(2026) 56, 140–165

The Review of Regional Studies

The Official Journal of the Southern Regional Science Association

U.S. State Marginal Tax Rates and State Capital per Worker, 1977–2017*

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Abstract: We use a newly created measure of state-level capital per worker to test whether tax structures can explain long-standing differences in capital investment and productivity across U.S. states. A standard neoclassical growth model shows that differences in marginal tax rates on property, sales, capital gains, and corporate income will lead to persistent differences in capital per worker across states, predictions that are borne out in the data. We also show that the factors that drive state variation in capital-labor ratios are consistent with their impacts on per capita income and labor productivity, results that are also consistent with predictions from the theory. Persistent differences in capital-labor ratios across states are leading to rising income inequality between states.

Keywords: Capital-labor ratio, sales tax, property tax, income tax, corporate tax, capital gains tax, efficiency

JEL Codes: H2, H3, H7

1. INTRODUCTION

Capital investments and technological innovation have played a major role in the growth of labor productivity in the U.S. economy since 1980 (Jorgenson et al., 2005). Differences in capital investment or technology across firms have been tied to differences in earnings and productivity between otherwise identical workers in the United States (Dunne et al., 2004;

*We are grateful for partial research support under USDA-NIFA grant 2018-68006-27639 and a grant from the Charles Koch Foundation. Research assistance was provided by Max Baum, Olivia Behn, and Josiah Johnson. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. *Corresponding Author:* Peter F. Orazem, University Professor of Economics and Director, Program for the Study of Midwest Markets and Entrepreneurship, 267 Heady Hall, Iowa State University, 518 Farm House Lane, Ames, Iowa 50011-1054. (515) 294-8656. E-mail: pfo@iastate.edu

ISSN 1553-0892, 0048-49X (online)
www.srsa.org/rrs

Autor et al., 2008; Goldin and Katz, 2008; Acemoglu and Autor, 2011; Syverson, 2011). Rising income inequality has also been strongly linked to the complementarity between new technologies and returns to education (Goldin and Katz, 2008; Autor et al., 2020). Over the 1977–2017 period, there have been persistent differences across states in real per capita incomes. The correlation in real state per capita income between 1977 and 2017 is 0.79. Over the same period, the correlation in real state output per worker is 0.58. It would seem plausible that these persistent differences in per capita incomes and productivities across states would be tied to differences in state capital per worker.

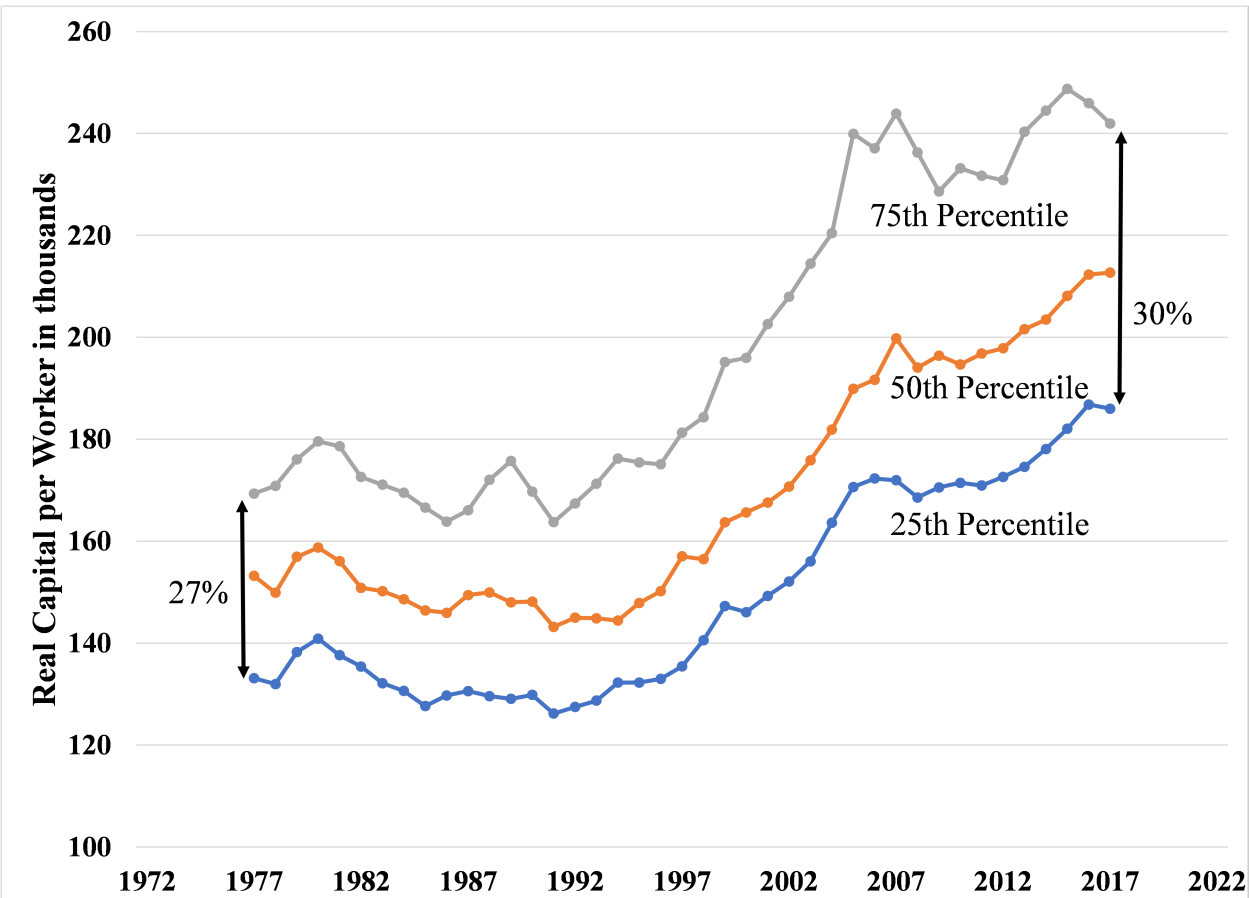
Before the work of Turner et al. (2013), there was no consistent measure of capital by state.[1] They created a series from 1840–2000 which covers the early period of rising inequality and rising returns to education. In Figure 1, we extend their series using comparable methods to illustrate the variation in capital per worker across states over the 1977–2017 period. Median real capital per worker has risen 0.33 log points over the period. There is substantial and persistent variation in capital per worker across states. The gap between the 3rd and 1st quartile capital-labor ratios was 27% in 1977, but 30% by 2017. There is also great persistence in state capital-labor ratios over the 40 years. State fixed effects alone explain 65% of the variation in capital-labor ratios over the 1977–2017 period. The correlation between a state's real capital per worker in 1977 and 2017 is 0.73, despite presumed free flow of capital across states.

There is a strong correlation between state capital-labor ratios and state per capita incomes and labor productivities. State capital-labor ratios and state output per job were correlated at 0.79. State capital-labor ratios and state per capita income were correlated at 0.64. The implication is that states with low capital-labor ratios also tended to have low labor productivity and lower incomes. If government policies such as distortionary tax structures, inadequate provision of public goods, or overzealous regulations constrain capital investment, they may be constraining labor productivity and resident incomes.

Standard growth models provide strong predictions regarding the relationship between capital investment and fiscal policies. We extend the typical representative agent model of capital investments by allowing a menu of taxes on property, sales, capital gains, corporate income and wage income, rather than focusing on only one or two taxes. The model yields sharp predictions on how capital investment would be affected by each of the tax types. Taxes on property, capital gains and corporate income will lower capital per worker, but taxes on wages do not affect capital per worker. Empirical evidence shows that these state marginal tax rates affect capital-labor ratios, labor productivity and per capita incomes, as predicted by the theory.

[1]Garofalo and Yamarik (2002) created a state capital stock by apportioning national capital stock among the states using each state's share of industry production. This presumes all states use the same production method and that there is no adjustment to production methods based on local wages and cost of capital. As this paper tests for the existence of capital investment responses to different cost of capital related to tax rates, their method will not serve our purpose.

Figure 1: Real Capital per Worker at the 25th, 50th and 75th Percentiles by State, 1977–2017



Note: Median real capital per worker rose 0.33 log points over the 1977–2017 period. The gap between the 75th and 25th percentile states widened from 27% in 1977 to 30% by 2017. The correlation between a state's real capital per worker in 1977 and 2017 is 0.73.

2. LITERATURE REVIEW

Our study builds on an extensive literature that explores the large differences in productivity across countries.[2] Some of the variation in productivity is due to poorer resources that restrict capital investments per worker, but as Hsieh and Klenow (2009) show, as much as 30–50% of the productivity gap between China, India and the U.S. is due to inefficient allocations of available capital and labor. While studies disagree about the proximate cause of the resource misallocations, several, including Chari et al. (1997), McGrattan and Prescott (2005) and Mankiw et al. (2009), argue that capital investment is discouraged by distortions in the return to capital driven by taxes. Governments can also induce resource misallocations through regulations, as Hsieh and Moretti (2019) found in examining how regulations and zoning restrictions distort housing prices that discourage migration to municipalities with artificially high housing prices.

Past research on the effects of state tax policy on economic outcomes have yielded mixed results (Rickman and Wang, 2020). There is broadly consistent evidence that state taxes have negative effects on new business location (Papke, 1993; Giroud and Rauh, 2019; Chen et al., 2023), although the induced location choices may have negative welfare consequences (Fajgelbaum et al., 2019). On the other hand, response to tax incentives appear to be small and inconsistent (Conroy et al., 2016; Leiser, 2017; Lee and Butler, 2022). Corporate and income tax rates have negative effects on firm R&D and patenting (Mukherjee et al., 2017; He and Tian, 2020) and affects location decisions of top scientists (Moretti and Wilson, 2017).

Lower tax rates appear to spur income growth (Reed, 2008; Adhikari and Alm, 2016), although results are not robust to changes in sample or specification (Waslyenko, 1997; Alm and Rogers, 2011; Gale et al., 2015).

These uneven results are surprising, given the theoretical consensus that high marginal tax rates are particularly damaging to capital investment.[3] It is possible that the past findings were disadvantaged by poor measures of capital at the state or local levels. We explore this possibility by using measures of state-level capital per worker that extend the data provided by Turner et al. (2013). Our results are consistent with the theoretical consensus based on standard growth models.

3. THEORY

We couch our analysis in the context of a neoclassical growth model, but with a more complete menu of state tax rates than normally considered. These include:

τ_k: The tax rate on capital income;

τ_w : The tax rate on wage income;

τ_p: The property tax rate;

τ_s: The sales tax rate.

[2]See Levine and Renelt (1992); Mankiw et al. (1992); Hall and Jones (1999), and reviews by McGrattan and Schmitz (1999) and Chari and Kehoe (2006).

[3]See the review by Mankiw et al. (2009).

These taxes are imposed on an infinitely lived representative household and an infinitely lived representative firm. Tax revenues are imposed and collected by a government authority that distributes revenue in the form of transfers or services back to the household. Households choose how much to consume, how much to work, and how much to save, subject to exogenously imposed taxes on capital income, wage income and property. The firm decides how much labor and capital to use in production subject to exogenously imposed sales taxes. We assume that capital is perfectly mobile across states, and so individuals in one state can invest in another state without moving. However, the high cost of moving across states means that labor is fixed, at least in the short-run.[4] Initially, we will assume that tax rates and productivity are fixed and then illustrate how the steady state capital-labor ratio changes as taxes and productivity change.

3.1. The Representative Firm

The representative firm hires labor, l_t, and capital, k_t in order to produce output, y_t, according to the Cobb-Douglas production function,

$$y_t = Ak_t^{\theta} l_t^{1-\theta} \tag{1}$$

where $0 < \theta < 1$ is the relative share of capital in production and A is the Hicks-neutral technical change parameter. The firm's profit maximization problem is to select k_t and l_t to maximize profit.

$$\Pi_t = (1 - \tau_s)\, Ak_t^{\theta} l_t^{1-\theta} - w_t l_t - r_t k_t, \tag{2}$$

subject to wages w_t and capital rental rate, r_t. The first order conditions require that

$$(1 - \tau_s)\, \theta A \left(\frac{l_t}{k_t}\right)^{1-\theta} = r_t \tag{3a}$$

$$(1 - \tau_s)\, (1 - \theta) A \left(\frac{k_t}{l_t}\right)^{\theta} = w_t \tag{3b}$$

To solve for the wage and rental rate, we add households.

3.2. The Representative Household

The household's preferences are given by

$$\sum_{t=0}^{\infty} B^t \left[\alpha \ln c_t + (1 - \alpha) \ln(1 - l_t)\right] \tag{4}$$

where c_t denotes real consumption of a single homogeneous good and l_t denotes household's labor supply. The parameters B and α are, respectively, household tastes for time preference

[4] This is consistent with Slemrod and Bakija's (2008, p. 81) observation that even though capital is not perfectly mobile, it is more mobile than labor and so the impact of capital taxes is shifted onto workers.

and relative taste for consumption versus leisure. Total time is normalized to one, and so $(1 - l_t)$ is the time devoted to leisure. The household gets income from three sources, labor it rents to firms at the market real wage rate w_t; real holdings of capital, k_t that it rents to firms at the pretax market rental rate, r_t; and a lump-sum transfer it receives from the government, G. With τ_k as the tax rate on capital income; τ_w as the tax on wage income; and τ_p as the property tax rate (the tax on capital holdings); the household's budget constraint is

$$c_t + k_{t+1} \leq (1 - \tau_w) w_t l_t + (1 - \tau_k) r_t k_t + (1 - \delta - \tau_p) k_t + G_t \tag{5}$$

where δ represents the capital depreciation rate. The Euler condition for optimal consumption and saving sets relative consumption in years t and $t+1$ by

$$\frac{c_{t+1}}{c_t} = B\left((1 - \tau_k) r_t + (1 - \delta - \tau_p)\right)$$

which says that the opportunity cost of current consumption is what would be available for future consumption from the after-tax capital income, $(1 - \tau_k) r_t$, and the after-property tax depreciated capital, $(1 - \delta - \tau_p)$. In steady state, the return on capital is

$$r_t = r = \frac{\rho + \delta + \tau_p}{1 - \tau_k} \tag{6}$$

where $\rho = B^{-1} - 1$. The return on capital is fixed by the discount factor, the rate of depreciation, and the taxes on property value and capital income. If the tax rates do not change, the return on capital will be constant at r. Inserting (6) into (3a) yields the steady state optimal capital-labor ratio

$$\frac{k}{l} = \left((1 - \tau_s) A \left(\frac{1 - \tau_k}{\rho + \delta + \tau_p}\right)\right)^{\frac{1}{1-\theta}} \tag{7}$$

The capital-labor ratio will be set by its tax rates and common values of technology, discount and depreciation rates, and capital's share of production. Capital per worker will be lower with higher values of τ_s, τ_p, and τ_k. Without changes in these taxes or the Hicks neutral technology parameter, the capital-labor ratio will not change.

The steady state equilibrium wage can be set by inserting (7) into (3b). We obtain

$$w = \frac{(1 - \theta)}{\theta} r \frac{k}{l} = (1 - \theta)\left[(1 - \tau_s) A\right]^{\frac{1}{1-\theta}} \left(\theta \frac{1 - \tau_k}{\rho + \delta + \tau_p}\right)^{\frac{\theta}{1-\theta}} \tag{8}$$

As with r and $\frac{k}{l}$, the wage is fixed by tax rates and the productivity parameter. Wages fall as marginal tax rates are increased on capital income, sales, and property. Interestingly, neither capital-per-worker, nor the equilibrium wage are affected by the wage tax, τ_w. As the wage tax rises, both labor supply and capital demand fall by the same proportion.[5]

[5] Prescott (2002) uses a similar formulation to demonstrate why higher taxes on wage income in Europe can result in lower employment and greater unemployment in European labor markets relative to the United

Equation (8) also shows that the wage rate is tied directly with the capital-labor ratio. Because wages equal marginal products, we also have a direct relationship between the capital-labor ratio and labor productivity. These findings are consistent with the large positive correlations between relative state capital per worker and relative state per capita incomes and productivities discussed in the introduction.

3.3. The Government

To complete the model, we add in the government budget constraint. The state government collects all four taxes plus an exogenous transfer from the federal government, F_t, that is not known at the time tax rates are chosen. The state government rebates all revenues back to the household in the form of a lump sum rebate,

$$G_t = \tau_w w_t l_t + \tau_s y_t + \tau_p k_t + \tau_k r_t k_t + F_t \tag{9}$$

The lump-sum transfer could be viewed as a nonrival public good that has no distortionary effect on the prices of consumption or investment goods. In this case, all of the equilibrium conditions above are unchanged. We can allow nonneutral effects of government spending on capital per worker if they enter the Hicks technology term, A in (1) as a source of productive externalities on private production, a possibility we test for in the empirical work.[6]

3.4. Hypotheses

The theory generates several testable hypotheses with which we can assess the consistency of the measured state capital-labor ratios with the neoclassical growth model.

H1: *An increase in the sales tax, τ_s, will lower the capital-labor ratio.*

H2: *An increase in the tax on capital income, τ_k, will lower the capital-labor ratio.*

H3: *An increase in the property tax rate, τ_p, will lower the capital-labor ratio.*

Using equation (7), $\frac{\partial(k/l)}{\partial \tau_s} < 0$, $\frac{\partial(k/l)}{\partial \tau_k} < 0$, and $\frac{\partial(k/l)}{\partial \tau_p} < 0$. All of these taxes lower labor supply but lower capital even more.

H4: *An increase in the wage income tax, τ_w, will not affect the capital-labor ratio.*

Inspection of equations (6) and (8) show that the tax on wage income, τ_w, does not enter either the equilibrium pretax return on capital or the equilibrium wage, and so τ_w does not affect the state's equilibrium capital-labor ratio in (7). As wage taxes rise, households cut back on labor supply, and firms cut back on capital by the same percentage, leaving the ratio, $\frac{k_t}{l_t}$, unchanged. Total output falls as capital and labor decrease proportionally.

H5: *Government expenditures will not affect capital-labor ratios if they are pure transfers, but they will affect capital-labor ratios if they affect factor productivity.*

States. Note that our results also remain when we use a CES utility function rather than the Cobb-Douglas specification. The wage tax will affect labor productivity when we relax the assumption of constant returns to scale and constant elasticity of substitution. Income taxes may also affect labor productivity if there are frictions that prevent a seamless movement toward equilibrium, as reviewed by Shimer (2010).

[6]See for examples Aschauer (1989), Lynde and Richmond (1993), or Pereira (2000).

If G_t is a pure lump-sum transfer, it does not enter equations (6), (7) or (8) and it does not affect equilibrium rental rates on capital, wages, or capital-labor ratios. Aschauer (1989), Munnell (1990), Lynde and Richmond (1993) and Pereira (2000) found evidence that public infrastructure encouraged private sector investment and productivity growth. Subsequent work, as summarized by Aschauer (2000), found a wide variety of effects of government spending, including that it could be neutral or even lower labor productivity. In our formulation, government expenditures could affect equilibrium labor productivity if G_t is an element of the Hicksian technology parameter, A in (1). Therefore, we can test formally whether G_t affects the equilibrium level of labor productivity, independent of the effects of marginal tax rates.[7]

A further implication of equations (6), (7) and (8) is that one must consider the impacts of all the taxes τ_s, τ_p and τ_k at the same time when assessing their impact on input prices or capital accumulation. The impact of a shock to any one tax depends on the levels of the other taxes.

4. EMPIRICAL STRATEGY

In order to test the hypotheses, we have to couch them within a broader empirical model that can impose the hypotheses as restrictions on a less restrictive specification. To do that, we propose a general relationship between capital per worker and all of the tax, fiscal, and technological factors that enter the household and firm decisions: $\frac{k}{l} = K(\tau_s, \tau_p, \tau_k, \tau_w, A, G)$. While our assumed utility and production specifications resulted in neutral effects of wage taxes on capital-labor ratios, a more general model would have included these factors in the reduced form. Therefore, we use a broader model that allows us to test all of the hypotheses rather than imposing them.

The theoretical model shows that the equilibrium capital-labor ratio responds negatively to the marginal property tax rate (τ_p); the sales tax rates (τ_s); and the marginal tax on capital income. In *application,* the tax on capital income takes on more than one form, notably a tax on capital gains (τ_k); and a tax on corporate earnings (τ_c). Only the income tax is tied to wages, and so we use the highest marginal state income tax rate as our measure of (τ_w). In all specifications, we assume that the Hicks neutral technical change includes time and state fixed effects, and then we add additional factors to test the robustness of our results. The empirical approximation to (7) is

$$\ln\left(\frac{k_{jt}}{l_{jt}}\right) = \beta_o + \beta_s\tau_{s,jt} + \beta_p\tau_{p,jt} + \beta_k\tau_{k,jt} + \beta_c\tau_{c,jt} + \beta_w\tau_{w,jt} + \mu_t + \eta_j + \gamma_G G_{jt} + Z'_{jt}\gamma_Z + \epsilon_{jt}. \quad (10)$$

The dependent variable is the natural logarithm of capital per worker. The specification controls for changing Hicksian aggregates over time and across states using fixed effects for

[7]We will relax the assumption that government expenditures are homogeneous in the empirical section by decomposing G_t by type of government expenditure including infrastructure, transfer payments, and all other government expenditures.

year (μ_t) and states (η_j).[8] To this, we add measures of government expenditures per capita, G_{jt}. To alleviate concerns that our results are biased by missing variables, we include a vector Z_{jt} of controls including factors often included in empirical models of regional growth. These should include factors that could be correlated with tax rates and that might affect state-level capital per worker on their own. If so, their exclusion would bias our results. The remaining unobservable ϵ_{jt} is a transitory state-specific productivity shock which we assume is uncorrelated with contemporaneous or past state marginal tax rates.

The first three testable hypotheses from the theory imply that $\beta_s < 0$, $\beta_p < 0$, $\beta_k < 0$, $\beta_c < 0$. The fourth hypothesis that wage taxes will not affect capital-labor ratios implies that $\beta_w = 0$. We can combine these hypotheses into joint tests such that $\beta_s = \beta_p = \beta_k = \beta_c = \beta_w = 0$. Alternatively, we can estimate the joint tax effect that $\sum_{i=1}^{5} \frac{d(k_{jt}/l_{jt})}{d\tau_i} = \beta_s + \beta_p + \beta_k + \beta_c + \beta_w = 0$. This will measure the percentage change in the capital-labor ratio from a unit increase in each of the 5 tax rates. The joint significance of the tax rates will be driven by the hypothesized negative impacts on capital-labor ratios of the taxes on property, capital gains, sales, and corporate income, while the effect on wage income, $\beta_w = 0$. The 5$^{\text{th}}$ hypothesis examines whether the government expenditures have no effect on capital per worker, $\gamma_G = 0$.

While our theory does not distinguish between marginal or average rates, our empirical work uses the highest marginal tax rate for each tax type. In practice when tax rates vary due to deductions, tax exemptions, or progressive rates, average rates will deviate from marginal rates as agents act strategically to limit their tax liability.[9] High marginal tax rates will induce legal or illegal tax advance measures so that the average rate is less than the marginal rate. In that way, average or effective tax rates are endogenous responses to marginal rates. Consequently, empirical studies of taxes on labor productivity must focus on marginal tax rates and not average tax rates.[10]

5. DATA

We use the data for the 48 contiguous states available annually from 1977 through 2017. This allows us to use a variant of the model focusing on state borders using the same sample of states. Alaska and Hawaii have no border states. We review our data and sources and provide additional details in the Appendix. Summary statistics are provided in Table 1A.

Our measure of capital per worker is based on Turner et al. (2013). For each state, they compile data on the value of land and buildings in agriculture and on capital stocks in manufacturing. They derive approximations of the capital stocks in eight other industries

[8]Bleaney et al. (2001) and Bania et al. (2007) also used state and time dummies to control for unobserved heterogeneity across regions.

[9]An interesting example is how changes in tax treatment of pass-through income changed incentives to declare business profits as income rather than retaining it as unrealized firm capital gains. See Smith et al. (2022) and DeBacker et al. (2019) for examples.

[10]Mankiw et al.'s (2009) summary of the main theoretical conclusions from the optimal tax literature included that the optimal tax structure is most likely flat across income levels; marginal tax rates should not rise and may even decline at upper income levels; and capital income should be untaxed at the margin. Those predictions reinforce that tests of the effects of tax policies on economic outcomes must consider marginal and not average tax rates and must distinguish between taxes on capital income versus other tax types.

Table 1A: Sample Statistics, 1977–2017

	1977–2017		1977		2017	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Capital per Worker: $\ln(k_{jt}/l_{jt})$	12.06	0.25	11.94	0.15	12.29	0.21
Output per Job: $\ln(q_{jt}/l_{jt})$	4.18	0.19	4.10	0.11	4.40	0.14
Per Capita Income: $\ln(y_{jt}/l_{jt})$	10.37	0.25	9.98	0.10	10.67	0.14
Sales tax: $\tau_{s,jt}$	4.70	1.76	4.04	0.74	5.24	1.88
Effective property tax: $\tau_{p,jt}$	1.74	0.86	2.63	1.53	1.61	0.71
Capital gains tax: $\tau_{k,jt}$	4.62	3.09	3.20	4.01	4.81	3.13
Corporate income tax: $\tau_{c,jt}$	6.57	2.94	6.16	3.11	6.05	2.85
Income tax: $\tau_{y,jt}$	5.20	3.15	4.40	4.65	5.15	3.06
Log real government expenditures per capita	1.91	0.31	1.43	0.19	2.24	0.18
Log real infrastructure expenditures per capita	−0.23	0.35	−0.50	0.29	−0.07	0.32
Log real transfer payments per capita	0.37	0.46	−0.29	0.30	0.94	0.24
Log real other payments per capita	1.48	0.30	1.02	0.21	1.77	0.20
Log of energy prices	2.40	0.44	1.38	0.16	2.87	0.15
Percent with at least a High School degree	80.17	8.38	60.12	5.92	88.49	2.98
Manufacturing share of GSP	0.16	0.07	0.23	0.08	0.12	0.05
Union density	13.38	6.65	23.88	8.55	9.62	4.83
Log of population per sq. mi.	4.47	1.28	4.84	0.92	4.61	1.27

Note: Summary statistics for the 48 contiguous U.S. states, 1977–2017. All tax rates are in percentage points. Dollar values are converted to 2009 chained constant dollars.

using a weighted average of national data on capital stocks where the weights are the state's share of total output in the industry. The sum of capital across these ten sectors is divided by the state labor force aged 16 and over. Their series ends in 2000. We used their detailed description of their data and methods to extend their series through 2017, the last year for which all of the comparable data sources were available. Our measure of the state labor force includes employed and unemployed civilians aged 16 and older, as reported by the U.S. Bureau of Labor Statistics.[11]

All of our tax rates are reported in percentages so that a unit increase raises the tax rate by one percentage point. We use the highest state marginal tax rate as the measure of each tax. We do not include federal tax rates, as they would be the same across states. With the exception of the property tax, we also do not include local tax increments to the state tax rates because not all firms in the state would face the same local tax rates.

The National Bureau of Economic Research has generated estimates of state marginal income tax and long-term capital gains tax rates since 1977, which dictates the start of our data set. The procedures underlying these estimates are described in Feenberg and Coutts (1993).

Corporate and sales tax rates are reported by The Council of State Governments (2023). Our marginal corporate tax rate is the highest reported state tax rate on business corporations. In states that report a different corporate rate for banks or financial businesses, we use the broader tax rate imposed on nonbank corporations. Our sales tax measure is

[11] Our series and the Turner et al. (2013) series overlap between 1977–2000, and so we smooth the transition between two series using a procedure outlined in the appendix that retains the relative cross-sectional and time series properties of each series with no abrupt break in 2001.

the highest reported sales tax on general merchandise and not an average that incorporates various exemptions for food, clothing, and medicine.

Unlike our other taxes, the property tax is primarily a local and not a state tax. The property tax rate was culled from annual information provided by the Government of the District of Columbia, Department of Finance and Revenue. Since 1977, this source has reported the effective property tax rate on residential properties reflecting the range of housing values at various household incomes in the largest city in each state.[12] The effective rate applies to the percentage of assessed value that is incorporated into the tax computation, meaning that a city with a 50% assessment level and a $4/100 nominal property tax rate would have the same effective rate as a city with a 100% assessment level and a $2/100 property tax rate.

Equation (10) includes a vector of productivity attributes, Z_{jt}, which may be correlated with state marginal tax rates and that could have their own impacts on state growth. Excluding them would bias our estimates of the tax rate effects. Crain and Lee's (1999) survey of factors included in state growth models identified nine families of measures that have been used to explain variation in gross state product growth. Of these, we note first that demographic attributes such as ethnic composition of the population should change only slowly over time, and so we capture them using state and time dummy variables. Energy prices vary across states and time, and they may affect the use cost of capital. We measure energy costs by the price per million BTU for all end users for all energy types in the state, as provided by the Energy Information Administration. Much of our sample period is characterized by the growth of skill-biased technical change that would change incentives to invest in physical capital. That suggests we add controls for the level of human capital by year and state, and so we include the percent of the population aged 18–64 that has at least a high school diploma as reported by the U.S. Bureau of the Census. Manufacturing is a relatively capital-intensive sector that has become more capital-intensive over time. To control for this source of capital investment demand, we add the share of Gross State Product in manufacturing for each state and year as reported by the Bureau of Economic Analysis. Historically, unions have resisted capital that can substitute for labor, an additional source of varying capital demand across states. We measure potential union power to limit capital investment by including union density as reported by Hirsch et al. (2025). Urbanization, frequently associated with agglomeration economies that raise productivity, is measured by the Bureau of Census' data on population density. Finally, in some specifications we include the log of state government expenditures by broad area, which were culled from the Tax Policy Center's State and Local Finance Data Query System.[13]

We add two more measures that we will use as robustness checks on our estimated effects of state tax rates on state capital per worker. Recall that equation (8) showed that wage income will depend positively on the capital-labor ratio. We use real per capita income, $\ln(y_{jt}/l_{jt})$, as reported by the Bureau of Economic Analysis, as our measure of wage income.

[12] Initially, only a subset of states was included, but all States were included starting in 1981.

[13] Endogenous controls will bias the tax effects. Average tax rates computed as tax revenue divided by income or property values or other bases are endogenous responses to the marginal tax rates. Our inclusion of government expenditures would be subject to similar concerns, and so we report result with and without government expenditures.

That same site reports the state real GDP and the number of jobs in the state, and so we generate a labor productivity measure as real output per job, $\ln(q_{jt}/l_{jt})$. Because real wages equal marginal products, there is also a direct relationship between capital per worker and labor productivity. If the capital-labor ratio is valid, it will have a similar relationship with the tax rates as the other two measures. It will also be highly correlated with the other two measures. As shown in Table 1B, the correlations between the capital-labor ratio and output per worker and per capita income are 0.79 and 0.64.

Table 1B: Correlation among Dependent Variables

	$\ln(k_{jt}/l_{jt})$	$\ln(y_{jt}/l_{jt})$
$\ln(q_{jt}/l_{jt})$	0.79	0.86
$\ln(y_{jt}/l_{jt})$	0.64	

Note: $\ln(k_{jt}/l_{jt})$ is log capital per worker; $\ln(q_{jt}/l_{jt})$ is log real output per job; $\ln(y_{jt}/l_{jt})$ is log real per capita income.

6. RESULTS

We report the estimation of various specifications of equation (10) in Table 2. Standard errors correct for clustering at the state level. The estimation controls for state and year fixed effects, and so the identification is from state-specific differences from the state's own average marginal tax rates.

The first column presents the basic model that includes only marginal tax rates and the fixed effects. The fixed effects alone explain 90%, and so the tax rates explain an additional 3 percentage points of the variation in capital-labor ratios. For the first 3 hypotheses, the taxes on sales, property, and corporate and capital gains income all lower capital-labor ratios with estimates that are statistically significant. We fail to reject the null hypothesis of wage tax neutrality, consistent with hypothesis 4. When we add up all the tax effects across the 5 taxes, we find that if all 5 taxes were increased by one percentage point, capital-labor ratios would fall by 0.096 log points.

In column 2, we add state government expenditures per capita. Government expenditures induce additional capital investment, but their inclusion does not affect the magnitude or significance of the tax effects. All the taxes retain their negative effects individually, and the joint effect of a unit increase in all tax rates is 0.093 log points. When we decompose the government expenditures by type, the infrastructure expenditures are related to added capital, consistent with Aschauer (1989), Munnell (1990), Lynde and Richmond (1993), and Pereira (2000). Again, the individual tax effects fall in magnitude slightly, and the joint effect becomes −0.085. In column 4, we add additional controls suggested in the literature.[14] The corporate tax loses its individual significance, and the joint tax effect falls in magnitude to −0.066 log points.

[14]Capital per worker is positively associated with energy prices and negatively correlated with greater manufacturing share and population share with at least a high school degree. The other covariate controls had no effect.

Table 2: Estimated Effect of Tax Structure on Physical Capital per Worker by State, 1977–2017

Tax Rates	(1) $\ln(k_{jt}/l_{jt})$	(2) $\ln(k_{jt}/l_{jt})$	(3) $\ln(k_{jt}/l_{jt})$	(4) $\ln(k_{jt}/l_{jt})$
Sales tax: $\tau_{s,jt}$	-0.031^{**}	-0.029^{***}	-0.028^{**}	-0.022^{**}
	(0.012)	(0.011)	(0.011)	(0.010)
Effective property tax: $\tau_{p,jt}$	-0.039^{***}	-0.037^{***}	-0.032^{***}	-0.025^{***}
	(0.012)	(0.011)	(0.011)	(0.008)
Capital gains tax: $\tau_{k,jt}$	-0.008^{**}	-0.007^{**}	-0.007^{*}	-0.006^{**}
	(0.003)	(0.003)	(0.003)	(0.003)
Corporate income tax: $\tau_{c,jt}$	-0.017^{*}	-0.017^{**}	-0.015^{**}	-0.013
	(0.009)	(0.008)	(0.007)	(0.008)
Income tax: $\tau_{w,jt}$	-0.001	-0.003	-0.003	< -0.001
	(0.008)	(0.007)	(0.007)	(0.005)
Government Expenditure				
Log government expenditures per capita		0.325^{***}		
		(0.081)		
Log infrastructure expenditures per capita			0.091^{***}	0.102^{***}
			(0.029)	(0.031)
Log transfer payments per capita			-0.028	-0.020
			(0.044)	(0.042)
Log other payments per capita			0.244^{***}	0.208^{***}
			(0.075)	(0.077)
Constant	12.088^{***}	11.655^{***}	11.909^{***}	11.945^{***}
	(0.067)	(0.101)	(0.081)	(0.307)
Year fixed effects	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y
Covariate controls[1]	N	N	N	Y
N	1850	1850	1850	1850
R^2	0.932	0.938	0.941	0.948
Joint tax neutrality: $\beta_{\tau_i} = 0 \ \forall\, i$	7.84^{***}	8.55^{***}	7.73^{***}	8.00^{***}
$F_{0.05}(5,\, N-5) = 2.21$				
Joint tax effect: $\beta_s + \beta_p + \beta_k + \beta_c + \beta_w = 0$	-0.096^{***}	-0.093^{***}	-0.085^{***}	-0.066^{***}
	(0.019)	(0.017)	(0.017)	(0.013)

Note: Standard errors corrected for clustering at the state level are in parentheses. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

[1] These include state energy prices, percent with a high school degree, percent in manufacturing, union density, and population density.

Higher marginal tax rates on property, capital gains, and corporate income are consistently associated with lower capital-labor ratios. The theory suggested that wage taxation would have neutral effects on capital-labor ratios, a finding that holds consistently across all tests. Government spending on infrastructure and other services had a positive effect on capital-labor ratios, consistent with models that presume that such payments act as capital-biased technology enhancements. However, government transfer payments appear to be Hicks-neutral and do not affect capital per worker.

It is useful to explain why wage taxes do not affect capital-labor ratios. The intuition follows directly from the interaction of firms' factor-demand conditions and households' intertemporal saving decisions. On the demand side, equation (3a) shows that firms choose the capital–labor ratio by equating the marginal product of capital to the rental rate they must pay. Wage taxes do not enter this condition because they are levied on households rather than firms and thus do not alter the relative price of capital to labor that firms face. On the supply side, equation (6) shows that the steady-state rental rate is determined entirely by households' intertemporal Euler condition, which depends on depreciation, the discount rate, and taxes on capital income and property, but is unaffected by wage taxation. Since the wage tax alters neither the required return on capital nor the marginal productivity condition determining firms' desired capital intensity, the equilibrium rental rate and the implied capital–labor ratio must remain unchanged. A higher wage tax does reduce labor supply by lowering the after-tax wage, but firms optimally scale capital and labor in the same proportion to maintain the unchanged marginal product condition. Consequently, wage taxes generate only a level effect on employment and output, while capital taxes directly distort the intertemporal return to saving and hence the steady-state capital–labor ratio.

Despite our inclusion of a vector of observed covariates, Z_{jt}, in Table 2, it is likely that there are other unmeasured market factors that affect capital investment and that are correlated with state marginal tax rates. We propose two alternative estimation strategies that should reduce this source of potential endogeneity bias. The first is a variant of the matched state strategy used by Goff et al. (2012) to estimate factors affecting state growth. Our version presumes that adjacent states, j and j', share unobserved market factors that are potentially correlated with state tax rates so that $\epsilon_{jt} = \theta_{jj't} + \theta_{jt}$. $\theta_{jj't}$ is a common time-varying effect shared by the bordering states, and θ_{jt} is a true random component. Differencing equation (10) across these bordering states, we get the difference-in-differences specification:

$$\begin{aligned}\ln\left[\frac{k_{jt}/l_{jt}}{k_{j't}/l_{j't}}\right] &= \beta_s\left[\tau_{s,jt} - \tau_{s,j't}\right] + \beta_p\left[\tau_{p,jt} - \tau_{p,j't}\right] + \beta_k\left[\tau_{k,jt} - \tau_{k,j't}\right] \\ &+ \beta_c\left[\tau_{c,jt} - \tau_{c,j't}\right] + \beta_w\left[\tau_{w,jt} - \tau_{w,j't}\right] + (\eta_j - \eta_{j'}) \\ &+ \gamma_G(G_{jt} - G_{j't}) + (Z_{jt} - Z_{j't})'\gamma_Z + (\theta_{jt} - \theta_{j't}) \end{aligned} \tag{11}$$

where the year fixed effects and the unobserved time-varying border effects are differenced away.[15]

Table 3, column 2, presents the results from estimation of (11). Standard errors are corrected for clustering at the state border pair. For reference, we repeat the results from column 2 in the first column. Results did not differ substantially by specification, so we focus on the specification with aggregate government expenditures.

[15]This is similar to the strategy used by Peltzman (2016) with county-level data. We also can motivate this specification as approximating a regression discontinuity in tax policy at the borders, although the discontinuity would be sharper with smaller jurisdictions than the state. See Lee and Lemieux (2010).

Table 3: Estimated Effect of Tax Structure on Physical Capital per Worker by State, 1977–2017: Border and Large-Change Robustness

	(1)	(2)	Large Tax Change Sample (3)	(4)
Relative Tax Rates	$\ln(k_{jt}/l_{jt})$	$\ln\left(\frac{k_{jt}/l_{jt}}{k_{j't}/l_{j't}}\right)$	$\ln(k_{jt}/l_{jt})$	$\ln\left(\frac{k_{jt}/l_{jt}}{k_{j't}/l_{j't}}\right)$
Sales tax	−0.031**	−0.002	−0.044***	−0.004
	(0.012)	(0.005)	(0.014)	(0.006)
Effective property tax	−0.039***	−0.019***	−0.028**	−0.017***
	(0.012)	(0.006)	(0.013)	(0.005)
Capital gains tax	−0.008**	−0.007***	−0.005	−0.009***
	(0.003)	(0.002)	(0.004)	(0.002)
Corporate income tax	−0.017*	−0.011***	−0.007	−0.014***
	(0.009)	(0.003)	(0.008)	(0.004)
Income tax	−0.001	0.001	0.005	0.005
	(0.008)	(0.003)	(0.007)	(0.003)
Relative Government Expenditure				
Log government expenditures per capita	0.325***	0.259***	0.257**	0.177***
	(0.081)	(0.049)	(0.102)	(0.064)
Constant		−0.127***	11.576***	−0.138***
		(0.011)	(0.137)	(0.012)
Year fixed effects differenced away	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y
N	1850	4020	381	1328
R^2	0.938	0.927	0.940	0.926
Joint tax neutrality: $\beta_{\tau_i} = 0 \; \forall \, i$	8.55***	9.90***	5.37***	9.96***
$F_{0.05}(5, N-5) = 2.21$				
Joint tax effect: $\beta_s + \beta_p + \beta_k + \beta_c + \beta_y = 0$	−0.093***	−0.038***	−0.079***	−0.039***
	(0.017)	(0.009)	(0.016)	(0.010)

Note: Standard errors in columns 1 and 3 corrected for clustering by state. Standard errors in columns 2 and 4 corrected for clustering at the state border pair. Standard errors in parentheses. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

The coefficients on property, capital gains and corporate income tax rates are smaller than in Table 2, but are still precisely estimated. The income (wage) tax remains neutral with respect to capital per worker. The joint effect of a unit increase in all 5 tax rates is to lower the capital per worker by .038 log points. The joint tax effect is 59% smaller than in Table 2, but is still statistically significant. The government tax effect is about 20% smaller, but still statistically significant.

A second strategy is to examine the effect when there are large tax changes. In Table 3, we replicate estimation of equation (10) excluding all observations except for the ones where at least one of the marginal tax rates has changed by at least 2 standard deviations. The strategy presumes that very large tax changes overwhelm the effect of unobserved market factors. We report the results column 3. Higher marginal tax rates on sales, property, capital gains, and corporate income still negatively associate with capital per worker, but only the first two retain significance. The income tax, which represents the tax on wages does not affect capital per worker. The joint tax effect suggests that a unit increase in all 5 taxes lowers capital per worker by 0.079 log points.

In column 4, we apply the large tax strategy with the border strategy embodied by equation (11). The results are virtually identical to those in column 2. The joint tax effect remains negative and statistically significant. The Table 3 results support the conclusion from Table 2 that the effect of marginal tax rates on capital-labor ratios are consistent with the predictions from theory.

States do not raise taxes in a vacuum. They use revenues to produce public goods that may themselves raise incentives to invest in capital. It is interesting to ask if the marginal tax effect is so large that it negates the potentially positive effects of state government expenditures. Our model is not ideal for this purpose, as it does not generate a direct link between changes in marginal tax rates and state tax revenues, but we can make a reasonable approximation. Using the estimates in column 2 of Table 3, a one percentage point increase in all 5 tax rates will lower capital per worker by 0.038 log points. At the same time, a one percentage point increase in state expenditures will raise capital per worker by 0.26 log points. The net effect of tax funded state expenditures is to raise capital per worker by at least 0.22 log points.[16]

To assess whether the factors affecting capital-labor ratio are consistent with other outcomes, we reestimate equation (10) using the log of real output per job (Table 4) and the log of real per capita income (Table 5) as alternative dependent variables. Equation (8) suggests that these measures should be directly related to capital-per-worker, and they should be similarly influenced by sales, property, and capital taxes while unaffected by wage taxes. In Table 4, all the tax rates have negative effects on labor productivity, but only the property tax and the corporate income tax are statistically significant. The joint effect of a unit tax increase is two-thirds the magnitude of the estimated effect on capital-labor ratios but significantly different from zero. In Table 5, sales, property, and capital gains taxes have negative and statistically significant effects on log real per capita income. The combined tax effect is negative and statistically significant, but roughly half the magnitude of the effect on capital-labor ratios. In both tables, the effect of government expenditures is about one-third the size of capital-labor ratios, with the strongest effects related to government infrastructure investments. Wage taxes do not affect either productivity or per capita income, as predicted by equation (8). We conclude that the factors affecting state capital-labor ratios are consistent with those affecting labor productivity and per capita incomes, consistent with the predictions from neoclassical growth models.

[16]This is not exactly a true balanced budget effect because we cannot determine how much additional revenue would be generated by a percentage point increase of each tax rate. That would require complicated tracing of each state's tax policies for tax deductions, sales tax exemptions, tax credits, and the like. We understate the true balanced budget effect because a simultaneous unit increase across all tax rates is actually larger than a 1% increase in marginal tax rates. For example, at sample means, a unit increase in sales tax would result in an increase from 4.7% to 5.7% while a 1% increase in the tax rate would be an increase of 4.7% to 4.747%. We prefer erring on the side of understating the balanced budget effect, as even the understated effect is close to the estimated government expenditure effect, and so the bias is small.

Table 4: Estimated Effect of Tax Structure on Real Output per Worker by State, 1977–2017

Tax Rates	(1) $\ln(q_{jt}/l_{jt})$	(2) $\ln(q_{jt}/l_{jt})$	(3) $\ln(q_{jt}/l_{jt})$	(4) $\ln(q_{jt}/l_{jt})$
Sales tax: $\tau_{s,jt}$	−0.014	−0.013	−0.012	−0.012
	(0.011)	(0.011)	(0.011)	(0.011)
Effective property tax: $\tau_{p,jt}$	−0.028***	−0.027***	−0.023***	−0.022***
	(0.008)	(0.008)	(0.008)	(0.008)
Capital gains tax: $\tau_{k,jt}$	−0.003	−0.002	−0.002	−0.001
	(0.003)	(0.003)	(0.003)	(0.002)
Corporate income tax: $\tau_{c,jt}$	−0.011*	−0.011*	−0.010*	−0.007
	(0.006)	(0.006)	(0.005)	(0.005)
Income tax: $\tau_{y,jt}$	−0.001	−0.003	−0.002	−0.002
	(0.004)	(0.004)	(0.004)	(0.003)
Government Expenditure				
Log government expenditures per capita		0.227***		
		(0.070)		
Log infrastructure expenditures per capita			0.080***	0.102***
			(0.025)	(0.025)
Log transfer payments per capita			−0.004	−0.010
			(0.040)	(0.036)
Log other payments per capita			0.120	0.139**
			(0.088)	(0.067)
Constant	4.028***	3.726***	3.958***	3.220***
	(0.051)	(0.094)	(0.098)	(0.342)
Year fixed effects	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y
Covariate controls[1]	N	N	N	Y
N	1851	1851	1851	1851
R^2	0.914	0.919	0.921	0.930
Joint tax neutrality: $\beta_{\tau_i} = 0 \; \forall i$	4.01***	3.91***	3.35***	2.51**
$F_{0.05}(5,\, N-5) = 2.21$				
Joint tax effect: $\beta_s + \beta_p + \beta_k + \beta_c + \beta_y = 0$	−0.057***	−0.056***	−0.049***	−0.044***
	(0.014)	(0.014)	(0.013)	(0.015)

Note: Standard errors corrected for clustering at the state level are in parentheses. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

[1] These include state energy prices, percent with a high school degree, percent in manufacturing, union density, and population density.

7. CONCLUSIONS

We show that in theory and in the data, state marginal tax rates on sale, property, capital gains and corporate income consistently lower capital-labor ratios, labor productivity, and

Table 5: Estimated Effect of Tax Structure on Real Income per Capita by State, 1977–2017

Tax Rates	(1) $\ln(y_{jt}/l_{jt})$	(2) $\ln(y_{jt}/l_{jt})$	(3) $\ln(y_{jt}/l_{jt})$	(4) $\ln(y_{jt}/l_{jt})$
Sales tax: $\tau_{s,jt}$	-0.016^{***}	-0.015^{***}	-0.015^{***}	-0.014^{**}
	(0.006)	(0.005)	(0.005)	(0.005)
Effective property tax: $\tau_{p,jt}$	-0.015^{***}	-0.013^{***}	-0.010^{**}	-0.013^{***}
	(0.004)	(0.004)	(0.004)	(0.004)
Capital gains tax: $\tau_{k,jt}$	-0.006^{***}	-0.005^{**}	-0.005^{**}	-0.005^{***}
	(0.002)	(0.002)	(0.002)	(0.002)
Corporate income tax: $\tau_{c,jt}$	−0.004	−0.004	−0.003	−0.004
	(0.007)	(0.006)	(0.005)	(0.005)
Income tax: $\tau_{y,jt}$	0.000	−0.001	0.000	−0.000
	(0.002)	(0.002)	(0.002)	(0.002)
Government Expenditure				
Log government expenditures per capita		0.247^{***}		
		(0.054)		
Log infrastructure expenditures per capita			0.091^{***}	0.083^{***}
			(0.020)	(0.017)
Log transfer payments per capita			0.039	0.036
			(0.029)	(0.026)
Log other payments per capita			0.068	0.041
			(0.045)	(0.044)
Constant	9.890^{***}	9.560^{***}	9.882^{***}	10.014^{***}
	(0.041)	(0.068)	(0.053)	(0.182)
Year fixed effects	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y
Covariate controls[1]	N	N	N	Y
N	1851	1851	1851	1851
R^2	0.973	0.977	0.978	0.979
Joint tax neutrality: $\beta_{\tau_i} = 0 \; \forall \, i$	5.69^{***}	5.20^{***}	4.56^{***}	5.23^{**}
$F_{0.05}(5,\, N-5) = 2.21$				
Joint tax effect: $\beta_s + \beta_p + \beta_k + \beta_c + \beta_y = 0$	-0.041^{***}	-0.038^{***}	-0.033^{***}	-0.036^{***}
	(0.010)	(0.009)	(0.008)	(0.008)

Note: Standard errors corrected for clustering at the state level are in parentheses. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

[1] These include state energy prices, percent with a high school degree, percent in manufacturing, union density, and population density.

per capita incomes. Wage taxes, as measured by the highest marginal state income tax rate, never affect capital-labor ratios, labor productivity, and per capita incomes in theory and in the data. Government expenditures affect capital-labor ratios, consistent with their characterization as a Hicksian productivity enhancement. The effect is strongest for government expenditures on infrastructure, while transfer payments have no effect. The government expenditure effects are sufficiently large to outweigh the adverse effects of marginal tax rates, and so, on net, government expenditures other than transfer payments generate a net positive effect of capital-labor ratios. However, there is a benefit to raising revenue using low marginal tax rates or property, sales, and capital income, presumably by having as broad a tax base as possible with few exemptions, credits, deductions, or rebates.

Many studies have tied rising income inequality to technological changes and capital investments that have raised returns to schooling. Our findings suggest that variation in capital per worker across states is leading to income differences across states. States with lower capital-labor ratios have lower labor productivity and per capita income. Because state capital-labor ratio levels persist over time, income and productivity differences also persist.

Our results of significant negative effects of tax rates on economic outcomes are consistent with empirical studies that incorporated subsets of the empirical strategies we employ. Funderburg et al. (2010) found that when they used marginal rather than average business tax rates, they find a negative effect on manufacturing value-added production. Reed (2008) found that a lagged measure of tax burden that incorporated all state taxes lowered growth in state income. Romer and Romer (2010) showed that exogenous increases in marginal federal tax rates had a large negative effect on investment. Giroud and Rauh (2019) found significant adverse responses of firm capital investment and location choice to measures of the corporate tax rate as they applied to each firm. Adhikari and Alm (2016) found that in 7 of 8 European countries, flattening the tax rate structure increased per capita income growth. Link et al. (2024) show that increased corporate tax rates cause firms to reduce their capital expansion. Cassidy et al. (2024) found that the introduction of the income tax increased outmigration from the state. Hence, our results are consistent with a broad range of studies finding that rising tax rates affect how much and where to invest.

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APPENDIX: DATA DEFINITIONS

The following data was collected for each of the 48 contiguous states of the United States from 1977 through 2017.

1. Dependent Variable

Capital per Worker is provided by Turner et al. (2013). Data on capital in agriculture is based on a consistent measure of the value of land and buildings from various editions of the Census of Agriculture. For manufacturing, the Census of Manufacturing includes measures of capital expenditures by state which are converted into capital measures using the perpetual inventory method and applying a six percent depreciation rate. Capital in the remaining sectors applies national data on capital per unit output to states using each state's share of national output by sector. The state level measures sums the information across these three data sources. The denominator is measured as the civilian labor force aged 16 and older. All dollar values were converted to 2009 chained constant dollars.

As the Turner et al. (2013) data ended in 2000, we extended the series through 2017 by following the guidance provided in Turner et al. (2011). Our series overlaps with Turner et al. (2013) from 1977–2000, and so we harmonize the two series by regressing $\ln\left(\frac{k_{\text{jt}}}{l_{\text{jt}}}\right)^T = \theta_j + \theta_C \ln\left(\frac{k_{\text{jt}}}{l_{\text{jt}}}\right)^C + e_{\text{it}}$ where the dependent variable is the Turner measure and $\ln\left(\frac{k_{\text{jt}}}{l_{\text{jt}}}\right)^C$ is the measure developed by the current authors. θ_j is the state fixed effect. We use the fitted values from 2001–2017 so that those measures correspond more closely to what the Turner et al. (2013) methods would have generated while still maintaining the relative capital-labor ratios across states and time.

Income per Capita: Total personal income of the residents of a state divided by the population of the state, as reported by the Bureau of Economic Analysis. All dollar values were converted to 2009 chained constant dollars.

Labor productivity: Measured as Gross State Domestic Product divided by the number of jobs by place of work, with both series compiled by the Bureau of Economic Analysis. All dollar values were converted to 2009 chained constant dollars.

2. Independent Variables

2A. Marginal Tax Rates

Income Tax Rate Feenberg and Coutts (1993).

Capital Gains Tax Rate Feenberg and Coutts (1993).

Property Tax Rate The effective property tax rate per $100 of assessed value in the largest city of each state. The estimate is based on housing values for households of varying incomes. Government of the District of Columbia, Office of the Chief Financial Officer (2025).

Sales Tax Rate The highest state retail sales tax rate ignoring exemptions or rebates. This is reported annually in The Council of State Governments (2023).

Corporate Tax Rate The highest state corporate tax rate ignoring exemptions or rebates. This is reported annually in The Council of State Governments (2023).

Additional Controls

Log Real State and Local Government Expenditures per Capita Information on aggregated total state and local government expenditures as well as expenditures on capital, transfer payments and other government expenditures were compiled from the Urban Institute's *State and Local Finance Initiative Data Query System.* The first measure was the logarithm of aggregated state and local government expenditures divided by population and converted to 2009 chained constant dollars.

The second took the logarithms of the following disaggregated total government expenditures into:

- **Total Capital Outlays** (E006). This was divided by population and converted to 2009 chained constant dollars.
- **Transfer Payments** = Health and Hospital Direct Expenditures (E052) + Housing & Community Direct Expenditures (E074) + Public Welfare Direct Expenditures (E090). This was divided by population and converted to 2009 chained constant dollars.
- **Other Government Expenditures** = Total − capital outlay − transfer payments. This was divided by population and converted to 2009 chained constant dollars.

Energy Prices The price per million BTU across all end users of all energy types as measured by variable TETCD in the U.S. Department of Energy, Energy Information Association, State Energy Data System (SEDS): 1960–2015. http://www.eia.gov/state/seds/seds-data-complete.php?sid=US\#PricesExpenditures

High School Share Proportion of the population aged 25 and over with at least a high school degree. The U.S. Bureau of the Census *Educational Attainment of the Population 25 Years and Over, By State* was a compilation provided by the Census historically. For more recent years, state educational attainment data was compiled from information provided by the Census through its American Community Survey.

Population Density Population per square mile. Population was reported by the Bureau of Economic Analysis series, *SA1 — Personal Income Summary: Personal Income, Population, Per Capita Personal Income.* This was divided by the square miles in the state.

Union Density This database provides time-consistent national and state-level estimates of union density for the years 1964 through 2017. Two sources of data are combined to produce these estimates, the Current Population Survey (CPS), a monthly survey of U.S. households, and the discontinued BLS publication *Directory of National Unions and Employee Associations*, based on data reported by labor unions to the government. The union density measure represents the percentage of nonagricultural wage and salary employees who are union members, including employees in the public sector. © 2018 by Barry T. Hirsch, David A. Macpherson, and Wayne G. Vroman. http://www.unionstats.com

Hirsch et al. (2001); Hirsch et al. (2025).

Manufacturing Share *Real GSP by state (millions of chained 2009 dollars)* is an inflation-adjusted measure of each state's GSP that is based on national prices for the goods and services produced within the state, measured in millions of chained (2009) dollars. GSP in manufacturing is divided by total GSP.