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Do State Marginal Tax Rates Lower State Labor Productivity?

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Disciplines

Finance | Growth and Development | Income Distribution | Regional Economics | Taxation

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JEL Classification: H2, H3, H7

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I. Introduction

There are large differences in labor productivity across states. Output per job in Delaware averages over $100 thousand per job, 79% larger than output per job in Montana. Despite presumed free flow of labor and capital across states, large productivity gaps have persisted over the past 25 years. The correlation between state output per job in 1981 and 2015 is 0.98. Because output per job and wages are theoretically and empirically tied, the persistent variation in labor productivity implies persistent wage inequality across states. Hence, identifying the impediments to conversion in labor productivity is necessary if we are to reduce income inequality across states.[1]

Capital investments and technological innovation have played a major role in the growth of labor productivity in the U.S. economy since 1980 (Jorgenson, Ho and Stiroh, 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 (Autor et al, 2008; Dunne et al, 2004; Goldin and Katz, 2008; Acemoglu and Autor, 2011; Syverson, 2011). As a result, differences in capital accumulation would plausibly have a role in the persistent differences in labor productivity across states.

This study investigates whether persistent differences in distortionary tax policies across states may have caused persistent differences in capital investment across states. We provide evidence consistent with that hypothesis, showing that other things equal, state marginal tax rates combine to lower labor productivity by an average of 15% per year. Because states do not alter their tax structures frequently, state tax structures cause persistent differences in productivity across states. The correlation in estimated decline in labor productivity associated with state tax

[1] See Faggio (2010) and Card *et al* (2018) for two examples of how wage inequality is related to unequal labor productivity between firms.

structure between 1981 and 2015 is 0.78. High marginal state tax rates on corporate income, property, and sales prove the most damaging to labor productivity. Taxes on wage income are the least damaging both in theory and in our empirical tests. Meanwhile, labor productivity is only positively influenced by a state's per capita government expenditures on capital investments.

II. Literature Review

Our study builds on an extensive literature that explores the large differences in labor 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 resources. Studies disagree about the proximate cause of the resource misallocations. 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. However, Levine and Renelt (1992) found that capital investment in a large sample of countries was unresponsive to fiscal policies. Hall and Jones (1999), Acemoglu and Johnson (2005) and Alesina and Giuliano (2015) trace low levels of capital investment to the lack of trust in government institutions as indicated by expropriation, corruption, uneven administration of the rule of law, or restraint of trade. Sachs (2005) blames the lack of capital investment on an inability to save because output in poor countries does not exceed subsistence consumption needs. Hsieh and Klenow (2007) blame distortions caused by very low prices of consumer goods relative to investment goods.

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[2] See Levine and Renelt (1992), Mankiw, Romer, and Weill (1992) and reviews by McGrattan and Schmitz (1999) and Chari and Kehoe (2006).

Our focus on a single country has some distinct advantages over the cross-country data sets with respect to isolating the effect of tax distortions on capital accumulation. Our results will not be clouded by differences in currency values, liquidity constraints, federal government regulatory, legal or political institutions, or even cultural differences that have complicated identification of tax effects in cross-country studies.[3] The availability of multiple state observations per year also allows us to control for common macroeconomic shocks that could otherwise complicate identification of tax effects.

Past research of the effects of state tax policy on economic outcomes have yielded mixed results. Some empirical analyses have found that state taxes have large negative effects on new business location (Papke ,1993), on investment incentives for domestic firms relative to foreign firms who can claim tax credits (Hines, 1996), on income (Giertz, 2010; Adhikari and Alm, 2016.) or income growth (Reed, 2008). Nevertheless, replications or reviews by Waslyenko (1997), Alm and Rogers (2011) and Gale *et al* (2015) suggest that the magnitude, significance, and even the direction of the estimated tax effects appears to be sensitive to changes in sample or specification. Other studies emphasize that the effect of government size on growth depends on the size of the government sector relative to the private sector (Brown, Hayes and Taylor, 2003) or the growth of government expenditures (Taylor and Brown, 2006).

These uneven results are surprising given the theoretical consensus that high marginal tax rates are particularly damaging to capital investment.[4] Our findings are much more consistent with the theoretical consensus. We believe this is because our analysis more closely mimics the theoretical relationship between tax rates and output per job: 1) We use marginal rather than

[3] For example, Prescott (2002) argued that differences in hours worked between Europe and the United States are attributable to tax differences, but Alesina et al (2005) argued that differences across countries in union power, tastes for leisure, employment protection, or other government policies are equally consistent with the data.
[4] See the review by Mankiw, Weinzierl and Yagan (2009).

average tax rates; 2) We incorporate a full menu of 6 tax types rather than a subset of tax instruments as required by theory; 3) We do not incorporate endogenous employment or capital as regressors; and 4) We conduct the analysis in levels, consistent both with theory and with prior work that suggests differenced data is inappropriate when analyzing slowly changing phenomena . As our empirical work demonstrates, across numerous alternative specifications, higher state marginal tax rates on sales, corporate income and property lower labor productivity, consistent with the presumed greater distortionary effects of high marginal tax rates on input prices, output prices and returns to capital. However, taxes and wages have neutral effects on productivity.

We first demonstrate that labor productivity differs across states and those differences persist over time. We then present a representative agent model that demonstrates that the equilibrium level of labor productivity will depend on the mix of marginal tax rates in the state. After reviewing the data and empirical strategy, we present results that show evidence in support of the predicted negative relationship between distortionary marginal tax rates and labor productivity. Results suggest that distortionary marginal tax rates lower labor productivity by an average of 15% across the states. There are large differences in the extent to which states rely on distortionary tax structures. In 2015, the decrease in labor productivity attributed to state marginal tax rate structure ranged from -3% in Wyoming to -22% in California. with an average reduction in labor productivity estimated effects of a 10% increase in marginal rates varying from -1.6% in Nevada to -3.9% in New York. Next, we show that there is only weak evidence supporting the view that tax rates are endogenous responses to past productivity shocks or altered in anticipation of productivity outcomes. We conclude with an assessment of the relative efficiency of tax types as revenue generators compared to their distortionary effects on productivity. Of the 6 tax types we investigate, income and sales taxes generate the most revenue per 1% lost productivity, while corporate and capital gains taxes generate relatively little revenue from the same productivity loss.

III. Variation in the Level and Source of State Labor Productivity

Labor productivity differs substantially across states. Those differences persist over time. The correlation in state output per job in 1981 and in 2015 is 0.98. On the other hand, the correlation between state output per job in 1981 and the growth in output per job between 1981 and 2015 is 0.09. The small positive correlation indicates that state output per job is not converging, a finding pointed out previously by Bauer *et al* (2012).[5] The three states with the lowest output per job among the 48 contiguous states in 1981 (Maine, South Carolina and Vermont) were ranked 45, 43 and 44 in 2015.

One should focus on levels rather than growth rates of output per job because, over time, levels of labor productivity are persistent and growth in labor productivity is almost random. As discussed by Hall and Jones (1999, p.85), government policies change levels but not growth rates. In fact, both theory and evidence suggest that jurisdictions will tend to grow at similar rates. Moreover, Hall and Jones (1999) and Mankiw, Romer and Weil (1992) found that Solow growth models are more consistent than endogenous growth models in explaining the long-run economic performance of nations. The stylized facts regarding the growth of states suggest a similar modeling strategy should hold for states as well.

The stylized facts regarding state growth are usefully described by decomposing labor productivity into two parts. In every year *t* since 1981 and for every state *i*, we have data on

[5] Turner *et al* (2013) argued that productivity was converging across states between 1840 and 2000, but most of the convergence was before 1940. Their figure 9 suggests that since 1960, labor productivity has remained constant or increased depending on the measure, consistent with rising income inequality in the United States.

Gross State Product (Q_{it}), and number of jobs by state (L_{it}). We can represent Q_{it} as the product of the number of jobs and the average product per job, $\frac{Q_{it}}{L_{it}}$.[6]

(1) $$Q_{it} = L_{it} \cdot (\frac{Q_{it}}{L_{it}})$$

Taking logs and totally differentiating (1), we can characterize changes in Gross State Product (GSP) over time from some base year 0 to year *t* as

(2) $$dln(Q_{it}) = dln(L_{it}) + dln\left(\frac{Q_{it}}{L_{it}}\right)$$

State *i's* growth in aggregate output is decomposed into two parts, the first attributable to growth in labor productivity and the second due to growth in employment.

We illustrate the results in Figure 1. Between 1981 and 2015, real state GSP in the 48 contiguous states grew an average of 86% or about 1.8% per year. Growth in labor productivity is responsible for 58% of GSP growth, while increases in employment explain the remaining 42%. As the trend lines in Figure 1 show, the fastest growing states depend predominantly on labor productivity growth. However, states vary considerably in productivity growth, from a low of 17.5% in West Virginia to a high of 120% in Nevada. The 3 states with the fastest productivity growth (Nevada, Florida and Utah) are among the top 4 in GSP growth.

Wage growth will be driven by productivity growth. Wage gaps across states would diminish if the fastest productivity growth occurred in states with the lowest initial productivity levels. Instead, gaps in wages and productivity have persisted since the 1970s. All of these states face the same macroeconomic policies, interstate regulatory structures, legal institutions, and cyclical and technological shocks. They face similar prices of consumption and investment

[6] Our productivity measure is gross state product per job rather than per worker or per hour. We use this because of the long-run consistency in measurement. Bauer and Lee (2006) showed that per worker and per hour measures of labor productivity have similar long-run trends. Bureau of Labor Statistics data shows that the incidence of moonlighting has only changed modestly over time. The average in the 1980s was 5.6% and the average between 2004-13 was 5.4%. Hence, the per job, per worker and per hour measures should yield similar results. We test the sensitivity of our results to other measures in the results section.

goods. Consequently, such large and persistent differences in levels of labor productivity across states beg for an explanation, especially because there is an incentive for workers to shift from low productivity to high productivity states which should lead labor productivity to equalize across states over time.

There is a strong *prima facie* case that state labor productivity is driven by capital per worker in the state. Around 1980, the U.S. began to experience an extended period of rising returns to schooling that has been attributed to rising firm investments in information technologies and other forms of capital. Capital and skill are complements, and so rising investments in capital have been shown to increase the employment and earnings of the more educated workers in the United States.[7] Income inequality across regions has also been tied to persistent differences in key factors of production, most notably physical and human capital (Bauer *et al,* 2012; Turner *et al* ,2013; Stephens *et al,* 2013; Islam *et al,* 2015). Given the presumption of easy flow of labor or capital across borders, the source of these persistent differences in factors across political jurisdictions is unclear. Should variation in state and local tax policies alter the incentives to invest in capital, to reside, or to work in one state versus another, then tax policies will affect labor productivity across states.[8] If tax policies are not changed over time, then the inefficient allocation of capital across states will result in persistent differences in labor productivity. We illustrate the argument in the next section.

IV. Theory

Past studies attempting to demonstrate tax effects on capital investment by state have been hampered by the lack of data on firm capital stocks by state. Instead, studies have relied on

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[7] See Goldin and Katz (2008) and Autor, Katz and Kearney (2008).

[8] Employment levels may also respond to state fiscal policies, but employment shifts are also influenced by factors that have caused the U.S. population to shift West and South such as rising demand for living near natural amenities or immigration location patterns.

national data on capital stock by industry prorated to the state level using the state's share of the industry. Paradoxically, the prorated capital data impose that all states have the same capital intensity by industry, an assumption that presumes capital investment does not respond to state tax structures.[9] Measuring capital stocks over time is also complicated by depreciation rates and differences in book versus market value. We use an alternate strategy that avoids the problem of absent or mismeasured data on capital. Couching our analysis in the context of a neoclassical growth model with a menu of taxes, we show that the equilibrium level of labor productivity is determined by the marginal tax rates on sales, capital gains, corporate income, and property. Therefore, we can assess the implied effects of distortionary taxes on investments indirectly through their effects on output per job without requiring an explicit measure of capital.

We derive a relationship between labor productivity and four alternative taxes commonly imposed by state and local governments:

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.

We do so in the context of a neoclassical growth model involving an infinitely lived representative household, an infinitely lived representative firm, and a government authority that imposes taxes and distributes revenues. Our choice of the neoclassical growth model was driven by the finding that there is more systematic variation across states in the levels rather than the growth rates of output per job.

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[9] Examples include Munnell (1990), Holtz-Eakin (1994), Crain and Lee (1999); Brown, Hayes and Taylor (2003); Reed (2008); and Yamarick (2013). The only study which we found that had an actual state level measure of capital was Turner *et al* (2013), but they did not examine the causes of different allocations of capital across states. In a paper most similar to ours in the consideration of multiple tax rates as they affect the impact of corporate income taxes, Giroud and Rauh (2015) use firm-level measures of capital and the location of plants as their capital indicators.

Households choose how much to consume, how much to work, and how much to save (invest), 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. The government does not engage in an optimal tax policy, an assumption that is not too strong in our context because the taxes are a mixture of apparently uncoordinated state and locally set taxes that vary too much across states to reflect any common behavioral rule. The government is only allowed a limited role in the economy, balancing the budget every period by collecting taxes and redistributing all revenues back to the household. We assume that capital is perfectly mobile across states but that labor is fixed at least in the short-run.[10]

<u>The representative household</u>

The household's preferences are given by

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

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 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 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

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

[10] 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 are shifted onto workers. It also is consistent with our finding in the previous section that labor supply shifts are not sufficient to eliminate or even diminish gaps in productivity over time.

where δ represents the capital depreciation rate.

The first-order conditions imply that households equate the marginal rate of substitution between consumption and leisure to their relative prices:

(5A) $$\frac{(1-\alpha)c_t}{\alpha(1-l_t)} = (1-\tau_W)w_t;$$

and the Euler condition that fixes growth of capital to the pre-tax rate of interest

5B) $$r_t = \frac{B^{-1}-1+\delta+\tau_p}{1-\tau_k}$$

Note that if the tax rates don't change, and with fixed depreciation and discount rates, the pretax return on capital is fixed over time.

<u>The representative firm</u>

The representative firm hires labor and capital stock in order to produce output according to the CES production function,

(6) $$y_t = A\left[\theta k_t^{1-\frac{1}{\varepsilon}} + (1-\theta)l_t^{1-\frac{1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}$$

where ε is the elasticity of substitution between capital and labor. The firm's profit maximization problem is to select k_t and l_t to maximize profit

(7) $$\Pi_t = \left\{(1-\tau_s)A\left[\theta k_t^{1-\frac{1}{\varepsilon}} + (1-\theta)l_t^{1-\frac{1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}} - w_t l_t - r_t k_t\right\}$$

which yields the optimal capital labor ratio

(8) $$\frac{k_t}{l_t} = \left(\frac{\theta}{(1-\theta)}\frac{w_t}{r_t}\right)^{\varepsilon}$$

<u>The government</u>

The government collects all four taxes and rebates all revenues back to the household in the form of a lump sum rebate,

(9) $$G_t = \tau_w w_t l_t + \tau_s y_t + \tau_p k_t + \tau_k r_t k_t$$

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. If we wanted to allow governmental distortions, we could add G_t directly into the production function (8), as was commonly done in the literature on productive public infrastructure expenditures.[11] However, we can allow nonneutral effects of government spending if they enter the Hicksian aggregate term, A in (8) as a source of productive externalities on private production.

Equilibrium

The equilibrium condition for the wage level is

(10) $$w_t = \left[\frac{(1-\theta)^{\varepsilon}}{\left([(1-\tau_s)A]^{1-\varepsilon} - \frac{\theta^{\varepsilon}}{r_t^{\varepsilon-1}}\right)}\right]^{\frac{1}{\varepsilon-1}}$$

Because wages are equal to the value of the marginal product of labor, equation (13) is also a representation of equilibrium labor productivity. The equilibrium wage reflects the equilibrium choice of capital, and so we can assess the effect of tax rates on capital investment indirectly through their effect on wages and labor productivity.

Equation (10) implies that the wage and the marginal product of labor will fall as the sales tax rate rises. That reduces the capital per unit labor through (8). From (5B), we know that the before-tax interest rate rises with the property tax rate and the capital income tax rate which lowers equilibrium capital per unit labor through (8). In addition, the property tax and capital income tax rates lower equilibrium wages and labor productivity, as can be confirmed by taking the derivative of w_t with respect to r_t in (10). The theory demonstrates that the effect of taxes on capital can be inferred by the effect of taxes on labor productivity.

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

Importantly, equation (10) states that the effect of marginal tax rates on productivity will be found in the levels of productivity and not necessarily in the changes in productivity. States with higher marginal tax rates on capital income, property values and sales will have permanently lower labor productivity and capital per worker than their neighbors with lower marginal tax rates. However, high marginal tax rates may not alter the rate of growth, and so trying to determine the effect of tax rates using growth measures may difference away the information. This was first pointed out by Easterly *et al* (1993) who showed that when there is little correlation of growth rates over time as we find in section III, differences in growth rates will be transitory and will not reflect underlying structural differences across states. In other words, to identify the underlying structural relationship between tax rates and productivity, the analysis should be conducted in levels.

A further implication of (10) 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 capital accumulation or labor productivity. The impact of a shock to any one tax depends on the levels of the other taxes. Importantly, the tax rates τ_s, τ_p and τ_k that affect equilibrium labor productivity are marginal and not average tax rates. As is clear from equation (9), average tax receipts will reflect endogenous decisions on l_t, k_t, and y_t, even if the marginal tax rates τ_w, τ_s, τ_p, and τ_k are set outside the model. Consequently, empirical studies of taxes on labor productivity must focus on marginal tax rates and not average tax rates.[12]

However, because the interest rate does not depend on τ_w, wages and marginal products of labor are unaffected by wage taxes. As wage taxes rise, households cut back on labor supply,

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[12] Mankiw, Weinzierl and Yagan'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..

leaving the marginal product of labor and hence wages unchanged.[13] Prescott (2002) uses a similar formulation to demonstrate why higher taxes on wages in Europe can result in lower employment and greater unemployment in European labor markets relative to the United States. Because this prediction is subject to our use of CES forms for utility and production and constant returns to scale, we test this prediction in the data and find support for the neutrality of taxes on wages.

Equation (10) also implies that equilibrium wage and labor productivity do not depend on the level of government expenditure. This outcome is a consequence of our assumption that G_t is a pure lump-sum transfer. 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 can affect equilibrium labor productivity if G_t is an element of the Hicksian technology parameter, A. Therefore, we can test formally whether G_t affects the equilibrium level of labor productivity independent of the effects of marginal tax rates. However, we note that government expenditures are set by the level of marginal tax rates and so even with a more complex theory, they would not be present in the reduced form.

V. Empirical Strategy

The theoretical model shows that the equilibrium level of the pretax wage, and hence the equilibrium average product of labor, responds negatively to the marginal property tax rate (τ_p);

[13] We get the same result 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. Income taxes may also affect labor productivity if there are frictions that prevent a seamless movement toward equilibrium, as reviewed by Shimer (2010).

the sales tax rates (τ_s); and the marginal tax on returns to capital. In application, the capital earnings tax takes on several forms including a tax on capital gains (τ_k); and a tax on corporate earnings (τ_c). The equilibrium condition (10) suggests that a pure wage tax (τ_w) would have a neutral effect on labor productivity. Rather than exclude wages taxes, we include two taxes that are tied to wages, state income taxes (τ_y) and unemployment insurance (τ_u) tax rates, and test whether the wage tax neutrality prediction holds.[14]

Rather than estimate the highly nonlinear relationship (10) directly, we specify the simpler first-order approximation as a log-linear variation relating labor productivity to the tax rates

$$\text{(11)} \quad \ln\left(\frac{y_{it+\Delta}}{l_{it+\Delta}}\right) = \beta_o + \beta_s \tau_{s,it} + \beta_p \tau_{p,it} + \beta_k \tau_{k,it} + \beta_c \tau_{c,it} + \beta_y \tau_{y,it} + \beta_u \tau_{u,it}$$

$$+ Z_{it}^{\prime} \gamma + \mu_t + \eta_i + \epsilon_{it}.$$

The vector Z_{it} will include a vector of controls to capture possible variation in productivity or tastes across states and across time.

The testable predictions from the theory are that $\beta_s < 0$; $\beta_p < 0$; $\beta_k < 0$; $\beta_c < 0$. In addition, if income and unemployment insurance taxes behave as wage taxes, we should find that $\beta_y = \beta_u = 0$. The dependent variable is the natural logarithm of output per job. The theoretically appropriate dependent variable would be the marginal product rather than the average product of labor. We cannot derive estimates of marginal products by state, but average

[14] Both taxes differ from a pure wage tax. The income tax includes nonlabor income and the unemployment insurance tax is experience rated and subject to upper limits on tax amounts that make the effective marginal rate zero for some firms. Nevertheless, the marginal tax rate will apply to wage income for a large number of firms and workers.

and marginal products must be positively correlated in the range of labor inputs consistent with profit maximization.[15]

Specification (11) subscripts output per job at $t+\Delta, \Delta \geq 0$. If states alter their tax policies in response to observed labor productivity, then contemporaneous marginal tax rates will be endogenous. Because it is not plausible that there are enough instruments to identify the full menu of potentially endogenous tax policies, we opted instead to examine the consistency of the relationships estimated in (11) as we add more distance sequentially between the tax rates and the observed outcomes.[16] If states set tax policies strategically to affect labor productivity, we should find evidence of instability in the coefficients. With positive values of Δ, we create the possibility of overlapping time periods, leading to autocorrelated errors. To side-step this problem, we sampled the data every Δ years when we used the dependent variable $\ln\left(\frac{y_{it+\Delta}}{l_{it+\Delta}}\right)$, eliminating any overlapping time periods. As Δ increases, we drop successively more time periods so that if the sample size at $\Delta=1$ is N, the sample size drops to at most $N/2$ at $\Delta=2$; $N/3$ at $\Delta=3$; and so on. We found little sensitivity of our parameter estimates to the magnitude of Δ although by $\Delta=5$, we were down to 20% of the sample which adversely affected precision of the estimates.

Another problem is possible unobserved heterogeneity that is correlated with state tax rates, a second possible source of endogeneity. In particular, persistence in state labor

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[15] The use of average products as a proxy for marginal products dates back to Cobb and Douglas (1928) who showed the approximation is exact in the specification that bears their names.

[16] Our use of lagged fiscal policies to explain regional growth is a common identification strategy. Previous studies using this specification include Benson and Johnson (1986), Mofidi and Stone (1990), Bleany et al (2001), Bania, Gray and Stone (2007), Reed (2008), and Gale *et al* (2015). Our use of a large menu of fiscal policies is common in the literature evaluating how unemployment rates and durations respond to various labor market policies (Nickell and Layard, 1999; Blau and Kahn, 2002; Heckman and Pages, 2004; and Nickel et al,2005). Gale *et al* (2015) used a menu of taxes, but used tax revenues rather than tax rates for many of the taxes. Studies using instrumental variables to evaluate the impact of government policies on per capita incomes such as Acemoglu *et al* (2001, 2005) can only include one or two policy variables before they overtax the identification requirements.

productivity over time may be attributable to unobserved state-specific effects, η_i. In addition, states will face common unobserved technology and macroeconomic shocks, μ_t. We use year dummies to control for the μ_t and we handle η_i as either a random effect or a state-specific fixed effect.[17] We also propose a range of control variables to proxy for the productivity and taste shifters, Z_{it}. The remaining unobservable ϵ_{it} is a transitory state-specific productivity shock which we assume is uncorrelated with contemporaneous or past state marginal tax rates.

While we find our results convincing, we acknowledge that if states set tax policies in response to these transitory state-specific productivity shocks, our coefficients will be biased. We subject our conclusions to several robustness checks. Among them, we examine whether there is evidence that states do fine-tune their tax policies in response to productivity shocks. We also examine whether similar results hold when we use alternate measures of labor productivity including state per capita income and average wage per job. Finally, we examine whether there is a systematic relationship between marginal tax rates and productivity on either side of state borders. All the tests lend support to our conclusions that marginal tax rates matter for labor productivity.

VI. Data

The sample is dictated by the availability of data on labor productivity and state tax rates. We use the data for the 48 contiguous states available annually from 1981 through 2015. Our focus on the 48 contiguous states is consistent with the freer flows of capital, labor and goods that drive our equilibrium relationship between taxes and labor productivity. We review our data and sources and provide additional details in Appendix 1.

Our measure of labor productivity is Gross State Product, as reported by the Bureau of

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[17] Bleany et al (2001) and Bania, Gray and Stone (2007) also used state and time dummies to control for unobserved heterogeneity across regions.

Economic Analysis (BEA), divided by the BEA estimate of the number of jobs in the state. Bauer and Lee (2006) showed that average output per worker and per hour have similar long run properties.

Theory specifies of the use of state marginal tax rates and not average tax rates. Marginal tax rates more closely measure the cost wedges that distort consumer and producer decisions, whereas average taxes reflect endogenously the income and tax revenue consequences of the behavioral responses to those marginal 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. The procedures underlying these estimates are described in Feenberg and Coutts (1993). We use the highest marginal tax rate for each, noting that the highest income tax rate will reflect also the marginal tax rate on earnings from the capital in small businesses and S corporations.

Corporate and sales tax rates are reported by The Council of State Governments *Book of States*. 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 the highest reported sales tax on general merchandise and not an average that incorporates various exemptions for food, clothing and medicine.[18]

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 1981, this source has reported the effective property tax rate on residential properties reflecting the range of housing values at

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[18] We do not add local tax rates. We could add average local taxes per capita but that would be inconsistent with our use of marginal tax rates. We do include local expenditures on our measure of government expenditures per capita which would be similar to average local taxes.

various household incomes in the largest city in each state.[19] The effective rate applies 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.

The top marginal unemployment insurance tax rates for each state were provided us by Robert Pavosevich of the U.S. Department of Labor. There are two components to the rate, the top marginal rate $\tau_{u,it}^{max}$, and the maximum wage level to which the rate is applied, W_{it}^{max}. Because the tax is per dollar, we normalize that maximum unemployment insurance tax by the average compensation per job in the state, $\overline{W_{it}}$. These terms are combined into a single rate $\tau_{u,it} = \frac{\tau_{u,it}^{max} \cdot W_{it}^{max}}{\overline{W_{it}}}$.

Equation (11) includes a vector of productivity attributes, Z_{it}, that may be correlated with state marginal tax rates. Crain and Lee's (1999) survey of factors included in state growth models identified nine families of measures which have been used to explain variation in state GSP 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. 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. The level of human capital by year and state is measured by 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. State industrial composition is measured by the share Gross State Product in manufacturing as reported by the Bureau of Economic Analysis. Union political influence is measured by union density which is provided at the web site http://www.unionstats.com/ using the methodology reported by Hirsch

[19] Before that year, information was provided on a subset of states.

and Macpherson (2003). Urbanization, frequently associated with agglomeration economies believed to foster more rapid growth, 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. We depart from Crain and Lee in our specification of Z_{it} in that we exclude measures of the capital stock and the size of the labor force as regressors, both of which are endogenously determined by the equilibrium responses to tax structures in equation (10). [20]

VI. Results

We report the estimation of various specifications of equation (11) in table 1. We report results setting Δ=0, 1, 2, and 3. All the regressions included the vector of covariate controls, $Z_{it.}$, plus a full complement of year and state dummy variables. Estimates are quite consistent across the specifications.[21]

The first column presents the model with contemporaneous tax policy ($\Delta = 0$). Two of the taxes, property taxes and corporate taxes, have significant negative effects on labor productivity, suggesting a negative effect on capital investment. The two taxes on wages that should have no effect on labor productivity, the income tax and the unemployment insurance tax, are individually and jointly insignificant. However, the joint test of significance across the 6 taxes easily rejects the null hypothesis of no effect. The implied joint effect of the 6 taxes evaluated at their sample means is -0.19 log points, implying that the use of distortionary

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[20] Endogenous controls will bias the tax effects. As an example, Gale *et al* (2015) added tax revenues as regressors and found that tax rates lost their explanatory power. But tax revenues are functions of tax rates, as shown by Bruce *et al* (2006). Similarly, 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.

[21] We have a large number of time series for relatively few states which can render cluster corrections unstable (Wooldridge, 2003). The problem goes away when we divide the sample in half and cluster at the state level. Our solution for the full sample was to cluster at the state level separately for the data before and after 2000.

marginal tax rates lowers labor productivity to 83% of the level that would have prevailed had nondistortionary taxes been employed.

The next 3 columns repeat the exercise with all the tax rates and covariate controls occurring at increasing lags. To avoid overlapping time periods, we reduce the sample so that with two lags, we use every other year and with three lags we use every third year. While the coefficients lose some precision, the conclusions remain the same. Even with 3-year lags, the joint effect of the marginal tax rates is -0.15 or a 14% reduction in labor productivity due to the use of distortionary taxes. Consistently, the wage taxes have an insignificant effect on labor productivity, consistent with our theoretical model under constant returns to scale technologies.[22]

In columns 5 and 6, we add in state and local government expenditures per capita. We expect this specification to be the most clouded by possible simultaneity between fiscal policy and labor productivity because expenditures are related to tax revenues which are in turn, related to tax rates (Bruce *et al,* 2006). Nevertheless, adding government expenditures at a 3-year lag did not alter our estimated marginal tax rate effects appreciably. We find that government expenditures do have a positive effect on labor productivity. Consistent with Aschauer (1989), Munnell (1990), Lynde and Richmond (1993) and Pereira (2000), the productivity effect is concentrated on government expenditures on infrastructure. However, our findings regarding the effect of marginal tax rates are robust. The smallest estimated joint effect of the 6 taxes is -0.13 log points or a 12% reduction in labor productivity. The joint test of the wage tax effects never rejects the neutrality prediction across any of the specifications.

In table 2, we repeat the exercise using alternative measures of labor productivity. Column 1 repeats the estimates from column 5 in table 1 to provide a comparison. Column 2

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[22] When we decompose the productivity measure into output versus employment, it is clear that it is output responses that are driving the productivity response. In other words, higher tax rates are lowering output in the numerator and not raising employment in the denominator.

uses per capita income as the measure of productivity. While per capita income is largely composed of wage and salary income, it also includes nonlabor income and so the link with labor productivity is not as direct. Consequently, the wage tax neutrality on labor productivity would not apply to all income types.[23] Nevertheless, the findings from table 1 carry over. The 6 taxes are jointly significant. Their joint effect is to lower per capita incomes by 0.097 log points, a reduction of per capita incomes of 9% per year. We cannot reject the null that the wage taxes have a neutral effect. Column 3 uses average wage per job as the measure of labor productivity. Again, the 6 taxes are jointly significant and imply a reduction of 8% in log average wage compared to a purely nondistortionary tax structure. Again, we cannot reject the null hypothesis that taxes on wages have neutral effects on wage levels.

Despite our demonstration that changing lags of tax rates do not alter our findings, a signal of likely endogeneity of the marginal tax rates, there is the possibility that states use tax policy strategically to manipulate labor productivity. This strategic option is not exercised in choosing which taxes to impose. As shown in Appendix Table 2, no state added or eliminated a tax since 1977 except for the income tax installed in Connecticut in 1991. In addition, states more frequently add or delete tax credits or exemptions to address strategic objectives rather than changing their highest marginal tax rates. Nevertheless, there might be changes in marginal tax rates that are correlated with unobserved shocks to labor productivity. To check this, we reestimated Table 1 allowing different tax effects when tax rates were raised, lowered, or left the same. Strategic tax rate manipulation suggests that tax rates would be raised when any negative feedback is expected to be small and rates would be lowered when the positive impacts on capital investment are expected to be atypically large. If true, we should find that the impact of

[23] For example, Reed (2008) and Giertz (2010) found that increases in marginal tax rates slowed individual income growth.

tax rates on labor productivity would differ when tax rates are rising or falling. However, we could not reject the null hypothesis that the tax rate effects are the same whether they are being raised, lowered, or left alone.

Taxes at state borders

If taxes make a difference to capital investment, the effect will be largest when capital flows most easily from one tax jurisdiction to another. At state borders, firms face a common customer and employment bases and similar locational comparative advantages for production. However, locating on one side of the border versus another can result in a sharply differing menu of taxes. Moreover, if there is a concern that taxes are set endogenously in response to anticipated labor productivity effects, a state border can be viewed as a regression discontinuity where the change in tax rates can be treated as locally exogenous.

Suppose that we observe counties in states *i* and *j* on either side of a state border. Using (11), the difference between their labor productivities would be

(12) $$\ln[\left(\frac{y_{it+\Delta}}{l_{it+\Delta}}\right)/\left(\frac{y_{jt+\Delta}}{l_{jt+\Delta}}\right)] = \beta_s\left[\tau_{s,it} - \tau_{s,jt}\right] + \beta_p\left[\tau_{p,it} - \tau_{p,jt}\right] + \beta_k\left[\tau_{k,it} - \tau_{k,jt}\right] +$$

$$\beta_c\left[\tau_{c,it} - \tau_{c,it}\right] + \beta_y\left[\tau_{y,it} - \tau_{y,it}\right] + \beta_u\left[\tau_{u,it} - \tau_{u,it}\right] + \left[Z_{it}^{'} - Z_{it}^{'}\right]\gamma + \epsilon_{ijt}$$

so that differences in labor productivity between the two states will be reflected in the response of labor productivity to differences in their tax rates and other covariate controls on either side of the border plus the differences between the states in unobserved productivity ϵ_{ijt}.

We do not have a good measure of labor productivity on either side of the border. Average wages are reported by place of work. Because individuals can work on either side of the border regardless of whether they live in the more or less heavily taxed state, wages will not necessarily reflect taxes tied to state of residence. Therefore, the only measure we could use was the per capita income which is reported by place of residence. The behavior also changes when considering tax responses at state borders versus the interior counties. For example, some of the response at the border will be shifting economic investments from one state to the other rather than forgoing the investment altogether, and so one might suspect a larger response than in table 2. Consequently, the link between the theory and the data is more tenuous.

Nevertheless, the results support the view that tax structure matters, although not in the same way as with the comparisons across states. As shown in table 3, the corporate tax continues to hamper economic growth in the cross-border comparisons. As before, the taxes are jointly significant. But now the income tax and unemployment insurance tax also matter and the joint test of significance only weakly supports the neutrality assumption. That is not necessarily a violation of the theory because per capita income is not just labor productivity but also returns to capital investments and nonlabor income returns which would be affected by taxes on wages. The most important corroborating evidence from table 3 is the joint effect of the 6 taxes on per capita income differences across the state borders. The accumulated effect is a decrease in relative per capita income compared to the neighbor of about 45% when evaluated at the mean tax rates, about 5 time larger than the effect estimated in Table 2. This overstates the true relative tax effects because the estimate represents the impact of the average tax structure compared to a bordering state that has no taxes, but it does show that relative marginal tax rates at state borders do have measurable effects on economic outcomes.

Which taxes are the most damaging to investment and productivity?

While our emphasis has been on examining our tax rates as a group, our estimates do suggest that taxes differ in their adverse effects on labor productivity. In table 4, we report the average effect of each tax type on labor productivity in log points. These are interpretable as productivity elasticities relative to changes in each marginal tax rate. The largest adverse effects are from corporate taxes, sales taxes and property taxes. A combined 10 % increase in these three taxes would lower labor productivity by 1.44%. Because the wage taxes are effectively neutral, the balance of the joint tax elasticity is attributable to the capital gains tax. Labor productivity falls by 0.09% for every 10% increase in the marginal capital gains tax rate.

It is important to remind that even though wage taxes do not alter labor productivity, they are not neutral to other economic outcomes. Because they lower labor supply sufficiently to leave the marginal product of labor unchanged, wage taxes are lowering household income through the lower induced labor supply. Consequently, our findings should not be interpreted as suggesting that income taxes and unemployment insurance taxes have no distortionary effects.

Which states have the best or worst tax structures and how persistent are their effects?

With the estimates from Table 1, we can rank the mix of state tax policies by how much they reduce labor productivity in the state. For this exercise, we use the estimates from column 4 of Table 1, but our results are not changed substantially using the other estimates. What matters is that the strategy holds constant the estimated impact of each tax rate on labor productivity over the sample period and then illustrates how the evolving tax structure changes the investment climate in each state.

Table 5 presents the results using each state's marginal tax structure in 1981 and 2015. The first finding is that states do not change their tax structures. The correlation between the estimated joint marginal tax rate effects over the 35-year span between 1981 and 2015 is 0.78. The rank correlation is 0.76. Consequently, the persistence in labor productivity differences across states reported in section 2 is consistent with the persistence in tax policies over time.

The second finding is that the joint effect of the tax rates is always negative, but tax structures differ in their distortionary effects. In particular, even if two states have the same average government expenditures per capita, the state that generates its government revenue using higher marginal rates will face a greater penalty in lost labor productivity. In 1981, the range of estimated lost productivity varies from a low of from a low of -0.035 log points in Wyoming to a high of -.244 log points in Massachusetts. Thirty-five years later, Wyoming still had the least distortionary tax structure at -0.028 log points while California had the most costly tax structure at -0.248 log points.[24] These estimates are interpretable as elasticities, and so the difference across states in lost labor productivity dues to high marginal tax rates varies between 3% to 22%. These differences are not small, and because states vary their tax structures very infrequently if at all, the differences in tax structures cause a persistent difference in labor productivity across states. Nevertheless, differences in tax structure are not large enough to explain even the majority of the persistent productivity gaps across states.

Third, over the 35-year period, state tax structures have become somewhat more distortionary on average with the negative effect on labor productivity. The joint tax effect of state marginal tax rates has risen in magnitude from -0.14 to -0.15. However, the relative distortion per dollar of tax revenue raised per capita has fallen from – 21% to -10%.[25] The reason is that labor productivity and resulting tax revenue has increased more than have marginal tax rates. In other words, labor productivity has grown more due to technological changes and improved worker skills than it has decreased due to rising marginal tax rates.

VII. Conclusions

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[24] Wyoming and other natural resource rich states are able to limit the level of their taxes by fees imposed on resource extractors.

[25] This is estimated as $\frac{\exp(\sum_{i=1}^{6} \beta_i \bar{\tau}_i)}{\exp(\ln(G))}$ or the per job productivity cost relative to government expenditures per capita.

We show that state tax rates consistently lower labor productivity when the analysis uses We use marginal rather than average tax rates; when a full menu of tax types is used; and when the analysis is conducted in levels rather than differences. The rationale for these choices was derived from a representative agent model of consumers and firms. The equilibrium labor productivity reflects the underlying distortions that marginal tax rates on property, sales, and corporate income create for capital investment. We find that state distortionary taxes lower output per job by an average of 15% per year and lower per capita income and wage per job by just under 10% per year. The estimated results are consistent with the theory that increasing marginal tax rates on property, capital income and sales will lower equilibrium output per worker through their disincentive to invest in capital. We also fail to reject the null hypothesis that taxes on wages do not affect labor productivity, consistent with the theory. The differences in state productivity associated with marginal tax rates are of similar magnitudes to the shortfall in output per worker found by Hsieh and Moretti (2015) attributed to housing regulations.

Our results of significant and robust negative effects of tax rates on economic outcomes are also 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 (2015) 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.

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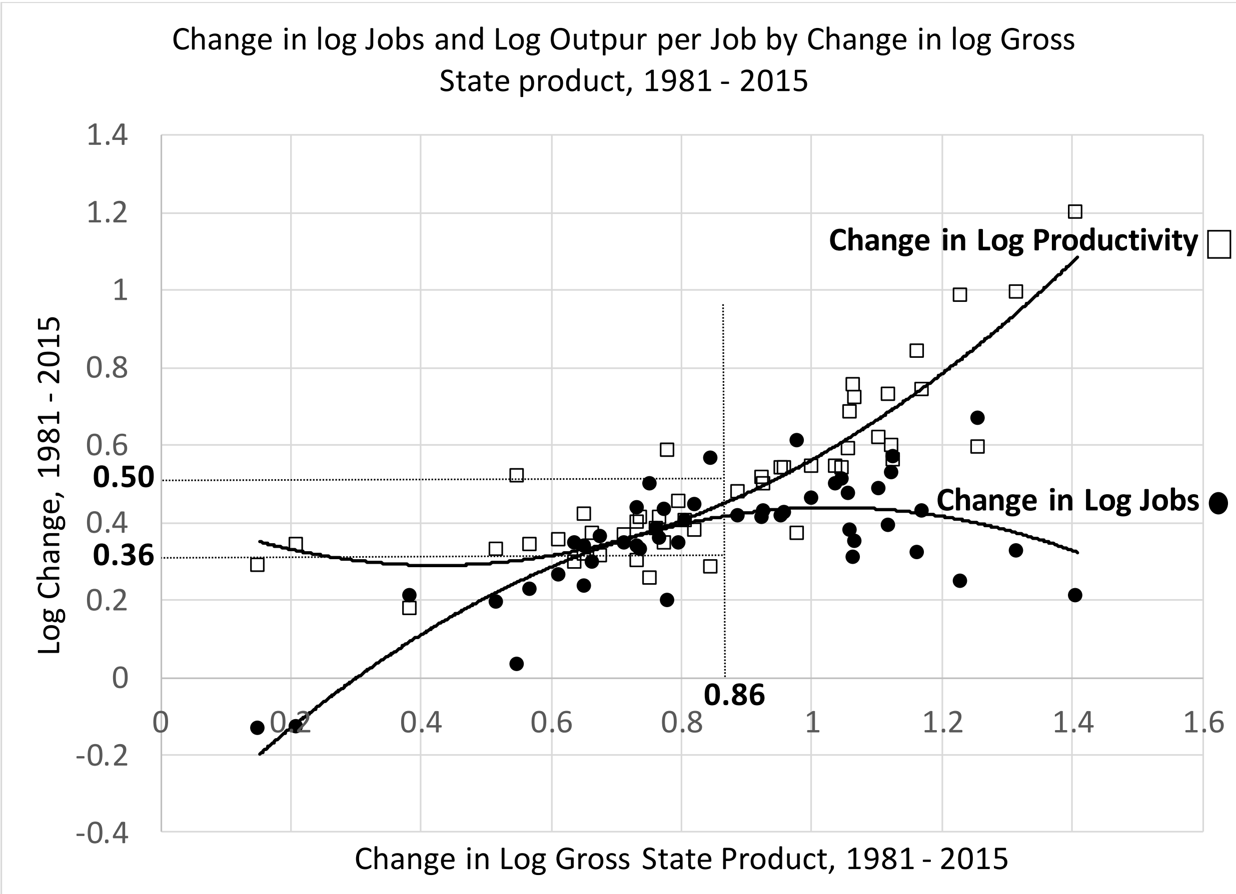
Figure 1: Change in Log Output by State Attributable to Changes in Log Jobs and Log Output per Job, 1981 - 2015



Notes: Average values are in bold. Productivity growth is responsible for $\frac{0.50}{0.86} \cdot 100 = 58\%$ of the growth in output across states.

Table 1: Estimated effect of tax structure on the log GSP per worker by state, 1981 – 2015

	1	2	3	4	5	6
Lag: Δ=	0	1	2	3	3	3
Tax						
Income: τ_y	-0.272	-0.138	-0.228	-0.291	-0.431	-0.353
	(0.95)	(0.46)	(0.76)	0.88)	(1.26)	(1.06)
Property: τ_p	-2.414**	-2.237**	-1.836**	-1.792**	-1.726**	-1.443**
	(3.33)	(2.91)	(2.16)	(2.68)	(2.63)	(2.21)
Sales: τ_s	-1.399	-1.306	-1.374	-1.058	-0.932	-0.934
	(1.63)	(1.46)	(1.48)	(1.23)	(1.12)	(1.14)
Corporate: τ_c	-0.979**	-0.930*	-0.758	-0.958*	-0.981*	-0.873*
	(2.13)	(1.74)	(1.38)	(1.68)	(1.77)	(1.80)
Capital Gains: τ_k	-0.184	-0.184	-0.212	-0.188	-0.145	-0.134
	(0.26)	(0.88)	(1.02)	(0.88)	(0.68)	(0.65)
Unemployment Insurance: τ_u	0.206	0.310	0.643	0.718	0.747	0.813
	(0.49)	(0.69)	(1.62)	(0.78)	(0.82)	(0.91)
Log government expenditures per capita					0.128** (2.16)	
Log infrastructure expenditures per capita						0.063** (2.99)
Log transfer payments per capita						0.001 (0.04)
Log other government expenditures per capita						.025 (0.53)
Observations	1632	1632	816	528	528	528
R-squared	0.93	0.92	0.92	0.93	0.93	0.93
Joint tax neutrality: $\beta_s = \beta_p = \beta_k = \beta_c = \beta_y = \beta_u = 0$ $F_{.05}(6, 90)=2.21$	2.77**	2.20*	1.55	2.07*	1.98*	1.71
Joint tax effect: $\beta_s \overline{\tau_s} + \beta_p \overline{\tau_p} + \beta_k \overline{\tau_k} + \beta_c \overline{\tau_c} + \beta_y \overline{\tau_y} + \beta_u \overline{\tau_u} + \beta_{wc} \overline{\tau_{wc}}=0$	-0.19** (3.50)	-0.17** (3.03)	-0.15** (2.58)	-0.15** (2.77)	-0.15** (2.76)	-0.13** (2.54)
Wage tax neutrality: $\beta_y = \beta_u = 0$, $F_{.05}(2, 94)=3.11$	0.09	0.32	1.40	0.58	0.96	0.81

Notes: t-statistics are reported in parentheses and elasticities in brackets. Standard errors corrected for clustering on states before and after 2000. Regressions include covariate controls for energy cost, fraction of the population with a high school degree, manufacturing as a share of GSP, state union density, and population density along with dummy variables for each state and year.

Table 2: Estimated effect of tax structure on the log GSP per worker, log Per Capita Income, and log wage per job, by state, 1981 – 2015

	ln(Productivity)	ln(Per Capita Income)	ln(Wage)
Lag: Δ=	3	3	3
Tax			
Income: τ_y	-0.431	0.027	0.165
	(1.26)	(0.14)	(0.77)
Property: τ_p	-1.726**	-0.192	-0.575
	(2.63)	(0.47)	(1.22)
Sales: τ_s	-0.932	-0.991**	-0.649
	(1.12)	(2.25)	(1.30)
Corporate: τ_c	-0.981*	-0.531	-0.630
	(1.77)	(1.00)	(1.38)
Capital Gains: τ_k	-0.145	-0.662**	-0.520**
	(0.68)	(5.19)	(3.11)
Unemployment Insurance: τ_u	0.747	0.794	0.673
	(0.82)	(1.20)	(1.00)
Log government expenditures per capita	0.128** (2.16)	0.021 (0.51)	0.087* (1.82)
Observations	528	528	528
R-squared	0.93	0.97	0.96
Joint tax neutrality: $\beta_s = \beta_p = \beta_k = \beta_c = \beta_y = \beta_u = 0$ $F_{.05}(6, 90)=2.21$	1.98*	5.90**	2.53**
Joint tax effect: $\beta_s \overline{\tau_s} + \beta_p \overline{\tau_p} + \beta_k \overline{\tau_k} + \beta_c \overline{\tau_c} + \beta_y \overline{\tau_y} + \beta_u \overline{\tau_u} = 0$	-0.15** (2.76)	-0.097** (2.76)	-0.083**- (2.57)
Wage tax neutrality: $\beta_y = \beta_u = 0$, $F_{.05}(2, 94)=3.11$	0.96	1.01	1.10

Notes: t-statistics are reported in parentheses and elasticities in brackets. Standard errors corrected for clustering on states before and after 2000. Regressions include covariate controls for energy cost, fraction of the population with a high school degree, manufacturing as a share of GSP, state union density, and population density along with dummy variables for each state and year.

Table 3: Estimated effect of relative tax structure on relative log Per Capita Income at state borders, 1981 – 2015

	ln(Per Capita Income)	ln(Per Capita Income)
Lag: Δ=	3	3
Difference in tax rate between		
Income: τ_y	-2.030	-2.297*
	(1.59)	(1.78)
Property: τ_p	3.914	4.793
	(1.21)	(1.48)
Sales: τ_s	-2.260	-2.335
	(1.27)	(1.34)
Corporate: τ_c	-1.813*	-1.80*
	(1.94)	(1.90)
Capital Gains: τ_k	2.143	2.046
	(1.36)	(1.34)
Unemployment Insurance: τ_u	-12.86**	-13.02**
	(2.25)	(2.27)
Log government expenditures per capita		0.297 (1.36)
Observations	10,707	10,707
R-squared	0.065	0.068
Joint tax neutrality: $\beta_s = \beta_p = \beta_k = \beta_c = \beta_y = \beta_u = 0$ $F_{.05}(6, 97)=2.22$	3.82**	4.16**
Joint tax effect: $\beta_s \overline{\tau_s} + \beta_p \overline{\tau_p} + \beta_k \overline{\tau_k} + \beta_c \overline{\tau_c} + \beta_y \overline{\tau_y} + \beta_u \overline{\tau_u} = 0$	-0.45** (2.19)	-0.46** (2.30)
Wage tax neutrality: $\beta_y = \beta_u = 0$, $F_{.05}(2, 101)=3.12$	2.26	2.57*

Notes: t-statistics are reported in parentheses and elasticities in brackets. Standard errors corrected for clustering on 103 state borders. Regressions include covariate controls for energy cost, fraction of the population with a high school degree, manufacturing as a share of GSP, state union density, and population density along with dummy variables for each state and year.

Table 4: Average estimated effect of state marginal tax rates on state labor productivity in log points and percent of average productivity, 1981 – 2015

Tax Type:	Mean	Tax Effect
Personal Income	5.24	-0.015
Property	1.72	-0.031
Sales	4.70	-0.050
Corporate Income	6.60	-0.063
Capital Gains	4.69	-0.009
Unemployment Insurance	2.23	0.016
Sum		-0.152

Estimates based on column 4 estimates in Table 1. Tax effect is the average estimated tax effects at each data point.

Table 5: Estimated productivity effect of state tax structures for the contiguous 48 states, 1981 and 2015

	Estimated Tax Structure Effects in 1981			Estimated Tax Structure Effects in 2015		
State	Summed tax effect	Rank, Tax Effect	Tax Effect relative to Government Expenditure	Summed tax effect	Rank, Tax Effect	Tax Effect relative to Government Expenditure
Alabama	-0.105	11	-24.7%	-0.126	14	-10.7%
Arizona	-0.168	35	-18.7%	-0.159	25	-11.5%
Arkansas	-0.124	21	-28.7%	-0.172	33	-10.7%
California	-0.198	40	-15.2%	-0.248	48	-7.0%
Colorado	-0.095	8	-20.5%	-0.099	7	-10.0%
Connecticut	-0.202	43	-20.1%	-0.216	45	-7.4%
Delaware	-0.174	37	-17.0%	-0.123	13	-8.1%
Florida	-0.113	13	-25.2%	-0.145	18	-11.1%
Georgia	-0.138	30	-23.0%	-0.155	23	-11.6%
Idaho	-0.120	19	-25.3%	-0.171	32	-12.6%
Illinois	-0.155	31	-18.5%	-0.160	28	-9.0%
Indiana	-0.165	33	-24.7%	-0.202	40	-10.6%
Iowa	-0.171	36	-19.7%	-0.228	46	-8.3%
Kansas	-0.097	9	-21.3%	-0.139	17	-9.7%
Kentucky	-0.117	17	-24.3%	-0.159	24	-9.8%
Louisiana	-0.127	25	-20.7%	-0.160	27	-8.6%
Maine	-0.185	39	-21.9%	-0.208	43	-9.0%
Maryland	-0.176	38	-18.5%	-0.203	41	-8.3%
Massachusetts	-0.244	48	-15.8%	-0.176	34	-7.5%
Michigan	-0.135	29	-17.6%	-0.192	38	-9.9%
Minnesota	-0.210	45	-16.1%	-0.208	44	-8.3%
Mississippi	-0.113	12	-25.0%	-0.165	30	-9.7%
Missouri	-0.114	15	-25.9%	-0.139	16	-10.7%
Montana	-0.084	6	-20.5%	-0.086	5	-10.4%
Nebraska	-0.134	28	-16.5%	-0.198	39	-8.3%
Nevada	-0.049	2	-19.2%	-0.075	4	-12.0%
New Hampshire	-0.114	14	-25.0%	-0.113	9	-10.9%
New Jersey	-0.225	47	-17.5%	-0.234	47	-7.4%

Table 5: Estimated productivity effect of state tax structures for the contiguous 48 states, 1981 and 2015 (continued)

State	Estimated Tax Structure Effects in 1981			Estimated Tax Structure Effects in 2015		
	Summed tax effect	Rank, Tax Effect	Tax Effect relative to Government Expenditure	Summed tax effect	Rank, Tax Effect	Tax Effect relative to Government Expenditure
New Mexico	-0.132	27	-20.1%	-0.148	19	-9.0%
New York	-0.207	44	-13.7%	-0.151	20	-6.0%
North Carolina	-0.124	20	-25.3%	-0.131	15	-10.4%
North Dakota	-0.118	18	-20.2%	-0.089	6	-8.3%
Ohio	-0.167	34	-20.7%	-0.114	10	-9.8%
Oklahoma	-0.093	7	-24.2%	-0.155	22	-11.4%
Oregon	-0.126	24	-17.3%	-0.120	11	-9.2%
Pennsylvania	-0.202	42	-19.9%	-0.187	36	-8.5%
Rhode Island	-0.214	46	-17.9%	-0.181	35	-8.2%
South Carolina	-0.128	26	-24.0%	-0.166	31	-10.2%
South Dakota	-0.055	4	-22.8%	-0.048	2	-12.1%
Tennessee	-0.125	22	-21.1%	-0.160	29	-10.6%
Texas	-0.078	5	-26.1%	-0.104	8	-11.4%
Utah	-0.103	10	-21.4%	-0.122	12	-10.7%
Vermont	-0.165	32	-20.1%	-0.207	42	-7.8%
Virginia	-0.115	16	-23.7%	-0.154	21	-10.5%
Washington	-0.055	3	-15.1%	-0.059	3	-9.2%
West Virginia	-0.125	23	-22.2%	-0.159	26	-10.3%
Wisconsin	-0.199	41	-17.8%	-0.191	37	-8.9%
Wyoming	-0.035	1	-15.3%	-0.028	1	-6.8%
Average	**-0.138**		**-20.7%**	**-0.153**		**-9.8%**

Ranking based on the estimated joint effect of tax rates on state labor productivity using the specification in column 3 of Table 3. The joint test that the summed tax effects differ across states was F(47, 1704) = 1080 which rejected the null of a common effect at the .001 level of significance. The average estimated state effects were significantly different from zero in all states.

Appendix I: Data Definitions (not for inclusion)

The following data was collected for each of the 48 contiguous states of the United States from 1977 through 2015.

1. Dependent Variables: All compiled from the U.S. Department of Commerce, Bureau of Economic Analysis *Regional Economic Accounts* https://www.bea.gov/regional/index.htm

Log Productivity: log(Real Gross State Product/Job)

Real Gross State Product (GSP) *Real GDP 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.

Jobs. *SA4 Personal Income and Employment by Major Component*

Number of full-time and part time jobs in the state. Wage and salary jobs and proprietors' jobs are counted, but unpaid family workers and volunteers are not. Proprietors' employment consists of the number of sole proprietorships and the number of general partners. Wage and salary employment is on a place-of-work basis. Proprietors' employment, however, is more nearly by place of residence because, for nonfarm sole proprietorships, the estimates are based on IRS tax data that reflect the addresses from which the proprietors' individual tax returns are filed, which are usually the proprietors' residences.

Log Real per capita income: log(Personal Income/Population)

Per capita personal income is calculated as the personal income of the residents of a given area divided by the resident population of that area.

Personal income *SA1 - Personal Income Summary: Personal Income, Population, Per Capita Personal Income*

includes income from provision of labor, land, and capital used in current production as well as other income, such as personal current transfer receipts. In the state and local personal income accounts the personal income of an area represents the income received by or on behalf of the persons residing in that area. It is calculated as the sum of wages and salaries, supplements to wages and salaries, proprietors' income with inventory valuation and capital consumption adjustments, rental income of persons with capital consumption adjustment, personal dividend income, personal interest income, and personal current transfer receipts, less contributions for government social insurance plus the adjustment for residence. This is converted into 1999 chained dollars.

Population *SA1 - Personal Income Summary: Personal Income, Population, Per Capita Personal Income* The number of civilian and military individuals who reside in a given area.

Log Real Wage per Job Average compensation per job is compensation of employees divided by total full-time and part-time wage and salary employment.

Wages and salaries *SA4 Personal Income and Employment by Major Component*

Broadly defined to include commissions, tips, and bonuses; voluntary employee contributions to deferred compensation plans, such as 401(k) plans; employee gains from exercising stock options; and receipts-in-kind that represent income. Supplements to wages and salaries consist of employer contributions for employee pension and insurance funds (previously called other labor income) and employer contributions for government social insurance. Supplements accounted for 18.9 percent of compensation at the national level. These are converted into 1999 chained constant dollars

Wage and salary employment *SA4 Personal Income and Employment by Major Component* The average annual number of full-time and part-time jobs in each area by place of work. The measure is based on the same source data as the corresponding earnings estimates and are prepared with parallel methodologies. All jobs for which wages and salaries are paid are counted. Although compensation paid to jurors, expert legal witnesses, prisoners, and justices of the peace (for marriage fees), is counted in wages and salaries, these activities are not counted as jobs in wage and salary employment. Corporate directorships are counted as self-employment.

County Data

Log Real per capita income: log(Personal Income/Population) same definitions as above except the county area data is used. Data is from *CA4 Personal Income and Employment by Major Component*

2. Independent Variables

2A. Marginal Tax Rates:

Income Tax Rate Feenberg, Daniel Richard, and Elizabeth Coutts. 1993. "An Introduction to the TAXSIM Model." *Journal of Policy Analysis and Management* 12(1): 189-194.

Capital Gains Tax Rate Feenberg, Daniel Richard, and Elizabeth Coutts. 1993. "An Introduction to the TAXSIM Model." *Journal of Policy Analysis and Management* 12(1): 189-194.

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, Department of Finance and Revenue, *Tax Rates and Tax Burdens in the District of Columbia: A Nationwide Comparison,* Various years.

Sales Tax Rate The highest state retail sales tax rate ignoring exemptions or rebates. This is reported annually in Council of State Governments. *The Book of the States.* Lexington, KY.

Corporate Tax Rate The highest state corporate tax rate ignoring exemptions or rebates. This is reported annually in Council of State Governments. *The Book of the States.* Lexington, KY.

Unemployment Insurance Tax Rate The top marginal unemployment insurance tax rates for each state were provided us by Robert Pavosevich of the U.S. Department of Labor. There are two components to the rate, the top marginal rate $\tau_{u,it}^{max}$, and the maximum wage level to which the rate is applied, W_{it}^{max}. We normalize that maximum wage by the average compensation per job in the state, $\overline{W_{it}}$, as defined above using data from the Bureau of Economic Analysis *SA4 Personal Income and Employment by Major Component*. These terms are combined into a single rate $\tau_{u,it} = \frac{\tau_{u,it}^{max} \cdot W_{it}^{max}}{\overline{W_{it}}}$.

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.
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www.unionstats.com

Hirsch, Barry T. and David A. Macpherson. 2003. "Union Membership and Coverage Database from the Current Population Survey: Note," *Industrial and Labor Relations Review* 56(2): 349-354.

Barry T. Hirsch, David A. Macpherson, and Wayne G. Vroman. *State Union Membership Density, 1964-2017* www.unionstats.com

Barry T. Hirsch, David A. Macpherson, and Wayne G. Vroman, "Estimates of Union Density by State," Monthly Labor Review, Vol. 124, No. 7, July 2001, pp. 51-55.

Manufacturing Share *Real GDP 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.

Appendix Table IA: Descriptive statistics for key variables from 1981-2015 (not for inclusion)

Variable	Mean	Std. Dev.	Minimum	Maximum
Income Tax	5.24	3.1	0%	14.1
Property Tax	1.71	0.83	0.30	7.87
Sales & Excise Tax	4.7	1.8	0	8.25
Corporate Tax	6.6	2.9	0	13.8
Capital Gains Tax	4.69	3.0	0	14.1
Unemployment Insurance Tax	2.22	1.1	0.04	17.6
Percent with High School Diploma	80.4	7.8	48.1	93.1
Ln Real Energy Prices	2.41	0.42	1.61	3.38
Percent Union Membership	13.1	6. 29	2.0	38.3
Ln Population Density	4.45	1.30	1.54	7.11
Proportion of GSP in Manufacturing	0.16	0.07	0.03	0.35

Appendix II. Derivation of the reduced form for labor productivity (not for inclusion)

There are four alternative taxes:
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.

The representative household

The household's preferences are given by

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

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 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 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

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

where δ represents the capital depreciation rate.

The household chooses c_t, l_t, and k_{t+1}, for each t, to maximize its present discounted utility. The Lagrangian of the problem can be written as

$$\Psi = \sum_{t=0}^{\infty} B^t[\alpha ln c_t + (1-\alpha)\ln(1-l_t)] + \sum_{t=0}^{\infty} B^t \lambda_t[(1-\tau_w)w_t l_t + (1-\tau_k)r_t k_t + (1-\delta-\tau_p)k_t + G_t - c_t - k_{t+1}];$$

with first order conditions:

$$\frac{\alpha}{c_t} = \lambda_t$$
$$\frac{1-\alpha}{1-l_t} = \lambda_t(1-\tau_w)w_t$$
$$r_t = \frac{B^{-1}-1+\delta+\tau_p}{1-\tau_k}$$

The first condition equates marginal utility of consumption to the marginal utility of income. When we combine the first two conditions, we get the standard condition (5a) in the text relating the marginal rate of substitution between consumption and leisure to their relative prices:

$$\frac{(1-\alpha)c_t}{\alpha(1-l_t)} = (1-\tau_W)w_t$$

The last first-order condition (5B in the text) is the Euler equation that fixes growth of capital in steady state. Note that if the tax rates don't change, and with fixed depreciation and discount rates, the pretax return on capital is fixed over time.

The representative firm

The representative firm hires labor and capital stock in order to produce output according to the CES production function,

$$y_t = A\left[\theta k_t^{1-\frac{1}{\varepsilon}} + (1-\theta) l_t^{1-\frac{1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}$$

where ε is the elasticity of substitution between capital and labor. The firm's profit maximization problem is to select k_t and l_t to maximize profit

$$\Pi_t = \left\{(1-\tau_s)A\left[\theta k_t^{1-\frac{1}{\varepsilon}} + (1-\theta) l_t^{1-\frac{1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}} - w_t l_t - r_t k_t\right\}$$

which yields the first order conditions

$$r_t = (1-\tau_s)A\left[\theta k_t^{1-\frac{1}{\varepsilon}} + (1-\theta)l_t^{1-\frac{1}{\varepsilon}}\right]^{\frac{1}{\varepsilon-1}} \theta k_t^{-\frac{1}{\varepsilon}}$$

$$w_t = (1-\tau_s)A\left[\theta k_t^{1-\frac{1}{\varepsilon}} + (1-\theta)l_t^{1-\frac{1}{\varepsilon}}\right]^{\frac{1}{\varepsilon-1}} (1-\theta)l_t^{-\frac{1}{\varepsilon}}$$

Combining the first order conditions yields the optimal capital labor ratio (8) in the text:

$$\frac{k_t}{l_t} = \left(\frac{\theta}{(1-\theta)}\frac{w_t}{r_t}\right)^{\varepsilon}$$

The government

The government collects all four taxes and rebates all revenues back to the household in the form of a lump sum rebate,

$$G_t = \tau_w w_t l_t + \tau_s y_t + \tau_p k_t + \tau_k r_t k_t$$

Equilibrium

Notice first from (5B) that r_t is solely dependent on τ_p and τ_k. State tax policy therefore fixes the before tax return on capital. The rental value of labor w_t is derived by inserting (A3) into (A2). We get

$$w_t = (1-\theta)(1-\tau_s)A\left[\theta\left(\frac{k_t}{l_t}\right)^{1-\frac{1}{\varepsilon}} + (1-\theta)\right]^{\frac{1}{\varepsilon-1}}$$

$$= (1-\theta)(1-\tau_s)A\left[\theta\left(\left[\left(\frac{\theta}{1-\theta}\right)\frac{w_t}{r_t}\right]^{\varepsilon}\right)^{1-\frac{1}{\varepsilon}} + (1-\theta)\right]^{\frac{1}{\varepsilon-1}}$$

Solving for w_t yields the equilibrium condition for the wage level (10) in the text,

$$w_t = \left[\frac{(1-\theta)^{\varepsilon}}{\left([(1-\tau_s)A]^{1-\varepsilon} - \frac{\theta^{\varepsilon}}{r_t^{\varepsilon-1}}\right)}\right]^{\frac{1}{\varepsilon-1}}$$

Appendix Table 2: Presence or Absence of State Tax by Type of Tax, 1977-2015 (not for inclusion)

State	Income Tax	Property Tax	Sales & Excise	Corporate Profits	Capital Gains Tax	Workers Comp Tax	Unemployment Insurance
Alabama	√	√	√	√	√	√	√
Arizona	√	√	√	√	√	√	√
Arkansas	√	√	√	√	√	√	√
California	√	√	√	√	√	√	√
Colorado	√	√	√	√	√	√	√
Connecticut	**Post 1990**	√	√	√	√	√	√
Delaware	√	√	√	√	√	√	√
Florida	**0**	√	√	√	**0**	√	√
Georgia	√	√	√	√	√	√	√
Idaho	√	√	√	√	√	√	√
Illinois	√	√	√	√	√	√	√
Indiana	√	√	√	√	√	√	√
Iowa	√	√	√	√	√	√	√
Kansas	√	√	√	√	√	√	√
Kentucky	√	√	√	√	√	√	√
Louisiana	√	√	√	√	√	√	√
Maine	√	√	√	√	√	√	√
Maryland	√	√	√	√	√	√	√
Massachusetts	√	√	√	√	√	√	√
Michigan	√	√	√	√	√	√	√
Minnesota	√	√	√	√	√	√	√
Mississippi	√	√	√	√	√	√	√
Missouri	√	√	√	√	√	√	√
Montana	√	√	√	√	√	√	√
Nebraska	√	√	√	√	√	√	√
Nevada	**0**	√	√	**0**	**0**	√	√
New Hampshire	**0**	√	√	√	**0**	√	√
New Jersey	√	√	√	√	√	√	√
New Mexico	√	√	√	√	√	√	√
New York	√	√	√	√	√	√	√
North Carolina	√	√	√	√	√	√	√
North Dakota	√	√	√	√	√	√	√
Ohio	√	√	√	√	√	√	√
Oklahoma	√	√	√	√	√	√	√
Oregon	√	√	√	√	√	√	√
Pennsylvania	√	√	√	√	√	√	√
Rhode Island	√	√	√	√	√	√	√
South Carolina	√	√	√	√	√	√	√
South Dakota	**0**	√	√	**0**	**0**	√	√
Tennessee	**0**	√	√	√	**0**	√	√
Texas	**0**	√	√	**0**	**0**	√	√
Utah	√	√	√	√	√	√	√
Vermont	√	√	√	√	√	√	√
Virginia	√	√	√	√	√	√	√
Washington	**0**	√	√	**0**	**0**	√	√
West Virginia	√	√	√	√	√	√	√
Wisconsin	√	√	√	√	√	√	√
Wyoming	**0**	√	√	**0**	**0**	√	√

√: Continuous presence of the tax since 1977. 0: The state never imposed the tax

Appendix Table 3: State Marginal Tax Rates in 1981 and 2015 by Tax Type (not for inclusion)

State	Income Tax		Capital Gains Tax		Sales Tax		Corporate Income Tax		Unemployment Insurance Tax		Property Tax	
	1981	2015	1981	2015	1981	2015	1981	2015	1981	2015	1981	2015
Alabama	2.56	3.02	3.77	3.83	4	4	5	6.5	1.63	1.05	0.69	0.73
Arizona	4.17	4.34	1.14	4.34	4	5.6	10.5	6.5	0.96	0.92	0.98	1.31
Arkansas	7	7	5.6	3.85	3	6.5	6	6.5	2.12	1.60	1.09	1.4
California	11	14.1	7.15	14.1	4.75	7.5	9.6	8.84	1.24	0.57	1.1	1.14
Colorado	3.48	4.77	0.95	4.77	3	2.9	5	4.63	1.45	1.47	0.76	0.66
Connecticut	0	6.99	2.8	6.99	7.25	6.35	10	7.5	2.19	1.29	2.25	2.95
Delaware	13.5	6.8	5.4	6.8	0	0	8.7	8.7	2.55	2.29	3.34	1.32
Florida	0	0	0	0	4	6	5	5.5	1.66	0.65	1.96	1.85
Georgia	6	6.18	2.4	6.18	3	4	6	6	2.04	0.83	2.32	1.78
Idaho	7.5	7.49	3	7.49	3	6	6.5	7.4	3.29	3.93	1.23	1.63
Illinois	2.5	3.75	2.5	3.75	4	6.25	6.675	7.75	1.94	1.51	2.83	0.68
Indiana	1.9	3.3	0.76	3.3	4	7	6	7	1.21	1.30	3.74	3.03
Iowa	6.95	5.64	1.92	7.1	3	6	10	12	3.17	3.82	2.34	2.65
Kansas	4.71	4.67	1.29	4.67	3	6.15	4.5	4	1.42	1.58	0.93	1.38
Kentucky	3.09	6.18	0.84	6.18	5	6	5.9	6	3.53	1.83	1.23	1.18
Louisiana	2.91	3.6	0.79	4.74	3	4	8	8	1.10	0.83	0.94	1.52
Maine	10	7.95	4	7.95	5	5.5	6.93	8.93	1.98	1.54	2.44	2.06
Maryland	5	5.83	2	5.83	5	6	7	8.25	1.82	1.05	2.82	2.25
Massachusetts	5.38	5.15	6.45	5.15	5	6.25	9.4962	8	2.24	2.10	4.96	1.31
Michigan	4.6	4.25	1.84	4.25	4	6	2.35	6	2.44	1.61	3.94	3.46
Minnesota	8.7	10.15	3.47	10.15	4.5	6.88	12	9.8	3.53	4.28	2.28	1.31
Mississippi	3.85	5.07	3.85	5.07	5	7	4	5	1.69	1.63	0.86	1.72
Missouri	2.91	6.08	0.79	6.08	3.125	4.23	5	6.25	1.95	2.19	2.08	1.16
Montana	5.82	7.11	1.6	5.11	0	0	6.75	6.75	2.12	3.59	0.84	0.92
Nebraska	9.39	7.02	3.76	7.02	3	5.5	4.4	7.81	1.22	0.89	1.95	2.1
Nevada	0	0	0	0	4.375	6.85	0	0	1.76	2.53	0.83	1.15

Appendix Table 3: State Marginal Tax Rates in 1981 and 2015 by Tax Type (continued)

	Income Tax		Capital Gains Tax		Sales Tax		Corporate Income Tax		Unemployment Insurance Tax		Property Tax	
State	**1981**	**2015**	**1981**	**2015**	**1981**	**2015**	**1981**	**2015**	**1981**	**2015**	**1981**	**2015**
New Hampshire	0	0	0	0	0	0	8.54	8.5	2.46	1.31	2.78	2.31
New Jersey	2.5	8.97	2.5	8.97	5	7	8.25	9	2.61	2.95	5.56	2.9
New Mexico	6.28	5.05	2.51	2.6	3.625	5.13	5.5	6.9	2.08	2.73	1.83	1.57
New York	12.5	6.89	8.07	6.89	4	4	10	7.1	1.53	1.12	1.6	0.86
North Carolina	7	5.75	7	5.75	3	4.75	6	5	2.27	2.13	1	1.16
North Dakota	2.44	2.9	0.98	1.78	3	5	7.75	4.53	2.86	5.70	1.33	1.24
Ohio	3.33	5	1.33	5	4.5	5.75	8.35	0	1.46	1.29	2.12	2.15
Oklahoma	6	5.14	2.4	0.15	2	4.5	4	6	1.07	1.67	1.08	2.62
Oregon	10	9.99	4	9.99	0	0	7.5	7.6	2.26	3.18	1.86	1.26
Pennsylvania	2.2	3.07	2.2	3.07	6	6	10.5	9.99	2.31	1.52	2.43	1.34
Rhode Island	8.78	5.99	4.57	5.99	6	7	8	7	3.21	3.25	3.52	1.93
South Carolina	7	7.08	3.5	4.02	4	6	6	5	1.63	1.57	0.71	2.11
South Dakota	0	0	0	0	4	4	0	0	2.85	2.86	1.86	1.48
Tennessee	0	0	0	0	4.5	7	6	6.5	1.56	1.60	1.74	1.95
Texas	0	0	0	0	4	6.25	0	0	1.28	1.04	2.52	2.54
Utah	4.03	5	1.1	5	4	5.95	4	5	1.89	4.06	1.25	0.93
Vermont	13.71	8.8	5.48	8.8	3	6	7.5	8.5	2.47	2.53	1.6	2.15
Virginia	5.75	5.83	2.3	5.83	3	5.3	6	6	2.26	0.76	1.17	0.99
Washington	0	0	0	0	5	6.5	0	0	1.62	3.51	0.76	0.88
West Virginia	8.76	6.5	3.5	6.5	3.5	6	6	6.5	2.51	1.74	0.93	0.84
Wisconsin	10	7.65	10	5.36	4	5	7.9	7.9	2.45	2.91	2.84	2.85
Wyoming	0	0	0	0	3	4	0	0	1.08	4.09	0.63	0.84
Average	**5.07**	**5.13**	**2.70**	**4.80**	**3.67**	**5.20**	**6.23**	**6.18**	**2.04**	**2.09**	**1.91**	**1.66**

Appendix Table 4: Estimated effect of tax structure on the log GSP per worker by state, 1981 – 2015 (not for inclusion)

	1A	1B	2A	2B	3A	3B	4A	4B	5	6
Lag: Δ=	**0**	0	1	1	2	2	3	3	3	3
Tax										
Income:	-0.125 (0.80)	-0.272 (0.95)	-0,223 (0.66)	-0.138 (0.46)	-0.288 (0.90)	-0.228 (0.76)	-0.307 (0.94)	-0.291 (0.88)	-0.431 (1.26)	-0.353 (1.06)
Property:	-2.667** (3.53)	-2.414** (3.33)	-2.30** (3.21)	-2.237** (2.91	-2.01** (2.62)	-1.836** (2.16)	-1.751 (2.75)	-1.792** (2.68)	-1.726** (2.63)	-1.443** (2.21)
Sales:	-1.56 (1.61)	-1.399 (1.63)	-1.456 (1.62)	-1.306 (1.46)	-1.457 (1.59)	-1.374 (1.48)	-1.149 (1.38)	-1.058 (1.23)	-0.932 (1.12)	-0.934 (1.14)
Corporate:	-1.140** (2.15)	-0.979** (2.13)	-1.111** (2.09)	-0.930* (1.74)	-0.942* (1.81)	-0.758 (1.38)	-1.036* (1.86)	-0.958* (1.68)	-0.981* (1.77)	-0.873* (1.8)
Capital Gains:	-0.300 (1.15)	-0.184 (0.26)	-0.272 (1.17)	-0.184 (0.88)	-0.283 (1.22)	-0.212 (1.02)	-0.208 (0.89)	-0.188 (0.88)	-0.145 (0.68)	-0.134 (0.65)
Unemployment Insurance:	0.080 (0.18)	0.206 (0.49)	0.267 (0.54)	0.31 (0.69)	0.664 (1.59)	0.643 (1.62)	0.892 (1.00)	0.718 (0.78)	0.747 (0.82)	0.813 (0.91)
Log government expenditures per capita									0.128** (2.16)	
Log infrastructure expenditures per capita										0.063** (2.99)
Log transfer payments per capita										0.001 (0.04)
Log other government expenditures per capita										.025 (0.53)
ln(energy price)		0.088 (1.24)		0.069 (1.03)		.029 (0.44)		.062 (1.16)	0.045 (0.91)	0.036 (0.79)

Appendix Table 4: Estimated effect of tax structure on the log GSP per worker by state, 1981 – 2015 (continued)										
	1A	1B	2A	2B	3A	3B	4A	4B	5	6
Lag: Δ=	**0**	0	1	1	2	2	3	3	3	3
Proportion High School Plus		0.028 (0.20)		-0.032 (0.24)		-0.094 (0.57)		-0.107 (0.64)	-0.200 (1.26)	-0.173 (1.12)
Proportion Manufacturing		-0.422* (1.77)		-0.308 (1.32)		-.240 (1.01)		-.046 (0.19)	0.003 (0.01)	-0.023 (0.10)
Proportion Union Density		0.567** (3.14)		0.541** (3.12)		0.431** (2.87)		0.432** (2.34)	0.378** (2.12)	0.409 (2.37)
ln(Population Density)		0.110* (1.75)		0.077 (1.25)		0.053 (0.41)		0.020 (0.30)	.037 (0.56)	0.039 (0.58)
Joint tax effect	-0.21** (3.99)	-0.19** (3.50)	-0.20** (3.84)	-0.17** (3.03)	-0.17** (3.49)	-0.15** (2.58)	-0.16** (3.35)	-0.15** (2.77)	-0.15** (2.76)	-0.13** (2.54)
Observations	1632	1632	1632	1632	816	816	528	528	528	528
R-squared	0.91	0.93	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93