

Do Governments Grow When They Become More Efficient? Evidence from Tax Withholding

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Abstract

The paper examines the claim that more efficient taxes lead to bigger government by studying the effects of income tax withholding, a particular technological shock to tax efficiency. I exploit the variation in the timing of the adoption of withholding by state governments in the USA during the 1940's through 1970's. Due to better compliance and other factors, withholding immediately and permanently increased income tax collections by 24 percent at given tax rates which corresponds to 2.8 percent reduction in deadweight costs. I find strong evidence that governments did respond to this efficiency shock; however, the major response was a shift in the composition of revenues towards a heavier reliance on the income tax. States sharply increased revenues from other taxes as they implemented withholding, which indicates that a need to raise more revenue was an important motive for the adoption of withholding. Withholding increased total tax revenues by 7.7 percent, but I find that the causal relationship from more efficient taxes to a bigger government accounts for at most 3.9 percent, while at least 3.8 percent should be attributed to a higher demand for spending that stimulated the adoption. Contrary to claims that withholding was *the* thing that enabled the post-war explosion of income taxation, I find that it did accounts for approximately 9 percent of the growth of state income taxes during the period in question.

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1 Introduction

Explaining the growth of government during the 20th century has been one of the vexing questions in economics.¹ One explanation, suggested for example by Kau and Rubin (1981) or Becker and Mulligan (1998), is that governments have become more efficient in raising taxes - in parlance of economic theory, that the deadweight costs of taxes have been declining. Indeed, a large class of positive models of the size of government is unanimous in the prediction that reducing the deadweight costs of taxes increases the size of government. These include Becker and Mulligan's (1998) model of interest groups, Meltzer and Richard's (1981) median voter model of pure redistribution, Hettich and Winer's (1988) model of determination of tax structure under probabilistic voting, or Brennan and Buchanan's (1980) model of Leviathan government.

In this paper I present a direct test of a causal link between tax efficiency and the size of government. I study the impact of one particular "technological shock" that increased the efficiency of taxes: the introduction of income tax withholding at the state level in the United States. As opposed to the

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¹For recent surveys, see Mueller (1989) or Holsey and Borcharding (1997).

original method of collecting income taxes (taxpayers "voluntarily" filing the tax returns at the end of the fiscal year), withholding makes tax evasion more difficult by deducting the tax immediately from workers' paychecks and collecting it from employers. Therefore it effectively broadens the tax base and enables to raise more revenue at given tax rates, or alternatively, the same amount of revenue at lower tax rates. In conventional models of optimal taxation, income taxes with relatively broader tax base and lower marginal tax rates are regarded as more efficient. The impact of withholding on tax efficiency is large, immediate, and discontinuous, which makes it a particularly attractive source of identification.

Income tax withholding was first adopted at the federal level in 1943 with the goal to raise more revenue to finance the war expenditures. Later, it has been blamed for enabling the post-war expansion of federal government. As Milton Friedman, who at that time worked for the U.S. Treasury and helped to put the federal withholding in place, stated in his memoirs:

*"Far more important, without the system of current tax collection, it would have been impossible to collect the amount of income taxes that we collected during the war. At the time, we concentrated single-mindedly on promoting the war effort. We gave next to no consideration to any longer-run consequences. It never occurred to me at the time that I was helping to develop machinery that would make possible a government that I would come to criticize severely as too large, too intrusive, too destructive of freedom."*²

While the expansion of the federal income tax after 1943 is indisputable, it is difficult to infer whether it was due to withholding or some other factors. The adoption of withholding at the state level, however, provides a unique set-up for identifying the effect of changes in tax efficiency on the size of government. Withholding was adopted state-by-state, and the variation in the timing of adoption is substantial. It spreads from 1948 (Oregon) to 1987 (North Dakota).³ This allows to exploit the difference-in-differences estimator in a panel of state-level data. The dataset itself is unique, because most of the statistical information on state government finances for the period in question still exists only in printed form. This paper is the first (to my best knowledge) to use an annual panel of states for 1940's through 1970's with information on the composition of taxes and expenditures.

How does my approach relate to previous literature? The claim that more efficient governments are bigger has so far been subject to only few tests, all relying either on a single time series or cross-country regressions. Kau and Rubin (1981) argue that the costs of collecting taxes have declined because changes in the structure of the economy made tax collection easier. They find that factors such as the growth in female labor participation and decline in self employment explain virtually all the growth of government during 1929-70. Yet while the connection between female labor participation and size of government may be indisputable, it is arguable whether such a connection is due to lower costs of tax collection, or due to a higher demand for government induced by higher female labor participation. Summers, Gruber and Vergara (1995) show that labor taxes are less distortionary when labor supply decisions are made collectively by labor unions (a phenomenon they dub "corporatism"). In their empirical analysis of 17 developed countries, they find that countries with a larger degree of corporatism do indeed have higher labor taxes as a share of GDP, though they do not tax more heavily other sources of income. Becker and Mulligan (1998) find support for their interest group model by regressing the size of government on various measures of tax efficiency⁴ in a cross section of countries. For most measures they find a positive correlation between tax efficiency and the size of government.

These studies contrast with the view that the growth of government has been "demand-driven".⁵ In this view, the size of government is determined primarily by the demand for public spending. Big

² Friedman and Friedman, p. 123.

³ Table 1 chronologically lists the year in which each state adopted withholding, together with the year in which that state first imposed the income tax.

⁴ For example, the share of government revenue raised from relatively more efficient taxes, or the ratio of average to marginal income tax rate.

⁵ Wallis (1999).

government still can be more efficient, but the direction of causality is reversed: Bigger governments are more likely to adopt a more efficient tax system since the benefits of doing so are increasing in the amount of revenue that needs to be raised. The difference between the "efficiency" and "demand" explanations of government growth is not as much about the underlying theory of government but rather about the relative importance of efficiency versus demand factors. Empirical framework of this paper allows to decompose how much of the post-withholding increase in revenues can be attributed to higher efficiency of taxes and how much to a higher demand for spending.

I generalize alternative positive models of government into a social planner model of the optimal size of government and composition of tax revenues. Withholding is modelled as an improvement in the technology of income tax collections. I also model the reverse causality and distinguish two stimuli for adoption: a "supply-driven" adoption, which occurs when the administrative costs of withholding fall, and "demand-driven" adoption, which occurs when the demand for spending exceeds a critical level. The effect of withholding on tax revenues can be decomposed into three effects: substitution effect (a shift in composition of revenues towards the income tax and away from other taxes, holding total revenues constant), scale effect (an increase in total revenues because the marginal deadweight costs have declined) and the demand effect (an increase in total revenues because of an increase in demand for spending that stimulated the adoption of withholding). Only the first two effects represent a causal relationship from efficiency to taxes, while the third represents the reverse causality. The model shows that taxes other than income tax should decline when adoption is supply-driven, while they may increase if adoption is demand-driven. Similarly, the model predicts that the income tax rates should decline when adoption is supply-driven (in a popular language, the government should return some of the windfall of revenue from withholding back to the taxpayers) while they may increase if adoption is demand-driven.

Empirical estimation of the model confirms that withholding indeed made income taxes more efficient by immediately and permanently increasing the collections by 23.7 percent, holding the tax rates constant. This estimate is very robust to alternative specifications and always statistically significant. The improvement in tax collection translates into a 2.8 percent reduction in deadweight costs of state income taxes. Estimates also show that over the three years following the adoption of withholding, income tax revenues increased by 29.4 percent and revenues from other taxes by 3.8 percent. Total tax revenues increased by 7.7 percent.

The results provide support for the predictions of the model. The substitution effect is demonstrated by the fact that an increase in income taxes significantly exceeds the increase in other taxes. Governments do respond to changes in tax efficiency - they shift the composition of revenues towards the more efficient tax. Second, the results show that higher demand for public spending motivated the adoption of withholding, because other taxes increased and governments did not reduce income tax rates.

While the results do show a causal relationship from efficiency to taxes, they also show that efficiency is empirically far less important than demand in explaining the growth of government. When I decompose the changes in revenues into substitution, scale, and demand effect, I find that substitution effect increased income taxes by 21.7 percent and decreased other taxes by 3.45 percent. Most of the increase in income taxes can thus be attributed to reshuffling in composition of revenues. In the presence of demand-driven adoption, the model allows only to set an upper bound on the scale effect and a lower bound on the demand shock: The scale effect increased total tax revenues by at most 3.9 percent, while the demand shock increased revenues by at least 3.8 percent. The demand shock played clearly an important role and we cannot even rule out the possibility that the scale effect was zero and all the increase in total revenues was solely due to the demand shock.

In the similar vein, withholding produced a once-and-for-all change in levels, but not growth rates, of income tax revenues. After accounting for other factors, income tax revenues grew at the same rate after withholding as they had before. Contrary to Milton Friedman's claim, withholding cannot be blamed for enabling the post-war expansion of income taxes (provided that qualitatively same results apply to the federal income tax).

Because the distinction between supply- and demand-driven adoption is crucial for interpretation of the estimates, I analyze factors that affected the timing of adoption directly, using standard techniques of duration analysis. The model predicts that the likelihood of adoption is increasing in the level of income tax revenues, which is strongly supported in the data and confirms the demand-driven adoption. In fact, income tax revenues are the only significant variable affecting the timing of adoption. A 10-percent increase in income tax revenue per capita increases the conditional probability of adopting withholding by 0.09 percent. Variables that could potentially induce supply-driven adoption, such as the share of dividend or farm income, did not significantly affect the timing of adoption.

Finally, I assess the contribution of withholding to the overall growth of state governments. The increase in income tax revenues attributable to the causal relationship from efficiency to taxes increased total tax revenues by 2.0–2.3 percent and accounted for 8-9.3 percent of the growth of income tax revenues during the sample period. In terms of empirical relevance, growth in demand for spending seems to be a far more important factor behind the growth of government than declining costs of tax collections.

2 The history and advantages of income tax withholding

By introducing income tax withholding in 1943 the federal government made a major change in tax administration.⁶ Until then, taxpayers paid their income taxes when they filed annual returns. Since then, employers have been required to withhold a certain fraction of their workers' paychecks and pay it directly to the government. At the end of the fiscal year, taxpayers file income tax returns in which they compute the assessed income tax. Any difference between the assessed tax and the amount withheld during the previous year is either refunded to the taxpayer (if negative) or has to be paid to the IRS (if positive).

Why should we expect this new method of tax collection to be superior from an economic efficiency viewpoint? In the case of state income taxes, I estimate (section 5) that withholding increased tax collections by 23.7 percent, holding the tax rates and income constant. Equivalently, it made it possible to raise a given amount of revenue at lower tax rates. In conventional models of public finance, lower marginal tax rates are associated with less distortion in labor supply, effort, tax evasion, or any other margin that affects the taxable income. The reasons why withholding generates more revenue are the following:

- Improved tax collections. Withholding makes tax avoidance more difficult, since the tax authorities receive the tax liability immediately as the income is earned and do not need to rely on taxpayers' self-reporting of income.
- Time shift in tax collections. First, withholding causes a transitory increase in tax revenues as the government collects the tax liability from two years during the adoption year. However, when nominal incomes are rising and taxes are progressive, as was the case during the 1950's and 1960's, withholding also generates a permanent increase in tax collections due to so called "earlier realization of the growth in the tax base". As incomes are rising, more people move into higher tax brackets with higher marginal tax rates, and the average tax rate rises. Because of withholding, the government receives the *growth* of the tax liability one year earlier than it would have under the traditional regime.
- Overwithholding. Both the state and federal systems are designed to overwithhold. An average tax filer does not owe the tax, but receives a refund. This represents an interest-free loan from the taxpayers to the government.

⁶United States were not the first country to implement withholding. Great Britain and Germany were withholding taxes before World War II.

How does the increase in revenue translate into deadweight costs? It is useful to think of withholding as a revenue-neutral tax reform that reduced marginal tax rates of state income taxes by 22.4 percent. One can then use Feldstein's (1995) formula for computing the deadweight cost of an income tax:

$$DWC = \frac{1}{2} \frac{\tau^2}{(1-\tau)} TI \epsilon$$

where τ is the marginal tax rate, TI is the taxable income, and ϵ is the elasticity of taxable income with respect to net-of-tax share. The percentage change in deadweight costs from a change in tax rate from τ_0 to τ_1 is then

$$\frac{dDWC}{DWC} = \frac{\tau_1^2 (1 - \tau_0)}{\tau_0^2 (1 - \tau_1)}$$

Note the percentage change does not depend on the elasticity of taxable income. In my computation, τ_0 is measured as a sum of the federal and state average marginal tax rate in a state one year prior the adoption of withholding. The average marginal tax rate for the federal tax is taken from Barro and Sahasakul (1983). The data for a state average marginal tax rate is not available for the period in question, therefore I assume that the ratio of the average marginal tax rate and the average tax rate for the state taxes is the same as for the federal tax. The federal average tax rates are also reported in Barro and Sahasakul (1983), and I construct the state average tax rate as a ratio of state income tax revenue to state personal income from my own dataset. The state average marginal tax rate is then easily imputed. τ_1 is the revenue-neutral post-withholding average marginal tax rate - i.e., the federal average marginal tax rate plus the state average marginal tax rate reduced by 23.7 percent. The federal average marginal tax rate one year prior to the adoption of withholding is, on average, 23.7 percent, and the imputed state average marginal tax rate is, on average, 1.6 percent. The percentage reduction in deadweight cost due to withholding is computed for each state and it ranges from 0.08 (Mississippi) to 5.5 (Wisconsin). The percentage reduction is the greatest in the states that have a high average tax rate. On average, I find that withholding reduced the deadweight cost of income taxes by 2.8 percent.

The impact of withholding on the administrative costs of tax collections is unclear. On one hand, there is obviously more paperwork involved. On the other hand, the costs of collecting taxes from delinquent taxpayers, potential evaders, and non-residents are probably much lower under withholding. When the tax returns are due, most of the tax liabilities that would have remained unreported or owed under the traditional system are already in the government coffers. It is not surprising that before withholding was expanded to all payroll income, some states were requiring it for non-resident income, where the costs of chasing delinquent taxpayers are larger. Combining these two effects suggests that withholding has probably increased the *fixed* but reduced the *marginal* administrative costs of income tax collection. Administrative costs count as deadweight costs of taxes, and it is the marginal, not fixed deadweight cost that matters for the size of government.

The history of state income taxes and withholding mimics, to some extent, the federal experience with a lag. Today, the individual income tax is (together with the general sales tax) the main source of revenue for state governments and represents 36 percent of states' total tax revenue. Yet back in 1932, income taxes were relatively unimportant, representing mere 4 percent of total tax revenue.⁷ During the 19th and in the early 20th century, states' efforts to tax income were frustrated by their inability to effectively collect the tax. In 1911 Wisconsin was the first state to enact a modern, broad-based income tax. State individual income taxes became widespread during the 1930's, when 18 states implemented them. Yet still by 1944, they represented less than 9 percent of tax revenues in the states that were imposing them, and mere 6 percent in all states.

In 1948, Oregon became the first state to require withholding on all wage and salary income. Nine states adopted withholding in the following 10 years (see Table 1). Adoption culminated during 1959-

⁷Source: Census of Governments.

1961, when 12 states joined the withholding club. With the exception of North Dakota, all 29 states that had a broad-based income tax at the end of the World War II implemented tax withholding by the early 1970's. (Perhaps surprisingly, California was the last one in 1971.) There were also 10 states that introduced individual income tax during the 1960's and 1970's. *All* of these states chose to withhold from the outset. Withholding has become an "industry standard" in the tax collection business. No state has abolished it, or even considered to abolish it.

3 Theoretical model

There is no shortage of alternative positive models of the size of government that predict a link between deadweight costs and the size of government. They include Becker and Mulligan (1998) model of political competition among interest groups, Meltzer and Richard (1981) model of income redistribution under majority voting, Hettich and Winer (1988) model of public goods provision under probabilistic voting, Grossman and Helpman (1996) model that combines both interest groups and voting, or Brennan and Buchanan (1980) of government as a Leviathan. While these models differ markedly in their view of how the public choice process works and how the size of government is determined, the political equilibrium in each of these models is typically equivalent to the solution to the social planner's problem (Samuelson (1954)) of maximizing a weighted sum of agents' utilities. Alternative mechanisms of public choice give different groups of taxpayers and subsidy recipients different "political power", which is reflected in the weights in the social planner's problem.

As a consequence, these models typically yield identical predictions on how the tax system responds to an improvement in the efficiency of a single tax source (the income tax in our case). The logic of the argument follows from the planner model, in which the marginal deadweight costs are equalized across tax sources and are equal to the social marginal benefit of public spending. A decline in the deadweight costs of the income tax implies that first there should be a *substitution effect*: for a given amount of total revenue, income tax revenue should increase and revenue from other taxes decrease in order to equalize marginal deadweight costs across tax sources. Since the entire tax system has become socially cheaper, there should also be a *scale effect*: both the income tax revenue and revenue from other taxes should increase to equalize the marginal benefit with marginal deadweight cost.

Below I use the social planner framework to formally model the effect of income tax withholding on the level and composition of tax revenues.⁸ The government provides G dollars of public spending, which creates a social benefit $\gamma B(G)$. The function $B(G)$ is increasing and concave. The parameter γ reflects both the value of public spending to its recipients as well as changes in their political power. An increase in γ hence represents a positive shock to the demand for government. The government has two revenue sources: the income tax, denoted R^I , and other taxes, denoted R^O .

To collect the income tax, the government imposes a flat rate τ on income y . However, the government is an imperfect tax collector, and the revenue actually collected is given by the technology of tax collection function:

$$R^I = a\tau y \tag{1}$$

The parameter $a \in (0, 1)$ is a fraction of revenue that the government collects compared what it ideally should collect. It depends, for example, on state's economic characteristics and the state's

⁸Before describing the model, an alternative view on withholding should be mentioned. A popular argument accuses withholding of reducing the visibility of the income tax. Allegedly, taxpayers do not perceive the tax as strongly as they did under the traditional method of collection, and they may be willing to accept higher taxes. However, despite the intuitive appeal, it seems difficult to accept the view that taxpayers can be fooled all the time, and that they do not know how much they pay in taxes just because they do not pay them at once. The fact that withholding makes paying the tax more comfortable does not necessarily imply that taxpayers are willing to accept higher taxes. Moreover, the empirical literature on other aspects of fiscal illusion has found evidence that is mixed at best. (Oates 1991). In the remainder of the paper, the focus is entirely on the "real effects" of withholding.

expenditures on tax enforcement. ay can be thought of as the taxable income - the fraction of income that is effectively being taxed. The deadweight costs increases linearly in taxable income and the elasticity of taxable income ϵ , and quadratically in the tax rate:

$$C(R^I) = \frac{1}{2}\tau^2(ay)\epsilon = \frac{1}{2}\frac{\epsilon}{ay}R^{I2}$$

where the last expression follows from the substitution of equation 1 and explicitly shows that the deadweight cost of the income tax falls when the government's ability to collect the tax improves.

Withholding enters this model as a (potentially large and discontinuous) increase in a : $da > 0$. More revenue is collected at a given tax rate and income. The percentage increase in the revenue collected, da/a is referred to as the "efficiency effect" of withholding and is one of the parameters of interest in the empirical section.

The specific composition or collection technology of other taxes is not of particular interest; I merely assume that the deadweight costs of other taxes is increasing in their square: $C(R) = \frac{1}{2}\delta R^{O2}$.

The government's problem is to choose R^I and R^O in order to maximize the social benefit of spending net of the deadweight costs of taxes:⁹

$$\max_{R^I, R^O} \gamma B(G) - \frac{1}{2}\frac{\epsilon}{ay}R^{I2} - \frac{1}{2}\delta R^{O2} \text{ s.t. } R^I + R^O = G$$

The solution to the problem is best characterized in two stages: First, for any given G , the government is choosing the mix of taxes ($R^{I*}(G), R^{O*}(G)$) that minimizes the deadweight costs. The solution to the first stage defines the deadweight costs of the tax system, $C(G) = C(R^{I*}(G)) + C(R^{O*}(G))$. Second, the government is choosing the total level of taxes/spending that maximizes $\gamma B(G) - C(G)$.

The solution to the first stage gives the familiar result that the marginal deadweight costs must be equalized across both tax sources. It is straightforward to verify that

$$\begin{aligned} C(G) &= \frac{1}{2}\frac{\delta\epsilon}{a\delta y + \epsilon}G^2 = \frac{1}{2}cG^2 \\ R^{I*}(G) &= \frac{a\delta y}{a\delta y + \epsilon}G = \frac{ay}{\epsilon}cG = s^I G \\ R^{O*}(G) &= \frac{\epsilon}{a\delta y + \epsilon}G = \frac{1}{\delta}cG = s^O G \\ \frac{R^{I*}}{R^{O*}} &= \frac{\delta}{\epsilon/ay} \end{aligned}$$

Both tax sources increase proportionally with total taxes and are inversely related to their deadweight cost parameters. Observe that the expressions $\frac{ay}{\epsilon}c$ and $\frac{1}{\delta}c$ denote the shares s^I and s^O of the income tax and other taxes, respectively, which are easily observable in the data.

The solution to the second stage determines the optimal size of government and is given by equalizing the marginal benefit of spending with marginal deadweight costs:

$$\gamma B' = cG \tag{2}$$

Equation 2 implicitly defines the demand for government revenues as a function of the demand and deadweight cost parameters. The comparative statics on a show the effect of withholding on total revenue and its composition:

⁹For income taxes, the direct choice variable is the tax rate τ instead of revenue R^I . However, it is analytically much more convenient to solve the model for R^I ; the tax rate then drops out according to $\tau = \frac{R^I}{ay}$.

$$\frac{dG}{da} = \frac{y}{\epsilon} \frac{c^2}{c - \gamma B''} G > 0 \quad (3)$$

$$\frac{dR^I}{da} = s^I \frac{dG}{da} + \frac{\partial s^I}{\partial a} G = \tau y \left(1 + \frac{acy}{\epsilon} \frac{\gamma B''}{c - \gamma B''} \right) = \tau y \beta^I > 0 \quad (4)$$

$$\frac{dR^O}{da} = s^O \frac{dG}{da} + \frac{\partial s^O}{\partial a} G = \frac{c^2 y}{\delta \epsilon} \frac{\gamma B''}{c - \gamma B''} G = \tau y \beta^O < 0 \quad (5)$$

Equation 3 shows that spending must increase, because it becomes cheaper to raise additional dollar of revenue. Equation 4 shows the response of income taxes and decomposes it into two effects: a scale effect and a substitution effect. The scale effect (the first term) reflects the higher demand for revenue induced by a reduction in marginal deadweight costs. The substitution effect (the second term) is the change in the share of income tax in total revenue. For income taxes, the substitution effect reinforces the scale effect.

There is an alternative, perhaps more intuitive way of decomposing the increase in income taxes. The efficiency effect mechanically produces a windfall of extra revenue $\tau y da$. Even if the government did not do anything but merely kept this windfall of revenue, we would see an increase in income tax revenues. However, the pre-withholding tax rate is no longer optimal, and the government should respond to an increase in a by adjusting the tax rate. I refer to the change in income tax revenues due to the adjustment in tax rate as the "political effect" of withholding, denoted β^I . The overall increase in income taxes, dR^I/da , is thus a product of the efficiency and political effects.

The political effect β^I reflects the sensitivity of demand for public spending to the efficiency improvement brought by withholding and has an intuitive interpretation. If $\beta^I = 0$, $dR^I/da = 0$ - tax revenues do not respond to deadweight costs. Once withholding is adopted, the tax rate should be reduced so that the government ends up collecting the same revenue as before. Essentially, the government would return the entire windfall of revenue from withholding back to taxpayers. Note, however, that $\beta^I = 0$ is inconsistent with the models predicting a link between tax efficiency and the size of government. $\beta^I = 1$ is a special case when the government simply keeps the extra revenue and does not change the tax rate. One can also imagine a demand for public spending so elastic with respect to tax efficiency that the government would increase the tax rate and end up collecting extra revenue "on top of" the efficiency effect - that is, $\beta^I > 1$. This seems to be suggested by Friedman's assessment of the post-war growth of the income tax - the government discovered how efficient revenue generator the income tax had become, and started using it even more.

Equation 5 shows the response of other taxes. The substitution effect is negative and dominates over the scale effect, so the revenue from other taxes must decrease. The substitution effect is greater than the scale effect because as total spending increases, the marginal benefit of spending decreases, which means that the marginal deadweight costs of both the income tax and other taxes must decrease. Since the efficiency of other taxes has not changed, revenue from other taxes must be reduced in order to reduce the marginal deadweight costs. The equation also shows that the response of other taxes can be expressed as a product of the efficiency and political ($\beta^O < 0$) effects - intuitively, the greater the efficiency improvement due to withholding, the more should other taxes decline.

The relative importance of the scale and substitution effect is of particular interest. When one tax becomes more efficient, do governments respond mainly by reshuffling the composition of revenues while changing the total revenues very little, perhaps not at all? Or are total revenues very sensitive to the improvement in efficiency? Answering these questions has, among other things, normative consequences for taxpayers, who clearly benefit from an efficiency improvement if the scale effect is zero, while they need not benefit if the scale effect is large.

To summarize, the model generates the following predictions about the responses of the tax system to withholding: (1) income tax revenues should increase, (2) total revenues should increase, (3) revenues from other taxes should decrease, and (4) the share of income tax in total revenue should increase.

So far the analysis assumed that the change in a is an exogenous shock. In fact, a is endogenous since the governments choose not only the tax revenues, but also whether to adopt withholding or not. The U.S. states adopted withholding voluntarily and for a reason. At a very general level, we may assume that withholding is implemented whenever the benefit exceeds the costs. The cost of withholding $F(da)$ includes the obvious administrative costs but may also capture the political costs, such as the unpopularity of withholding among taxpayers who were able to avoid taxes in its absence. The benefit of withholding is the reduction in deadweight costs, $(\epsilon/a^2y)R^I da$. Withholding is adopted when

$$F(da) < \frac{\epsilon}{a^2y}R^I da \quad (6)$$

Since it took five years since the federal withholding for the first state to adopt state-level withholding, and it took another 12 years for the majority of states to follow, the costs of withholding must have been significant and initially made the adoption not worthwhile. Withholding is adopted either when the costs $F(da)$ falls, when the income tax becomes less efficient (ϵ/ay increases) or when the income tax revenue R^I reaches a critical level so that the efficiency gain is large enough. An example of a decline in $F(da)$ at the state level may be the federal withholding, since it reduced the administrative costs of withholding at the state level. It helps explain why no state had withholding before the federal government, but it fails to explain why the states did not implement withholding shortly afterwards. Adoption stimulated by the decline in the costs of withholding is referred to as "supply-driven" adoption in the remaining text.

When the income tax revenues reach the critical level, a "demand-driven" adoption occurs. In the language of the model, the demand parameter γ is high enough to warrant income tax revenues that are high enough so that withholding pays off. We should observe that the adoption of withholding follows after a period of growth of income tax revenues. More importantly, "demand-driven" adoption can occur only at a time when the demand for spending increases. Withholding is, after all, a technology that generates more revenue, so it is natural to expect adoption when governments need more revenue. An example is the adoption of federal withholding, where the increase in γ was due to the war.

When adoption is supply-driven, the predictions of the model are the same as if da were exogenous. However, the simultaneity of da and $d\gamma$ under demand-driven adoption has significant implications for the *observed* changes in tax revenues after withholding. While the predicted responses dR^I/da and dR^O/da are described in equations 4 and 5, they are mingled with responses to the demand shock:

. Then, the total change in tax revenues that follows the demand-driven adoption is

$$dR^I = \frac{dR^I}{da} da + \frac{dR^I}{d\gamma} d\gamma = \frac{dR^I}{da} da + s^I \frac{dG}{d\gamma} d\gamma = \frac{dR^I}{da} da + \frac{ay}{\epsilon} c \frac{B'}{c - \gamma B''} d\gamma > 0 \quad (7)$$

$$dR^O = \frac{dR^O}{da} da + \frac{dR^O}{d\gamma} d\gamma = \frac{dR^O}{da} da + s^O \frac{dG}{d\gamma} d\gamma = \frac{dR^O}{da} da + \frac{1}{\delta} c \frac{B'}{c - \gamma B''} d\gamma \leq 0 \quad (8)$$

where the second term in each expression shows the response of taxes to the demand shock (both tax sources increase proportionally when the demand for public spending increases).

The post-withholding changes in tax revenues cannot be attributed solely to the causal relationship from efficiency to taxes. Income taxes increase by more than what dR^I/da predicts. It need no longer be true that the income tax rate should decline (that is, we may observe $\beta^I \geq 1$). Similarly, other taxes do not decrease by as much as dR^O/da predicts, and they may even rise (we may observe $\beta^O > 0$). In this case, other taxes should increase less than income taxes because of the substitution effect. In fact, a rise in other taxes and the income tax rate would indicate that adoption was demand-driven. This feature will be used in the estimation to detect whether adoption was supply or demand-driven.

4 Empirical strategy

4.1 The model

Below I derive an econometric model of the technology of tax collections and demand for tax revenues that directly reflects the structure of the theoretical model. For expositional clarity, the model presented here abstracts from the complexities of the actual income tax schedules and assumes that all income y_{it} is taxed at a flat tax rate τ_{it} , without any exemptions, deductions, or loopholes. Estimation issues raised by relaxing this assumption will be discussed in subsection 4.3. The subscripts i and t denote state and year, respectively. All financial variables (revenues and income) are in per capita terms.

The technology of tax collections is defined as follows:

$$R_{it}^T = (1 + \alpha D_{it}) r^T(X_{it}, y_{it}) \tau_{it} y_{it} e^{u_{it}^T} \quad (9)$$

The term $(1 + \alpha D_{it}) r^T(X_{it}, y_{it})$ is an empirical counterpart of a in equation 1. D_{it} is a dummy variable indicating whether a state has withholding, The coefficient on the withholding dummy, α measures the efficiency effect - the percentage increase in tax collections holding the tax rate constant (that is, $\alpha = da/a$). The term $r^T(X_{it}, y_{it}) < 1$ denotes the fraction of income that the government is able to tax in the absence of withholding. It is assumed to be a function of X_{it} , the socio-economic variables that affect the government's ability to raise revenue, and the income per capita is explicitly included among these variables. u_{it}^T is the error term.

Equations 10 and 11 express, in a reduced form, the demand for income tax revenue, R_{it}^D , and demand for revenue from other taxes, R_{it}^O . They are functions of the socio-economic parameters of the state and also the efficiency effect of withholding:

$$R_{it}^I = (1 + \beta^I \alpha D_{it}) r^I(y_{it}, X_{it}, Z_{it}) e^{u_{it}^I} \quad (10)$$

$$R_{it}^O = (1 + \beta^O \alpha D_{it}) r^O(y_{it}, X_{it}, Z_{it}) e^{u_{it}^O} \quad (11)$$

The parameters β^I and β^O denote the political effects, also our parameters of interest. Both β^I and β^O interact with α because, as the model predicts, the political effect is greater (in absolute terms) the more revenue withholding brings in. The products $\beta^I \alpha$ and $\beta^O \alpha$ are of interests themselves - they denote the "total effect" of withholding, the overall change in revenue (in percent) due to efficiency and political effects combined. The functions $r^I(\cdot)$ and $r^O(\cdot)$ are empirical counterparts of the parameter γ in the theoretical section and reflect changes in the demand for public spending due to factors other than efficiency of taxes. Z_{it} are variables that affect the demand but not the tax technology, and u_{it}^I and u_{it}^O are error terms.

Faced with the demand and the technology functions, the government selects the tax rate τ_{it} such that the income tax revenue demanded equals the revenue collected:

$$R_{it}^I = R_{it}^T \Leftrightarrow \tau_{it} = \frac{(1 + \beta^I \alpha D_{it}) r^I(y_{it}, X_{it}, Z_{it}) e^{u_{it}^I}}{y_{it} (1 + \alpha D_{it}) r^T(X_{it}, y_{it}) e^{u_{it}^T}} \quad (12)$$

I assume a log-linear functional form for r^T , r^I and r^O :

$$\begin{aligned} \log r^T &= a_X \log X + a_y \log y \\ \log r^I &= \gamma_X^I \log X + \gamma_y^I \log y + \gamma_Z^I \log Z \\ \log r^O &= \gamma_X^O \log X + \gamma_y^O \log y + \gamma_Z^O \log Z \end{aligned}$$

Taking take logs of the equations 9, 10 and 12 gives a system of estimating equations:

$$\log R_{it}^I = \log(1 + \alpha)D_{it} + \log \tau_{it} + (1 + a_X) \log X_{it} + (1 + a_y) \log y_{it} + u_{it}^T \quad (13)$$

$$\begin{aligned} \log \tau_{it} &= \log\left(\frac{1 + \beta^I \alpha}{1 + \alpha}\right)D_{it} + (\gamma_X^I - a_X) \log X_{it} + (\gamma_y^I - a_y - 1) \log y_{it} + \\ &\quad + \gamma_Z^I \log Z_{it} + u_{it}^I - u_{it}^T \end{aligned} \quad (14)$$

$$\log R_{it}^O = \log(1 + \beta^O \alpha)D_{it} + \gamma_X^O \log X_{it} + \gamma_y^O \log y_{it} + \gamma_Z^O \log Z_{it} + u_{it}^O \quad (15)$$

The system can be estimated by three-stage least squares and α , β^I , and β^O can be identified. Identification requires variables, denoted Z , that affect the demand for revenue but not the government's ability to collect it. I have two variables for which we can be reasonably confident that this condition is satisfied: the percentage of Democrats in the state legislature, and federal grants. The percentage of Democrats obviously reflects the tastes of voters for specific government policies (including redistributive policies). Yet it is difficult to imagine how this variable could affect the tax collections, unless more Democratic states are more likely to use some unobservable methods of tax collections (such as more frequent audits). Similarly for federal grants - they are correlated with the demand for revenue through the so called "flypaper effect", widely documented in the literature¹⁰, and through matching grants, when a federal grant for a given project is conditional on the state's providing a certain fraction of funds from its own sources. To be a valid instrument, the grants cannot be awarded on the basis of the state's unobserved ability to raise revenue, as would occur if the federal government "compensated" the states with a poor record of tax collection by higher grants.

4.2 Endogeneity of withholding

The above procedure gives unbiased estimates of the parameters of interest only if withholding was an exogenous shock, randomly superimposed upon the states, or if its adoption was supply-driven. Demand-driven adoption complicates things, because increases in both a and γ affect tax revenues simultaneously. If the increase in γ comes only from the observable variables X_{it} or Z_{it} , we still obtain unbiased estimates. However, if the increase in γ comes from an *unobservable* shock to the demand for public spending, withholding dummy and the error term would be correlated and the estimates of β^I and β^O would be biased upward. However, we can still make inference. First, the theoretical model provides two tests that detect an unobservable demand shock. Second, the model allows to set bounds on the demand shock.

Our ultimate goal is to test the predictions of the model that tax revenues respond to a reduction in deadweight costs. To do so in the possible presence of demand-driven adoption, it is useful to combine the equations 4-5, and 7-8 to decompose the percentage increase in income taxes and other taxes associated with withholding (estimated as $\widehat{\alpha\beta^I}$, $\widehat{\alpha\beta^O}$):

$$\widehat{\alpha\beta^I} = \dot{R}^I = \dot{s}^I + \dot{G}_a + \dot{G}_\gamma \quad (16)$$

$$\widehat{\alpha\beta^O} = \dot{R}^O = \dot{s}^O + \dot{G}_a + \dot{G}_\gamma \quad (17)$$

The first term is the substitution effect, the percentage change in the share of each tax source, holding revenue constant. The second term, \dot{G}_a is the scale effect, the percentage increase in total revenue due to the efficiency shock. The third term, \dot{G}_γ is the demand shock, the percentage increase in revenue due to an unobservable increase in γ .

¹⁰For a recent survey, see Hines and Thaler (1995).

First, consider the supply-driven adoption, a case when $\dot{G}_\gamma = 0$. If the model is wrong and tax revenues do not respond to efficiency ($dR^I/da = 0, dR^O/da = 0$), we should obtain estimates $\widehat{\alpha\beta^I} = 0$ and $\widehat{\alpha\beta^O} = 0$. The model would be supported by finding that $\widehat{\alpha\beta^I} > 0$, $\widehat{\beta^I} \in (0, 1)$ and $\widehat{\alpha\beta^O} < 0$. The decomposition into scale and substitution effects would be straightforward. The scale effect is computed as the increase in total revenues: $\dot{G}_a = s^I \dot{R}^I + s^O \dot{R}^O$. The substitution effect follows directly from equation 16: $\dot{s}^I = \dot{R}^I - \dot{G}_a$ and equivalently for other taxes.

Now consider demand-driven adoption, when $\dot{G}_\gamma > 0$. If taxes do not respond to efficiency, only the demand shock will change the revenues. We should therefore obtain estimates $\widehat{\alpha\beta^I} = \widehat{\alpha\beta^O} = \dot{G}_\gamma$. That is, income taxes and other taxes should increase by the same percentage. If the model is correct, income tax revenues should increase by more than the demand shock and other taxes should increase by less than the demand shock, therefore, we should obtain estimates $\widehat{\alpha\beta^I} > \widehat{\alpha\beta^O}$. If the demand shock is small enough we can still obtain $\widehat{\beta^I} \in (0, 1)$ and $\widehat{\alpha\beta^O} < 0$. In this sense we would "miss" the demand shock even if there was one. However, if the demand shock is large enough, we can find that $\widehat{\beta^I} \geq 1$ or that $\widehat{\alpha\beta^O} \geq 0$. Increases (or no change) in other taxes and increases (or no change) in the tax rate provide unambiguous evidence that $\dot{G}_\gamma > 0$ and therefore adoption was demand-driven.

If adoption is demand-driven, we cannot precisely decompose the increase in total revenues into scale effect and the demand shock, but we can at least put bounds on both. Note we can easily obtain the increase in total revenue, due to the scale effect and the demand shock combined: $\dot{G}_\alpha + \dot{G}_\gamma = s^I \dot{R}^I + s^O \dot{R}^O$. As in the case of supply-driven adoption, we can pin down the substitution effect: $\dot{s}^I = \dot{R}^I - (\dot{G}_\alpha + \dot{G}_\gamma)$, and equivalently for other taxes. We can set an upper bound on the demand shock by assuming that the scale effect is zero and the entire increase in total revenue comes from the demand shock: $G_\gamma^{\max} = s^I \dot{R}^I + s^O \dot{R}^O$. To set a lower bound, we can use the fact that the response of other taxes is negative: $\dot{s}^O + \dot{G}_\alpha < 0$. Therefore the increase in other taxes is the minimum by which the demand must have increased: $G_\gamma^{\min} = \dot{R}^O$. The difference between the increase in total revenue and the increase in other taxes then sets an upper bound on the scale effect: $G_\alpha^{\max} = G_\gamma^{\max} - \dot{R}^O$.

To summarize this discussion, Table 2 systematically shows what estimates would reject or support the model under both supply-driven and demand-driven adoption.

Table 2		
Testable predictions		
	Model supported $dR^I/da > 0, dR^O/da < 0$	Model rejected $dR^I/da = 0, dR^O/da = 0$
Supply-driven adoption	$\alpha\beta^I > 0, \beta^I \in (0, 1)$ $\alpha\beta^O < 0, \beta^O < 0$	$\alpha\beta^I = 0, \beta^I = 0$ $\alpha\beta^O = 0, \beta^O = 0$
Demand-driven adoption:	$\alpha\beta^I > \alpha\beta^O$ $\alpha\beta^I > 0, \beta^I \in (0, \infty)$ $\alpha\beta^O < > 0$ ($\beta^I \geq 1$ and $\alpha\beta^O > 0$ prove demand-driven adoption)	$\alpha\beta^I = \alpha\beta^O > 0$

It should be noted that the prediction of the model should hold only in the long run. The model has no time dimension; the political process adjusts simultaneously to the efficiency shock. Yet in the real world the political process probably responds to a shock with a lag. It takes some time (perhaps a few fiscal years) for the interest groups, voters and legislators to observe the shock and learn about

its magnitude; it takes additional time until their responses to the shock translate into legislative changes in the tax structure. For example, procedural guidelines slow down the legislative process. The new vote-maximizing tax policy may be discovered by a party that is not currently in power, hence the new policy gets implemented only after the party wins the next election. Instantaneous response would require, at the very least, a perfect foresight of the efficiency effect. It turned out, however, that withholding was a bigger success than originally expected. In his survey of revenue officials, Murray (1964) asked whether the improvements in tax collections due to withholding met their expectations, and found that "eight of the fourteen answers to this question indicate that the estimates were too low and only one records an overly optimistic estimate." Therefore even if the political process reacts instantaneously, we should expect the political effect of withholding to occur with some lag. In the short run, we may expect to see only the mechanical increase in income tax revenue due to the efficiency effect. I will be estimating the speed of response non-parametrically by replacing the withholding dummy with a set of dummy variables representing each year before and after adoption and so will be able to distinguish the short-run from long-run responses.

4.3 Additional estimation issues

There are additional practical issues that need to be addressed when estimating the equations 13-15.

First, the actual tax systems are not characterized by a single flat tax rate, but by a (rather large) number of variables such as progressive tax rates, income brackets, exemptions, deductions, credits, differential treatment of different sources of income, etc. To obtain an estimate of α , I treat τ_{it} as a vector of tax variables, include all of them into the technology equation (13) and have a separate demand equation (14) for each variable. However, this procedure produces estimates of many β^I s, one for each tax variable. These are not our ultimate parameters of interest, since changes in tax rates or brackets in actual tax systems do not translate one-for-one to changes in income tax revenues. To obtain a consistent estimate of the "true" β^I , I separately estimate the system of demand equations for all tax sources (10-11, in logs) by seemingly unrelated regressions, to allow for the possible correlation of error terms across taxes. The coefficient on the withholding dummy in the income tax equation is the total effect of withholding, $\log(1 + \alpha\beta^I)$, from which β^I is easily recovered by substituting the estimate of α from the technology equation, and its standard error is computed by the delta method. The disadvantage of this method is that since I have only two instruments for the tax rate, I can use only two tax variables in the technology equation. Naturally, I choose the lowest and the top tax rate.

As an alternative, I estimate the technology equation by OLS, and include all available tax variables in the technology equation. While OLS may produce a biased estimate of α due to the correlation between αD and τ , it enables me to include all available tax parameters in the regression, which should reduce the omitted variable bias. Fortunately, the estimates of α are quite insensitive to the particular estimation method.

In all regressions that follow, state and year dummies are included to capture unobservable fixed effects that are constant within a state over time, or across states within a year. The standard errors are computed by the "robust" standard error estimator (Kezdi (2001)), where the clustering is by state. It is likely that unobservable shocks u^I , u^O , and u^T in state i , time t , are correlated to the shocks in state i at other times, even after picking up the state fixed effect. It has been established that the failure to account for the within-unit autocorrelation between residuals leads to an underestimate of the standard error of the difference-in-differences estimator (Bertrand, Duflo and Mullainathan (2001)). The robust estimator eliminates this concern.

4.4 Data

The dataset is an annual panel of 48 states from 1944 till 1980. The data on state government tax revenues (by each tax source), general expenditures (broken down into six major categories), federal

grants and debt were taken from "Compendium of State Government Finances", an annual printed publication by the Bureau of Census. Alaska and Hawaii are excluded because fiscal data for these states are available only since 1959 and by that time, both states already had withholding. The information on when each state implemented income tax withholding and the income tax itself comes from Murray (1964) and Penniman (1980).

The Book of the States, a biennial publication by the U.S. Bureau of Census, provided some information on the design of the income tax systems at the state level. Since 1947, the publication reports the lowest statutory tax rate, the end of the lowest income bracket, the top tax rate, and the beginning of the top income bracket, as well as some special provisions (temporary surtaxes, differential tax rates on dividend income etc.). More detailed information (total number of income brackets, exemptions or credits for single and married taxpayers and dependents, etc.) is reported only from 1960 onwards; unfortunately by this time a majority of states had adopted withholding so this information is not useful for before-after analysis. The publication also describes legislative changes occurring in each calendar year, which makes it possible to fill in the tax rates for those years that are not reported in biennial tables.

A variety of socio-economic control variables is used in the regressions. The data on state population, personal income, share of farm income¹¹, and share of interest and dividend income in state's personal income come from Bureau of Economic Analysis, Regional Accounts Data. The percentage of state population that is black, elderly (65+) and lives in urban areas was obtained from Census enumerations.¹² The data on the percentage of Democrats in the state legislature was provided by the National Council on State Legislatures.¹³

The personal income variables were converted into real 1982 dollars by the consumer price index. Government revenue and expenditure variables were converted into real 1982 dollars by the "state and local government expenditure deflator". Both indices are published in the Economic Report of the President.

Table 3 presents summary statistics for the subsample of states that is used for estimation, i.e., those states that had a broad-based individual income tax at the beginning of the sample period.

5 Results: income taxes and other taxes

Figure 1 provides a cursory exploration into the impact of withholding on income tax revenues. The vertical axis shows the ratio of income tax revenues to the state's personal income, averaged across the 29 states which had income tax in 1944. All state years on the horizontal axis are normalized so that year zero is the fiscal year in which a state implemented withholding. While the figure has to be read with caution since no other factors affecting tax revenues are controlled for, it strongly suggests that withholding indeed had a profound impact on income tax revenues. Income tax revenues grow steadily before withholding until they reach 0.66 percent of personal income, then they discontinuously jump up to 1 percent immediately after withholding is adopted, and later continue to grow at a slightly higher rate.

In the same vein, Figure 2 shows the evolution of the sum of sales and corporation income taxes before and after withholding. We can see that these major revenue alternatives to the income tax do not fall in absolute terms after withholding. They fluctuate around 3 percent before, then they jump up somewhat once withholding is adopted, and then continue to grow to about 3.5 percent of personal income in eight years. This suggests that a demand shock motivated the adoption of withholding and

¹¹The farm income is very volatile and is negative for some states in some years. Since this variable is meant to capture the long-term agricultural vs. industrial character of the state rather than short-term shocks to agricultural incomes, I use three-year moving averages of farm income in the analysis.

¹²Since Census data are decennial, observation for the years between censuses were generated by simple linear extrapolation.

¹³I am indebted to Tim Storey of NCSL for sharing this data.

manifested itself in the growth of other taxes, not just the income tax.

Table 4 presents estimates of the three-stage least squares model of tax technology with endogenous top and lowest tax rates. The key result is that withholding generated 23.7 percent more revenue holding tax rates constant. The coefficient on the withholding dummy is significant at 1% significance level.

In the tax rate equations (column (2) and (3)), the coefficients on the withholding dummy are small in magnitude (0.033 and -0.026 for the top and lowest tax rates, respectively) and insignificant. This suggests that states did not adjust income tax rates in either direction in response to withholding, but merely "cashed in" the windfall of revenue from improved collection. Several socio-economic variables significantly affect the top tax rate. Namely, higher income per capita, share of black population, and share of urban population are associated with lower top tax rate. Higher share of Democrats in the state legislature is associated, as one might expect, with a higher top rate.

The estimates of the efficiency effect are very robust to alternative specifications. If we ignore the endogeneity of tax rates and estimate the technology equation by OLS (Table 5, column (1)), the coefficient on the withholding dummy is 0.27 and is also significant at 1%. Virtually the same coefficient is obtained if we include additional tax parameters (the lowest and highest tax brackets and their interactions with tax rates) in the regression (Table 5, column (2)). This gives us great confidence that withholding indeed substantially improved collections.¹⁴

Table 6 estimates the system of demand equations for all taxes. The coefficient on the withholding dummy in the income tax equation (column (1)) is the estimate of the total effect. The total effect (0.297) is only marginally larger than the efficiency effect, which is consistent with the previous finding that the tax rates did not change significantly in response to withholding. This estimate, and the estimated efficiency effect from Table 3, are used to compute the estimate of β^I , reported in the bottom of Table 6. The estimated β^I of 1.279 is significantly greater than zero, but not significantly greater than one, hence we cannot reject the hypothesis that withholding did not induce a change in tax rates and all post-withholding increase in income tax revenue is accounted for solely by the efficiency effect.

How did other taxes respond? According to Table 6, the corporation income taxes and sales taxes increased by 8.1 and 6.4 percent, respectively. Both estimates are statistically significant. The only tax category that declined was "miscellaneous taxes", which include property, license, death and gift, poll, and other miscellaneous taxes, although the estimated decline is not statistically significant and much smaller in magnitude (3 percent). Note that the percentage increase in the other taxes is much lower than an increase in income taxes. This holds also in absolute levels: One year before withholding, the sales and corporation income tax revenues were, on average, \$207 and \$25 per capita, respectively. The estimated percentage increases represent an absolute increase by 13.2 and 2 dollars, respectively. On the other hand, the income taxes were \$58 one year before adoption, so the 29.4 percentage increase implies an absolute increase by 17 dollars.

Referring to Table 2, the results are clearly consistent with the predictions of the model in the presence of demand-driven adoption. The fact that an increase in income taxes significantly exceeds the increase in other taxes provides a strong evidence of a substitution effect. Governments do respond to changes in tax efficiency - at the very least they shift the composition of tax revenues and rely more heavily on the tax that becomes more efficient. However, is the scale effect of withholding also important? Or are the observed increases in all taxes solely due to the demand shock?

I decompose the estimated increases in revenues into substitution, scale and demand effect using equations 16 and 17. I use the estimates of the total effect from Table 6. The shares of income, corporation income, sales, and miscellaneous taxes one year before withholding are 15.2, 6.4, 54.3, and

¹⁴As another robustness test, I also re-estimated the models in a linear form, and always obtained positive and significant estimates of the efficiency effect. They implied an increase in tax revenue per capita by 11-14 dollars, depending on specification.

24 percent. The total increase in revenue is then $\dot{G}_\alpha + \dot{G}_\gamma = 7.7\%$.¹⁵ This is also an upper bound on the demand shock, under the assumption that the scale effect is zero. The lower bound on the demand shock is the increase in other taxes, 3.8%.¹⁶ The lower bound is based on an extreme assumption that the scale and substitution effect on other taxes precisely cancel out, while the model predicts that the substitution effect should dominate. As a consequence, the scale effect of withholding could not exceed the difference between the total increase in revenue and the lower bound on the demand shock: $7.7 - 3.8 = 3.9\%$.

The results thus show that the response to the efficiency shock increased taxes by 0 to 3.9 percent, while the demand shock accompanying withholding increased taxes by 3.8 to 7.7 percent. We cannot even rule out the possibility that the entire increase in taxes was due to the demand shock. However, since the model's prediction about the substitution effect are clearly supported, we can reasonably expect that the scale effect is not zero either. Nevertheless, the bounds tell us a lot about the relative importance of the demand versus the scale effect. The lower bound on the demand effect and the upper bound on the scale effect are equal.

Finally, the substitution effects measure the percentage changes in the shares of each tax and are computed as $\dot{s} = \dot{R} - (\dot{G}_\alpha + \dot{G}_\gamma)$. The share of the income tax in total tax revenues increased by 21.7 percent while the share of other taxes decreased by 3.9 percent. Translating these numbers into percentage points, we obtain that the share of income taxes increased and the share of other taxes decreased by 3.3 percentage points.¹⁷

One may be concerned that pre-existing unobservable trends are potentially biasing the above results. If, for example, some unobservable factor, positively correlated with the demand for tax revenue, was operating several years before a state adopted withholding, then the coefficient on a withholding dummy variable would be capturing the effect of such unobservable factor rather than an actual response to withholding. To check for possible unobservable trends, and to obtain additional insights about the speed of response of tax revenues to withholding, I estimate the same systems of equations as in Tables 4 and 6, but replace the withholding dummy with dummy variables each representing the year of adoption, the 1st, 2nd, etc. up to 8th year after adoption, and a dummy variable equal to 1 for 9 and more years after adoption. I also include dummy variables for the 1st, 2nd, etc. up to 9 and more years before withholding. The dummy variable representing the last year before adoption is taken out of the regression so that this year serves as the baseline. For expositional clarity, only the coefficients on the dummy variables from selected equations and their 95% confidence intervals are presented in Figures 3 through 7.¹⁸

Figure 3 plots the estimated efficiency effect from the three-stage model. It shows that there was no unobservable trend before the adoption and that the efficiency effect of withholding was immediate: Holding the tax rates constant, income tax revenues rose by 31.9 percent in the adoption year. The efficiency effect then declines until it reaches 18.7 percent 3 years after adoption. The reason for this decline is that the increase in the adoption year is represented in large part by the one-time forward shift in payments of taxes. This effect appears not only in the adoption year, but also in the first year after, because in many states withholding came into force on January 1, while in almost all states the fiscal year begins on July 1. Hence the forward shift in tax collections that occurs in the first 12 months after adoption is accounted for in two fiscal years. After the 3rd year, the technological effect rebounds back to 33 percent during the next five years. This is somewhat puzzling, since we would expect withholding to be a once-and-for-all improvement in tax collection technology. One possible explanation for this growth is that the states learned over time how to use the withholding system and gradually improved collections. We can speculate that after appreciating the benefits of withholding, the states expanded its use to the sources of income not initially covered (small firms, the self-employed), although I do not have direct evidence of that. The other explanation is that the

¹⁵Since $0.294 \times 0.152 + 0.081 \times 0.064 + 0.064 \times 0.543 - 0.031 \times 0.24 = 7.7\%$

¹⁶Since $(0.081 \times 0.064 + 0.064 \times 0.543 - 0.031 \times 0.24)/(0.064 + 0.543 + 0.24) = 3.8\% = 7.7\%$

¹⁷The model imposes a restriction that $(\partial s^I/\partial a)da = (\partial s^O/\partial a)da$.

¹⁸Complete results from the regressions are available upon request.

growth is picking up unobservable changes in the tax structure, and therefore we are overestimating the technological effect.

Figure 4 shows the total effect of withholding on income tax revenues by plotting the coefficients from the demand equation. It does suggest that there was an unobservable upward trend in the demand before adoption, although rather small in magnitude. The "pre-effect" of withholding grows steadily from -0.1 to zero during the eight years that precede adoption. Once withholding is adopted, income tax revenues immediately rise by 32 percent, decline somewhat (due to overlapping) in the next two years and then steadily grow again to 38 percent above the pre-withholding level over the next six years. The average value of coefficients on the dummy variables representing years before the adoption of withholding is -0.046 , which can be interpreted as the magnitude of the upward bias of the "static" estimate of the total effect (Table 6, column (1)). Deducting the pre-withholding trend would reduce the estimate from 0.294 to 0.248.

Figure 5 provides a direct comparison between the efficiency and total effects by plotting them in the same graph. The confidence intervals are not shown for expositional clarity. For all years after the adoption, the total and efficiency effect are almost identical, which confirms that all post-withholding growth in income tax revenues can be accounted for by the improvement in tax collection and that tax rates did not adjust to withholding (i.e., the political effect is $\beta^T = 1$). This finding also indicates that the adoption was demand driven, since the model predicts that in the absence of demand shock, the tax rates should be reduced and the total increase in revenue should fall short of the efficiency effect.

Last, the fact that income tax revenues did not increase "on top of" the efficiency effect refutes the assertion that withholding provided a major stimulus for accelerating the growth of income taxes. Although it substantially increased income tax revenues at the time of adoption, it only had a level effect, but not a growth effect.¹⁹

The ultimate test of the model comes from the response of other taxes. The coefficients on the pre- and post-withholding dummy variables for the sum of sales and corporation income taxes are plotted in Figure 6. One can see that the other taxes were actually on a downward trend (after controlling for other determinants) before withholding. The trend reverses exactly when withholding is adopted - other taxes jump up by 6.2 percent and then they continue to grow at a slow rate. The switch in the trend for other taxes²⁰, and especially their discrete jump in the adoption year provide strong evidence for the demand-driven adoption.

Finally, Figure 7 plots the difference between the coefficients on the income tax and coefficients on the sales and corporation income taxes, and confirms that the percentage increase in the demand for income taxes far exceeded the increase in other taxes, and hence withholding had a significant positive effect on the share of income taxes in total tax revenues.

While we interpret the estimated increases in corporation income and sales taxes due to withholding as an evidence of the demand shock that stimulated the adoption of withholding, there is a possible objection that withholding may have also improved the efficiency of other taxes. In the presence of such "technology spillover", all taxes may rise even if there is no demand shock, and the entire increase in income as well as other taxes could be interpreted as the causal effect of more efficient taxes. However, I do not find any evidence of such spillover. In Table 5, I estimate the technology of tax collection also for corporation income, general sales, and excise taxes, by regressing the revenue per capita against the respective tax rates, income per capita, and other variables that potentially effect collections. The results show no effect of withholding on the revenue from the other taxes, once

¹⁹If federal withholding had the same impact on the federal income tax, we can assert that Milton Friedman gives withholding too much blame for the growth of federal government.

²⁰As a statistical check, I regressed the coefficients for the 8 years before withholding and 8 years after withholding against a time trend. The coefficient on the time trend is -0.0045 before withholding and 0.0084 after withholding, and the difference between coefficients is statistically significant. This supports the claim that withholding reversed the unobservable trend in corporation income and sales taxes.

the tax rates are controlled for.²¹

In the absence of technology spillovers, the increase in other taxes should be explained by higher tax rates. Partial evidence of that is presented in Table 7, which presents the 3SLS estimates of the equations 13 and 14 (tax collection technology with endogenous tax rates) for the corporation income tax and the general sales tax. The results show that the income tax rate increased by 11.2 percent, but show only a statistically insignificant increase of the general sales tax rate.

6 Results: timing of adoption

Since the data support the model only under demand-driven adoption, I use standard techniques of duration analysis to explore directly factors that influenced the timing of adoption. While the results only answer the question "when" rather than "why" states adopt withholding, they at least provide more hints for the motives behind.

Equation 6 gives a very general adoption condition: the state should adopt withholding when the costs of withholding $F(da)$ fall below the efficiency gain, which is increasing in the revenue collected and in the deadweight cost parameter of the income tax (ϵ/ay). A fall in $F(da)$ or an increase in ϵ/ay leads to a supply-driven adoption. An increase in income tax revenue (after a steady growth or a sudden demand shock) leads to a demand-driven adoption. The model thus predicts, first of all, that states with higher income taxes should adopt withholding earlier. There are several variables which could potentially stimulate adoption through their effect on the demand for tax revenue: percent black and the elderly, Democrats in state legislature, federal grants and debt/revenue ratio (low federal grants or high debts imply that the states "need" more tax revenue).

Second, the model predicts that states with an inefficient income tax (low a or high ϵ) are more likely to adopt. Share of farm income and share of dividend income are potential proxies for a relative inefficiency of a state's income tax, and should have a positive effect on the likelihood of adoption. However, these variables could also be positively related to the costs of implementing withholding, which would have an opposite effect on the likelihood of adoption. Unfortunately, I do not have variables that directly measure the administrative costs of withholding. The effect of population should be positive effect if, as seems plausible, the total deadweight costs of an income tax are increasing linearly in population while the costs of implementing withholding per capita are decreasing in population due to scale economies in tax administration. An effect of these variables would indicate a supply-driven adoption.

I estimate two alternative duration models. The first is the logit discrete-time hazard model with time-varying covariates, described in Allison (1984) and used, for example, by Fischback and Kantor (1998) to analyze the adoption of workers' compensation laws:

$$\log[P(t|X)/(1 - P(t|X))] = A + bX + e$$

where $P(t|X)$ is the conditional probability of adoption in a discrete point in time t given that adoption did not occur prior to t and given the vector of covariates X . A and b are parameters of the model and e is the error term. Dummy variables representing distinct five-year intervals are included among the covariates to capture the baseline hazard.²² The second model is the Weibull proportional hazard model with time-varying covariates. I chose 1943, the year when withholding was "discovered" by the

²¹Ideally, the technology equations should be estimated by seemingly unrelated regressions, since unobservable shocks to collection are likely to be correlated across taxes. This way, however, we would lose many observations, since less than half of the states simultaneously impose individual income, corporation income, general sales, and excise taxes.

²²The use of year dummies would be inappropriate since there are many years when no state adopts withholding. In such years the year dummies would fully "explain" non-adoption. Clustering into five year intervals smoothes out these implausible jumps in the estimated baseline hazard.

federal government, as the origin of the time scale because since then the states had the technology available for copying. A secular growth in most of the explanatory variables presents a potential concern: A government with an 8 percent ratio of general revenue to personal income, adopting withholding in 1960, would be considered relatively large in that year, while equally big government adopting withholding in 1970 would be considered relatively small. Therefore I estimate each model with the current values of regressors and also with their detrended values.²³

Results are reported in Table 8. For logit estimates, the table reports the marginal effects of regressors on the hazard rate. For Weibull estimates, the table reports the hazard ratios. The results are fairly robust to the use of current versus detrended values of regressors and to model specification. A sharp finding emerges: higher income tax revenues significantly increase the hazard rate, and they are the only variable that has a significant effect on adoption in all specifications. The only other regressor that is significant in more than one specification is population, which has a negative effect on the hazard rate. The effect of population is, however, largely driven by California, which is a large state but adopts withholding as late as 1971. If California is taken out of the regression, the estimated marginal effect of population (in the logit model) has the same magnitude but is not significant. The estimated marginal effect of income tax revenues is quite substantial: a 10-percent increase in income taxes per capita (which, in pre-withholding years, would represent \$4.5 per capita on average) increases the hazard rate by 0.0905. Since the average hazard rate in the sample is 0.055, this represents a 17-percent increase in the hazard rate.

The finding of a positive effect of income taxes on the likelihood of adoption is consistent with the demand-driven explanation for adoption. The income taxes first had to grow enough so that it paid to collect them with a better technology. The results of timing regressions give extra weight to the demand story of the adoption of withholding since they are based on a new source of identification. Here, the likelihood of adoption depends on observable demand variables, while in section 5 the demand-driven adoption was detected from unobservable demand shocks correlated with withholding. The finding of a negative effect of population on adoption is somewhat puzzling since it contradicts the predicted effect. It is worth noting that none of the variables that could be associated with supply-driven adoption has a significant effect on adoption.

7 Conclusions

As a conclusion I would like to assess the contribution of withholding to the overall growth of state governments. One important results was mentioned in section 5: Withholding produced only a one-time shift in the level of income taxes, but did not accelerate their growth. How important was the level change? Table 6 shows that income taxes increased, by 29.4 percent, of which 21.7 percent was due to the substitution effect, at most 3.9 to the scale effect, and at least 3.8 to the demand shock. Hence the causal relationship from improved efficiency to higher income taxes can be blamed for increasing income taxes by 21.7 percent at least and 25.6 percent at most. Since the ratio of income tax revenues to personal income was, on average, 0.67 percent one year before adoption, the response to withholding added 0.14-0.17 percentage points. During the sample period, the ratio of income taxes to personal income increased from 0.31 percent to 1.93 percent. Therefore withholding accounts for only 8.6 to 10.5 percent of the overall growth of income tax revenues. And this was most likely the single biggest improvement in the tax collection technology during the period we are studying. In terms of empirical relevance, growth in demand for government seems to be a far more important reason behind the growth of income taxes than improvements in tax efficiency.

Because income taxes represented 15.2 percent of total tax revenues prior to adoption, withholding

²³The detrending is done as follows: For every fiscal variable X , I regress that variable on the withholding dummy, state and year dummies, and socio-economic controls. Then I compute the detrended value of $\hat{X}_{it} = X_{it} - \hat{\lambda}_t$, where $\hat{\lambda}_t$ is the estimate of the year fixed effect. This method removes the common time component from X_{it} . In the same way I detrended the socio economic variables, the only difference being that they were regressed only on state and year dummies since I have no good predictors of these variables.

contributed an accordingly smaller amount to the overall growth of total tax revenues. The change of income taxes/personal income ratio by 0.14 to 0.17 percentage points represents a 2.1–2.6 percent increase in total tax revenues. Over the sample period, the ratio of state tax revenues to personal income has increased from 3.7 percent to 6.4, a 73-percent increase, therefore the increases in income tax revenues caused by withholding account for about 3 percent of the growth of government during the 1944-1980 period.

While theories of the size of government have been unanimous in the prediction that more efficient taxes lead to a bigger government; the empirical literature has been so far inconclusive in assessing whether the growth of government should be attributed primarily to improvements in the efficiency of taxes or to demand for government. This paper uses the historical experience with income tax withholding at the state level to present a new test of the theoretical prediction and to assess the relative importance of demand versus efficiency factors. The results confirm that taxes do respond to efficiency; namely the shift in the composition of tax revenues caused by withholding resonates with the view that the political process favors efficient methods of redistribution (Becker (1983), Wittman (1985)). As for the empirical importance of demand vs. efficiency factors, I find that the reverse causality from higher demand towards more efficient taxes is an important part of the story and accounts for more than one-half, and possibly all, of the post-withholding increases in taxes. Also, despite popular beliefs, withholding did not accelerate the growth of income taxes. The particular experience of withholding appears to give more weight to the demand explanation of government growth

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Figure 1:

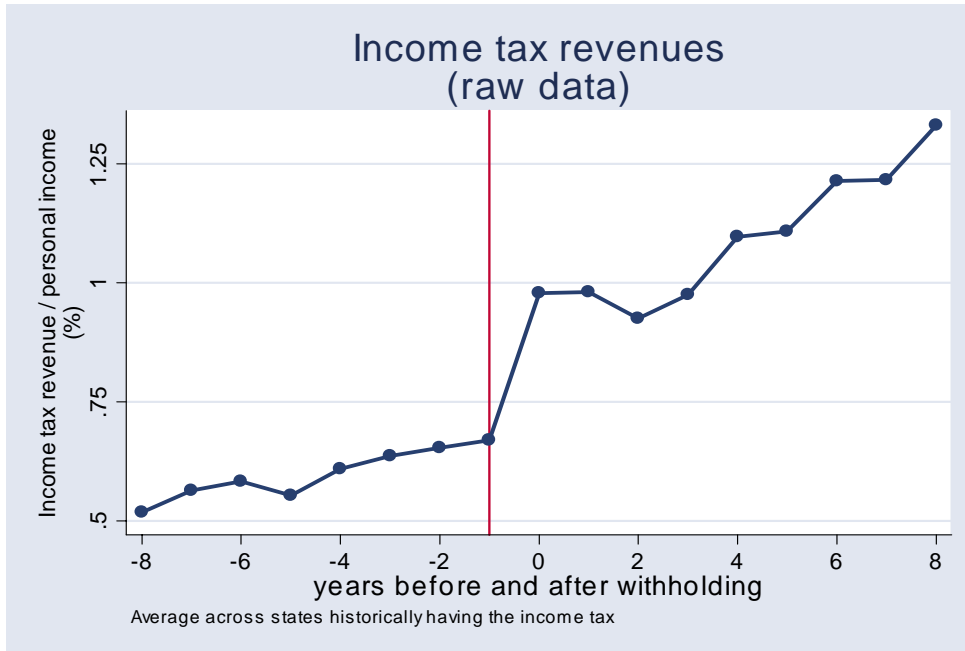


Figure 2:



Figure 3:

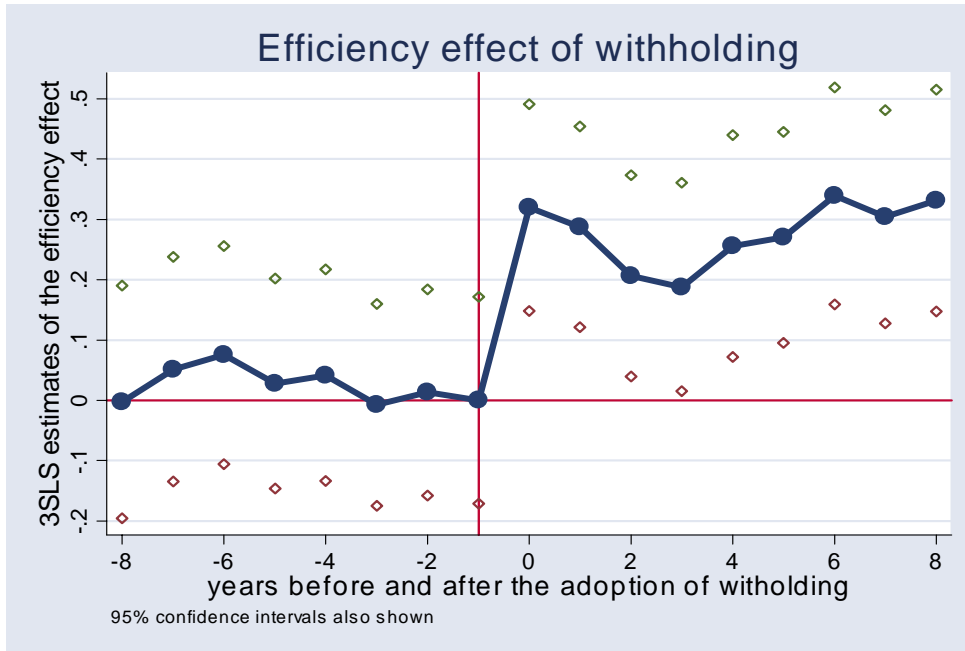
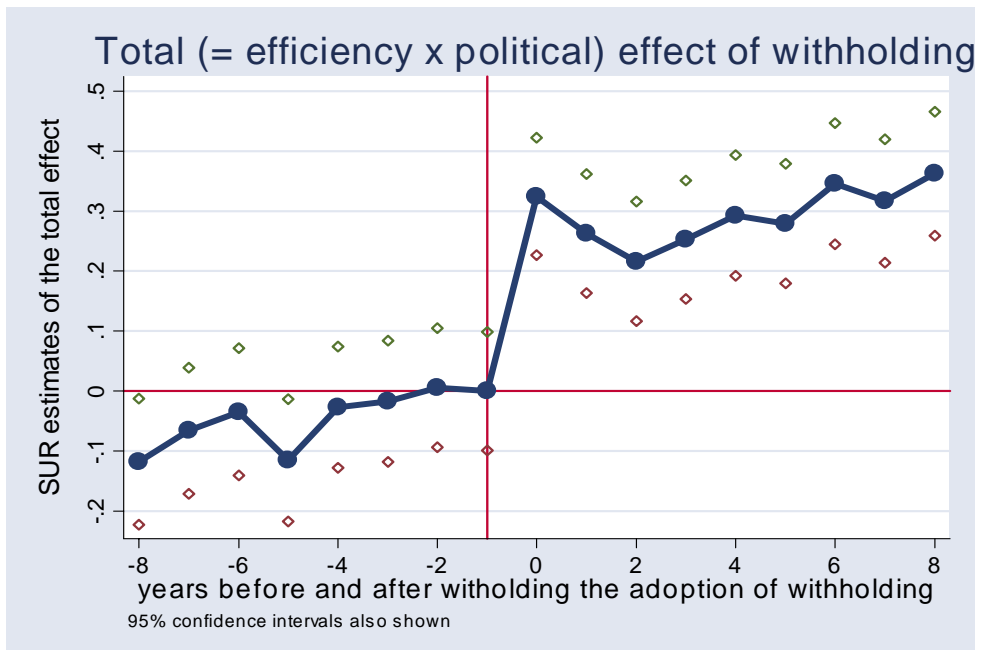


Figure 4:



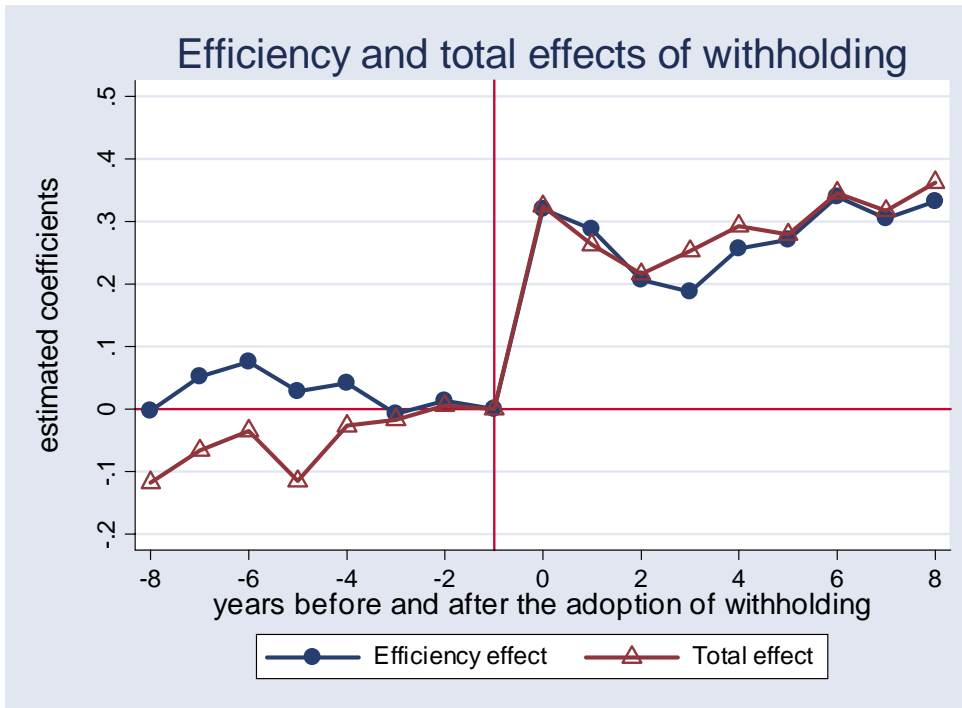


Figure 5:

Figure 6:

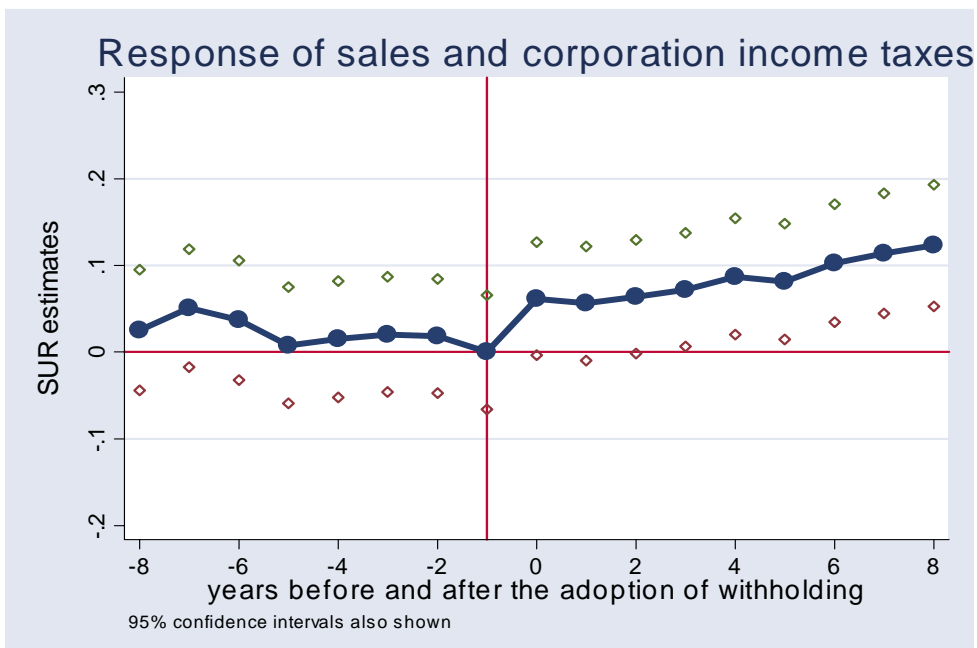


Figure 7:

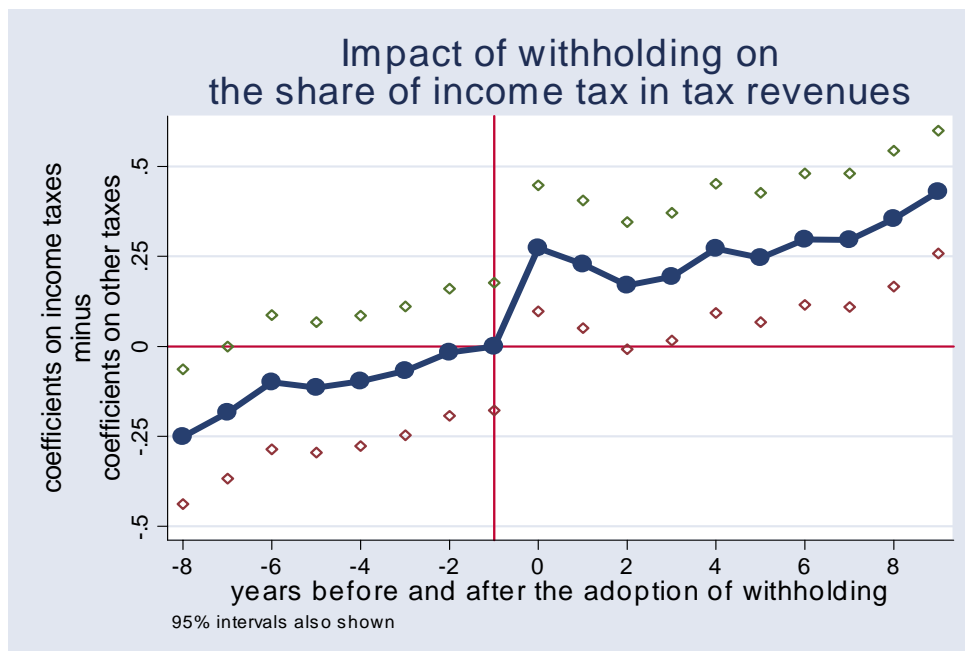


Table 1
Adoption of income tax withholding

Year	States adopting withholding
1948	Oregon (1930)
1949	Delaware (1917)
1951	Vermont (1931)
1954	Arizona (1933), Colorado (1937), Kentucky (1936)
1955	Idaho (1931), Maryland (1937), Montana (1933)
1956	Alabama (1933)
1959	Massachusetts (1916), North Carolina (1921), New York (1919), South Carolina (1922), Utah (1931)
1960	Georgia (1929)
1961	Louisiana (1934), Minnesota (1933), Missouri (1917), New Mexico (1933), Oklahoma (1915), West Virginia (1961)
1962	Wisconsin (1911)
1963	Indiana (1963), Virginia (1931)
1966	Arkansas (1929), Iowa (1934), Kansas (1933)
1967	Michigan (1967), Nebraska (1967)
1968	Mississippi (1912)
1969	Illinois (1969), Maine (1969)
1971	California (1935), Ohio (1971), Pennsylvania (1971), Rhode Island (1971)
1976	New Jersey (1976)
1987	North Dakota (1919)

States with narrow - based income tax:
 Connecticut, New Hampshire, Tennessee

States without income tax:
 Florida , Nevada, Wyoming
 South Dakota, Texas, Washington

Table 3
Summary statistics

Variable	obs	mean	std. dev	min	max
Withholding dummy	1073	0.56	0.50	0.00	1.00
Income tax revenue / personal income	1073	1.06	0.78	0.10	3.77
Share of income tax in tax revenue	1073	19.14	11.82	1.90	59.64
Corporation income taxes / personal income	1073	0.39	0.21	0.00	1.22
Sales taxes / personal income	1073	2.81	1.11	0.64	6.30
Misc. taxes / personal income	1073	1.16	0.57	0.24	3.61
Federal grants / personal income	1073	2.26	1.23	0.22	6.28
Lowest income tax rate	985	1.75	0.86	0.50	5.74
Top income tax rate	985	7.12	3.23	1.70	20.13
Corporation income tax rate	986	4.25	2.66	0.00	12.00
General sales tax rate	986	2.17	1.48	0.00	5.00
Motor fuel tax rate (cents per gallon)	986	6.55	1.33	2.00	11.00
Cigarette tax rate (cents per pack)	986	6.42	4.55	0.00	21.00
Distilled spirits tax rate (\$ per gallon)	986	1.32	1.17	0.00	4.53
Population (1000s)	1073	3,443	3,928	285	23,700
Income per capita	1073	7,684	2,459	2,859	14,417
Percent black	1073	11.0	12.2	0.0	47.6
Percent elderly	1073	9.0	1.9	4.5	13.7
Percent urban	1073	58.6	15.6	23.0	91.3
Farm income / personal income	1073	8.0	7.6	0.2	58.5
Interest and dividend income / total income	1073	12.5	2.8	5.0	24.0
Share of Democrats in state legislature	1073	63.1	27.0	1.2	100.0

Sample: States that had a broad-based income tax in 1944, years 1944-1980

Table 4
3SLS estimates of the income tax revenue technology

Dependent variable:	(1)	(2)	(3)
	Income tax revenue (technology)	Top rate	Lowest rate
Withholding dummy	0.237 [0.091]**	0.033 [0.022]	-0.026 [0.027]
Top tax rate	0.982 [0.603]		
Lowest tax rate	-0.829 [3.842]		
Income per capita	2.038 [0.937]*	-1.07 [0.123]**	-0.077 [0.147]
Share of farm income	0.012 [0.064]	0.082 [0.034]*	0 [0.040]
Share of capital income	0.305 [1.191]	-0.053 [0.076]	0.319 [0.091]**
Population	0.377 [1.347]	0.187 [0.077]*	0.318 [0.092]**
Percent elderly	-1.088 [1.964]	0.04 [0.128]	-0.526 [0.152]**
Percent black	0.276 [0.557]	-0.224 [0.032]**	0.178 [0.038]**
Percent urban	1.57 [2.923]	-1.685 [0.138]**	-0.52 [0.165]**
Share of Democrats in state legislature		0.002 [0.001]*	-0.001 [0.001]
Federal grants per capita		0.159 [0.035]**	-0.014 [0.042]
Observations	985	985	985
"R-squared"	0.90	0.84	0.80

Standard errors in brackets

* significant at 5%; ** significant at 1%

Year and state dummies included (coefficients not shown).

Fiscal and socio-economic variables are in logs. Fiscal variables are in per-capita terms.

Table 5
OLS estimates of the tax technology, by tax source

Dependent variable:	(1) Income tax revenue	(2) Income tax revenue	(3) Corporation income tax revenue	(4) General sales tax revenue	(5) Excise taxes revenue
Withholding dummy	0.270 <i>[0.062]**</i>	0.240 <i>[0.055]**</i>	0.020 <i>[0.046]</i>	-0.026 <i>[0.037]</i>	-0.015 <i>[0.019]</i>
Top tax rate	0.436 <i>[0.094]**</i>	1.534 <i>[0.345]**</i>			
Lowest tax rate	0.038 <i>[0.064]</i>	-0.585 <i>[0.549]</i>			
Corp. income tax rate			0.767 <i>[0.122]**</i>		
General sales tax rate				0.663 <i>[0.108]**</i>	
Motor fuel tax rate					0.444 <i>[0.068]**</i>
Cigarette tax rate					0.113 <i>[0.046]*</i>
Distilled spirits tax rate					0.015 <i>[0.033]</i>
Income per capita	1.535 <i>[0.248]**</i>	1.637 <i>[0.213]**</i>	1.385 <i>[0.477]**</i>	0.791 <i>[0.239]**</i>	0.192 <i>[0.132]</i>
Share of farm income	0.042 <i>[0.062]</i>	0.022 <i>[0.063]</i>	0.048 <i>[0.209]</i>	-0.052 <i>[0.035]</i>	-0.014 <i>[0.030]</i>
Share of capital income	-0.037 <i>[0.180]</i>	0.058 <i>[0.194]</i>	0.146 <i>[0.278]</i>	0.076 <i>[0.190]</i>	0.001 <i>[0.047]</i>
Population	0.107 <i>[0.167]</i>	-0.01 <i>[0.156]</i>	-0.733 <i>[0.298]*</i>	-0.121 <i>[0.095]</i>	-0.264 <i>[0.088]**</i>
Percent elderly	-0.596 <i>[0.338]</i>	-0.753 <i>[0.336]*</i>	-0.306 <i>[0.581]</i>	0.402 <i>[0.406]</i>	-0.147 <i>[0.164]</i>
Percent black	0.025 <i>[0.070]</i>	0.049 <i>[0.080]</i>	0.092 <i>[0.109]</i>	-0.051 <i>[0.095]</i>	-0.042 <i>[0.034]</i>
Percent urban	0.939 <i>[0.408]*</i>	0.74 <i>[0.446]</i>	0.386 <i>[0.409]</i>	-0.026 <i>[0.571]</i>	0.169 <i>[0.131]</i>
Lowest tax bracket		-0.059 <i>[0.074]</i>			
Top tax bracket		0.11 <i>[0.083]</i>			
Lowest bracket * lowest rate		0.086 <i>[0.074]</i>			
Top bracket * top rate		-0.102 <i>[0.035]**</i>			
Observations	985	984	759	719	588
Adjusted R-squared	0.95	0.95	0.85	0.86	0.89

Robust standard errors in brackets

* significant at 5%; ** significant at 1%

Year and state dummies included (coefficients not shown).

Fiscal and socio-economic variables are in logs. Fiscal variables are in per-capita terms.

Table 6
SUR estimates of the demand for tax revenue, by tax source

Dependent variable:	(1) Income taxes	(2) Corporate income taxes	(3) Sales taxes	(4) Miscellaneous taxes
Withholding dummy	0.294 [0.024]**	0.081 [0.040]*	0.064 [0.018]**	-0.031 [0.023]
Income per capita	1.13 [0.133]**	0.366 [0.227]	0.922 [0.098]**	-0.365 [0.127]**
Share of farm income	0.068 [0.035]*	0.032 [0.059]	-0.023 [0.026]	0.009 [0.033]
Share of interest and dividend income	0.128 [0.088]	0.021 [0.150]	0.163 [0.065]*	0.128 [0.084]
Population	0.1 [0.081]	-1.079 [0.138]**	-0.156 [0.060]**	-0.205 [0.078]**
Percent elderly	-0.204 [0.136]	-0.532 [0.232]*	0.397 [0.101]**	0.618 [0.130]**
Percent black	-0.073 [0.034]*	-0.043 [0.058]	0.182 [0.025]**	-0.135 [0.033]**
Percent urban	-0.206 [0.148]	0.077 [0.252]	-0.746 [0.109]**	0.547 [0.142]**
Federal grants	-0.002 [0.039]	-0.339 [0.066]**	0.372 [0.029]**	-0.05 [0.037]
Share of Democrats in state legislature	0.001 [0.001]	0.003 [0.001]*	-0.003 [0.001]**	0.001 [0.001]
Observations	941	941	941	941
"R-squared"	0.96	0.81	0.89	0.87
Alpha	0.268 [0.115]*			
Beta	1.279 [0.562]*			

Breusch-Pagan test of independence: $\chi^2(6) = 75.416$

Standard errors in brackets

* significant at 5%; ** significant at 1%

Fiscal and socio-economic variables are in logs. Fiscal variables are in per-capita terms.

Table 7

3SLS estimates of the tax technology, other taxes

Dependent variable:	(1) Corporation income tax revenue (technology)	(2) Corporation income tax rate	(3) General sales tax revenue (technology)	(4) General sales tax rate
Withholding dummy	-0.225 [0.271]	0.112 [0.026]**	-0.043 [0.034]	0.025 [0.021]
Corporation income tax rate	2.921 [2.305]			
General sales tax rate			1.763 [0.225]**	
Income per capita	3.661 [2.472]	-1.053 [0.170]**	1.641 [0.274]**	-0.737 [0.132]**
Share of farm income	-0.378 [0.477]	0.184 [0.056]**	-0.082 [0.045]	0.06 [0.028]*
Share of capital income	0.695 [0.657]	-0.266 [0.116]*	0.68 [0.189]**	-0.442 [0.091]**
Population	-0.687 [0.279]*	-0.026 [0.111]	-0.112 [0.090]	0.022 [0.059]
Percent elderly	0.582 [1.066]	-0.386 [0.192]*	0.215 [0.198]	0.033 [0.123]
Percent black	0.569 [0.519]	-0.23 [0.041]**	-0.034 [0.054]	0.002 [0.034]
Percent urban	1.324 [1.094]	-0.453 [0.175]**	-0.821 [0.326]*	0.685 [0.178]**
Share of Democrats in state legislature		0.001 [0.001]		-0.001 [0.001]*
Federal grants		-0.055 [0.036]		0.233 [0.032]**
Observations	759	759	719	719
"R-squared"	0.52	0.72	0.75	0.81

Standard errors in brackets

* significant at 5%; ** significant at 1%

Year and state dummies included (coefficients not shown).

Fiscal and socio-economic variables are in logs. Fiscal variables are in per-capita terms.

Table 8

Impact of explanatory variables on the probability of the adoption of withholding

Model:	Logit current-valued regressors	Logit detrended regressors	Weibull current-valued regressors	Weibull detrended regressors
Explanatory variables:				
Population (millions)	-0.0121 [0.0035]**	-0.0122 [0.0039]**	0.888 [0.058]	0.844 [0.0724]*
Percent elderly	0.0080 [0.0068]	0.0116 [0.0106]	1.056 [0.164]	1.214 [0.1699]
Percent black	-0.0003 [0.0017]	0.0014 [0.0019]	0.988 [0.028]	1.025 [0.0399]
Percent urban	-0.0023 [0.0023]	-0.0032 [0.0041]	1.003 [0.045]	0.984 [0.0558]
Income per capita	0.0000 [0.0000]	0.0000 [0.0000]	0.999 [0.000]	1.000 [0.0004]
Share of farm income	-0.0080 [0.0051]	-0.0099 [0.0084]	0.901 [0.106]	0.857 [0.1110]
Share of dividend and interest income	-0.0032 [0.0056]	-0.0002 [0.0106]	1.026 [0.205]	0.862 [0.1481]
Share of democrats in state legislature	0.0006 [0.0007]	0.0011 [0.0010]	1.010 [0.018]	1.017 [0.0215]
Income tax revenue per capita	0.0021 [0.0005]**	0.0013 [0.0003]**	1.028 [0.007]**	1.018 [0.0031]**
All other taxes per capita	0.0002 [0.0002]	-0.0001 [0.0002]	1.003 [0.003]	0.995 [0.0049]
Federal grants per capita	0.0003 [0.0003]	0.0006 [0.0003]*	1.001 [0.006]	1.011 [0.0056]
Debt / general revenue	0.0003 [0.0003]	0.0001 [0.0002]	1.006 [0.005]	1.003 [0.0042]
Dummy for 1944-48	0.0195 [0.1113]	-0.3023 [0.1259]*		
Dummy for 1949-53	0.0106 [0.1078]	-0.1821 [0.0679]**		
Dummy for 1954-58	0.0433 [0.0972]	-0.0964 [0.0524]*		
Dummy for 1959-63	0.0656 [0.0888]	-0.0443 [0.0534]		
Dummy for 1964-68	0.0523 [0.0671]	-0.0126 [0.0439]		
estimate of p			2.79 [1.192]	3.74 [0.639]

Robust standard errors in brackets

* significant at 5%; ** significant at 1%

Marginal effects are reported for the logit estimates.

Hazard ratios are reported for the Weibull estimates.