax rate (CIT), and the capital apportionment weight (CAW). The strategic tax competition model implies the following specification of the reaction function,

$$\tau_{i,t} = \alpha\tau^{\#}_{i,t} + \beta x_{i,t} + u_{i,t}, \tag{11}$$

where $\tau_{i,t}$ is a tax variable for state i at time t, $\tau^{\#}_{i,t}$ is the tax variable for the competitive states, $x_{i,t}$ is a vector of control variables, $u_{i,t}$ is an error term, and α and β are parameters to be estimated. We measure $\tau^{\#}_{i,t}$ by the first-order spatial lag of the tax variable, $\tau_{i,t}$,

$$\tau^{\#}_{i,t} \equiv S^1\left\{\tau_{i,t}\right\} = \sum_{j\neq i}\omega_{i,j}\tau_{j,t}\ , \tag{12a}$$

$$\sum_{j\neq i}\omega_{i,j} = 1\,, \tag{12b}$$

where $S^n\{.\}$ is the spatial lag operator of order n, $\omega_{i,j}$ is a weight defining the "distance" between state i to the remaining 47 states indexed by j.

Our specification of the error term is somewhat new to the study of state tax policy and has a generalized two-way error component structure that allows for heterogeneous cross-section dependence (CSD) among states,

$$u_{i,t} = \varphi_i + \gamma_i f_t + \varepsilon_{i,t}\,, \tag{13}$$

where φ_i is a state-specific shock, $\varepsilon_{i,t}$ is a state-specific shock that varies over time and is independent of $x_{i,t}$, f_t is an unobserved time-specific shock (f_t may represent a vector of shocks), and γ_i is a state-specific aggregate factor loading. The $\gamma_i\, f_t$ term allows for heterogeneous CSD among the states. All states are affected by common aggregate factors such as energy prices, federal and foreign tax policies, and macroeconomic conditions represented by

f_t. However, the impact (direction and magnitude) of these aggregate factors may vary by state. For instance, changes in energy prices may have different effects on New England states than they do on those in the "oil patch" (e.g., Oklahoma and Texas). This differential response is captured by the γ_i aggregate factor loadings. The conventional time fixed effect (TFE) model is a special case of this framework and is obtained from equation (13) when $\gamma_i = \gamma$ for all i.

We make three additional modeling choices. First, three control variables are chosen to account for preferences for the mix of private and public goods ($x_{i,t}^{pref}$) and for economic ($x_{i,t-1}^{eco}$) and demographic ($x_{i,t}^{dem}$) effects. To avoid estimation problems arising from simultaneity, the economic variable is lagged one period. Second, as suggested by equation (4) in the theoretical model, first-order spatial lags of the economic and demographic control variables ($x_{i,t-1}^{eco,\#}$ and $x_{i,t}^{dem,\#}$) are included to capture the impact of out-of-state variables on the competition for capital between a given state and its competitors. Third, we allow for the possibility that the impact of the key tax competition variable may be distributed over several time periods. These considerations lead to the following specification of our estimating equation,

$$\begin{aligned}\tau_{i,t} &= \alpha_0 \hat{\tau}_{i,t}^{\#} + \sum_k \alpha_k \tau_{i,t-k}^{\#} + \varphi_i + \gamma_i f_t + \varepsilon_{i,t} \\ &+ \beta^{pref} x_{i,t}^{pref} + \beta^{eco} x_{i,t-1}^{eco} + \beta^{dem} x_{i,t}^{dem} + \beta^{eco,\#} x_{i,t-1}^{eco,\#} + \beta^{dem,\#} x_{i,t}^{dem,\#} \qquad (14) \\ \alpha &\equiv \sum_k \alpha_k ,\end{aligned}$$

where the second line contains the control variables and α is the sum of the coefficients on the competitive states tax variable, thus representing the slope of the reaction function.

The strategic tax competition model necessarily implies that the three shocks – φ_i, $\varepsilon_{i,t}$, and $\gamma_i f_t$ – that affect state i are correlated with tax policy in the competitive states, $\tau_{i,t}^{\#}$. We address the resulting estimation problem with the following three steps. First, φ_i is modeled as a fixed effect. Second, $\gamma_i f_t$ is modeled using the common correlated effects pooled (CCEP) estimator of Pesaran [2006] that captures the effects of f_t and will be discussed in

Section III.B. Third, the correlation between $\varepsilon_{i,t}$, and $\tau^{\#}_{i,t}$ is accounted for by projecting the latter variable on a set of instruments, $z_{i,t}$, discussed in the Section III.C.

B. The Common Correlated Effects Pooled (CCEP) Estimator

The CCEP is an important innovation for analyzing tax competition because it allows states to have heterogeneous responses to aggregate shocks. Such common shocks are usually controlled for in panel studies with time fixed effects. As discussed above with respect to energy prices, federal and foreign tax policies, and macroeconomic conditions, this is a restrictive assumption that may bias coefficients. Heterogeneous responses can be accounted for by a Seemingly Unrelated Regression, but this framework is not feasible when the number of states exceeds 10. The CCEP is both feasible for a large number of states and easy to implement, requiring only the inclusion of several cross-section averages. Moreover, it generates estimates of the aggregate factor loadings (γ_i's) that will permit a better understanding (in Section V) of the forces affecting the setting of tax policy.

The CCEP estimator models $\gamma_i f_t$ by cross-section averages of the dependent and independent variables. In general, the cross-section averages are formed with a set of state weights, v_j for j = 1,…,48, (note that these weights are unrelated to the $w_{i,j}$ state-pair weights used to construct the tax competition variable),

$$\begin{aligned} \bar{\tau}_t &\equiv \sum_j v_j \tau_{j,t} \\ \bar{\hat{\tau}}^{\#}_t &\equiv \sum_j v_j \hat{\tau}^{\#}_{j,t}, \\ \bar{x}_t &\equiv \sum_j v_j x_{j,t}, \\ &\sum_j v_j = 1. \end{aligned} \tag{15}$$

where the "^" over $\hat{\tau}^{\#}_{j,t}$ indicates that $\tau^{\#}_{j,t}$ has been instrumented by $z_{j,t}$. As shown by Pesaran (2006), the asymptotic properties of the CCEP estimator are invariant to the choice of the v_j

weights; the empirical work reported here is based on equal weighting ($v_j = 1/48$ for all j).

Our implementation of the CCEP differs from that of Pesaran in two ways. Pesaran's model imposes a set of nonlinear restrictions. (For example, for the term containing the cross-section average on the preference variable, $\phi_i^{pref} = \gamma_i * \beta^{pref}$; see equation (16) below and Pesaran, 2006, equations 4 and 6 and page 977.) Consistent estimation of all model parameters can nonetheless be obtained with the linear-in-parameters version of the CCEP that does not impose this constraint. The absence of the constraints involves a loss in efficiency. In future work, we will improve the efficiency of the linear-in-parameters CCEP estimator by undertaking a two-step process -- 1) estimating the parameters in the unconstrained model (equation (16)) and 2) then imposing the estimated γ_i's as constants and reestimating this constrained version of the model. This two-step process can be iterated until the γ_i's converge. The second departure from Pesaran's model is that one of the regressors is endogenous, and we instrument the endogenous $\tau_{i,t}^{\#}$. This procedure leads, in general, to a generated regressor problem and a potential understatement of standard errors. However, no adjustment for standard errors is needed for testing the hypothesis of most interest in this study, whether $\alpha = 0$ (Pagan, 1984).

C. Instrument Selection

As noted above, the logic of tax competition among states strongly suggests that the tax competition variable, $\tau_{i,t}^{\#}$, will be correlated with the stochastic error. To estimate α and other parameters consistently, we project the tax competition variable, $\tau_{i,t}^{\#}$, on an optimal set of instruments, $z_{i,t}^{*}$, to obtain $\hat{\tau}_{i,t}^{\#}$.[4]

The challenge is to identify a set of instruments that are both valid and relevant from the very large pool of feasible instruments. We adopt the following three-step search procedure.

1) First, the potential set of instruments -- $z_{i,t}$ -- is constructed from lists of included and excluded instruments. Included instruments are the five conditioning x-variables appearing

[4] Instrumental variables is one of two approaches typically used to estimate spatially autoregressive models. The other is maximum likelihood (e.g., Case, Hines, and Rosen [1993]), which is far more computationally intensive. See Brueckner [2003] for an extensive discussion of the econometric issues associated with identification of spatially autoregressive models in the context of tax competition and Pesaran [2006, Section 1] for a general review of estimation strategies.

in equation (14).[5] Excluded instruments are a set of voter preference variables for the competitive states and are the 1st and 2nd order spatial lags of the eight voter preference variables defined in Section IV.D.

2) Second, we examine all possible combinations of these instrument sets (supplemented with fixed effects to capture state and time effects) and store the J statistic and the 1st-Stage F-statistic testing the joint significance of the excluded instruments. We focus on a model with four time lags. The J statistic and the associated p-value are based on the overidentifying restrictions and the assumption of homoscedastic errors. A p-value greater than an arbitrary critical value (e.g., 0.10) implies that the null hypothesis is sustained and that the instruments are not invalid. Admissible instrument sets are identified as those whose p-values exceed a critical value of 0.10.
3) Third, from this admissible set of not invalid instruments, we then choose the instrument set that is most relevant, as assessed by the 1st Stage F-Statistic. While we are not interested in hypothesis testing per se, it is interesting to note that the null hypothesis of instrument irrelevance is assessed in terms of the 5% critical values presented in Table 1 of Stock and Yogo (2005); for seven or fewer excluded instruments and a bias greater than 10%, the critical value is 11.29. The instrument set we identify exceed this critical value.

The optimal instrument set thus identified is labeled $z_{i,t}^{*}$. While this procedure does not have a formal statistical basis, it has the virtues of generating a set of instruments that will generate consistent estimates and that are based on a formal, non-discretionary algorithm. To the best of our knowledge, there are no formal statistic tests for choosing instruments (or moment conditions) that satisfy both the validity and relevance criteria. For example, the moment selection procedures of Andrews (1999) and Andrews and Biao (2001) focus on instrument validity and maintain instrument relevance.

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[5] An interesting issue related to the proper choice of instruments for a panel model with two-way fixed effects is the potential "Nickell" bias (Nickell [1981]). As is well known, the within IV estimator with predetermined variables (time-lagged endogenous variables) is biased in finite-T samples because the predetermined variables are correlated with the within-transformed error term. In principle, this suggests that time lags of included instruments are invalid. However, what is not generally recognized is that there also is a parallel (or perhaps "perpendicular") finite-N bias coming from the spatial dimension. The two-way within estimator also transforms the error to sweep out time fixed effects which may be correlated with *spatial* lags of the included instruments, thus invalidating such spatial lags as instruments. It is important to keep in mind, however, that both biases vanish as T or N gets large and the rate of convergence is rather rapid. Thus, these potential problems do not arise in our dataset with T and N dimensions of 35, and 48, respectively.

D. The General Specification

The above considerations lead to the following general specification that is the basis of the estimates reported in Section V,

$$\tau_{i,t} = \alpha_0 \hat{\tau}^{\#}_{i,t} + \sum_k \alpha_k \tau^{\#}_{i,t-k} + \eta_i + \varepsilon_{i,t} \tag{16}$$
$$+ \beta^{pref} x^{pref}_{i,t} + \beta^{eco} x^{eco}_{i,t-1} + \beta^{dem} x^{dem}_{i,t} + \beta^{eco,\#} x^{eco,\#}_{i,t-1} + \beta^{dem,\#} x^{dem,\#}_{i,t}$$
$$+ \gamma_i \bar{\tau}_t - \gamma_i \sum_k \alpha_k \hat{\bar{\tau}}^{\#}_{t-k} - \phi^{pref}_i \bar{x}^{pref}_t - \phi^{IK}_i \bar{x}^{IK}_t - \phi^{pop}_i \bar{x}^{pop}_t - \phi^{IK,\#}_i \bar{x}^{IK,\#}_t - \phi^{pop,\#}_i \bar{x}^{pop,\#}_t$$

$$\alpha \equiv \sum_k \alpha_k ,$$

where the third line contains the cross-section means (indicated by a bar over the x's) capturing the effects of CSD as modeled by the CCEP estimator. When responses to aggregate shocks are constrained to be the same for all states, $\gamma_i = \gamma$ and $\phi^h_i = 0 \ \forall i, h$, the third line is replaced with standard time fixed effects. Lastly, we will present some estimates based on ignoring aggregate shocks and, in this case, $\gamma_i = 0 = \phi^h_i \ \forall i, h$

IV. U.S. State-Level Panel Data

Our estimates of the state capital tax reaction function are based on a U.S. state-level panel data for the period 1969 to 2004. The panel aspect of these data is crucial for understanding state tax policy for at least three reasons. First, state-specific fixed factors, such as natural amenities, affect a state's desire for government services and hence its tax and expenditure policies. The impact of these and other state-specific fixed factors will be accounted for with state fixed effects. Second, state tax policy may be sensitive to aggregate factors (e.g., energy prices) that vary over time, and these influences will be captured by time fixed effects or, more generally, by the CCEP model that allows heterogeneous responses across states. Third, panel data long in the time dimension allow for the possibility that the response of state tax policy is distributed over several years. As we shall see in Section V, the latter two factors prove important in the empirical analysis. We now turn to a discussion of the data sources underlying the variables used in our empirical analysis.

A. Capital Tax Policy (τ)

The model developed above, as well as the tax competition literature in general, analyzes the determination of simple, single tax on each unit of capital. In particular, the primary instruments used by U.S. states are investment tax credits (ITC), corporate income tax (CIT), and the capital apportionment weight (CAW), the weight that the state assigns to capital (property) in its formula apportioning income among the multiple states in which firms generate income.[6] These instruments target different types of capital and hence should have different slopes to their reaction functions depending on the degree of mobility of the targeted capital. We explore this hypothesis in the empirical section below. Data on statutory values of the ITC, CIT, and CAW by state and year are obtained from various sources (see Chirinko and Wilson, [2007b]).

B. Out-of-State Variables ($^{\#}$)

The two-state model developed in Section II is useful for understanding the intuition of strategic tax competition, but its focus on only one competitive state is obviously highly stylized. In taking a tax competition model to data, however, one must confront the issue of evaluating the model in real-world contexts in which there are many competitive states. It is generally infeasible to allow for a separate slope of the tax reaction function for each and every other possible competitive state. The approach taken in the literature, which we follow in this paper, is to proxy the "other state" in the model above by the (first-order) *spatial lag* of the own jurisdiction – i.e., a weighted-average of all other jurisdictions. These out-of-state variables are denoted by a # superscript.

In this paper, we focus on tax competition among the 48 contiguous U.S. states.[7] Equation (12) details the construction of the spatial lag and the weighting matrix, W, a 48x48 matrix with elements $\omega_{i,j}$ defining the "relatedness" of state i to the remaining 47 states indexed

[6] In the United States, for the purposes of determining corporate income tax liability in a given state, corporations that do business in multiple states must apportion their national income to each state using formulary apportionment. The apportionment formula is always a weighted average of the company's sales, payroll, and property (with zero weights allowed). However, the weights in this formula vary by state. Over the last 30 years, states have increasingly moved toward increasing the weight on sales and decreasing the weights on payroll and property as a way to encourage job creation and investment in their state (and "export" the tax burden to out-of-state business owners that sell goods and services in-state but employ workers and capital out-of-state). The capital (property) weight can be thought of as a capital tax instrument with similar effects as the corporate income tax.

[7] We exclude Alaska, Hawaii, and the District of Columbia due to missing data for some of the weighting matrices.

by j. The elements of the weighting matrix are chosen a priori and are meant to capture the degree of potential mobility of capital from i^{th} state to one of the j competitive states. Natural possibilities for weighting schemes are those based on geographic proximity, geographic contiguity, and commercial trade. We consider three possibilities. First, a W matrix could be constructed with elements equal to the inverse-distance between state pairs (i.e., the inverse of the number of miles between each state's population centroid). Each row is normalized so that the elements sum to one. Second, we could construct a matrix with elements (prior to row-normalization) equal to 1 if states i and j share a border and 0 otherwise. Lastly, we could construct a commodity trade-based matrix in which element $\omega_{i,j}$ is the (row-normalized) value of commodity shipments from i^{th} state to one of the j competitive states, according to the 1997 Survey of Commodity Flows (U.S. Bureau of Transportation Statistics). The results reported in this paper use only the weighting matrix based on inverse distance.

C. Control Variables (x)

Recall that our model of strategic tax competition implies that variation in state capital tax policy is due to three control variables: population size (POPULATION), local economic conditions (IK), and voters preferences (PREFERENCES). State population size is easily measured with data from the U.S. Census Bureau. We account for economic conditions with the manufacturing investment rate (i.e., ratio of investment to capital stock). The data source for this variable is the Annual Survey of Manufacturers (ASM). See Chirinko and Wilson [2007b] for details on the deflation of investment and on the construction of real manufacturing capital stocks via the perpetual inventory method. Data outside of manufacturing for the years of our sample are unavailable.

Political preferences of state residents are, of course, unobserved. However, these preferences should, to a large extent, be revealed by electoral outcomes. Thus, good proxies for preferences may be the political party affiliations of the governor and state legislators. Specifically, we measure the following two political outcomes as indicator variables:

(a) the governor is Republican (R). (The complementary class of politicians is Democrat (D) or Independent (I). An informal examination of the political landscape suggests that Independents tend to be more closely aligned with the Democratic Party. We thus treat D or I politicians as belonging to the same class, DI);

(b) the majority of both houses of the legislature are R;

The PREFERENCES variable takes on one of three values:

- 0 if the governor and the majority of both houses of the legislature are not R;
- 1/2 if the governor is a R but the majority of both houses of the legislature are not R or if the governor is not a R but the majority of both houses of the legislature are R;
- 1 if the governor and the majority of both houses of the legislature are R.

D. Candidate Instrumental Variables (z)

As discussed in Section III.C under instrument selection, we rely on eight voter preference variables for competitive states to form the candidate instrumental variables. In addition to the two preference variables listed above the for governorship and legislature, we use the following six variables:

(c) the majority of both houses of the legislature are DI;

(d) the governorship changed last year from R to DI;

(e) the majority control of the legislature changed last year from D or split (between houses) to R;

(f) an interaction between the R governor and the R legislature indicator variables;

(g) an interaction between R governor and the D legislature indicator variables (note that the omitted interaction category is R governor and a split legislature dummy);

(h) the reelection of an incumbent governor last year.

Data for these political variables came from the Statistical Abstract of the United States (U.S. Census Bureau [Various Years]).

V. Empirical Results

A. Baseline Results For The ITC and CIT

Table 1 presents the results of estimating equation (16) for the investment tax credit (ITC) with CSD accounted for by the CCEP estimator and with various time lags. Column 1 contains a static model and, as has occurred frequently in the literature, the slope of the reaction function is positive and statistically significant at conventional levels.

The positive slope is sensitive to time lags. Column 2 adds the first time lag to the specification. The sum of the two coefficients on the tax competition variable is now negative. The addition of second and third lags leads to an increase in the sum to -0.909 and -0.847, respectively and a marked increase in the precision of the estimates.[8] The conclusion to be drawn from Table 1 is that, when time lags are included in the specification, the reaction function has a negative slope.

Table II repeats this exercise with the ITC replaced by the corporate income tax (CIT) rate. The results are largely similar with one important exception. As before, the static model generates a positive slope, which turns negative as time lags are added. The important exception is that these negative slopes are not estimated precisely. The null hypothesis that these slopes are zero can not be rejected.

A comparison of the results for ITC and CIT confirms one of the implications of the theoretical model. As shown in equation (9), the slope of the reaction function slope is expected to decline with capital mobility. For the model with three time lags, the slopes are -0.909 and -0.538 for the ITC and CIT models, respectively. The gap is larger for the four lag model; the comparable numbers are -0.847 and -0.297. These results are consistent with the ITC targeting new capital.

Table 3 presents a summary of results focusing solely on the reaction function slope as measured by α. Panel A contains results for the ITC, and Panel B comparable results for the CIT. The results is the first row of each panel are based on the CCEP estimator and were discussed above. The second and third rows of each panel estimate models that differ only by the way in which CSD is treated, either by including time fixed effects or excluding any adjustment. A uniform result for all six models in Table 3 is that when only the current tax competition variable is included (column 1), the slope is always positive and statistically

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[8] Note that the sample means of the dependent and independent variables are quite similar, and thus the point estimates approximately represent elasticities.

different from zero in five of the six cases. While the CCEP model is our preferred estimator, there is not a great deal of difference in the estimated slopes between this model and the more restrictive but conventional time fixed effect model. However, the CCEP estimates are much more precise. Lastly, excluding any adjustment for CSD generates misleading results, as the estimated slopes are always positive when no adjustment is made for the effects of aggregate shocks. These positive slopes accord with observation and the data in Figures 1 and 2 and highlight the critical importance of conditioning on trended aggregate shocks such as the decline in corporate tax rates in the European Union over the past two decades.

B. Additional Results For CAW

The third tax instrument that we study is the capital apportionment weight (CAW) in the multi-state income apportionment formula. Unlike the ITC and CIT, the impact of a change in CAW is ambiguous because any decrease in CAW will generally be met by a commensurate increase in the sales weight in the apportionment formula (while there is a third apportionment weight on labor, it usually closely follows the apportionment weight on capital). The net impact on firms depends on the proportion of sales and capital allocated to a given state, as well as the behavioral reallocations that will occur as the apportionment weights change. Thus, the results summarized in panel C of Table 4 are a bit more difficult to interpret. Interestingly, the empirical results are quite similar to those for the ITC and CIT. The slope is positive when no time lags are excluded, and then turns sharply negative as the dynamic adjustment is permitted. For a maximum time lag of three years, the slope equals -0.841 and is statistically far from zero. Relative to the ITC and CIT, there are noticeable differences between estimates based on the CCEP and TFE estimators. Thus, apart from this point and the precision of the CIT estimates, the three tax instruments generate quite similar results.

C. The Moran Graphs

The CCEP model generates factor loadings on the aggregate shocks, and these estimated γ_i's can shed light on the importance of CSD. We create Moran Graphs by plotting γ_i against the spatial lag of the γ_i's for state i, where this spatial lag is a weighted average of the γ_i's for the competitive states. If there is a great deal of heterogeneity in responses and these responses are positively related, we would expect that the points in a Moran Graph would lie along a 45 degree line. If the responses are positively related but largely similar, we would expect the points to be clustered around a common point on the 45 degree line. In a TFE model where this latter constraint is maintained, all of the Moran observations would be concentrated at a single point on the 45 degree line.

The Moran Graphs associated with ITC, CIT, and CAW are presented in Figures 5(a), 5(b), and 5(c), respectively. (Note γ_i and its spatial lag are both divided by their standard deviations to enhance comparability.) The points for ITC and CIT are more or less concentrated around a common point on the 45 degree line. By contrast, the points for CAW are more spread-out along the 45 degree line, and hence differ most from those associated with a TFE model. Interestingly, as we saw in Table 4, the differences between the CCEP and TFE estimates for ITC and CIT were not very large, while more noticeable differences exist for CAW. The Moran Graphs suggest that the heterogeneity in responses to aggregate shocks is responsible for the differences.

D. Preferences Affecting The Slope

The third implication following from our theoretical model is that the slope of the reaction function will be lower for those states with a preference for private goods, measured by the influence of Republicans in holding high office (see Section IV.C). We test this implication by expanding equation (16) to include an additional set of variables interacting these preferences with competitive states tax variable, as well as the cross-section averages of these interactions for the CCEP estimator,

$$\theta_k * \tau^{\#}_{i,t-k} * \text{PREFERENCES}_{\text{i,t-k}} \quad \text{for k=0,2}, \tag{17a}$$

$$\theta = \sum_k \theta_k \ . \tag{17b}$$

The results are presented in Table 5. For each of the tax instruments, the sum of the coefficients is negative, though only in the case of CIT is the sum precisely estimated. When evaluated at the mean value of the PREFERENCE variable, the overall effects of $\tau^{\#}_{i,t-k}$ remains negative as in prior tables but, in this case, only the sum for CAW is significantly different from zero.

VI. Comparison to Previous Studies

The empirical literature on fiscal competition has grown considerably in recent years, though the policy focus and methodologies used differ widely across studies. Among studies of "horizontal" (same level of government) competition, studies vary in whether they focus on expenditure policy or tax policy, and among tax policy studies, some focus on business taxes and some on consumer/resident taxes. In terms of policy focus, our paper is most closely related to Devereux, Lockwood, and Redoano [2004] (DLR), and, to a lesser extent, Altschuler and Goodspeed [2002]; and Hayashi and Boadway [2001]. All of these papers estimate a static model for some measure of corporate tax policy. All find that the slope of the reaction function is positive, as do we when we use the static model.

Motivated by a tax competition model in which both capital and corporate income are mobile (the latter via transfer pricing), DLR estimate a two-equation system where Z_1 equals the statutory corporate income tax rate and Z_2 equals a measure of the effective marginal tax rate (EMTR) on capital. As mentioned earlier, though, the EMTR measure is inappropriate in the context of U.S. states because of interstate differences in income apportionment formulae.[9] Thus, we opt to estimate the tax reaction functions for the components of EMTR – CIT rate, ITC rate, and capital apportionment weight – separately. Altschuler and Goodspeed [2002] and Hayashi and Boadway [2001] are somewhat less comparable to our study since they estimate reaction functions for the average effective corporate income tax rate – corporate income tax revenues divided by total corporate income (or GDP in Altschuler and Goodspeed [2002]) – rather than for statutory tax rates.[10] There are substantial drawbacks to using average effective rates. First, the ratio of tax revenues to income, especially its year-to-year variation, is not entirely under the control of policymakers. Changes in the composition of income (e.g., across industries or business size classes) will affect this ratio even if no changes are made to tax policy. Moreover, as emphasized in DLR, it is the marginal, not average, tax rate that affects marginal business decisions such as whether to continue to invest in a particular location or to invest somewhere else, and the marginal tax rate on income is the statutory tax rate. Second, the presence of income or GDP in the denominator of the dependent variable may lead to biased estimates if income or GDP (or correlates) are included in the regressor set.

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[9] This issue is less relevant for international tax competition. U.S. states, unlike countries (in general), have legal authority (and enforcement mechanisms) to tax income generated from outside sales as long as the business has some physical presence, or "nexus," in the taxing state. This is referred to as a destination-based tax. National taxes generally are source-based: only income generated within the country or repatriated to the country is domestically taxed.

[10] Altschuler and Goodspeed also separately look at the average effective personal income tax rate.

In terms of methodology, our paper is most closely related to the papers of Egger, Pfaffermayr, and Winner [2005a, b] and Altschuler and Goodspeed [2002], and, to a lesser extent, DLR; Case, Rosen, and Hines [1993]; Besley and Case [1995]; Heyndels and Vuchelen [1998]; Bruecker and Savaadra [2001]; and Revelli [2002]. With the exceptions of the latter three studies, these papers all use panel data to estimate a static model, and all of these papers (including the latter three) estimate a positive-sloping reaction function, despite the fact that they vary widely in terms of what type of fiscal policy they analyze.[11]

Among these papers, only Egger, et al. [2005a, b], Altschuler and Goodspeed [2002], and Case, Rosen, and Hines [1993] include both jurisdictional and time fixed effects (DLR uses a linear time trend), both of which we find to be extremely important for estimating the reaction function slope. The main methodological difference between our paper and these other studies using two-way fixed effects is our inclusion of a distributed time-lag of fiscal policy in other jurisdictions, rather than just contemporaneous policy. Though these studies look at entirely different measures of fiscal policy than we do, our empirical findings suggest that the positive reaction function slope found in these studies may be upward biased due to the omission of time-lagged tax policy in other jurisdictions.

VII. Summary And Future Work

This paper estimates a capital tax reaction function motivated by strategic tax competition theory. The model contains both spatial lags and time lags. We estimate this model using state panel data from 1969-2004 for three measures of capital tax policy: the investment tax credit rate (ITC), the corporate income tax rate (CIT), and the capital apportionment weight (CAW) in the state's income apportionment formula for multi-state business income reporting.

Our key empirical finding is that the slope of the tax reaction function is negative for all three measures of capital tax policy and statistically significant for the ITC and CAW models. We document that including time lags of out-of-state tax policy and accounting for cross-section dependence (CSD) are crucial in accurately estimating this slope. Two other implications of the theoretical model are confirmed.

The finding of a negative-sloping capital tax reaction function provides empirical support for the strategic tax competition model. The finding is a rejection of both the hypothesis that

[11] Case, et al. [1993] and Brueckner and Savaadra [2001] use a maximum-likelihood estimator as an alternative to IV/GMM to handle the problem of endogeneity of out-of-state tax policy. DLR, Altschuler and Goodspeed [2002], Besley and Case [1995], Heyndels and Vuchelen [1998], and Egger, et al. [2005a, b] all use IV/GMM.

capital is immobile and the hypothesis that the supply of capital to the nation is perfectly elastic; either hypothesis implies a zero slope to the reaction function in equilibrium. The negative slope also is rejection of a leading alternative theory of fiscal strategic interaction, yardstick competition, which predicts a positive-sloping reaction function.

In future work, we hope to expand both the theory and empirical analysis to assess the role of rent-seeking/business-lobbying on fiscal policy. Part of that extension would involve going beyond tax competition and considering strategic interactions among a broader set of fiscal variables (Wildasin, 2007). In terms of theory, we envision extending the basic model to have imperfectly benevolent policymakers motivated by maximizing their probability of reelection, which is a decreasing function of the gap between actual policy and socially-optimal policy and an increasing function of rent-seeking effort by capital owners. One testable hypothesis is that rent-seeking effort should have a (presumably negative) effect on capital tax rates. We hope to empirically test this and other implications of the model with state-level data on business contributions to political action committees (PACs).

APPENDIX Tax Variable: Investment Tax Credit Rate
Table A-1(b): Tax Competition Model: Equation (16)
Various Time Lags; Time Fixed Effects

	Maximum Time Lag				
	0	1	2	3	4
A. Competitive States Tax Variable	(1)	(2)	(3)	(4)	(5)
$\tau^{\#}_{i,t}$	1.966 (1.453)	5.621 (3.124)	5.619 (3.073)	5.869 (3.120)	5.645 (3.290)
$\tau^{\#}_{i,t-1}$	------	-6.265 (2.735)	-6.568 (3.200)	-7.073 (3.300)	-6.808 (3.509)
$\tau^{\#}_{i,t-2}$	------	------	0.353 (0.778)	1.861 (1.197)	1.709 (1.329)
$\tau^{\#}_{i,t-3}$	------	------	------	-1.462 (0.599)	-1.109 (1.074)
$\tau^{\#}_{i,t-4}$	------	------	------	------	-0.326 (0.661)
α = Sum of Coefficients on the $\tau^{\#}_{i,t}$'s	1.966 (1.453) [0.176]	-0.644 (0.471) [0.172]	-0.596 (0.536) [0.266]	-0.805 (0.510) [0.115]	-0.889 (0.591) [0.133]
B. Control Variables					
$\text{PREFERENCES}_{i,t-1}$	-0.450 (0.120)	-0.401 (0.114)	-0.402 (0.114)	-0.394 (0.114)	-0.391 (0.114)
$\text{IK}_{i,t-1}$	1.167 (1.025)	1.237 (1.011)	1.223 (1.009)	1.333 (1.011)	1.342 (1.002)
$\text{POPULATION}_{i,t}$	-1.422 (0.624)	-0.554 (0.503)	-0.561 (0.504)	-0.551 (0.508)	-0.548 (0.505)
$\text{IK}^{\#}_{i,t-1}$	2.888 (9.822)	10.234 (12.057)	9.188 (10.843)	13.929 (11.486)	14.329 (11.149)
$\text{POPULATION}^{\#}_{i,t}$	7.376 (4.684)	2.514 (3.285)	2.498 (3.256)	2.637 (3.275)	2.529 (3.314)
Cross-Section Dependence (CSD)	TFE	TFE	TFE	TFE	TFE
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
C. Instrument Assessment					
p-Value For J Test	0.937	0.611	0.618	0.713	0.739
1st-stage F statistic	15.240	14.873	15.762	15.256	13.854

APPENDIX Tax Variable: Investment Tax Credit Rate
Table A-1(c): Tax Competition Model: Equation (16)
Various Time Lags; No Time Effects (None)

	Maximum Time Lag				
	0	1	2	3	4
A. Competitive States Tax Variable	(1)	(2)	(3)	(4)	(5)
$\tau^{\#}_{i,t}$	1.283 (0.491)	2.607 (1.104)	2.791 (1.362)	2.588 (1.449)	2.322 (1.393)
$\tau^{\#}_{i,t-1}$	------	-2.378 (1.038)	-2.747 (1.591)	-2.567 (1.653)	-2.288 (1.595)
$\tau^{\#}_{i,t-2}$	------	------	0.228 (0.488)	0.401 (0.569)	0.192 (0.569)
$\tau^{\#}_{i,t-3}$	------	------	------	-0.198 (0.396)	0.448 (0.609)
$\tau^{\#}_{i,t-4}$	------	------	------	------	-0.566 (0.392)
α = Sum of Coefficients on the $\tau^{\#}_{i,t}$'s	1.283 (0.491) [0.009]	0.228 (0.164) [0.164]	0.272 (0.210) [0.196]	0.223 (0.238) [0.347]	0.108 (0.235) [0.645]
B. Control Variables					
$PREFERENCES_{i,t-1}$	-0.408 (0.110)	-0.422 (0.109)	-0.421 (0.110)	-0.420 (0.109)	-0.416 (0.107)
$IK_{i,t-1}$	0.859 (0.965)	1.076 (0.997)	1.084 (1.002)	1.079 (0.999)	1.108 (0.996)
$POPULATION_{i,t}$	-0.707 (0.464)	-1.070 (0.441)	-1.044 (0.450)	-1.074 (0.451)	-1.140 (0.448)
$IK^{\#}_{i,t-1}$	-1.571 (2.217)	1.819 (1.495)	1.706 (1.547)	1.812 (1.570)	1.877 (1.557)
$POPULATION^{\#}_{i,t}$	-0.435 (3.132)	5.650 (1.416)	5.418 (1.625)	5.696 (1.748)	6.235 (1.717)
Cross-Section Dependence	None	None	None	None	None
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
C. Instrument Assessment					
p-Value For J Test	0.871	0.290	0.284	0.307	0.393
1^{st}-stage F statistic	58.379	61.064	37.741	29.558	29.966

APPENDIX Tax Variable: Corporate Income Tax Rate
Table A-2(b): Tax Competition Model: Equation (16)
Various Time Lags; Time Fixed Effects (TFE)

	Maximum Time Lag				
	0	1	2	3	4
A. Competitive States Tax Variable	(1)	(2)	(3)	(4)	(5)
$\tau^{\#}_{i,t}$	1.263	6.303	7.012	7.195	7.894
	(0.546)	(1.695)	(1.813)	(1.805)	(1.973)
$\tau^{\#}_{i,t-1}$	------	-6.302	-5.498	-5.616	-6.142
		(1.415)	(1.426)	(1.442)	(1.589)
$\tau^{\#}_{i,t-2}$	------	------	-1.688	-1.680	-1.740
			(0.625)	(0.741)	(0.769)
$\tau^{\#}_{i,t-3}$	------	------	------	-0.022	0.472
				(0.506)	(0.628)
$\tau^{\#}_{i,t-4}$	------	------	------	------	-0.544
					(0.400)
α = Sum of Coefficients on the $\tau^{\#}_{i,t}$'s	1.263	0.002	-0.174	-0.122	-0.059
	(0.546)	(0.433)	(0.445)	(0.481)	(0.491)
	[0.021]	[0.997]	[0.695]	[0.799]	[0.905]
B. Control Variables					
$\text{PREFERENCES}_{i,t-1}$	-0.306	-0.269	-0.274	-0.275	-0.284
	(0.080)	(0.082)	(0.085)	(0.085)	(0.087)
$\text{IK}_{i,t-1}$	0.069	0.302	0.249	0.258	0.391
	(1.029)	(1.070)	(1.100)	(1.109)	(1.146)
$\text{POPULATION}_{i,t}$	-1.697	-1.556	-1.521	-1.522	-1.485
	(0.269)	(0.294)	(0.307)	(0.311)	(0.319)
$\text{IK}^{\#}_{i,t-1}$	-4.890	8.830	10.788	11.435	14.782
	(5.198)	(7.319)	(7.736)	(7.719)	(8.262)
$\text{POPULATION}^{\#}_{i,t}$	2.954	0.375	-0.444	-0.454	-1.025
	(1.392)	(1.317)	(1.355)	(1.422)	(1.478)
Cross-Section Dependence	TFE	TFE	TFE	TFE	TFE
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
C. Instrument Assessment					
p-Value For J Test	0.924	0.238	0.383	0.389	0.454
1st-stage F statistic	92.135	32.721	28.457	30.531	26.974

APPENDIX Tax Variable: Corporate Income Tax Rate
Table A-2(c): Tax Competition Model: Equation (16)
Various Time Lags; No Time Effects (None)

	Maximum Time Lag				
	0	1	2	3	4
A. Competitive States Tax Variable	(1)	(2)	(3)	(4)	(5)
$\tau^{\#}_{i,t}$	1.045	1.561	1.613	1.594	1.306
	(0.322)	(0.649)	(0.673)	(0.722)	(0.749)
$\tau^{\#}_{i,t-1}$	------	-0.903	-0.781	-0.767	-0.594
		(0.548)	(0.475)	(0.490)	(0.506)
$\tau^{\#}_{i,t-2}$	------	------	-0.173	-0.155	-0.143
			(0.281)	(0.300)	(0.298)
$\tau^{\#}_{i,t-3}$	------	------	------	-0.011	-0.155
				(0.245)	(0.271)
$\tau^{\#}_{i,t-4}$	------	------	------	------	0.195
					(0.180)
α = Sum of Coefficients on the $\tau^{\#}_{i,t}$'s	1.045 (0.322) [0.001]	0.658 (0.148) [0.000]	0.659 (0.147) [0.000]	0.661 (0.149) [0.000]	0.609 (0.145) [0.000]
B. Control Variables					
$PREFERENCES_{i,t-1}$	-0.272	-0.280	-0.280	-0.283	-0.289
	(0.078)	(0.078)	(0.077)	(0.077)	(0.077)
$IK_{i,t-1}$	0.063	0.105	0.114	0.113	0.038
	(1.029)	(1.025)	(1.023)	(1.024)	(1.023)
$POPULATION_{i,t}$	-1.605	-1.793	-1.803	-1.814	-1.794
	(0.317)	(0.287)	(0.285)	(0.280)	(0.275)
$IK^{\#}_{i,t-1}$	0.388	-1.343	-1.254	-1.273	-1.586
	(2.097)	(1.516)	(1.542)	(1.594)	(1.593)
$POPULATION^{\#}_{i,t}$	1.880	3.554	3.688	3.698	3.511
	(1.112)	(0.546)	(0.562)	(0.602)	(0.621)
Cross-Section Dependence	None	None	None	None	None
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
C. Instrument Assessment					
p-Value For J Test	0.943	0.828	0.851	0.840	0.904
1st-stage F statistic	28.154	29.415	29.002	25.943	28.520

APPENDIX Tax Variable: Capital Apportionment Weight
Table A-4(a): Tax Competition Model: Equation (16)
Various Time Lags; Common Correlated Effects (CCEP)

	Maximum Time Lag				
	0	1	2	3	4
A. Competitive States Tax Variable	(1)	(2)	(3)	(4)	(5)
$\tau^{\#}_{i,t}$	0.204 (0.926)	-0.295 (1.128)	-0.375 (1.124)	0.147 (1.161)	-0.059 (1.160)
$\tau^{\#}_{i,t-1}$	------	-1.198 (1.021)	-0.954 (1.015)	-1.280 (1.049)	-1.083 (1.045)
$\tau^{\#}_{i,t-2}$	------	------	-0.072 (0.311)	-0.527 (0.367)	-0.354 (0.378)
$\tau^{\#}_{i,t-3}$	------	------	------	0.820 (0.355)	0.358 (0.401)
$\tau^{\#}_{i,t-4}$	------	------	------	------	0.766 (0.329)
α = Sum of Coefficients on the $\tau^{\#}_{i,t}$'s	0.204 (0.926) 0.826]	-1.493 (0.283) [0.000]	-1.401 (0.347) [0.000]	-0.841 (0.420) [0.046]	-0.372 (0.469) [0.429]
B. Control Variables					
$\text{PREFERENCES}_{i,t-1}$	-0.984 (0.341)	-0.803 (0.309)	-0.905 (0.316)	-0.968 (0.323)	-0.969 (0.338)
$\text{IK}_{i,t-1}$	0.159 (2.973)	-0.584 (3.006)	-0.512 (3.045)	-0.564 (3.065)	-0.226 (3.081)
$\text{POPULATION}_{i,t}$	0.945 (5.189)	3.145 (5.172)	2.968 (5.308)	2.908 (5.418)	0.094 (5.740)
$\text{IK}^{\#}_{i,t-1}$	-7.922 (27.269)	-26.952 (23.184)	-25.893 (23.378)	-35.269 (23.900)	-39.212 (23.944)
$\text{POPULATION}^{\#}_{i,t}$	73.183 (28.001)	105.335 (23.850)	103.404 (24.556)	111.755 (25.633)	127.824 (28.099)
Cross-Section Dependence	CCEP	CCEP	CCEP	CCEP	CCEP
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
C. Instrument Assessment					
p-Value For J Test	0.925	0.995	0.992	0.733	0.805
1st-stage F statistic	6.436	19.761	19.463	19.488	19.341

APPENDIX Tax Variable: Capital Apportionment Weight
Table A-4(b): Tax Competition Model: Equation (16)
Various Time Lags; Time Fixed Effects (TFE)

	Maximum Time Lag				
	0	1	2	3	4
A. Competitive States Tax Variable	(1)	(2)	(3)	(4)	(5)
$\tau^{\#}_{i,t}$	0.352	1.032	1.605	1.589	1.985
	(1.711)	(1.554)	(1.592)	(1.606)	(1.636)
$\tau^{\#}_{i,t-1}$	------	-4.792	-4.125	-4.103	-4.512
		(1.439)	(1.494)	(1.505)	(1.539)
$\tau^{\#}_{i,t-2}$	------	------	-1.524	-0.989	-0.974
			(0.426)	(0.520)	(0.521)
$\tau^{\#}_{i,t-3}$	------	------	------	-0.654	0.147
				(0.427)	(0.582)
$\tau^{\#}_{i,t-4}$	------	------	------	------	-0.960
					(0.486)
α = Sum of Coefficients on the $\tau^{\#}_{i,t}$'s	0.352	-3.760	-4.044	-4.157	-4.314
	(1.711)	(0.308)	(0.323)	(0.347)	(0.355)
	[0.837]	[0.000]	[0.000]	[0.000]	[0.000]
B. Control Variables					
$\text{PREFERENCES}_{i,t-1}$	0.240	0.797	0.742	0.730	0.659
	(0.533)	(0.389)	(0.391)	(0.391)	(0.395)
$\text{IK}_{i,t-1}$	-18.010	-19.390	-19.458	-19.339	-19.190
	(4.241)	(3.902)	(3.933)	(3.939)	(3.919)
$\text{POPULATION}_{i,t}$	5.810	5.349	5.572	5.637	5.735
	(1.252)	(1.188)	(1.179)	(1.176)	(1.175)
$\text{IK}^{\#}_{i,t-1}$	6.265	-78.099	-85.091	-85.550	-85.508
	(38.766)	(21.185)	(21.574)	(21.625)	(21.672)
$\text{POPULATION}^{\#}_{i,t}$	4.367	54.214	54.369	54.857	54.926
	(23.089)	(7.392)	(7.424)	(7.472)	(7.521)
Cross-Section Dependence	TFE	TFE	TFE	TFE	TFE
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
C. Instrument Assessment					
p-Value For J Test	0.695	0.209	0.345	0.362	0.617
1st-stage F statistic	6.436	19.761	19.463	19.488	19.341

APPENDIX Tax Variable: Capital Apportionment Weight
Table A-4(c): Tax Competition Model: Equation (16)
Various Time Lags; No Time Effects (None)

	Maximum Time Lag				
	0	1	2	3	4
A. Competitive States Tax Variable	(1)	(2)	(3)	(4)	(5)
$\tau^{\#}_{i,t}$	0.511	0.604	0.610	0.631	0.661
	(1.160)	(0.747)	(0.781)	(0.786)	(0.781)
$\tau^{\#}_{i,t-1}$	------	-0.482	-0.455	-0.495	-0.534
		(0.741)	(0.728)	(0.739)	(0.736)
$\tau^{\#}_{i,t-2}$	------	------	-0.037	-0.174	-0.219
			(0.283)	(0.356)	(0.355)
$\tau^{\#}_{i,t-3}$	------	------	------	0.174	-0.143
				(0.293)	(0.375)
$\tau^{\#}_{i,t-4}$	------	------	------	------	0.411
					(0.316)
α = Sum of Coefficients on the $\tau^{\#}_{i,t}$'s	0.511	0.122	0.118	0.136	0.176
	(1.160)	(0.103)	(0.113)	(0.121)	(0.126)
	[0.659]	[0.238]	[0.295]	[0.261]	[0.163]
B. Control Variables					
$\text{PREFERENCES}_{i,t-1}$	0.236	0.314	0.313	0.316	0.345
	(0.462)	(0.388)	(0.388)	(0.388)	(0.391)
$\text{IK}_{i,t-1}$	-18.847	-19.367	-19.380	-19.410	-19.562
	(4.408)	(4.152)	(4.154)	(4.164)	(4.151)
$\text{POPULATION}_{i,t}$	8.370	10.073	10.090	10.038	9.969
	(5.578)	(1.348)	(1.346)	(1.347)	(1.342)
$\text{IK}^{\#}_{i,t-1}$	9.062	1.225	1.205	1.204	0.735
	(23.399)	(5.526)	(5.580)	(5.583)	(5.610)
$\text{POPULATION}^{\#}_{i,t}$	-25.365	-40.370	-40.459	-40.106	-39.761
	(47.473)	(5.276)	(5.300)	(5.368)	(5.339)
Cross-Section Dependence	None	None	None	None	None
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
C. Instrument Assessment					
p-Value For J Test	0.796	0.864	0.857	0.859	0.872
1st-stage F statistic	3.769	52.495	49.285	48.509	49.017

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Table 1: Tax Variable: Investment Tax Credit Rate
Tax Competition Model: Equation (16)
Various Time Lags; Common Correlated Effects Pooled (CCEP)

	Maximum Time Lag				
	0	1	2	3	4
A. Competitive States Tax Variable	(1)	(2)	(3)	(4)	(5)
$\tau^{\#}_{i,t}$	2.388 (1.223)	1.662 (2.323)	0.971 (2.308)	1.785 (2.471)	1.511 (2.650)
$\tau^{\#}_{i,t-1}$	------	-2.228 (2.022)	-1.565 (2.350)	-2.445 (2.564)	-2.210 (2.769)
$\tau^{\#}_{i,t-2}$	------	------	-0.315 (0.469)	0.151 (0.793)	0.131 (0.899)
$\tau^{\#}_{i,t-3}$	------	------	------	-0.337 (0.401)	-0.539 (0.647)
$\tau^{\#}_{i,t-4}$	------	------	------	------	0.332 (0.352)
α = Sum of Coefficients on the $\tau^{\#}_{i,t}$'s	2.388 (1.223) [0.051]	-0.566 (0.378) [0.135]	-0.909 (0.460) [0.049]	-0.847 (0.464) [0.069]	-0.775 (0.522) [0.138]
B. Control Variables					
$PREFERENCES_{i,t-1}$	0.012 (0.082)	0.048 (0.081)	0.089 (0.081)	0.113 (0.083)	0.110 (0.086)
$IK_{i,t-1}$	2.272 (0.825)	2.004 (0.835)	1.438 (0.809)	1.472 (0.842)	1.181 (0.868)
$POPULATION_{i,t}$	-3.975 (1.318)	-3.811 (1.239)	-4.243 (1.324)	-4.406 (1.357)	-4.464 (1.407)
$IK^{\#}_{i,t-1}$	18.038 (7.356)	7.420 (8.796)	9.686 (7.965)	12.522 (8.926)	12.068 (8.968)
$POPULATION^{\#}_{i,t}$	-30.748 (6.737)	-53.511 (8.034)	-50.721 (8.151)	-49.615 (8.464)	-49.589 (8.685)
Cross-Section Dependence	CCEP	CCEP	CCEP	CCEP	CCEP
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
C. Instrument Assessment					
p-Value For J Test	0.996	1.000	0.904	0.976	0.915
1st-Stage F statistic	15.240	14.873	15.762	15.256	13.854

Table 2: Tax Variable: Corporate Income Tax Rate
Tax Competition Model: Equation (16)
Various Time Lags; Common Correlated Effects Pooled (CCEP)

	Maximum Time Lag				
	0	1	2	3	4
A. Competitive States Tax Variable	(1)	(2)	(3)	(4)	(5)
$\tau^{\#}_{i,t}$	1.180 (0.447)	0.253 (0.914)	0.431 (1.013)	0.853 (1.039)	0.822 (1.119)
$\tau^{\#}_{i,t-1}$	------	-0.562 (0.644)	-0.688 (0.652)	-0.967 (0.680)	-0.748 (0.734)
$\tau^{\#}_{i,t-2}$	------	------	-0.281 (0.227)	-0.461 (0.282)	-0.165 (0.285)
$\tau^{\#}_{i,t-3}$	------	------	------	0.279 (0.245)	0.300 (0.258)
$\tau^{\#}_{i,t-4}$	------	------	------	------	-0.243 (0.191)
α = Sum of Coefficients on the $\tau^{\#}_{i,t}$'s	1.180 (0.447) [0.008]	-0.309 (0.374) [0.408]	-0.538 (0.399) [0.178]	-0.297 (0.445) [0.505]	-0.034 (0.429) [0.937]
B. Control Variables					
$PREFERENCES_{i,t-1}$	-0.059 (0.062)	-0.049 (0.064)	-0.057 (0.066)	-0.021 (0.068)	0.019 (0.065)
$IK_{i,t-1}$	0.331 (0.595)	-0.075 (0.601)	0.017 (0.609)	-0.058 (0.638)	-0.550 (0.616)
$POPULATION_{i,t}$	-2.066 (1.223)	-2.144 (1.357)	-2.078 (1.396)	-1.841 (1.403)	-1.740 (1.308)
$IK^{\#}_{i,t-1}$	0.479 (4.604)	-2.635 (5.052)	-2.706 (5.240)	0.128 (5.442)	-0.557 (5.499)
$POPULATION^{\#}_{i,t}$	2.978 (6.949)	2.323 (7.828)	1.096 (8.246)	0.520 (8.324)	0.185 (7.843)
Cross-Section Dependence	CCEP	CCEP	CCEP	CCEP	CCEP
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
C. Instrument Assessment					
p-Value For J Test	0.696	0.628	0.782	0.763	0.600
1st-stage F statistic	92.135	32.721	28.457	30.531	26.974

Table 3: **Tax Variables: Investment Tax Credit And The Corporate Income Tax Rates**
Tax Competition Model: Equation (16)
Various Time Lags; Various Adjustments For Cross-Section Dependence
α = Sum of Coefficients on the $\tau^{\#}_{i,t}$'s

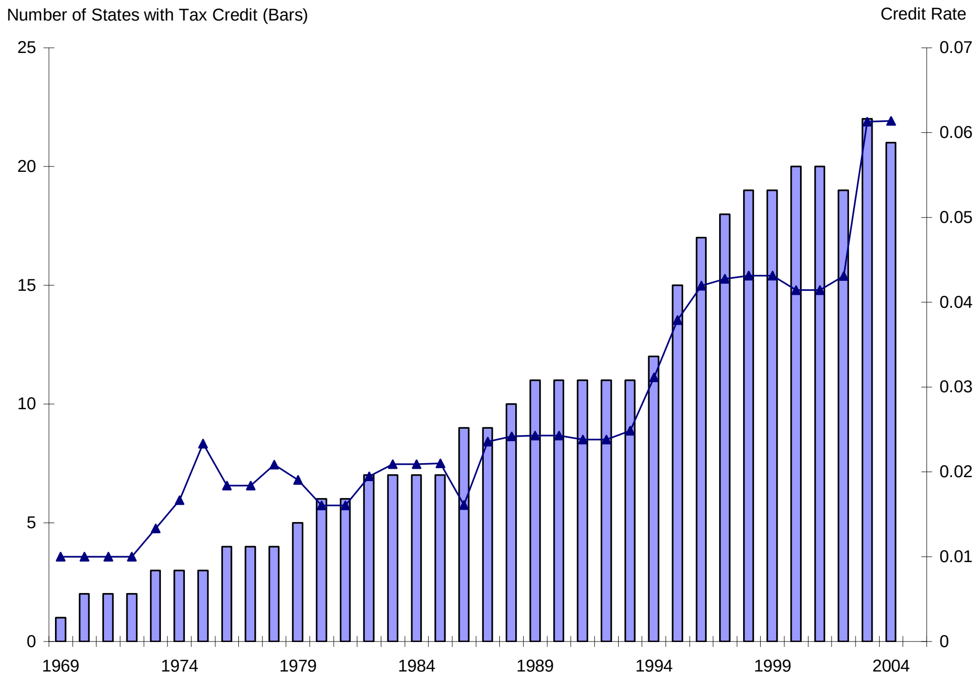
	Maximum Time Lag				
	0	1	2	3	4
A. Investment Tax Credit Rate "New Capital"	(1)	(2)	(3)	(4)	(5)
Common Correlated Effects Pooled (CCEP)	2.388 (1.223) [0.051]	-0.566 (0.378) [0.135]	-0.909 (0.460) [0.049]	-0.847 (0.464) [0.069]	-0.775 (0.522) [0.138]
Time Fixed Effects (TFE)	1.966 (1.453) [0.176]	-0.644 (0.471) [0.172]	-0.596 (0.536) [0.266]	-0.805 (0.510) [0.115]	-0.889 (0.591) [0.133]
None	1.283 (0.491) [0.009]	0.228 (0.164) [0.164]	0.272 (0.210) [0.196]	0.223 (0.238) [0.347]	0.108 (0.235) [0.645]
B. Corporate Income Tax Rate "Old Capital"					
Common Correlated Effects Pooled (CCEP)	1.180 (0.447) [0.008]	-0.309 (0.374) [0.408]	-0.538 (0.399) [0.178]	-0.297 (0.445) [0.505]	-0.034 (0.429) [0.937]
Time Fixed Effects (TFE)	1.263 (0.546) [0.021]	0.002 (0.433) [0.997]	-0.174 (0.445) [0.695]	-0.122 (0.481) [0.799]	-0.059 (0.491) [0.905]
None	1.045 (0.322) [0.001]	0.658 (0.148) [0.000]	0.659 (0.147) [0.000]	0.661 (0.149) [0.000]	0.609 (0.145) [0.000]
C. Capital Apportionment Weight					
Common Correlated Effects Pooled (CCEP)	0.204 (0.926) [0.826]	-1.493 (0.283) [0.000]	-1.401 (0.347) [0.000]	-0.841 (0.420) [0.046]	-0.372 (0.469) [0.429]
Time Fixed Effects (TFE)	0.352 (1.711) [0.837]	-3.760 (0.308) [0.000]	-4.044 (0.323) [0.000]	-4.157 (0.347) [0.000]	-4.314 (0.355) [0.000]
None	0.511 (1.160) [0.659]	0.122 (0.103) [0.238]	0.118 (0.113) [0.295]	0.136 (0.121) [0.261]	0.176 (0.126) [0.163]

Table 4: Various Tax Variables
Tax Competition Model With Preferences Affecting the Slope Of The Reaction Function: Equations (16) and (17)
Two Time Lags; Time Fixed Effects (TFE)

	Investment Tax Credit Rate	Corporate Income Tax Rate	Capital Apportionment Weight
A. Interaction Between Competitive States' Tax Variable and Preferences	(1)	(2)	(3)
$\tau^{\#}_{i,t}$ * $PREFERENCES_{i,t}$	-55.688 (134.958)	-12.174 (7.725)	-1.591 (15.681)
$\tau^{\#}_{i,t-1}$ * $PREFERENCES_{i,t-1}$	66.412 (163.817)	10.267 (6.921)	2.578 (14.297)
$\tau^{\#}_{i,t-2}$ * $PREFERENCES_{i,t-2}$	-12.368 (30.867)	1.408 (0.978)	-1.297 (1.860)
θ = Sum of Coefficients on the Interactions	-1.643 (1.932) [0.395]	-0.498 (0.259) [0.055]	-0.311 (0.341) [0.363]
B. Overall Effect of Competitive States' Tax Variable (Evaluated at Mean $PREFERENCES_{i,t}$)			
$\tau^{\#}_{i,t}$	10.150 (15.455)	6.662 (1.894)	1.201 (1.943)
$\tau^{\#}_{i,t-1}$	-12.794 (19.585)	-5.612 (1.469)	-3.673 (2.086)
$\tau^{\#}_{i,t-2}$	2.443 (5.689)	-1.444 (0.678)	-1.504 (0.431)
$\alpha + \theta * MEAN\{PREFERENCES_{i,t}\}$ = Sum of Overall Effects of the $\tau^{\#}_{i,t}$'s	-0.200 (1.479) [0.892]	-0.394 (0.457) [0.389]	-3.976 (0.433) [0.000]
Cross-Section Dependence	TFE	TFE	TFE
State Fixed Effects	Yes	Yes	Yes
C. Instrument Assessment			
p-Value For J Test	Exactly Identified	0.816	0.103
1st-stage F statistic	12.26	15.41	10.15

Notes To Tables:
Estimates are based on equation (16) and panel data for 48 states for the period 1969 to 2004. Given the maximum of four time lags, the effective sample is for the period 1973 to 2004. To enhance comparability across models, the 1973 to 2004 sample is used for all estimates. The tables differ with respect to the dependent variable; Table 4 expands the basic model (equation (16)) to include equation (17). The competitive states tax variable ($\tau^{\#}_{i,t-s}$, $s = 0,...,4$) is defined in equation (12) as the spatial lag of the investment tax credit. The competitive set of states is defined by all states other than state i, and the spatial lag weights are the inverse of the distance between the population centroids for state i and that of a competitive state, normalized to sum to unity. There are three control variables. $PREFERENCES_{i,t-1}$ captures the preferences of the state for the mix of private to public goods; a higher value of $PREFERENCES_{i,t-1}$ indicates that the state favors private goods relative to public goods. This variable is the average of three indicator variables, is lagged one period to avoid endogeneity issues, and ranges from 0.0 to 1.0. The three indicator variables are 1) the political party of the governor (1 if Republican; 0 otherwise), 2) the political party controlling both houses of the legislature (1 if Republican; 0 otherwise), and 3) an interaction between the indicator variables defined in 1) and 2). $IK_{i,t-1}$ is the investment to capital ratio, lagged one period to avoid endogeneity issues. $POPULATION_{i,t}$ is the state population as measured by the U.S. Census Bureau. The CCE estimator requires cross-section averages of the dependent and independent variables as additional regressors; see Section III for details. To account for the endogeneity of $\tau^{\#}_{i,t}$, we project this variable against a set of instruments whose selection is discussed in Section III.C. See Sections III and IV for further details about data sources and construction. Instrument validity is assessed in terms of the J statistic based on the overidentifying restrictions and the assumption of homoscedastic errors. The null hypothesis of instrument validity is assessed in terms of the p-values presented in the table. A p-value greater than an arbitrary critical value (e.g., 0.10) implies that the null hypothesis is sustained and that the instruments are not invalid. Instrument relevance is assessed in terms of the 1st-Stage F-statistic testing the joint significance of the excluded instruments from the above projection of $\tau^{\#}_{i,t}$ on the included (i.e., control variables) and excluded instruments relative to the critical values discussed in Stock, Wright, and Yogo (2002). The null hypothesis of instrument irrelevance is assessed in terms of the 5% critical values presented in Table 1 of Stock and Yogo (2005); for seven or fewer excluded instruments and a bias greater than 10%, the critical value is 11.29. The α parameter measures the slope of the reaction function ($\tau_{i,t}$ vs. $\tau^{\#}_{i,t-s}$, $s = 0,...,4$) and is the sum of the immediately preceding coefficients on the $\tau^{\#}_{i,t-s}$ variable(s). Standard errors are heteroscedastic consistent using the technique of White (1980); the standard error for α is the sum of the underlying variances and covariances raised to the one-half power.

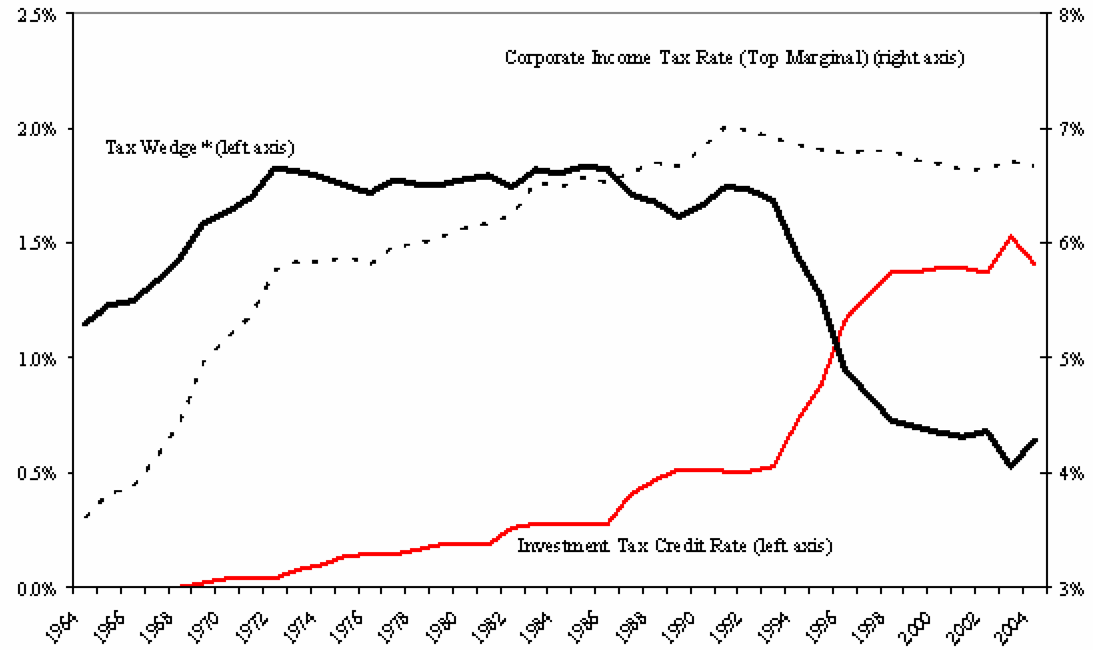
Figure 1. State Investment Tax Credits: 1969 to 2004



Notes: Counted investment tax credits (ITCs) include only general, statewide ITCs. Excluded are ITCs targetted at specific geographic zones ("Enterprise" zones) or at specific industries.
Data Source: Authors' calculations based on state corporate tax forms.

Notes to Figure 1: The number of states with an investment tax credit is indicated on the left vertical axis); the average credit rate (as an unweighted average across all states) is indicated on the right vertical axis). The figure is drawn for all 50 states and excludes the District of Columbia. This figure is taken from Chirinko and Wilson [2007a].

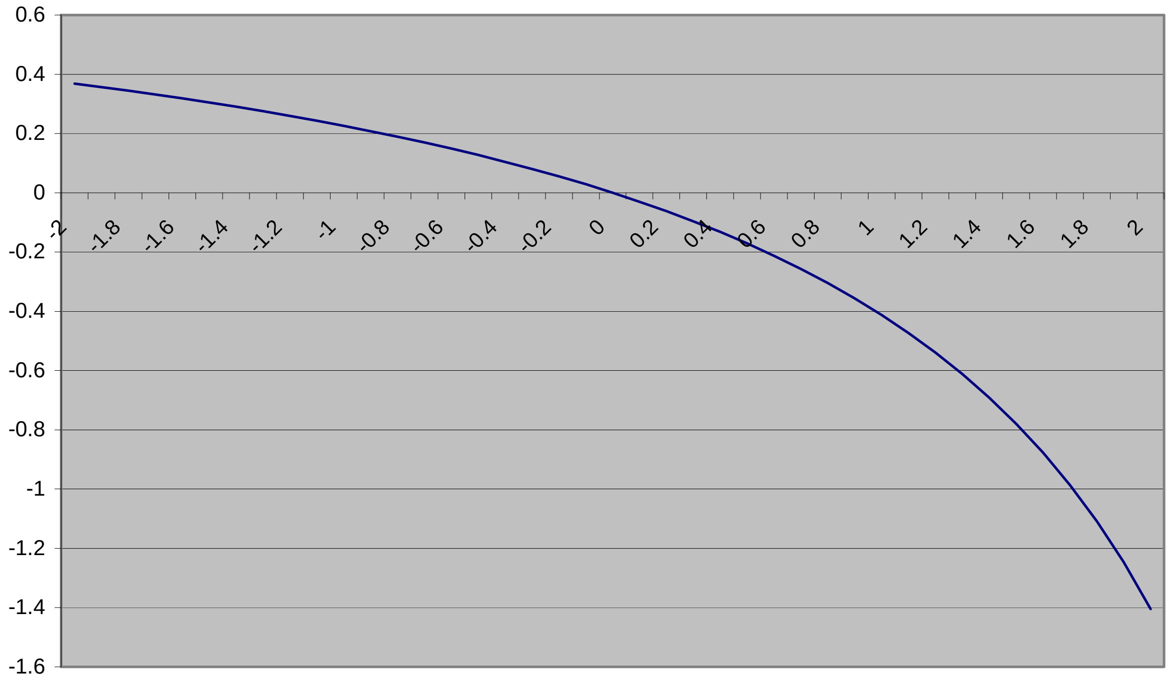
Figure 2. Average State Tax Parameters, Unweighted
1964-2004



*$TAX_{a,t}$ - 1, where $TAX_{a,t}$ is defined in eqn. (2) in the text.

Notes to Figure 2: The figure is drawn for all 50 states and excludes the District of Columbia. This figure is taken from Chirinko and Wilson [2007a].

Figure 3: The Slope Of The Reaction Function



Notes to Figure 3: This figure plots the slope of the reaction function (equation (7)) on the vertical axis against values of $\eta_{\zeta,y}$ ranging from -2.00 to +2.00 in increments of 0.10 on the horizontal axis. These computations also depend on $\eta_{y,k} = 0.33$, $-\eta_{k,\tau} = 1.00$, and $\zeta = 0.13^{-1}$.

Figure 4: Omitted

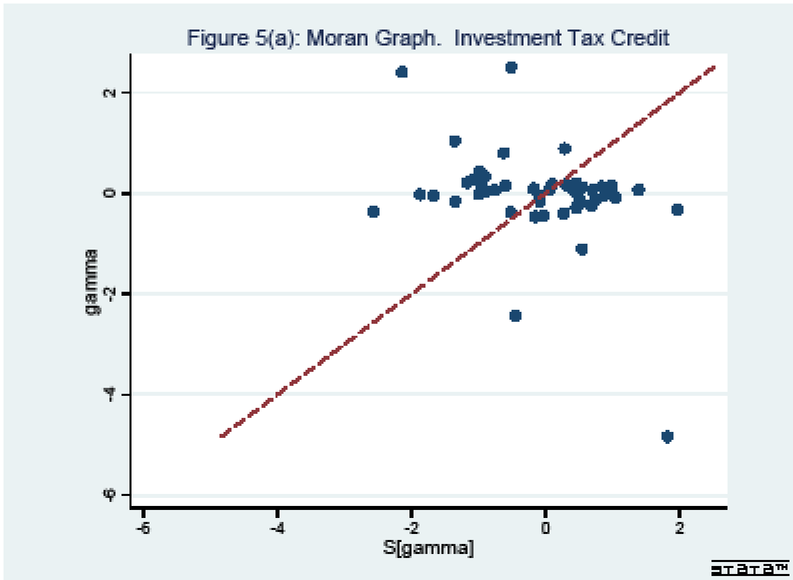


Figure 5(a): Moran Graph. Investment Tax Credit
gamma
-6
-4
-2
0
2
-6
-4
-2
0
2
S[gamma]
stata™

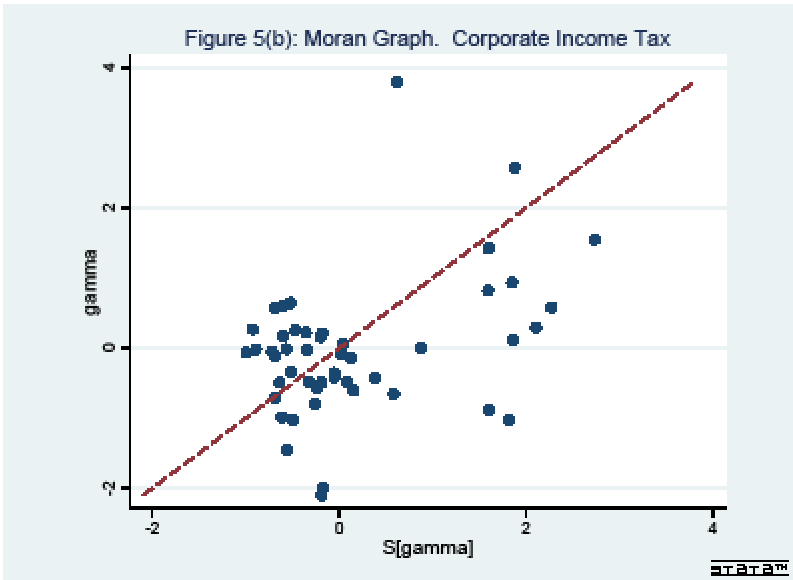


Figure 5(b): Moran Graph. Corporate Income Tax
gamma
S[gamma]
-2
0
2
4
-2
0
2
4

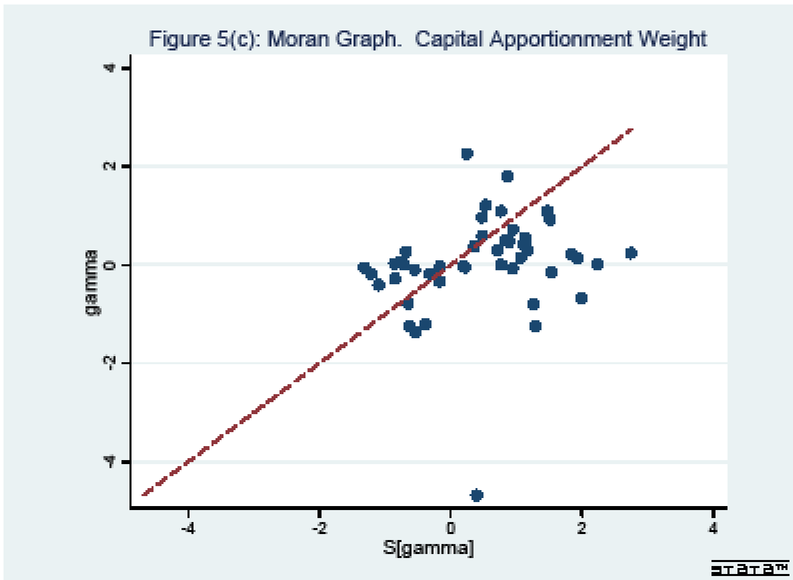


Figure 5(c): Moran Graph. Capital Apportionment Weight
gamma
S[gamma]
4
2
0
-2
-4
-4
-2
0
2
4