The Poverty of States: Do State Tax Policies Affect State Labor Productivity?

Joseph E. McPhail, Peter Orazem, Rajesh Singh

Working Paper No. 10010
May 2010

IOWA STATE UNIVERSITY
Department of Economics
Ames, Iowa, 50011-1070

The Poverty of States: Do State Tax Policies Affect State Labor Productivity?

Joseph E. McPhail
PwC

Peter F. Orazem
Iowa State University

Rajesh Singh
Iowa State University

July 2012

ABSTRACT

There are substantial differences in output per worker across states that have persisted over time. This study demonstrates that in the context of a neoclassical growth model, differences in marginal tax rates on income from capital investment, capital ownership, and consumption will lead to persistent differences in labor productivity across states. These theoretical predictions are supported, using data on state marginal tax rates and output per worker over the 1977-2008 sample period. Over that period, the mix of state tax policies has led to a reduction in labor productivity averaging almost 2.8% per year. The implied adverse effect of tax distortions on labor productivity across states is substantial, varying from -1.6% in Nevada to -3.9% in New York. On the other hand, government expenditure policies explain none of the variation in labor productivity across states or time. Results allow rankings of state tax structures by their adverse impacts on productivity and by their efficiency at raising revenue relative to lost productivity.

Key Words: Labor productivity, sales tax, property tax, income tax, corporate tax, capital gains tax, workers' compensation, unemployment insurance, growth, efficiency

JEL Classification: H2, H3, H7

Correponding author: Peter F. Orazem, Department of Economics, Iowa State University, Ames IA 50011-1070, Tel.: +1 515 294 8656, fax: +1 515 294 0221, E-mail address: pfo@iastate.edu
We thank Brent Kreider and Lihong Lu McPhail Stephen Woodbury for comments and suggestions. We are very grateful for the help we received from Art Hall, Craig Langley, Robert Pavosevich Wayne Vroman and Pete Zimmerman in locating consistent time series on state and local marginal tax rates and government expenditures.

I. Introduction

There are large differences in labor productivity across states. Output per worker in Delaware averages $82 thousand per job, 78% larger than output per worker in Montana. Despite presumed free flow of labor and capital across states, large productivity gaps have persisted over the past thirty years. One likely source of the gap is variation in capital per worker across states. Capital investments and technological innovation have played a major role in the growth of labor productivity in the U.S. economy over this period (Jorgenson, Ho and Stiroh, 2005). Differences in capital investment 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).

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, there are lower levels of labor productivity in states that rely on the most distortionary tax policies compared to states with more favorable tax policies. High marginal state tax rates on corporate income, property, and capital gains prove the most damaging to labor productivity while the least damaging are taxes on wage income. Meanwhile, labor productivity is unaffected by a state's per capita government expenditures.

Our study builds on a large literature that explores the dramatic differences in labor productivity across countries.[1] As emphasized in Chari, Kehoe and McGrattan's (1997) study, *The Poverty of Nations*, labor productivity drives a country's per capita income levels. A consistent explanation across numerous studies has been that the differences in productivity or

---

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

per capita income has been driven by variation in the shares of physical and human capital in production. Less clear is the source of the variation in capital intensity across countries. Chari, Kehoe and McGrattan (1997) and Chari and Kehoe (2006) claimed that low investment was driven by distortions in the return to capital driven by taxes, consistent with McGrattan and Prescott's (2005) finding that variation in tax and regulatory policies in the U.S. and the U.K. can explain large differences in the value of corporate equity across countries and time. However, Levine and Renelt (1992) found that capital investment in a large sample of countries was unresponsive to fiscal policies. Hall and Jones (1999) argued that poor government institutions and restrictions on trade led to slow capital accumulation. Acemoglu and Johnson (2005) link weak protection of property rights with low investment rates. Sachs (2005) asserts that poor countries cannot save or invest because they are not able to produce enough for subsistence consumption needs. Hsieh and Klenow (2007) find that the lower investment rates in developing countries were a result of their very low prices of consumer goods relative to investment goods. In short, the case that tax distortions are the root source of low capital investment rates in developing countries is subject to considerable debate.

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.[2] The availability of multiple state observations per year also allows us to control for common macroeconomic shocks that could also complicate identification of tax effects.

---

[2] 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.

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) or on investment incentives for domestic firms relative to foreign firms who can claim tax credits (Hines, 1996). Nevertheless, Waslyenko's (1997) review suggests that the magnitude and significance of the effects appears to be sensitive to changes in sample or specification. More recent studies report mixed signs of taxes on measures of productivity or investment depending on the type of tax (Mark, McGuire and Papke, 2000), the level of the tax (Bania, Gray, and Stone, 2007) or the size of the government sector relative to the private sector (Brown, Hayes and Taylor, 2003).

These uneven results are surprising given the theoretical consensus that high marginal tax rates are particularly damaging to capital investment.[3] 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 worker: 1) We use marginal rather than average tax rates; 2) We incorporate full menu of 7 tax types rather than a subset of tax instruments; and 3) We do not incorporate endogenous employment or capital as regressors. As our empirical work demonstrates, regardless of time frame or specification, higher state marginal tax rates lower labor productivity, consistent with the presumed greater distortionary effects of high marginal tax rates on input prices, output prices and returns to capital.

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 the predicted

[3] See the review by Mankiw, Weinzierl and Yagan (2009).

negative relationship between distortionary taxes and labor productivity is found in the data. We then generate an aggregate index of the relative efficiency of state tax structures.

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

Labor productivity differs substantially across states, these differences persist over time, and they represent a significant share of state growth.[4] On the other hand, growth in labor productivity is not persistent across time. These facts suggest that to evaluate labor productivity differences across states, one should focus on levels rather than differences in growth rates of output per worker. 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.

State growth patterns are usefully described using a shift share analysis of Bureau of Economic Analysis data. In every year *t* since 1977 and for every state *i*, we have data on Gross State Product (Q_{it}), and number of workers by state (L_{it}). We can represent Q_{it} as the product of the number of workers and the average product of labor, $\frac{Q_{it}}{L_{it}}$.[5]

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

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

[4] Our empirical work relies on observed average product as our measure of labor productivity rather than the theoretically appropriate marginal product of labor. In the range where firms are maximizing profits, marginal and average products are positively correlated and so changes in average products should be in the same direction as changes in marginal products.

[5] State output per worker has numbers of workers and not hours in the denominator. Bauer and Lee (2006) showed that per worker and per hour measures of labor productivity have similar long-run trends, especially if the long trend toward fewer hours per worker is accommodated in the econometric work.

Equation (2) is a shift-share characterization of state economic growth. 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.

Between 1977 and 2008, real state GSP in the 48 contiguous states reported in Table 1 grew an average of 90% or about 2.1% per year. Growth in labor productivity is responsible for 37% of GSP growth, while increases in employment explain the remaining 63%. However, states vary considerably in GSP growth, from a low of 34% in Michigan, to a high of 179% in Nevada. States also differ greatly in the relative importance of the two components. Nevada, Arizona and Florida grew the most overall, mainly because they rank in the top four in employment growth. None of those states ranks highly in productivity growth. Connecticut, Rhode Island and Massachusetts experienced the fastest productivity growth but finished in the middle third in GSP growth because they did not add many employees.

As shown in the last column of Table 1, there are large differences in labor productivity across states with Delaware's average output per worker exceeding Montana's by 78% over the 1977-2008 period. These gaps in labor productivity are quite persistent: the correlation in state labor productivity over the 32 years between 1977 and 2008 is 0.74. In contrast, the correlation in labor productivity growth rates over the period is just 0.07. In other words, there has been no reversion to a common mean labor productivity across states, implying lasting differences by state in output per worker.

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 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. Shortly after 1977, 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. [6] Consequently, should variation in state and local tax policies alter the incentives to invest in capital across states, those tax policies will also affect the levels of technology adoption and related labor productivity across states.[7]

III. 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 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.[8] We use an alternate strategy that avoids the problem of absent data on capital stocks by state. 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 sales, capital gains, corporate, and property taxes. Therefore, we can assess the implied effects of

---

[6] See Goldin and Katz (2008) and Autor, Katz and Kearney (2008).
[7] 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.
[8] Examples include Munnell (1990), Holtz-Eakin (1994), Crain and Lee (1999); Garofalo and Yamarik (2002); Brown, Hayes and Taylor (2003); and Reed (2008).

distortionary taxes on investments indirectly through their effects on output per worker 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 worker.

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.[9]

The representative household

[9] 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.

The household's preferences are given by

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

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

where δ represents the capital depreciation rate.

The first-order conditions are standard. 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.

The representative firm

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

The government

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

(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.

Equation (10) implies that the wage and the marginal product of labor will fall as the sales tax rate rises. From (5B), we know that the before-tax interest rate rises with the property tax rate and the capital income tax rate. As a consequence, 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). 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, leaving the marginal product of labor and hence wages unchanged.[11] 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.

All the remaining determinants of the equilibrium wage and the marginal product of labor in (10) are parameters that capture tastes and productivities: A, θ, and ε, and (indirectly through (5B)) δ, and B. If these taste and production parameters and the tax rates do not change over time, then the wage and labor productivity will not change. States with higher marginal tax rates on capital income, property values and sales will have permanently lower labor productivity than their neighbors with lower marginal tax rates.

[11] 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 seemless movement toward equilibrium, as reviewed by Shimer (2010).

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.

An additional implication of equation (10) is that the 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.

This proposed empirical assessment of tax effects incorporates several of the main conclusions regarding theoretical tax effects on economic outcomes as summarized by Mankiw, Weinzierl and Yagan (2009). In particular, 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 suggest that tests of the effects of tax and transfer policies on economic outcomes must consider marginal and not average tax rates and must distinguish between taxes on capital income versus taxes on other income sources or taxes on consumption.

IV. 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); 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. However, as implemented, state income taxes (τ_y) take a share of earnings from capital as well as labor and would not be a pure wage tax. Unemployment insurance (τ_u) and worker's compensation (τ_{wc}) tax rates are more closely tied to wages paid and should behave more like τ_w. Nevertheless, as applied, both taxes deviate from a pure wage tax because of the application of experience ratings, premium discounts, retrospective ratings, dividends and maximum taxes. Consequently, the taxes may still create distortions that would affect the equilibrium marginal product of labor. In addition, the neutrality prediction may not hold if the production function is not CES or if frictions retard the adjustment to equilibrium. Therefore, we incorporate all seven tax rates in our reduced form estimate of the impact of state tax policies on labor productivity and will examine whether wage taxes are indeed neutral in practice.

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

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

$$+\beta_{wc}\,\tau_{wc,it} + A_{it}^{'}\gamma + \mu_t + \eta_i + \epsilon_{it}.$$

We will test the predictions from the theory that $\beta_s < 0;\ \beta_p < 0;\ \beta_k < 0;\ \beta_c < 0$ and to the extent that they are wage taxes, that $\beta_y = \beta_u = \beta_{wc} = 0$. The dependent variable is the natural logarithm of output per worker. 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 and marginal products must be positively correlated in the range of labor inputs consistent with profit maximization.[12]

Specification (11) subscripts output per worker 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.[13] 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 Δ=1 is N, the sample size drops to at most $N/2$ at Δ=2; $N/3$ at Δ=3; and so on. We found little sensitivity of our conclusions to the magnitude of Δ although by

[12] 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.

[13] 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) and Reed (2008). 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). Studies using instrumental variables to evaluate the impact of government policies on per capita incomes such as Acemoglu and colleagues (2001, 2005) can only include one or two policy variables before they overtax the identification requirements.

Δ=5 when we have lost 80% of the sample, we lose precision and significance for several 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 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.[14] 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. If states set tax policies in response to these transitory state-specific productivity shocks, our coefficients will be biased. In fact, there is little evidence that states fine tune their tax policies to that extent. Instead, state tax policies are remarkably stable. Table 2 reports the presence or absence of each tax by state. Except for the income tax installed in Connecticut in 1991, no state either added or eliminated a tax over the 32 years we study.

The final concern is that we should include other plausible sources of variation in labor productivity to avoid missing variables bias. The equilibrium level of labor productivity (10) varies by the Hicks neutral technology parameter A; productivity parameters θ and ε; the household rate of discount, B; and the depreciation rate, δ. That suggests that we should control for observable factors that might be expected to shift either productivity or tastes. We include the factors identified in Crain and Lee's (1999) survey as explaining Gross State Product or growth rates across states. In addition, we add government expenditures into the vector A_{it} to relax the assumption that the government expenditures are pure public goods that do not affect

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

labor productivity. Our conclusions regarding the direction or significance of the impact of tax rates on labor productivity are not sensitive to the inclusion or exclusion of these factors.

V. Data

The sample is dictated by the availability of data on labor productivity and state tax rates. Our measure of output per worker is Gross State Product, as reported by the Bureau of Economic Analysis (BEA), divided by the BEA estimate of the number of workers in the state. Ideally we would have hours of work, but that data is not available by state. We use the data for the 48 contiguous states available annually from 1977 through 2008.[15]

Our specification requires measures of state marginal tax rates and not average tax rates. Marginal tax rates are closer to 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. The income and capital gains tax rates are tied together through the individual tax form and the tax rates on income and capital gains are highly correlated, and so we will also test whether these taxes have independent effects on labor productivity.

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

[15] We focus on the 48 contiguous states assuming that they would have freer flows of capital, labor and goods that drive our equilibrium relationship between taxes and labor productivity. Alaska is even more unique in its heavy reliance on oil royalties rather than taxes to fund government.

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.

The property tax rate was calculated from household level data provided by IPUMS for all single family detached residential homes. IPUMS reports the average property tax paid and the average home value, allowing a direct estimate of the property tax rate in each state. The IPUMS data on property taxes paid only goes back to 1990. For prior years, the U.S. Bureau of the Census reports total property tax revenue and total value of state housing units from which we compute an average state property tax rate for each year. We backcasted property tax rates from 1990 using changes in the average property tax rates by state for 1977-1989 as instruments.

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 wage per job in the state, $\overline{W_{it}}$. These terms are combined into a single rate $\tau_{u,it} = \frac{\tau_{u,it}^{max} \cdot W_{it}^{max}}{\overline{W_{it}}}$.

Worker's compensation tax rates are based on two sources. Thomason et al (2001) provide adjusted manual rates between 1977 and 1995, reported as the tax rate per $100 of wages paid. From 1994 on, the Oregon Department of Consumer and Business Services provides a similar series. Because the two series overlap, we are able to generate a smoothed time series for each state.

Crain and Lee's (1999) survey identifies 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. The log of energy costs per million BTU is provided by year and state from 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 represented by the manufacturing share of Gross State Product 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 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 A_{it} in that we exclude measures of the capital stock and the size of the labor force as regressors, both of which must be endogenous according to the theory as they are decisions made by firms and households conditional on the tax structure.

VI. Results

We report the estimation of various specifications of equation (11) in table 3. We report results setting Δ=0, 1, 3, and 5. Similar coefficients in sign and magnitude are obtained up to Δ=10 but with reduced precision as the sample size decreases. All the specifications include the vector of covariate controls, A_{it}, including or excluding per capita government expenditures where noted. All equations include a full complement of year and state dummy variables. Below each coefficient, we report the related t-statistic in parentheses and the associated arc elasticity in brackets.

Individual and joint tax effects on state labor productivity

The first column presents the model with contemporaneous tax policy ($\Delta = 0$). We expect this specification to be the most clouded by possible simultaneity between tax policy and labor productivity. All seven taxes have negative effects on labor productivity and all but the income tax coefficient are statistically significant and the seven taxes are jointly significant. Focusing on the elasticities allows us to assess the relative damage to labor productivity caused by the various taxes. The elasticities vary between -0.004 for the income tax to -0.07 for the sales tax. These elasticities may seem small, but the average tax rates are all small, ranging between a 1.2% average property tax rate to a 6.5% average corporate tax rate. For example, a 10% increase in the average sales tax would raise the sales tax by only 4.5 cents per $10 purchase.

The most costly taxes in terms of labor productivity effect is the sales tax with a 0.7% loss of labor productivity per 10% increase in sales tax. The next most costly taxes are the property tax and the corporate tax with a 0.6% loss of output per worker per 10% increase in tax rate. The tax rates on capital gains, unemployment insurance and worker's compensation reduce labor productivity by between 0.2% and 0.3% per 10% increase in tax rates. The income tax effect is negligible, but income and capital gains taxes are collected simultaneously on the same tax form and the tax rates are highly correlated at 0.77. When we combine the two taxes into a single combined effect $\beta_k\overline{\tau_k} + \beta_y\overline{\tau_y}$, the joint elasticity is consistently near -0.03 and is significant at all lag lengths until we set Δ=5.

Although the individual elasticities are small, the joint distortionary effect of these taxes is quite large. Using (11), the joint elasticity of labor productivity with respect to a one percent change in all seven tax rates evaluated at sample means is

(12) $\frac{d(\ln(\frac{y}{l}))}{d\vec{\tau}}\bar{\vec{\tau}} = \beta_s\,\overline{\tau_s} + \beta_p\,\overline{\tau_p} + \beta_k\,\overline{\tau_k} + \beta_c\,\overline{\tau_c} + \beta_y\,\overline{\tau_y} + \beta_u\,\overline{\tau_u} + \beta_{wc}\,\overline{\tau_{wc}}$

where $\vec{\tau}$ is our notation for the vector of tax rates. We report the estimates at the bottom of Table 3. The summed effect is statistically significant and implies that a 10% increase across all 7 tax rates lowers labor productivity by 2.8%. The sales, property and corporate taxes are each responsible for about one quarter of the lost productivity with the remaining quarter shared by the other four taxes.

When we move to estimates that lag the tax effect in columns 2-4, these conclusions remain remarkably persistent. All estimated tax effects remain negative although we lose precision as the sample sizes decrease. The adverse impact of the property tax gets larger while the estimated effects of taxes on sales, corporate earnings and capital gains get smaller but retain significance until we set $\Delta=5$. The joint tax neutrality test always rejects the null that the tax rates have zero effects. The joint tax effect varies between -0.23 and -0.28 and is always statistically significant despite loss of sample.

The most notable loss of impact is with the taxes that most closely resemble a wage tax. The income tax never is significant even though the marginal tax rate on capital gains maintains a strong negative effect until we set $\Delta=5$. The estimated effect of the worker's compensation tax drops in magnitude and significance beyond $\Delta=1$. Only the unemployment insurance tax rate maintains its negative effect in magnitude and significance across all lag specifications. The test that these three taxes have no impact cannot be rejected at $\Delta=5$ or at $\Delta=3$ when we add controls for government expenditures. None of these taxes are pure wage taxes and so these tests are merely suggestive. Nevertheless, while we cannot conclude that wage taxes do not alter labor productivity, we can say that the effects are clearly smaller than for the taxes on property, returns to capital and sales as predicted by the theory.

In columns 5 and 6, we add information on government expenditures. If the benefits of state expenditures act as a per capita lump sum transfer as we model, they should have a neutral impact on equilibrium labor productivity. However, if they distort the prices of consumption or investment goods, they can enter as part of the Hicksian productivity component and raise or lower labor productivity. We report the result where all tax rates and government expenditures are lagged three years, but our conclusions were similar using other lags. In short, the estimated marginal tax effects are unchanged. In addition, per capita government expenditures do not affect labor productivity, whether in aggregate or disaggregated into infrastructure investment[16], transfer payments[17], and other government expenditures.[18]

The last column combines the capital gains and income tax rate effects into a single effect. The estimated effect is virtually identical to the summed effect of the two tax rates and is statistically significant. Therefore, while our earlier conclusion that the income tax has no impact on labor productivity is consistent with the data, we cannot reject the possibility that the income tax effect is confounded by the correlation with the capital gains tax.

Ranking State Tax Policy Effects on Productivity

With the estimates from Table 3, we can rank the mix of state tax policies by how much they reduce labor productivity in the state. Applying (12) successively to each state's marginal tax rates, we generate a predicted impact on labor productivity in each state i and year t of a 10%

[16] Infrastructure investment includes all direct expenditures on transportation, education, buildings, libraries, natural resources, parking, recreation, sanitation, and utilities totaling 11 categories. Definitions for these measures can be found in the Government Finance and Employment Classification Manuals located at http://www.census.gov/govs/classification/.

[17] Transfer payments include all direct expenditures into employment security, health, hospitals, housing and community development, public welfare, unemployment compensation, and veteran's life insurance.

[18] The remaining government expenditures include intergovernmental expenditures, finance administration, police and fire protection, correctional, interest on general debt, liquor stores, employment retirement, other insurance trust, benefit payments, railroad retirement, and all expenditures that are not elsewhere classified.

increase in all their marginal tax rates. The rankings based on the coefficients from column 3 of Table 3 are presented in Table 4. Results are similar regardless of which lag length is selected.[19]

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 tax rates, the state with higher marginal rates will face a greater penalty in lost labor productivity. Evaluated over the full sample period 1977 – 2008, the estimated lost productivity varies from a low of -1.6% in Nevada to a high of -3.9% in New York. By 2008, the range in estimated negative effects of tax structure ranged from a low of -1.4% in Wyoming to a high of -4.0% in New Jersey.

There is considerable persistence in relative state tax policies. The rank correlation between the 1977 and 2008 tax effects is 0.81. As a result, state tax policies explain how differences in labor productivity growth of the magnitude found in Table 1 can arise and persist over time. Nevertheless, some states have had large changes in rank. Texas (7,22), Indiana (16, 29) and West Virginia (12, 24) all fell at least 12 positions by making their tax structures more distortionary. Texas fell the most by raising their property tax rate from a modest 1.35% in 1977 to 1.89%, the highest rate in the country except for New Jersey, and by increasing their sales tax by 2.3 percentage points. The best gainers were Delaware (30, 6), South Dakota (25, 7), and Oregon (34, 17), all of which rose at least 17 positions. The biggest mover, Delaware, lowered its maximum marginal income tax rate from 19.8% to 6.6% and lowered its highest capital gains tax rate from 9.9% to 6.01%. These changes in tax policies can influence productivity growth but they are clearly not the only factor driving productivity growth. Looking back at Table 1, both Delaware (#4) and South Dakota (#11) are among the leaders in labor productivity growth since 1977, but so is Texas (#12). Indiana (#42) and West Virginia (#46) are among the laggers, but so is Oregon (#35).

---

[19] For example, the rank correlation of state tax productivity effects using the 3-year and 5-year lags is 0.95.

On average, state tax policies have become only slightly more distortionary over time. The averaged joint tax effect across states was -2.6% in 1977 and -2.8% in 2008. Average top tax rates fell for property (-0.1%), income (-0.4%) and unemployment insurance (-0.5%)taxes. These small reductions in marginal tax rates were more than offset by increases in the capital gains (1.3%), sales (1.5%), corporate (0.6%), and worker's compensation (0.8%) tax rates.

Our presumption was that states whose taxes discourage capital investment would experience lower labor productivity increases in an era in which productivity was atypically tied to capital-skill complementarity. Interestingly, the correlation between the estimated tax effect and state population growth since 1977 is even larger (0.53) than the correlation between the tax effect and labor productivity growth (0.13). There is a net population shift toward states with faster growth of capital that complement skills and away from states with less capital investment. That population shift would slow the growth of labor productivity in the 'good' tax states while shoring up labor productivity in the 'bad' tax states, narrowing the gaps in labor productivity and wages caused by differences in tax policies across states.

Note that these effects are not tied to the level of government expenditures—they are due to the distortions created by high marginal tax rates on labor productivity. States will attain the same level of government expenditure at greater or lesser cost to the economy depending on the degree to which they rely on the most distortionary taxes.

Tax Efficiency

Our analysis thus far does not factor in the ability of a tax to generate revenue. A tax may have a higher per unit cost on productivity and still be worth imposing if it is also relatively efficient at producing revenue. That suggests that a better measure of a tax's effect on labor productivity should trade off the benefits of revenue generated against the cost of lost productivity. Let $\xi_{R\tau}$ be the elasticity of tax revenue with respect to the tax rate, and let $\xi_{q\tau}$ be the elasticity of labor productivity ($q = \frac{Q}{L}$) with respect to the tax rate as estimated in Table 3. Then the measure of relative tax efficiency is

$$(13)\ E_\tau = -\frac{\xi_{R\tau}}{\xi_{q\tau}}$$

The tax efficiencies are reported in Table 5. For the numerator, we regressed the natural log of aggregated state and local total revenue on the same tax rates and covariate controls we used in Table 3. The exception is that we also include the log of real gross state product as an additional covariate control as we need to standardize for differences in the size of the economies across states and across time. The denominator is taken from the elasticities from column 3 of Table 3.

Property and sales taxes are the most strongly tied to revenue. A 10% increase in the property and sales tax rates increases government revenue by 0.93% and 0.85% respectively. A 10% increase in income tax rates and corporate tax rates raises revenues by 0.48% and 0.3% respectively. A 10% increase in unemployment insurance, worker's compensation, and taxes on capital gains raises revenue by less than 0.2%. Although smaller, all of these tax rate effects are significant at the 5% level.

In the third column, we compute the tax efficiency coefficients according to (13). A tax with a higher E_τ will be "cheaper" to impose in that it generates revenue at a relatively low cost of lost labor productivity. Using that criteria, the most efficient taxes are those most closely tied to wages, namely income, worker's compensation and unemployment insurance. The sales tax is also relatively efficient. In contrast, the taxes on corporate income, capital gains, and property are the most costly taxes, producing between 0.5% to 0.9% more revenue per 1 percent loss in labor productivity. These results suggest that income taxes are the least costly taxes to impose in funding state and local government.

The last column lists the number of states that never imposed the tax over the 32-year period from 1977 - 2008. Six states avoided the least efficient tax, the corporate tax, and eight never imposed the capital gains tax, the next most inefficient. Eight states did not utilize the most efficient tax on income, presumably because it is politically difficult to impose taxes on labor income but not income derived from capital gains.

We generate an aggregate measure of each state i's tax structure efficiency according to

(14) $E_{\tau i} = \sum_{j=1}^{7} S_{\tau ji}^{R} \cdot E_{\tau j}$

where $S_{\tau ji}^{R}$ is the share of tax *j* in state i's total revenue and $E_{\tau j}$ is the estimated efficiency of tax *j*. The only modification we make is that income and capital gains taxes are combined in state revenue statistics and so we use a combined share for those two taxes and an estimated tax efficiency of the combined tax rates on income and capital gains. We rank the states by the efficiency of their tax structures in Table 6 and compare these rankings to the lost labor productivity rankings from Table 4. States with inefficient tax structures tend to have lower labor productivity with a rank correlation between state tax efficiency and lost labor productivity of 0.29. State tax efficiency rankings do not vary much over time, reflecting the conclusion from Table 2 that states don't alter their mix of taxes. The correlation in state tax efficiency between 1977 and 2008 is 0.77. Of the bottom 8 states in 1977, half were in the bottom 8 in 2008. Of the top 8 states in 1977, all but 2 were among the top 8 in 2004.

New Jersey stands out as the prime example of a state that relies extensively on taxes that raise revenue inefficiently at a high cost of lost productivity, having the 45th worst tax efficiency and the 46th largest loss of labor productivity due to high marginal tax rates. But while reliance on inefficient tax types is costly on average in lost productivity, there are some interesting exceptions. Wyoming's lack of the efficient income tax leads them to the heavy reliance on inefficient property taxes for revenue, but their low marginal property tax rates still has them ranked with the 2nd smallest loss of labor productivity. To limit damage to labor productivity in setting tax policy, it is more important to maintain low top marginal rates on the taxes used than to pick the right type of tax.

VII. Conclusions

This study shows that studies of tax effects must use marginal and not average tax rates, must consider many taxes at once rather than a single tax in isolation, and must treat capital and labor as endogenous variables. We also derive a reduced form relationship between labor productivity and tax rates that allows us to infer the negative effect of marginal tax rates on capital investment even without reliable data on capital investments by state. The estimated results are consistent with the theory that shows that increasing marginal tax rates on property, capital income and sales will lower equilibrium output per worker.

Our results of significant and robust negative effects of tax rates on economic outcomes are also consistent with three recent 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.

Our most important finding is that higher marginal rates lowered labor productivity for all seven tax types investigated, albeit to differing degrees and levels of significance. Taxes on property, sales and corporate income are the most damaging with each responsible for about a quarter of the estimated adverse effect of tax structures on output per worker. The smallest effects on labor productivity are from taxes on wages. Equally important, while the individual effect of a given tax type on labor productivity may be small, the cumulative effect across seven different taxes commonly used by states are large. Raising marginal tax rates by 10% across the seven tax types lowers labor productivity by 2.8%. In contrast to tax rates, per capita government expenditures have no impact on labor productivity, consistent with the presumption that public services provided by states are nonrival and do not distort prices of capital or consumer items.

Driving the negative effect of tax structure on labor productivity is a reliance on high marginal tax rates. New York, with the most damaging tax structure, would have 2.3% higher labor productivity if it used the least damaging tax structure employed by Nevada. In generating revenue to provide public services, it makes sense for states to raise revenue using the least disruptive tax structures.

To that end, taxes differ in their propensity to generate revenue per induced percentage reduction in labor productivity. Taxes on corporate income, capital gains, and property generate the least revenue per 1% decrease in output per worker. Taxes on wage income and sales prove the most efficient by that criteria, and the most efficient state tax structures place higher weights on those tax sources. However, efficient tax structures are characterized more by low marginal rates on the tax types used than by using the most efficient tax types.

It is possible that alternative measures of efficiency based on growth of output or employment could produce different rankings of taxes. Our focus on labor productivity was motivated by our desire of implicitly capturing an assumed distortion caused by high marginal tax rates on capital investment. The neoclassical growth model also generates equilibrium relationships between labor supply, output and tax rates. Our results suggest that further exploration of these other responses to marginal tax rates would be quite useful.

References

Acemoglu, Daron and Simon Johnson. 2005. "Unbundling Institutions." *Journal of Political Economy* 113(5):949-995.

Acemoglu, Daron, Simon Johnson and James A. Robinson. 2001. "The Colonial Origins of Comparative Development: An Empirical Investigation." *American Economic Review* 91(5):1369-1401.

Acemoglu, Daron, Simon Johnson and James A. Robinson. 2005. "The Rise of Europe: Atlantic Trade, Institutional Change, and Economic Growth." *American Economic Review* 95(3):546-579.

Alesina, Alberto, Edward L. Glaeser, and Bruce Sacerdote. 2005. "Work and Leisure in the U.S. and Europe: Why So Different?" in Mark Gertler and Kenneth Rogoff, eds. *NBER Macroeconomics Annual, 2005.* Cambridge, MA: The MIT Press.

Aschauer, David A. 1989. "Is Public Expenditure Productive." *Journal of Monetary Economics* 23(2):177-200.

Aschauer, David A. 2000. "Do states optimize? Public Capital and Economic Growth" *The Annals of Regional Science* 34(3): 343-363.

Autor, David H., Lawrence F. Katz and Melissa S. Kearney. 2008. "Trends in U.S. Wage Inequality: Revising the Revisionists." *The Review of Economics and Statistics* 90(2):300-323.

Bania, Neil, Jo Anna Gray and Joe A. Stone. 2007. "Growth Taxes and Government Expenditures: Growth Hills for U.S. States. *National Tax Journal* 60(2): 193-204.

Bauer, Paul W. and Yoonsoo Lee. 2006. "Estimating GSP and Labor Productivity by State." *Policy Discussion Working Paper #16.* Federal Reserve Bank of Cleveland.

Benson, Bruce L., and Ronald N. Johnson. (1986) The lagged impact of state and local taxes on economic activity and political behavior. Economic Inquiry 24 (3): 389-401.

Blau, Francine D. and Lawrence M. Kahn. 2002. *At Home and Abroad: U.S. Labor Market Performance in International Perspective* New York: Russell Sage Foundation.

Brown, Stephen P. A., Kathy J. Hayes and Lori L. Taylor. 2003. "State and Local Policy, Factor Markets and Regional Growth." *The Review of Regional Studies* 33(1): 40-60.

Chari, V.V. and Patrick J. Kehoe. 2006. "Modern Macroeconomics in Practice: How Theory is Shaping Policy." *The Journal of Economic Perspectives* 20(4): 3-28.

Chari, V.V., Patrick J. Kehoe and Ellen McGrattan. 1997. "The Poverty of Nations: A Quantitative Investigation." Research Department Staff Report 204. Federal Reserve Bank of Minneapolis.

Cobb, Charles W., and Paul H. Douglas. "A Theory of Production." The American Economic Review 8 (March 1928): 139-65.

Council of State Governments. Various years. *The Book of the States.* Lexington, KY.

Crain, W. Mark and Katherine J. Lee. 1999. "Economic Growth Regressions for the American States: A Sensitivity Analysis." *Economic Inquiry* 37(2): 242-257.

Dunne, Timothy, Lucia Foster, John Haltiwanger and Kenneth R. Troske. 2004. "Wage and Productivity Dispersion in United States Manufacturing: The Role of Computer Investment." *Journal of Labor Economics* 22(2): 397-430.

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

Funderburg, Richard, Timothy Bartik, Alan H. Peters, and Peter S. Fisher. 2010. "The Impact of Business Taxes on State Economic Growth: Revisited with Improved Tax Measures." University of Iowa. Mimeo.

Garofalo, Gasper A. and Steven Yamarik. 2002. "Regional Convergence: Evidence from a New State-by-State Capital Stock Series." *The Review of Economics and Statistics* 84(2): 316-323.

Goldin, Claudia and Lawrence F. Katz. 2008. *The Race Between Education and Technology* Cambridge, MA: Harvard University Press.

Hall, Robert E. and Charles I. Jones. 1999. "Why Do Some Countries Produce So Much More Output per Worker than Others?" *The Quarterly Journal of Economics* 114 (1): 83-116.

Heckman, James J. and Carmen Pages. 2004. *Law and Employment: Lessons from Latin America and the Caribbean.* University of Chicago Press.

Hines, James R., Jr. 1996. "Altered States: Taxes and the Location of Foreign Direct Investment in America." *The American Economic Review* 86(5): 1076-1094.

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.

Holtz-Eakin, Douglas. 1994. "Public Sector Capital and the Productivity Puzzle." *The Review of Economics and Statitics* 76(1):12-21.Hsieh, Chang-Tai and Peter J. Klenow. 2007. "Relative Prices and Relative Prosperity." *The American Economic Review* 97(3): 562-585.

Jorgenson, Dale W., Mun S. Ho and Kevin J. Stiroh. 2005. *Productivity vol 3: Information Technology and the American Growth Resurgence* Cambridge, MA: The MIT Press.

Levine, Ross and David Renelt. 1992. "A Sensitivity Analysis of Cross-Country Growth Regressions." *The American Economic Review* 82(4): 942-963.

Lynde, Catherine and J. Richmond. 1993. "Public Capital and Total Factor Productivity." *International Economic Review* 34(2):401-414.

Mankiw, N. Gregory, David Romer and David N. Weil. 1992. "A Contribution to the Empirics of Economic Growth." *The Quarterly Journal of Economics* 107(2): 407-437.

Mankiw, N. Gregory, Matthew Weinzierl, and Danny Yagan. 2009. "Optimal Taxation in Theory and Practice." *The Journal of Economic Perspectives* 23(4):147-174.

Mark, Stephen T., Therese J. McGuire and Leslie E. Papke. 2000. "The Influence of Taxes on Employment and Population Growth: Evidence from the Washington D.C. Metropolitan Area." *National Tax Journal* 53(1): 105-124.

McGrattan, Ellen R. and Edward C. Prescott. 2005. "Taxes, Regulation, and the Value of U.S. and U.K. Corporations." *Review of Economic Studies* 72(3): 767-796.

McGrattan, Ellen R. and James A. Schmitz, Jr. 1999. "Explaining Cross-Country Income Differences." in John B. Taylor and Michael Woodford, eds. *Handbook of Macroeconomics vol 1A.* Amsterdam: Elsevier.

Mofidi, Alaeddin, and Joe A. Stone. (1990) Do state and local taxes affect economic growth?. Review of Economics and Statistics 72 (4): 686-91.

Nickell, Stephen and Richard Layard, 1999. "Labor Market Institutions and Economic Performance," in Orley C. Ashenfelter and David Cards eds. *Handbook of Labor Economics vol. 3C.* Amsterdam: Elsevier: 2029-2084.

Nickell, Stephen, Luca Nunziata, and Wolfgang Ochel. 2005. "Unemployment in the OECD Since the 1960s. What Do We Know?" *The Economic Journal* 115 (500): 1–27.

Munnell, Alicia H. 1990. "How Does Public Infrastructure Affect Regional Economic Performance?" in A. Munnell ed. *Is There a Shortfall in Public Capital Investment?* Boston: Federal Reserve Bank of Boston

Oregon Department of Consumer and Business Services. Various years. *Oregon Workers' Compensation Premium Rate Ranking.* http://actprod.cbs.state.or.us/iportal/report_catalog.html

Papke, Leslie E. 1993. "Interstate Business Tax Differentials and New Firm Location: Evidence from Panel Data." *Journal of Public Economics* 45(1): 47-68.

Pereira, Alfredo M. 2000. "Is all Public Capital Created Equal?" *The Review of Economics and Statistics* 82(3):513-518.

Prescott, Edward C. 2002. "Richard T. Ely Lecture: Prosperity and Depression." *The American Economic Review* 92(2): 1-15.

Reed, W. Robert. 2008. "The Robust Relationship Between Taxes and U.S. State Income Growth." *National Tax Journal* 61(1): 57-80.

Romer, Christina D. and David H. Romer, 2010. "The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks," *American Economic Review* 100(3): 763-801.

Sachs, Jeffrey. 2005. *The End of Poverty: Economic Possibilities for our Time.* New York: The Penguin Press.

Shimer, Robert. 2010. *Labor Markets and Business Cycles* Princeton, NJ: Princeton University Press.

Siniavskaia, Natalia. 2007. "Residential Real Estate Tax Rates in the American Community Survey." *Special Studies* (May 22). HousingEconomics.com http://www.nahb.org/default.aspx

Slemrod, Joel and Jon Bakija. 2008. *Taxing Ourselves: A Citizen's Guide to the Debate over Taxes* Cambridge, MA: The MIT Press.

Tax Policy Center. 2012. *State and Local Finance Data Query System* http://slfdqs.taxpolicycenter.org/#

Thomason, Terry , Timothy P. Schmidle, and John F. Burton Jr. 2001. *Workers' Compensation: Benefits, Costs, and Safety under Alternative Insurance Arrangements*. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research

Waslyenko, Michael J. 1997. "Taxation and Economic Development: The State of the Economic Literature," *New England Economic Review* (March/April): 37-52.

Table 1: Shift-Share Analysis of Gross State Product by State, 1977-2008.

State	dln(Q	rank		dln(Q/	rank		dln(L)	rank	Average
Alabama	0.80	30		0.33	24		0.47	28	$50,917
Arizona	1.46	2		0.27	37		1.19	2	$57,766
Arkansas	0.82	28		0.33	25		0.49	26	$47,641
California	1.04	13		0.40	10		0.64	15	$65,902
Colorado	1.20	6		0.35	20		0.85	5	$57,836
Connecticut	0.94	20		0.55	1		0.39	37	$70,908
Delaware	1.14	9		0.52	4		0.62	16	$81,908
Florida	1.34	3		0.37	17		0.98	4	$55,669
Georgia	1.19	8		0.39	13		0.80	6	$57,726
Idaho	0.98	16		0.21	43		0.77	9	$46,445
Illinois	0.64	42		0.32	26		0.32	42	$64,622
Indiana	0.59	44		0.23	42		0.37	40	$55,205
Iowa	0.58	45		0.27	36		0.31	44	$50,837
Kansas	0.74	34		0.30	32		0.44	31	$50,471
Kentucky	0.61	43		0.17	45		0.44	32	$53,743
Louisiana	0.74	33		0.36	18		0.38	38	$62,286
Maine	0.80	31		0.30	31		0.49	25	$47,846
Maryland	0.97	17		0.38	14		0.59	19	$60,547
Massachusetts	0.95	19		0.54	3		0.41	36	$63,190
Michigan	0.34	48		0.04	48		0.30	46	$63,759
Minnesota	0.90	24		0.33	23		0.56	22	$56,624
Mississippi	0.69	37		0.32	28		0.38	39	$46,713
Missouri	0.66	39		0.24	39		0.42	33	$52,880
Montana	0.65	40		0.09	47		0.56	23	$46,062
Nebraska	0.73	35		0.32	27		0.41	34	$51,051
Nevada	1.79	1		0.33	22		1.45	1	$62,055
New Hampshire	1.21	5		0.49	6		0.72	11	$53,766
New Jersey	0.89	25		0.45	8		0.44	30	$71,801
New Mexico	1.00	14		0.27	38		0.73	10	$56,758
New York	0.82	29		0.50	5		0.32	41	$73,631
North Carolina	1.10	12		0.45	9		0.66	12	$55,546
North Dakota	0.71	36		0.30	33		0.41	35	$47,089
Ohio	0.49	46		0.19	44		0.30	45	$57,787
Oklahoma	0.77	32		0.28	34		0.48	27	$50,812
Oregon	0.93	22		0.28	35		0.65	13	$53,433
Pennsylvania	0.65	41		0.34	21		0.31	43	$58,275
Rhode Island	0.83	27		0.54	2		0.29	47	$56,200
South Carolina	0.96	18		0.36	19		0.60	18	$50,022
South Dakota	0.90	23		0.39	11		0.50	24	$48,027
Tennessee	0.94	21		0.37	15		0.57	20	$52,373
Texas	1.19	7		0.39	12		0.80	7	$62,019
Utah	1.26	4		0.24	40		1.02	3	$52,196
Vermont	0.98	15		0.37	16		0.61	17	$46,148
Virginia	1.13	10		0.49	7		0.64	14	$59,348
Washington	1.11	11		0.31	29		0.79	8	$62,511
West Virginia	0.37	47		0.16	46		0.21	48	$53,749
Wisconsin	0.69	38		0.24	41		0.46	29	$53,603
Wyoming	0.87	26		0.31	30		0.56	21	$65,060
United States	**0.90**			**0.33**			**0.56**	**1.13**	**$56,683**

Table 2: Presence or Absence of State Tax by Type of Tax, 1977-2008

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	√	√	√	**0**	√	√	√
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 over the period 0: The state never imposed the this tax

Table 3: Estimated effect of tax structure on the log GSP per worker by state, 1977 – 2008

	1	2	3	4	5	6	7
Lag: Δ=	0	1	3	5	3	3	3
Tax							
Income: τ_y	-0.079	-0.107	-0.290	-0.001	-0.268	-0.258	-0.493
	(0.69)	(0.94)	(1.34)	(<0.01)	(1.22)	(1.17)	(2.44)
	[-0.004]	[-0.01]	[-0.02]	[<-0.01]	[-0.01]	[-0.01]	[-0.03]
Property: τ_p	-5.193	-6.707	-8.717	-8.273	-8.577	-8.558	-8.831
	(7.88)	(10.10)	(7.01)	(5.06)	(6.74)	(6.76)	(7.06)
	[-0.06]	[-0.08]	[-0.11]	[-0.10]	[-0.11]	[-0.10]	[-0.11]
Sales: τ_s	-1.684	-1.483	-1.144	-1.157	-1.148	-1.159	-1.181
	(6.11)	(5.31)	(2.09)	(1.74)	(2.08)	(2.12)	(2.15)
	[-0.07]	[-0.07]	[-0.05]	[-0.05]	[-0.05]	[-0.05]	[-0.05]
Corporate:τ_c	-0.947	-0.860	-0.871	-0.431	-0.850	-0.856	-0.977
	(5.06)	(4.44)	(2.30)	(0.96)	(2.23)	(2.26)	(2.58)
	[-0.06]	[-0.06]	[-0.06]	[-0.03]	[-0.06]	[-0.06]	[-0.06]
Capital Gains: τ_k	-0.573	-0.550	-0.487	-0.393	-0.482	-0.489	
	(5.82)	(5.54)	(2.55)	(1.61)	(2.51)	(2.56)	
	[-0.03]	[-0.02]	[-0.02]	[-0.02]	[-0.02]	[-0.02]	
Worker's Compensation: τ_{wc}	-0.967	-0.982	-0.430	-0.323	-0.378	-0.383	-0.267
	(2.90)	(2.91)	(0.70)	(0.40)	(0.61)	(0.62)	(0.43)
	[-0.02]	[-0.02]	[-0.01]	[-0.01]	[-0.01]	[-0.01]	[-0.01]
Unemployment Insurance: τ_u	-1.263	-1.370	-0.681	-1.184	-0.667	-0.669	-0.701
	(6.67)	(7.20)	(2.47)	(2.05)	(2.41)	(2.42)	(2.53)
	[-0.03]	[-0.02]	-0.02]	[-0.03]	[-0.02]	[-0.02]	[-0.02]
Log government expenditures per capita						0.031 (0.69)	
Log infrastructure expenditures per capita					-0.021 (0.55)		
Log transfer payments per capita					-0.006 (0.35)		
Log other government expenditures per capita					-0.008 (0.51)		
Observations	1536	1488	480	288	480	480	480
R-squared	0.87	0.87	0.85	0.87	0.85	0.85	0.85
Joint tax neutrality: $\beta_s = \beta_p = \beta_k = \beta_c = \beta_y = \beta_u = \beta_{wc} = 0$; $F_{.05}(7, N-7)=2.02$	40.1	45.2	13.7	7.0	12.4	12.4	14.7
Joint income and capital gains tax: $\beta_k \overline{\tau_k} + \beta_y \overline{\tau_y}=0$	-0.03 (5.36)	-0.03 (5.36)	-0.04 (3.39)	-0.02 (1.41)	-0.03 (3.22)	-0.03 (3.20)	n/a
Joint tax effect: $\beta_s \overline{\tau_s} + \beta_p \overline{\tau_p} + \beta_k \overline{\tau_k} + \beta_c \overline{\tau_c} + \beta_y \overline{\tau_y} + \beta_u \overline{\tau_u} + \beta_{wc} \overline{\tau_{wc}}=0$	-0.28 (3.95)	-0.28 (3.89)	-0.28 (2.79)	-0.23 (2.28)	-0.27 (2.74)	-0.27 (2.74)	-0.27 (2.77)
Joint wage neutrality: $\beta_y = \beta_u = \beta_{wc} = 0$; $F_{.05}(3, N-3)=2.61$	17.78	20.38	2.73	1.44	2.47	2.44	4.02

Notes: t-statistics are reported in parentheses and elasticities in brackets.
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: Impact of a 10% increase in all marginal tax rates on labor productivity, by state, 1977 – 2008

State	Avg Effect	Rank		77 Effect	Rank		08 Effect	Rank
Alabama	-1.8%	3		-1.6%	4		-2.0%	5
Arizona	-2.6%	22		-2.5%	27		-2.4%	15
Arkansas	-2.7%	26		-2.3%	22		-2.9%	28
California	-3.1%	33		-3.3%	40		-3.2%	34
Colorado	-2.0%	5		-1.9%	9		-1.9%	4
Connecticut	-3.4%	38		-3.6%	42		-3.3%	36
Delaware	-2.2%	8		-2.6%	30		-2.0%	6
Florida	-2.2%	9		-1.9%	13		-2.2%	10
Georgia	-2.3%	13		-2.2%	20		-2.4%	13
Idaho	-3.0%	32		-2.5%	26		-3.0%	32
Illinois	-3.1%	34		-2.6%	28		-3.3%	37
Indiana	-2.5%	20		-2.1%	16		-2.9%	29
Iowa	-3.7%	43		-2.9%	36		-3.8%	47
Kansas	-2.8%	28		-2.3%	23		-2.9%	30
Kentucky	-2.6%	21		-2.1%	17		-2.7%	25
Louisiana	-2.0%	6		-1.4%	3		-2.1%	8
Maine	-3.4%	37		-3.2%	37		-3.3%	35
Maryland	-2.7%	27		-2.7%	32		-2.8%	26
Massachusetts	-3.2%	36		-4.7%	47		-3.0%	31
Michigan	-2.8%	29		-2.7%	31		-3.2%	33
Minnesota	-3.6%	42		-3.2%	38		-3.6%	45
Mississippi	-2.4%	17		-1.9%	8		-2.5%	19
Missouri	-2.4%	15		-2.0%	14		-2.7%	23
Montana	-2.9%	31		-2.4%	21		-2.3%	12
Nebraska	-3.5%	41		-3.2%	39		-3.6%	46
Nevada	-1.6%	1		-1.2%	2		-1.7%	2
New Hampshire	-2.6%	23		-2.8%	33		-2.5%	21
New Jersey	-3.8%	46		-3.9%	46		-4.0%	48
New Mexico	-2.5%	18		-2.2%	19		-2.5%	20
New York	-3.9%	48		-5.1%	48		-3.5%	41
North Carolina	-2.6%	25		-2.4%	24		-2.8%	27
North Dakota	-3.5%	39		-2.8%	35		-3.4%	40
Ohio	-3.2%	35		-2.6%	29		-3.4%	38
Oklahoma	-2.3%	11		-1.8%	6		-2.2%	9
Oregon	-2.8%	30		-2.8%	34		-2.4%	17
Pennsylvania	-3.5%	40		-3.4%	41		-3.4%	39
Rhode Island	-3.7%	44		-3.8%	44		-3.5%	42
South Carolina	-2.3%	12		-2.1%	18		-2.3%	11
South Dakota	-2.5%	19		-2.4%	25		-2.0%	7
Tennessee	-2.2%	7		-1.9%	11		-2.4%	14
Texas	-2.4%	14		-1.8%	7		-2.5%	22
Utah	-2.4%	16		-1.9%	10		-2.4%	16
Vermont	-3.7%	45		-3.8%	43		-3.6%	44
Virginia	-2.3%	10		-2.1%	15		-2.4%	18
Washington	-1.9%	4		-1.7%	5		-1.9%	3
West Virginia	-2.6%	24		-1.9%	12		-2.7%	24
Wisconsin	-3.9%	47		-3.9%	45		-3.5%	43
Wyoming	-1.7%	2		-0.9%	1		-1.4%	1
Average	-2.8%			-2.6%			-2.8%	

Ranking based on the estimated joint effect of tax rates on state labor productivity using the specification in column 3 of Table 3.

Table 5: Tax rank by efficiency defined as percent revenue generated per 1% loss in labor productivity

Tax	ln R[a]	ln Q/L[b]	E_τ[c]	States without tax
Income: τ_y	0.904 (6.63) [0.05]	-0.290 (1.34) [-0.02]	**3.12**	8
Property: τ_p	7.578 (9.48) [0.09]	-8.717 (7.01) [-0.11]	**0.87**	0
Sales: τ_s	1.907 (5.77) [0.08]	-1.144 (2.09) [-0.05]	**1.67**	0
Corporate: τ_c	0.458 (2.01) [0.03]	-0.871 (2.30) [-0.06]	**0.53**	6
Capital Gains: τ_k	0.294 (2.49) [0.01]	-0.487 (2.55) [-0.02]	**0.60**	8
Worker's Compensation: τ_{wc}	0.818 (2.04) [0.02]	-0.430 (0.70) [-0.01]	**1.90**	0
Unemployment Insurance: τ_u	0.840 (3.67) [0.02]	-0.681 (2.47) [-0.02]	**1.23**	0
Observations **R-squared**	1536 0.99	480 0.85		

[a] Regression of log aggregate state and local revenue on tax rates, log GSP, and all the other covariate controls listed in Table 3. Estimate of $\xi_{R\tau}$ is reported in brackets.

[b] Repeat of column 3 from Table 3. Estimate of $\xi_{q\tau}$ is reported in brackets.

[c] Ratio of column 1 to column 2 equal to E_τ from equation (13)

Table 6: State rankings by tax efficiency and tax effects on labor productivity, 1977-2008

State	Base Model Without Capital Gains*			
	Tax Efficiency		Lost Productivity	
	E_τ [a]	Rank	Avg Effect[b]	Rank
Alabama	1.67	1	-1.8%	3
Arizona	1.51	28	-2.6%	22
Arkansas	1.64	6	-2.7%	26
California	1.55	21	-3.1%	33
Colorado	1.56	20	-2.0%	5
Connecticut	1.46	39	-3.4%	38
Delaware	1.65	3	-2.2%	8
Florida	1.40	44	-2.2%	9
Georgia	1.58	15	-2.3%	13
Idaho	1.57	17	-3.0%	32
Illinois	1.46	37	-3.1%	34
Indiana	1.52	26	-2.5%	20
Iowa	1.51	30	-3.7%	43
Kansas	1.51	31	-2.8%	28
Kentucky	1.65	2	-2.6%	21
Louisiana	1.60	10	-2.0%	6
Maine	1.47	35	-3.4%	37
Maryland	1.64	5	-2.7%	27
Massachusetts	1.53	24	-3.2%	36
Michigan	1.45	40	-2.8%	29
Minnesota	1.57	16	-3.6%	42
Mississippi	1.54	22	-2.4%	17
Missouri	1.61	9	-2.4%	15
Montana	1.41	43	-2.9%	31
Nebraska	1.49	34	-3.5%	41
Nevada	1.52	25	-1.6%	1
New Hampshire	1.16	48	-2.6%	23
New Jersey	1.40	45	-3.8%	46
New Mexico	1.62	7	-2.5%	18
New York	1.51	29	-3.9%	48
North Carolina	1.62	8	-2.6%	25
North Dakota	1.46	36	-3.5%	39
Ohio	1.59	12	-3.2%	35
Oklahoma	1.65	4	-2.3%	11
Oregon	1.56	19	-2.8%	30
Pennsylvania	1.54	23	-3.5%	40
Rhode Island	1.46	38	-3.7%	44
South Carolina	1.57	18	-2.3%	12
South Dakota	1.40	46	-2.5%	19
Tennessee	1.50	32	-2.2%	7
Texas	1.41	42	-2.4%	14
Utah	1.60	11	-2.4%	16
Vermont	1.44	41	-3.7%	45
Virginia	1.59	13	-2.3%	10
Washington	1.49	33	-1.9%	4
West Virginia	1.58	14	-2.6%	24
Wisconsin	1.51	27	-3.9%	47
Wyoming	1.34	47	-1.7%	2
Average	1.52		-2.8%	

[a] State tax efficiency using equation (14). Estimates of $\xi_{R\tau}$ are similar to those reported in column 1 of Table except that the effects of income and capital gains taxes are forced to be equal and we use estimates of $\xi_{q\tau}$ reported in column 7 of Table 3.
[b] Replicates the first two columns of Table 4.

Appendix Table 1: Descriptive statistics for key variables from 1977-2008

Variable	Mean	Std.	Min	Max
Income Tax	5.26%	3.30%	0.00%	19.80%
Property Tax	1.23%	0.52%	0.30%	3.04%
Sales & Excise Tax	4.45%	1.73%	0.00%	8.00%
Corporate Tax	6.54%	3.04%	0.00%	13.80%
Capital Gains Tax	4.47%	3.13%	0.00%	14.00%
Workers Comp Tax	2.07%	0.83%	0.05%	6.33%
Unemployment Insurance Tax	2.26%	1.08%	0.04%	17.59%
Percent with High School Diploma	76.91	8.87	46.20	93.10
Ln Real Energy Prices	2.52	0.24	1.80	3.30
Percent Union Membership	14.74	6.89	2.30	38.30
Population Density	174.87	241.71	4.20	1181.80
Percent GSP in Manufacturing	0.18	0.07	0.03	0.39

Appendix Table 2: Average tax rates over time for all contiguous United States.

Year	Income Tax	Property Tax	Sales + Excise Tax	Corporate Tax	Capital Gains Tax	Workers Comp	UI Tax
1977	5.42%	1.25%	3.57%	5.96%	3.36%	1.17%	2.47%
1978	5.36%	1.21%	3.60%	6.03%	3.25%	1.31%	2.37%
1979	5.27%	1.18%	3.60%	6.10%	2.87%	1.39%	2.25%
1980	5.15%	1.14%	3.60%	6.16%	2.77%	1.45%	2.12%
1981	5.07%	1.14%	3.67%	6.18%	2.70%	1.45%	2.04%
1982	5.12%	1.14%	3.74%	6.20%	2.74%	1.42%	2.01%
1983	5.55%	1.14%	3.93%	6.41%	2.93%	1.41%	2.33%
1984	5.51%	1.15%	4.11%	6.62%	2.85%	1.44%	2.65%
1985	5.33%	1.15%	4.16%	6.63%	2.78%	1.57%	2.76%
1986	5.20%	1.16%	4.21%	6.64%	2.70%	1.80%	2.79%
1987	5.00%	1.18%	4.30%	6.63%	5.01%	1.96%	2.76%
1988	4.87%	1.20%	4.40%	6.62%	4.87%	2.12%	2.62%
1989	4.91%	1.22%	4.45%	6.66%	4.99%	2.36%	2.53%
1990	4.98%	1.22%	4.49%	6.70%	5.13%	2.60%	2.47%
1991	5.35%	1.33%	4.58%	6.79%	5.45%	2.73%	2.37%
1992	5.52%	1.39%	4.66%	6.87%	5.53%	3.00%	2.34%
1993	5.54%	1.42%	4.70%	6.82%	5.57%	3.19%	2.32%
1994	5.50%	1.46%	4.74%	6.77%	5.52%	3.05%	2.36%
1995	5.44%	1.47%	4.76%	6.71%	5.44%	2.85%	2.28%
1996	5.36%	1.44%	4.78%	6.65%	5.36%	2.61%	2.23%
1997	5.34%	1.42%	4.78%	6.67%	5.33%	2.43%	2.12%
1998	5.30%	1.38%	4.78%	6.69%	5.29%	2.24%	1.96%
1999	5.28%	1.30%	4.77%	6.64%	5.25%	2.11%	2.37%
2000	5.24%	1.27%	4.77%	6.59%	5.12%	1.98%	2.02%
2001	5.24%	1.16%	4.79%	6.59%	5.20%	2.03%	2.00%
2002	5.24%	1.15%	4.81%	6.59%	5.23%	2.08%	1.86%
2003	5.30%	1.12%	4.89%	6.61%	5.22%	2.11%	1.93%
2004	5.29%	1.10%	4.96%	6.61%	5.20%	2.15%	2.00%
2005	5.24%	1.06%	4.96%	6.59%	4.94%	2.12%	1.97%
2006	5.12%	1.04%	4.96%	6.51%	4.89%	2.10%	1.99%
2007	5.09%	1.04%	4.98%	6.48%	4.82%	2.05%	1.92%
2008	5.06%	1.15%	5.04%	6.59%	4.78%	2.00%	1.98%
Average	5.26%	1.23%	4.45%	6.54%	4.47%	2.07%	2.26%

Appendix—Derivation of the reduced form for labor productivity

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

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

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 theCES 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,

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