TAX BURDEN AND THE MISMEASUREMENT
OF STATE TAX POLICY

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Abstract
Tax Burden, defined as the ratio of total tax revenues over personal income, is frequently used as a measure of state tax policy. We analyze the empirical relationship between changes in Tax Burden and changes in tax policies from 1987 to 2000 using states’ own forecasts of the revenue impacts of new tax legislation. We find that Tax Burden significantly mismeasures state tax policy. We explain this result by decomposing Tax Burden changes into three components: (1) changes in state tax policy, (2) income-induced changes in revenue that are unrelated to state tax policy, and (3) other factors that do not measure state tax policy. We demonstrate the statistical significance of the second component. For researchers and policy-makers interested in how tax rates affect economic growth, this finding highlights the need for better measures of overall state tax policy. We present ideas for future research in our conclusion.

JEL Categories: E62, H20, H71, R11
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I. INTRODUCTION

The variable “Tax Burden,” defined as the ratio of state and local tax revenues to personal income,\(^1\) is widely used in studies that estimate the effect of taxes on economic growth. However, there is ambivalence about the interpretation of this variable. Sometimes Tax Burden is interpreted as the direct variable of interest -- as a measure of the importance of taxes relative to the size of the economy. Other times Tax Burden is interpreted as a proxy for statutory tax rates (“state tax policy”). This latter interpretation is frequently adopted (e.g., Canto and Webb, 1987; Helms, 1985; Mullen and Williams, 1994; Xie and Zou, 1999; Knight, 2000; and Yamarik, 2000). Further, the theoretical literature on taxes and economic growth is constructed in terms of tax rates -- not the ratio of tax revenue to income (e.g., Barro, 1990; Barro and Sala-i-Martin, 1992; Stokey and Rebelo, 1995; Wright, 1996; Kim, 1998; Baier, and Glomm, 2001; Ihori, 2001). Thus, to the extent that the empirical literature sees itself as a test of this theoretical literature, it relies on the “Tax Burden as a measure of tax policy” interpretation.

The difference between these two interpretations is easily illustrated. Suppose a state has a regressive tax structure. Further, suppose that state does not change its statutory tax rates, but the size of the economy decreases due to a business cycle downturn. Tax Burden will rise. This poses no particular problem for those whose interest lies directly with Tax Burden. However, it does pose a problem for researchers who view Tax Burden as a measure of statutory tax rates.

The purpose of this study is to quantitatively analyze whether Tax Burden is a reliable measure of state tax policy. We employ state-generated forecasts of revenue impacts associated with new tax legislation. If Tax Burden is a reliable indicator of changes in state tax policy, then changes in Tax Burden should generally correspond to the changes predicted by the state-generated revenue forecasts. We find that they do not.

\(^1\) Surveys of this literature may be found in Bartik (1991) and Wasylenko (1997).
We explain the source of this measurement error by decomposing Tax Burden changes into three components: (1) changes in state tax policy, (2) income-induced changes in revenue that do not measure state tax policy, and (3) other factors that do not measure state tax policy. Our study demonstrates the significance of the second component, thus providing statistical evidence that Tax Burden mismeasures state tax policy.

While others have recognized the possibility of mismeasurement in the Tax Burden variable (e.g., Gold, 1996), our paper is the first to quantitatively identify this problem. For researchers and policy-makers interested in the effect of tax policy on economic growth, our results highlight the need for better measures of policy. We present some ideas for how this can be done in the conclusion to this paper.

II. DIRECT MEASURES OF STATE TAX POLICY

State laws generally require states to estimate the budgetary impacts of tax and spending legislation. This information is collected by two national organizations -- the National Association of State Budget Officers (NASBO) and the National Conference of State Legislatures (NCSL). NASBO is an independent professional organization for the chief financial advisors to governors, including heads of state budget offices, state finance departments and their staffs. NCSL is a bipartisan organization that serves state legislatures and represents their interest to federal policy makers. Both organizations began conducting annual surveys of their membership regarding state tax policy in 1987.

NASBO, in conjunction with the National Governors’ Association, surveys state budget officers.\(^2\) Among other things, respondents provide estimates of changes in the next fiscal year’s

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\(^2\) NASBO estimates are reported in a series entitled *The Fiscal Survey of the States* (1987-2002). The latest estimates are available online at www.nasbo.org.
tax revenues resulting from changes in tax legislation. NCSL surveys state legislative staff.\footnote{NCSL estimates are published in \textit{State Budget Actions} (1987-1989), \textit{State Budget and Tax Actions} (1990-1991) and \textit{State Tax Actions} (1992-2002).} Historically, the NCSL has used two methods to report tax change impacts. The baseline method (NCSL-B), available as an annual time series from 1987 to 1997, tracks tax legislation changes adopted in a given year in terms of the impact on the following fiscal year. It was discontinued in favor of the taxpayer liability method (NCSL-TL), which was initiated in 1995. The NCSL-TL series provides estimates of changes in the taxes actually paid by taxpayers.\footnote{For example, in the tax liability method, multi-year tax changes are credited to the fiscal year when the change is scheduled to take effect. Thus, if tax increases are phased in over a three-year period, the tax liability method shows three years of increases, whereas the baseline method only shows changes in the first year. Further, if the legislature decides to extend a tax increase that was previously scheduled to expire, or to postpone a tax decrease that was previously scheduled to take effect, the tax liability method shows no change in taxes, while the baseline measure would show an increase. \textit{See State Tax Actions} 1996 for a comparison of the treatment of tax changes under both methods.}

In addition to definitional variations on the nature and timing of tax changes, the NASBO and NCSL surveys also differ with respect to when information is collected. Thus, revisions in revenue forecasts may be picked up by one survey and not by another. FIGURE 1 compares the NASBO and NCSL-collected, state revenue forecasts associated with tax policy changes. In the figure, fiscal year represents the year that the tax changes are legislated to take effect. Despite some differences, the overall impression from FIGURE 1 is that the different series present similar pictures of revenue changes resulting from changes in states’ tax policies.\footnote{See Merriman (2000) for further discussions of the NASBO and NCSL estimates.}

We take as our point of departure that the state revenue forecasts collected by NASBO and NCSL represent unbiased estimates of the revenue impacts of changes in state tax policy. Corroborating support for employing this assumption comes from three sources: (i) previous research on strategic bias in state revenue forecasts, (ii) personal conversations with professional staff at NASBO, NCSL, and state budgetary offices, and (iii) the use of these series in recent studies.
While no studies directly evaluate the accuracy of state revenue forecasts associated with tax legislation, some studies have investigated state forecasts of total tax revenues—a related subject. No conclusive evidence of bias has been found. However, even if states strategically bias total revenue forecasts, it does not follow that this bias would extend to revenue forecasts of specific tax legislation. These latter forecasts are likely to be more closely scrutinized than overall budget forecasts since they are inputs in the legislative process and impact specific economic groups. As such, they need to be credible to many different constituencies. Personal conversations with current and former professionals from NASBO, NCSL, and several state budgetary offices provided anecdotal confirmation that the survey responses supplied by the states are untainted by strategic bias.

Finally, we note that several recent studies have employed the NASBO and NCSL-collected revenue forecasts as direct measures of state tax policy. Poterba (1994) and Poterba and Rueben (2001) use NASBO data to represent state fiscal policy in their studies of how states respond to unexpected revenue shocks. Merriman (2001) uses both series in his analysis predicting changes in tax legislation. Maag and Merriman (2003) use NASBO-related estimates to investigate tax policy responses to the 1990 and 2001 recessions.

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6 Various hypotheses address why policymakers might want to either over- or under-state expected revenues (Klay, 1983; Rodgers and Joyce, 1996). These include partisan politics and aversion to revenue shortfalls. In contrast, other researchers argue that the overriding concern of the revenue forecast process is to minimize the costs associated with inaccurate forecasts (Mocan and Azad, 1996; Shkurti and Winefordner, 1989; Bretschneider et al., 1989). Budget shortfalls cause cuts in program spending while surpluses can be seen as evidence of excessive tax rates or the underfunding of public goods (Feenberg et al., 1989).

7 Building on Cassidy et al. (1989), Bretschneider and Gorr (1992) find that a complicated mix of partisan politics and fiscal stress factors drive forecast errors in sales tax revenues. In contrast, Mocan and Azad (1995) find no systematic bias in general fund revenues and little evidence of political and institutional influences as a whole. This is perhaps the most econometrically rigorous analysis of state revenue forecast errors. It uses a rich set of forecast variables, including the source of state and federal economic trend forecasts for 20 states from 1986-92, to estimate a cross section, times series model with random effects.

8 Corroborating this interpretation are the similarities in the NASBO and NCSL estimates (cf. FIGURE I), despite originating from organizations facing different political pressures.
III. QUALITATIVE EVIDENCE THAT TAX BURDEN MISMEASURES STATE TAX POLICY

In the analysis that follows, we define the variable *Tax Burden* as the ratio of state (but not local) tax revenues \( R \) over Personal Income \( Y \),

\[
\text{Tax Burden}_{st} = \frac{R_{st}}{Y_{s,t-1}}.
\]

We exclude local tax revenues in order to be consistent with the NASBO and NCSL-collected estimates. If this restricted version of Tax Burden mismeasures state tax policy, we will take that as evidence that the more broadly defined Tax Burden variable mismeasures state and local tax policy. Note that tax revenues are reported by fiscal year, while state Personal Income is measured over the calendar year. Following convention, Personal Income is from the calendar year that spans the beginning of the fiscal year.\(^9\)

FIGURE 2 compares the *Tax Burden* time series with the NASBO and NCSL-B time series for the state of Iowa for fiscal years 1988-2001.\(^{10}\) For the most part, Iowa’s *Tax Burden* series behaves in the manner expected of a reliable measure of state tax policy: it rises during years in which tax legislation was projected to increase state revenues, declines during years in which tax legislation was projected to decrease state revenues, and stays the same when no changes in state tax policy occurred.

A careful examination of the *Tax Burden* series for all the states, however, reveals that Iowa’s experience is the exception, not the rule. FIGURES 3 and 4 illustrate two typical scenarios in which *Tax Burden* mismeasures state tax policy. In FIGURE 3, large increases in Louisiana’s taxes in 1989 had little effect on the state’s *Tax Burden*. Furthermore, during the

\(^9\) For example *Tax Burden* for 1996 would have tax revenues corresponding to Fiscal Year 1996 (which typically runs from July 1, 1995 through June 30, 1996) divided by Personal Income for calendar year 1995.

\(^{10}\) The NCSL-TL series is omitted because it is available for only a small number of years. However, as discussed above, it bears close resemblance to the NASBO series. The series only extend to 2001 because this is the most recent year for which *Tax Burden* could be calculated.
early 1990’s, legislated tax increases corresponded with a general decline in the *Tax Burden* series. In contrast, the example in FIGURE 4 shows large movements in Michigan’s *Tax Burden* from 1988 through 1994 despite little change in that state’s tax policy. Cases like Louisiana where significant changes in state tax policy correspond with little, or even perverse, movement in *Tax Burden*; and Michigan, where large movements in *Tax Burden* are not generated by changes in tax legislation, are common. In fact, the motivation for this study came from an (unsuccessful) attempt in previous research to identify significant tax legislation from movements in states’ *Tax Burden* time series.\(^{11}\)

FIGURE 5 aggregates data from all the states to present an overall picture of how well changes in *Tax Burden* correspond to changes in state tax policy.\(^{12}\) According to both the NASBO and NCSL-B measures, states raised taxes on net every year between 1988 and 1994. Yet, the value of *Tax Burden* in 1994 was about the same as it was in 1988. States lowered taxes on net every year from 1996 to 2001. Except for fiscal year 2001, however, there is little evidence of these tax cuts in the corresponding *Tax Burden* series. Clearly, *Tax Burden* does not rise (fall) during those years when states were increasing (decreasing) taxes as one would expect a reliable tax policy measure to do.

**IV. EVALUATING THE SOURCES OF TAX BURDEN MEASUREMENT ERROR**

**A. The Decomposition of Tax Burden**

To investigate the implications of this measurement error, we develop a theoretical structure relating the *Tax Burden* variable to actual state tax policy. Following the literature, the

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\(^{11}\) Figures representing *Tax Burden* time series for each state may be accessed via the internet at: “http://faculty-staff.ou.edu/R/Cynthia.Rogers-1/TAX/TAXBURDEN.htm”.

\(^{12}\) In FIGURE 5, *Tax Burden* for the U.S. is calculated as the ratio of the sum of state tax revenues for the U.S. over national Personal Income.
relationship between a state’s tax revenues ($R$) and its income ($Y$) is approximated with a linear revenue function$^{13}$:

$$R_{st} = \beta_{0, st} + \beta_{1, st} Y_{s,t-1} + \epsilon_{st}^R,$$

where $\epsilon_{st}^R$ is a mean-zero error term assumed to be uncorrelated with state income. Thus, tax policy for state $s$ at time $t$ can be characterized by the pair $(\beta_{0, st}, \beta_{1, st})$, where $\beta_{1, st}$ is the state’s effective marginal tax rate on income at time $t$.

A “true” measure of the revenue change caused by a change in state tax policy parameters $(\beta_{0, st}, \beta_{1, st})$ in fiscal year $t$, which shows up in fiscal year $t+1$ revenues, should hold income constant. This can be specified as follows,

$$\Delta Taxes_{st}^{True} = \Delta Taxes_{st} |_Y = \Delta \beta_{0, st} + \Delta \beta_{1, st} \cdot Y_{s,t-1},$$

where $\Delta \beta_{0, st}$ is the component of tax changes that does not change with a state’s income, and $(\Delta \beta_{1, st} \cdot Y_{s,t-1})$ is the component of tax changes that are affected by a state’s income.

Let us consider measuring the change in state tax policy by the change in $Tax Burden$, $\Delta TaxBurden_{st} = Tax Burden_{s,t+1} - Tax Burden_{st} = \frac{R_{s,t+1}}{Y_{st}} - \frac{R_{st}}{Y_{s,t-1}}$.

Substituting Equation (2) into Equation (4), the relationship can be expressed as,

$$\Delta TaxBurden_{st} = \Delta \beta_{1, st} + \left( \frac{\beta_{0, st+1}}{Y_{st}} - \frac{\beta_{0, st}}{Y_{s,t-1}} \right) + \left( \frac{\epsilon_{s,t+1}^R}{Y_{st}} - \frac{\epsilon_{st}^R}{Y_{s,t-1}} \right).$$

Equation (5) makes clear that changes in state income $(Y_{s,t-1})$ cause changes in $Tax Burden$ even when there is no corresponding change in state tax policy parameters $(\beta_{0, st}, \beta_{1, st})$. As we shall

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$^{13}$ See for example Koester and Kormendi (1989) and Mullen and Williams (1994).
subsequently demonstrate, this is not the only problem associated with using *Tax Burden* to measure the impact of changes in tax policy.

Substituting Equation (3) into (5) yields the following:

\[
\Delta TaxBurden_{st} = \frac{\Delta Taxes_{st}^{\text{True}}}{Y_{s,t-1}} + \beta_{0,st+1} \left( \frac{Y_{s,t-1} - Y_{st}}{Y_{s,t-1}Y_{st}} \right) + \eta_{st},
\]

where \( \eta_{st} = \left( \frac{\varepsilon_{s,t+1}^R - \varepsilon_{st}^R}{Y_{st}} \right) \), \( E(\eta_{st}) = 0 \), and \( \eta_{st} \) is heteroscedastic. Note that the coefficient on \( \Delta Taxes_{st}^{\text{True}} \), the variable measuring the true change in state tax policy, is one.

Equation (6) decomposes the change in *Tax Burden* into three components. The first term is the change in *Tax Burden* due to the change in state tax policy. The second term represents the change in *Tax Burden* due to changes in income. The third term is composed of miscellaneous factors that are unrelated to state tax policy. The latter two terms cause *Tax Burden* to mismeasure state tax policy. Estimation of Equation (6) would provide an indication of the extent of this measurement error. Unfortunately the policy variable \( \Delta Taxes_{st}^{\text{True}} \) is unobserved. In the remainder of this section, we devise a strategy for overcoming this problem, allowing us to estimate the components of the *Tax Burden* variable.

**B. A Consistent Estimator of Tax Policy Based on State Revenue Forecasts**

This section shows how the unobserved policy variable, \( \Delta Taxes_{st}^{\text{True}} \), can be expressed as a function of observed variables. Let the variable \( \Delta Taxes_{st}^{\text{Forecast}} \) represent the NASBO/NCSL-collected forecasts of the revenue change at time \( t+1 \) attributed to a tax policy change at time \( t \). In the context of the model above,
\[ \Delta \text{Taxes}_{st}^{\text{Forecast}} = \Delta \beta_{0,st} + (\Delta \beta_{1,st} \cdot Y_{st}^E), \]

where \( \Delta \beta_{0,st} \) is the component of tax changes that does not change with a state’s income\(^{14} \), \( Y_{st}^E \) is the forecasted value of state income for the next year, and \( (\Delta \beta_{1,st} \cdot Y_{st}^E) \) is the component of tax changes that are affected by a state’s income.\(^{15} \)

We need to make two assumptions in order to express \( \Delta \text{Taxes}_{st}^{\text{True}} \) as a function of observables. First, we assume that \( \Delta \beta_{0,st} = 0 \). In this case, it follows from Equations (3) and (7) that

\[ \frac{\Delta \text{Taxes}_{st}^{\text{True}}}{Y_{s,t-1}} = \frac{\Delta \text{Taxes}_{st}^{\text{Forecast}}}{Y_{st}^E}. \]

Note that previous studies estimating marginal tax rates assume both (i) \( \Delta \beta_{0,st} = 0 \) and (ii) \( \Delta \beta_{1,st} = 0 \); i.e., they assume a linear revenue function that does not vary over time (e.g., Koester and Kormendi, 1989; Becsi, 1996). In comparison, our approach is less restrictive. However, there is an additional reason to support the assumption that \( \Delta \beta_{0,st} = 0 \): As a practical matter, the effect of this assumption is small. The Appendix demonstrates that under reasonable assumptions, the error associated with measuring \( \Delta \text{Taxes}_{st}^{\text{True}} \) using states’ forecasts of tax policy changes when \( \Delta \beta_{0,st} \neq 0 \) will generally be less than 5%.

The second assumption we make is that the relationship between the realized and forecasted values of state income is given by

\[ Y_{st} = (1 + \epsilon_{st}^E)Y_{st}^E. \]

\(^{14} \)Note that the NASBO/NCSL-collected forecasts consist solely of taxes, excluding fees.\(^ {15} \) \( \Delta \text{Taxes}_{st}^{\text{Forecast}} \) is the same variable that Poterba (1994) calls “\( \Delta \text{TAXNEXT}_{st} \).”
where $\varepsilon_{st}^F$ represents the percentage difference between the income forecast developed by state budgeters and the realized value of state income, and $E(\varepsilon_{st}^F) = 0$.\(^{16}\)

Substituting Equation (9) into Equation (8) produces the following relationship,

\[
\frac{\Delta_{\text{Taxes}}_{st}^{\text{Forecast}}}{Y_{st}} = \frac{\Delta_{\text{Taxes}}_{st}^{\text{True}}}{Y_{s,t-1}} + \nu_{st},
\]

where $\nu_{st} = -\frac{\Delta_{\text{Taxes}}_{st}^{\text{Forecast}}}{Y_{st}} \cdot \varepsilon_{st}^F$, $\nu_{st}$ is heteroscedastic, and $\lim_{T \to \infty} \left( \frac{\sum_{t=1}^{T} \nu_{st}}{T} \right) = 0$. Thus, the ratio of the observed variables $\Delta_{\text{Taxes}}_{st}^{\text{Forecast}}$ and $Y_{st}$ is a consistent estimate of the change in state tax policy in the sense that $\sum_{t=1}^{T} \frac{\Delta_{\text{Taxes}}_{st}^{\text{Forecast}}}{Y_{st}} / T$ is arbitrarily close to $\sum_{t=1}^{T} \frac{\Delta_{\text{Taxes}}_{st}^{\text{True}}}{Y_{s,t-1}} / T$ for sufficiently large $T$.\(^{17}\)

C. Quantitative Estimation of Mismeasurement in the Tax Burden Variable

Having shown that the observed variable $\frac{\Delta_{\text{Taxes}}_{st}^{\text{Forecast}}}{Y_{st}}$ is a consistent estimator of the unobserved variable $\frac{\Delta_{\text{Taxes}}_{st}^{\text{True}}}{Y_{s,t-1}}$, we employ the former as a proxy in Equation (6), yielding the following estimable regression equation,

\[\text{\textit{\footnotesize Note that the “next” year is } Y_{st}, \text{ since the budget forecast is made at the beginning of fiscal year } t, \text{ which begins in the calendar year corresponding to } Y_{s,t-1}.}\]

\[\text{\textit{\footnotesize Although } \frac{\Delta_{\text{Taxes}}_{st}^{\text{Forecast}}}{Y_{st}} \text{ and } \Delta_{\text{TaxBurden}}_{st} \text{ both suffer from measurement error, the nature of the errors are different. The measurement error in the former stems from errors in forecasting next year’s state income (} \varepsilon_{st}^F). \text{ In contrast, the measurement error in } \Delta_{\text{TaxBurden}}_{st} \text{ is due to changes in income as well as miscellaneous factors that are unrelated to state tax policy. These measurement errors have different consequences to the extent that these other sources of measurement error matter.}}\]
\[ \Delta Tax \ Burden_{st} = \alpha_0 + \alpha_1 \cdot \frac{\Delta Taxes_{st}^{Forecast}}{Y_{st}} + \alpha_{2,s} \left( \frac{Y_{st,t-1} - Y_{st}}{Y_{s,t-1} Y_{st}} \right) + \omega_{st}, \]

where \( \alpha_{2,s} \) is a state-specific coefficient estimating \( \beta_{0,s} \). The estimation is at best suggestive, since \( \frac{\Delta Taxes_{st}^{Forecast}}{Y_{st}} \) measures \( \frac{\Delta Taxes_{st}^{True}}{Y_{s,t-1}} \) with error (cf. Equation [10]).

Columns (1) and (2) of TABLE 1 report the results of estimating Equation (11) using the NASBO- and NCSL-collected, state revenue forecasts to calculate \( \frac{\Delta Taxes_{st}^{Forecast}}{Y_{st}} \), respectively. Of particular interest are the 47 state-specific interaction terms (corresponding to the terms \( \alpha_{2,s} \left( \frac{Y_{st,t-1} - Y_{st}}{Y_{s,t-1} Y_{st}} \right) \), \( s=1,2,...,47 \), in Equation [11]). Due to space constraints, the individual coefficient estimates (\( \hat{\alpha}_{2,s} \)’s) are not reported.

At the bottom of each of these columns we report the results of testing the null hypothesis that these coefficients are jointly equal to zero. In both cases, the hypothesis is soundly rejected (cf. “Hypothesis Test: State-Specific Interaction Terms”). The corresponding \( p \)-values are well below 0.1 percent. This provides statistical evidence that changes in state income induce significant movement in the Tax Burden variable, causing the Tax Burden variable to change even when there has been no change in state in tax policy (cf. Equation [5] and the subsequent discussion).

TABLE 1 also yields insights about the other components of the change in Tax Burden. The component representing the change in Tax Burden due to actual changes in state tax policy,  

\[ \Delta Tax \ Burden_{st} = \alpha_0 + \alpha_1 \cdot \frac{\Delta Taxes_{st}^{Forecast}}{Y_{st}} + \alpha_{2,s} \left( \frac{Y_{st,t-1} - Y_{st}}{Y_{s,t-1} Y_{st}} \right) + \omega_{st}, \]

is calculated using state revenue forecasts.

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18 The reader may note that the error term in Equation (11) includes the components \( \frac{\varepsilon_{s,t+1}}{Y_{st}} \) and \( \frac{\varepsilon_{t}}{Y_{s,t-1}} \), where \( Y_{st} \) and \( Y_{s,t-1} \) also appear as explanatory variables in the second term. However, recall that \( E(\varepsilon_{st}^R) = 0 \) and is assumed to be uncorrelated with the income variable.
proxied in Equation (11) by $\frac{\Delta Taxes_{st}^{Forecast}}{Y_{st}}$, shows up as positive and significant in both Columns (1) and (2). Both of the estimated coefficients are less than 1 (0.5872 and 0.5578, respectively), as one would expect if $\frac{\Delta Taxes_{st}^{Forecast}}{Y_{st}}$ measured changes in state tax policy with error.

Finally, the component representing all of the other factors that cause Tax Burden to mismeasure tax policy is captured in Equation (11) by the regression error term, $\omega_{st}$. This source of measurement error contributes to the corresponding low $R^2$ values of 0.209 and 0.273, respectively; though other factors, such as using an imperfect measure for $\frac{\Delta Taxes_{st}^{True}}{Y_{s,t-1}}$, also contribute.

V. CONCLUSION

This paper investigates whether the variable Tax Burden, widely used in empirical studies of taxes and economic growth, reliably measures state tax policy. We have some good news: Our findings indicate that changes in Tax Burden are positively and significantly related to changes in state tax policy. Unfortunately, we also find evidence of substantial measurement error.

We decompose Tax Burden changes into three components: (1) changes in state tax policy, (2) income-induced changes in revenue that do not measure state tax policy, and (3) other factors that do not measure state tax policy. The latter two categories constitute measurement error with respect to measuring state tax policy. Our empirical analysis establishes the quantitative and statistical importance of the second component. In other words, we demonstrate
that changes in state income cause the *Tax Burden* variable to change even when there has been no change in state in tax policy.

These findings should be of particular interest to researchers and policy-makers interested in measuring the effects of state tax policy. On a positive note, this study demonstrates how state revenue forecasts can be used to construct consistent measures of state tax policy. We believe that researchers will find these forecast data increasingly attractive as the respective time series lengthen over time.

In the meantime, instrumental variables remain a potentially fruitful way to address measurement error bias in Tax Burden. Statutory tax parameters (e.g., property and sales tax rates, including information on the tax base; income tax rate parameters, including bracket and tax credit data) are obvious candidates for instruments. In addition, researchers may find it useful to pursue alternative methodologies for measuring and estimating tax effects. Representative agent models (e.g. Fisher and Peters, 1998) and new, quasi-experimental methods (e.g., Reed and Rogers, 2003; Reed and Rogers, 2004) are promising avenues for future research.
REFERENCES


## TABLE 1
Estimating the Components of the Tax Burden Variable

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Using NASBO estimates</th>
<th>Using NCSL estimates</th>
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<tr>
<td></td>
<td>(1) (^a)</td>
<td>(2) (^a)</td>
</tr>
<tr>
<td>Constant</td>
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<td>0.0015 (4.58)</td>
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<tr>
<td>(\Delta TAXES_{st}^{\text{Forecast}})</td>
<td>0.5872 (10.02)</td>
<td>0.5578 (8.19)</td>
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<tr>
<td>(Y_{st})</td>
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<tr>
<td>Other variables</td>
<td>State-Specific Interaction Terms (^b)</td>
<td>State-Specific Interaction Terms (^b)</td>
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<tr>
<td>Observations</td>
<td>658</td>
<td>517</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.209 (0.146)</td>
<td>0.273 (0.198)</td>
</tr>
<tr>
<td>(Adjusted (R^2))</td>
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<tr>
<td><strong>Hypothesis Test:</strong> State-Specific Interaction Terms (^c)</td>
<td>(F = 2.211) ((p\text{-value}=0.000))</td>
<td>(F = 2.356) ((p\text{-value}=0.000))</td>
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**NOTES:**
- \(t\)-statistics are reported in parentheses below the estimated coefficients. Hypothesis tests use White’s heteroscedastic-consistent covariance matrix.
- The dependent variable is \(\Delta Tax\ Burden_{st}\). Equation specification is that of Equation (11) in the text, with \(\Delta TAXES_{st}^{\text{Forecast}}\) alternatively being measured by the NASBO- and NCSL-collected state revenue forecasts, respectively.
- 47 state-specific interaction terms, \(\alpha_{s,t}\left(Y_{s,t-1} - Y_{st}\right)/Y_{s,t-1}Y_{st}\), are included in this equation.
- The associated null hypothesis is that the state-specific interaction terms are jointly equal to zero.
FIGURE 1
A Comparison of Three Measures of State Tax Policy Changes: NASBO, NCSL-B, and NCSL-TL

Estimate Change in State Tax Revenues ($ Millions)

Fiscal Year

NOTES: The figure plots the annual sum of state tax changes as estimated by the NASBO, NCSL-B and NCSL-TL measures. NCSL-B and NCSL-TL refer to NCSL’s “Baseline” and “Tax Liability” measures. The three measures are described in the text. Fiscal year refers to fiscal year when tax changes are estimated to take effect.
FIGURE 2

Tax Burden Versus Changes in State Tax Policy: Iowa

**NOTES:** The NASBO estimates run through 2002, while the NCSL-B estimates only extend through 1998. Tax Burden measures the ratio of total state tax revenues over total state Personal Income.
FIGURE 3
Tax Burden Versus Changes in State Tax Policy: Louisiana

NOTES: The NASBO estimates run through 2002, while the NCSL-B estimates only extend through 1998. Tax Burden measures the ratio of total state tax revenues over total state Personal Income.
NOTES: The NASBO estimates run through 2002, while the NCSL-B estimates only extend through 1998. *Tax Burden* measures the ratio of total state tax revenues over total state Personal Income.
FIGURE 5
Tax Burden Versus Changes in State Tax Policy: United States

NOTES: The NASBO estimates run through 2002, while the NCSL-B estimates only extend through 1998. Tax Burden measures the ratio of total state tax revenues over total state Personal Income.
APPENDIX
A Calculation of the Error Associated with Measuring \( \frac{\Delta Taxes_{st}^{\text{True}}}{Y_{s,t-1}} \) with \( \frac{\Delta Taxes_{st}^{\text{Forecast}}}{Y_{st}^{F}} \) when \( \Delta \beta_{0, st} \neq 0 \)

We define the error associated with measuring \( \frac{\Delta Taxes_{st}^{\text{True}}}{Y_{s,t-1}} \) with \( \frac{\Delta Taxes_{st}^{\text{Forecast}}}{Y_{st}^{F}} \) when \( \Delta \beta_{0, st} \neq 0 \) by

\[
\text{Error} = \frac{\left( \frac{\Delta Taxes_{st}^{\text{Forecast}}}{Y_{st}^{F}} \right) - \Delta Taxes_{st}^{\text{True}} - \frac{\Delta Taxes_{st}^{\text{True}}}{Y_{s,t-1}}}{Y_{s,t-1}}.
\] (A1)

Substituting Equations (3) and (7) into (A1) yields

\[
\text{Error} = \frac{\left( \Delta \beta_{0, st} + \Delta \beta_{1, st} \cdot Y_{st}^{F} \right) - \left( \Delta \beta_{0, st} + \Delta \beta_{1, st} \cdot Y_{s,t-1} \right)}{Y_{s,t-1}}.
\] (A2)

Algebraic manipulation allows us to rewrite (A2) as follows,

\[
\text{Error} = \frac{\Delta \beta_{0, st} \left( \frac{Y_{st}^{F}}{Y_{st}} \right) - \Delta \beta_{0, st}}{\left( \Delta \beta_{0, st} + \Delta \beta_{1, st} \cdot Y_{s,t-1} \right)}.
\] (A3)

Note that when \( \Delta \beta_{0, st} = 0 \), Error = 0.

Define \( k_{st} \) such that

\[
\Delta \beta_{0, st} = k_{st} \left( \Delta \beta_{1, st} Y_{s,t-1} \right).
\] (A4)
Thus, if \( k_{st} = 1 \), the component of total new taxes that is independent of state income, \( \Delta \beta_{0, st} \), is equal to the component of total new taxes that is dependent on the value of state income, \( (\Delta \beta_{1, st} Y_{s,t-1}) \).\(^{19}\) Substituting (A4) into (A3) and doing some manipulation yields,

\[
\text{Error} = \frac{-k_{st} \left( 1 - \frac{Y_{s,t-1}}{Y_{st}^F} \right)}{1 + k_{st}}.
\]

(5)

We now define a new variable, \( g_{st} \), such that

\[
Y_{st}^F = (1 + g_{st}) \cdot Y_{s,t-1}.
\]

(A6)

Thus, \( g_{st} \) is the forecasted annual growth rate of Personal Income. Substituting (A6) into (A5) and performing some algebraic manipulation yields

\[
\text{Error} = \frac{-k_{st} \left( \frac{g_{st}}{1 + g_{st}} \right)}{1 + k_{st}}.
\]

(A7)

We are now in a position to estimate the size of the error. The annual growth rate of (nominal) state Personal Income from 1970-2000 is approximately 6%. Further, it is unlikely that the changes in total taxes that were independent of income would ever be as large as the portion that is dependent on income. Accordingly, if we substitute “upper bound” values of \( g_{st} = 0.10 \) and \( k_{st} = 1 \), we get Error = \(-0.045 = -4.5\% \). This constitutes the basis for our claim in the text that “the error associated with measuring \( \frac{\Delta \text{Taxes}_{st}^{\text{True}}}{Y_{s,t-1}} \) by \( \frac{\Delta \text{Taxes}_{st}^{\text{Forecast}}}{Y_{st}^F} \) when \( \Delta \beta_{0, st} \neq 0 \) will generally be less than 5%.”

\(^{19}\) Strictly speaking this should read, “the component of total new taxes that is dependent on the value of state income assuming state income stays constant.”