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Consumption Taxes, Income Taxes, and Revenue Sensitivity: States and the Great Recession

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Abstract

This article uses an income-distributional approach to state tax sensitivity to examine the assumption that consumption taxes are more stable than income taxes. We estimate the 2007 to 2009 change in tax revenues as a function of state income distributions and tax burdens by income class. We estimate tax burdens as a function of income tax shares and consumption tax shares. We then simulate the change in tax revenues with tax shares at the national average. If high-income-tax states were to lower their reliance on this tax, the revenue decline during the recession would have been *greater*. For high consumption tax states, the revenue decline under higher income tax shares would have been *smaller*. Had they shifted toward consumption taxes, income tax reliant states would not have reduced the cyclical sensitivity of tax revenues during the Great Recession. The interaction between tax burdens and recession shocks by income class is key to these results.

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Stability of tax revenue during economic downturns is an important feature of state tax systems. With almost all states subject at least to some degree to balanced budget requirements, the greater the decline in revenue during recessions, the greater the pressure to cut services or raise taxes. While some expenditure needs are stable throughout the business cycle, income maintenance, health care, unemployment insurance, and other services for the needy tend to be countercyclical, with need rising during recessions. The more stable are revenues, the less is the need for adjustments that may worsen the effects of economic downturns.

The major sources of state tax revenue are personal income taxes and taxes on consumption, including general sales and gross receipts taxes and excise taxes on tobacco, alcohol, and gasoline. Among the forty-eight contiguous states in 2007, the median share of tax revenue contributed by the personal income tax was 35 percent, while the median share from consumption taxes was 45 percent. With little support in the literature, the conventional wisdom says that consumption taxes are more stable than taxes on income because the consumption tax base is less elastic than the income tax base with respect to changes in aggregate income (Tax Foundation 2013).

The Great Recession provides an important test case for investigating the role of state tax structure in revenue sensitivity. The recession precipitated the sharpest decline in state tax revenues in the postwar period. From peak to trough (Q4 2008 to Q2 2010), real per capita income tax receipts fell by 19.4 percent, and sales tax receipts fell by 17.6 percent (Q4 2008 to Q3 2010). State tax revenues did not regain their prior nominal peak until 2011, and real receipts did not reach their prior peak until the fourth quarter of 2013.[1] However, amid the depth of the aggregate decline, there was considerable variation across states. Of the forty-eight contiguous states, thirty-six had nominal declines in state tax revenue between 2007 and 2009, while twelve had increases. While part of this variation was undoubtedly due to regional differences in the severity of the recession, another part may have been due to differences across states in tax structure. The goal of this article is to quantify the role of these two factors.

While the Great Recession marked an unprecedented downturn in the national economy, it comprised a set of shocks with differential impacts

across income classes, states, and regions. The financial shock, reflected in sharp drops in capital gains, dividends, and interest income, hit high-income households the hardest (Saez 2012).[2] Hence, the impact of the financial shock was likely to be greatest in states with the greatest concentration of high-income households and the greatest reliance on capital gains and other income from capital. Included among such states are New York, California, Florida, Connecticut, and Wyoming.

The bursting of the housing bubble, which led to a dramatic decline in housing values, an increase in mortgage delinquencies and home foreclosures, and the collapse of the home construction sector, was greatest in states with the greatest prior run-ups in housing prices.[3] Housing market declines were more likely than the financial shock to affect the entire income distribution.[4] Construction and other housing-related employment losses were also more likely to be concentrated among middle-income earners. There was a substantial overlap between the financial shock and the housing shock, putting California and Florida among those states with the greatest potential revenue shocks from the Great Recession (Chernick, Reimers, and Tennant 2014).

Other industry-specific shocks also varied in their regional impacts, depending on industry structure. Declines in financial service employment had particularly large impacts in New York, New Jersey, and Connecticut, while the shock to manufacturing employment in states such as Michigan and Wisconsin imposed a strong hit on middle-income earners. In contrast, mineral-dependent states benefited from positive shocks to the energy sector, while some agricultural states benefited from increased exports. Both the positive and negative shocks had differential impacts across the income distribution.

This article questions the conventional wisdom that heavier state reliance on income taxation as opposed to consumption taxes increases the sensitivity of tax revenues to the business cycle. Using the Great Recession as a test case, we show that even controlling for policy responses, the shares of state taxes from the personal income tax and sales and excise taxes at the outset of the recession are unable to explain the variation in the change in tax revenue across states. By contrast, we find that an income-distributional approach, in which the shock to different income classes is interacted with differences in effective tax burdens by income class, is able to explain a substantial portion of the variability of tax revenue changes during the Great Recession.

Our approach differs from the conventional analysis of revenue volatility in that we estimate separate effects, not for each type of tax, but for changes

in income at different points in the income distribution. The income changes are interacted with estimates of prerecession (2007) tax burdens by income class, produced by the fifty-state simulation model of the Institute on Taxation and Economic Policy (ITEP). We relate our approach to the more usual tax-by-tax analysis by estimating the relationship between tax burdens by income class and a state's reliance on income versus consumption taxes. This latter relationship forms the basis for a set of policy simulations that involve changing the mix of state taxes.

We emphasize that our study is based on a single, albeit important, episode—the change in state tax revenues from 2007 to 2009 induced by the Great Recession. We do not claim to have proved that the conventional wisdom—that consumption taxes are more stable than income taxes—is always incorrect. To be able to do so, our approach would have to be applied to a longer time period than just two years in order to incorporate multiple downturns and recoveries.

This article has five sections. The first section provides a short literature review. The second section discusses our models of tax burdens and tax revenue change. The third section presents the model estimates, while the fourth section discusses the simulation results. Conclusions are presented in the fifth section. This article has four Online Appendixes.

Literature Review

Prior research on state tax volatility has used panel data to estimate separate revenue elasticities for the major state taxes and attempted to distinguish between short- and long-run elasticities. Holcombe and Sobel (1997) find similar short-run elasticities with respect to personal income for the sales tax (1.3) and the income tax (1.4) in the period 1972 to 1993. Dye and McGuire (1991), using consumption estimates from the National Income Accounts and income changes by income class from the Current Population Survey, find greater variability of the income tax under a progressive structure and conclude that state tax structure has an important impact on volatility. In a later review paper, however, Dye (2004) suggests that changing the mix of taxes would, on average, have little effect on state tax volatility.

A number of observers have noted an increase in state tax volatility in the 2000s (Dadayan and Boyd 2009). In contrast to Dye's conclusion for the 1990s and earlier, Seegert (2012) concludes that most of the increase in state tax volatility in the 2000s can be attributed to what he calls "imbalance" in state tax structures, meaning heavy reliance on either sales or income taxes. Matoon and McGranahan (2012) and Kodrzycki (2014)

also find an increase in cyclicality of state revenues in the 2000s. Matoon and McGranahan attribute about 70 percent of this increase to greater cyclicality of the base, mainly due to greater volatility of income from capital, leaving about 30 percent due to the fact that tax rate changes in the 2000s were less likely to offset base changes than in the 1990s. Kodrzycki (2014) finds that state tax revenues were more volatile than their economies in the period 2000 to 2012 and that the main source of this increased volatility was an increase in the volatility of the personal income tax base. She attributes the greater base volatility to an increase in the share of investment income coming from capital gains and an increase in the cyclicality of capital gains receipts. She also points out that the income tax became more volatile than the sales tax in the 2000s.

As a test for differences across states in tax base and tax revenue elasticities, Matoon and McGranahan (2012) group states based on the degree of income concentration. Although they find some difference across groups in the degree of increase in volatility, they conclude that there was an increase in almost all states. Kodrzycki (2014) finds that the principal source of increased income tax volatility was an increase in the volatility of the federal tax base rather than differences in tax structure across states. However, she also finds that states with greater degrees of graduation in income tax rates were not more volatile and suggests that this may be because such states were more likely to raise top marginal rates and change bracket widths in response to the Great Recession.

Although several of these papers note the role of increased volatility of investment income in the 2000s, none of them makes the link between increased volatility by income source and increased concentration of income. By contrast, our examination of revenue sensitivity during the Great Recession focuses on the role of differences in the distribution of income across states and the interaction of those differences with differences in tax structure.

Modeling Tax Changes

A general expression for a change in tax revenues due to an economic shock is given by

$$\Delta \text{tax}_s = \sum_{i=1}^{n} \Delta B_{is} t_{is} + \Delta t_{is} B_{is} + \Delta B_{is} \Delta t_{is}. \quad (1)$$

In equation (1), B_{is} is the ith tax base in state s in the initial period, t_{is} is the initial tax rate on that base, and the Δs denote changes in bases and rates

over the analysis period. Base changes resulting from exogenous shocks may be offset (or reinforced) by policy changes such as broadening (or narrowing) the base for the general sales tax. Tax rate changes may also be offsetting or reinforcing. In general, the shorter the time period of analysis, the greater the importance of exogenous base changes as opposed to policy responses.

In the usual approach to tax volatility, the bases in equation (1) are individual taxes, such as the general sales tax and the personal income tax, and the rates are the nominal rates on those bases. The first key innovation in our research is that, instead of base changes for individual taxes, we use changes in income-by-income class. We start with a broad measure of economic activity, federal adjusted gross income (AGI), and break this measure down into changes in income within separate income classes. Because our focus is on the effect of increased concentration of income, at the top on the volatility of state tax revenues, we divide the AGI distribution into three income classes, representing the top 5 percent, the next 15 percent, and the bottom 80 percent of all filing units. Income classes are specific to each state, so the top 5 percent will have a higher average AGI in a rich state such as California than in a poor state such as Alabama.

The rationale for this alternative approach is not that it provides more accurate predictions of revenue volatility than the tax-by-tax approach. Instead, by directly incorporating the long-standing trend in the US economy toward increasing concentration of income, while also taking account of the significant regional variation in the patterns of income concentration, our measure of changes in the tax base provides a direct link between structural changes in the economy and the stability of state tax revenues.[5]

The second innovation in our approach is that, rather than using the nominal rate for a given tax, say 6 percent for a state sales tax, we use the effective tax burden by income class of all state taxes. Each state has its own specific rules defining tax bases, rates, and coverage for the various state taxes, all of which may affect the change in tax revenue in a recession. It is not possible to incorporate all of these rules into a multistate analysis. Instead, in this article, we use effective tax burdens by income class. Such burdens, assuming the estimates are done appropriately, provide an efficient set of statistics for summarizing both the tax codes in each state and the individual consumption and income patterns that underlie the burden estimates. Sources and methodologies for the income class data and the tax burden estimates are discussed more extensively in the next section.

While changes in income concentrations are largely exogenous to state policy, effective tax burdens by income class are a direct result of state tax choices. By estimating a statistical relationship between tax burdens by income class and the broad dimensions of state tax policy, we can trace the effect of simulated changes in state tax policy through to tax changes in the face of economic downturns. Our analysis incorporates the links between policy choices over income and consumption taxes and revenue stability in the face of an economic shock, given prior changes in income concentration. Ultimately, of course, the usefulness of our approach depends on empirical tests of the ability to explain actual tax changes. Most of the paper is devoted to these empirical tests.

Tax Revenue Change as a Function of Income Changes and Initial Tax Burdens

To implement our alternative, income-distributional approach, we specify the tax revenue change model in equation (1) as

$$\Delta \mathrm{TAX}_s = b_0 + \sum_{j=1}^{3} b_{1,j}\,\mathrm{Burd}_{js} + \sum_{j=1}^{3} b_{2,j}\Delta \mathrm{AGI}_{js} + \sum_{j=1}^{3} b_{3,j}\mathrm{Burd}_{js} \times \Delta \mathrm{AGI}_{js} + b_4(\text{Rate Change Indicators}_s) + \mathrm{error}_{js}. \tag{2}$$

In equation (2), ΔTAX is the change in state tax revenue from 2007 to 2009, s indexes states, j indexes income classes, Burd is the effective tax burden in 2007, and ΔAGI is the change in federal AGI between 2007 and 2009. The Rate Change Indicators are explained below. The tax base for each state is measured in terms of federal AGI and is divided into three separate income classes. All dollar amounts are in nominal terms and are scaled by the number of 2007 federal tax returns for that state either in total or for the particular income class.[6] Effective tax burdens for each income class are taken from the Institute for Taxation and Economic Policy (ITEP 2009) microsimulation model, which provides estimates for all fifty states.

The first set of terms in equation (2) includes the tax burdens alone, the second includes the changes in AGI alone, while the third set represents the interaction between the tax burdens and the changes in income. In contrast, the generalized expression for tax revenue changes in equation (1) has three terms, the first two reflecting changes in bases and rates weighted by initial rates and bases, respectively, and the third interacting the changes in both rates and bases. The empirical implementation in equation (2) differs from

the general model for two reasons. First, because we lack appropriate data on rate changes, we substitute a set of rate change indicator variables for the terms in equation (1) involving rate changes. Second, the first term in the generalized expression of equation (1) represents the interaction between base changes and rates, whereas the empirical model in equation (2) separates this term into three separate sets of variables—initial rates, changes in bases, and the interaction between the two. Including the interaction as a single term, as in equation (1), constrains the estimated coefficient(s) to be the same for both changes in bases and initial rates. The empirical analysis indicated that this constraint was unjustified. Due to the nonlinear nature of the revenue effects, the unconstrained model proved to provide more explanatory power and insight into how base changes and initial rates affected tax revenue changes.

We use the term "fiscal exposure" to represent the third set of terms in equation (2); i.e., the sum across three income classes of the change in income times the initial tax burden. Fiscal exposure thus represents the potential change in tax revenues from an economic shock, assuming no offsetting policy response. The change in tax revenues is equal to the fiscal exposure caused by the recession (a negative number in most states) plus any offsetting increases in tax rates or broadening of tax bases. If offsets are systematically related to overall fiscal exposure or any of its components, then estimates of the effect of fiscal exposure will be biased toward zero.

To address the potential relationship between exposure and tax offsets and given the lack of tax burden data for 2009, we proxy for Δt_{is} in the second and third terms of equation (1) with a set of zero-one indicator variables denoting rate changes for the income tax and general sales tax, denoted in equation (2) by Rate Change Indicators. The first indicator equals one if a state increased any income tax rate between 2007 and 2009, while the second indicator equals one if a state decreased any income tax rate. The third equals one if a state increased its general sales tax rate. Nine states raised their income tax rates over this period, while seven states decreased their rates.[7] Twelve states raised their general sales tax rate, while none decreased their rate. Data sources are Tax Policy Center, Urban Institute and Brookings Institution (2007) and Tax Foundation (2009). There were very few changes in excise tax rates over this period, with minimal impact on state tax revenues. Hence, such changes are not included in the regression specifications.[8]

To take account of the differential impact of the recession by income class, we use Internal Revenue Service (IRS) data on changes in AGI by income bracket by state. Based on the available IRS data and our focus on

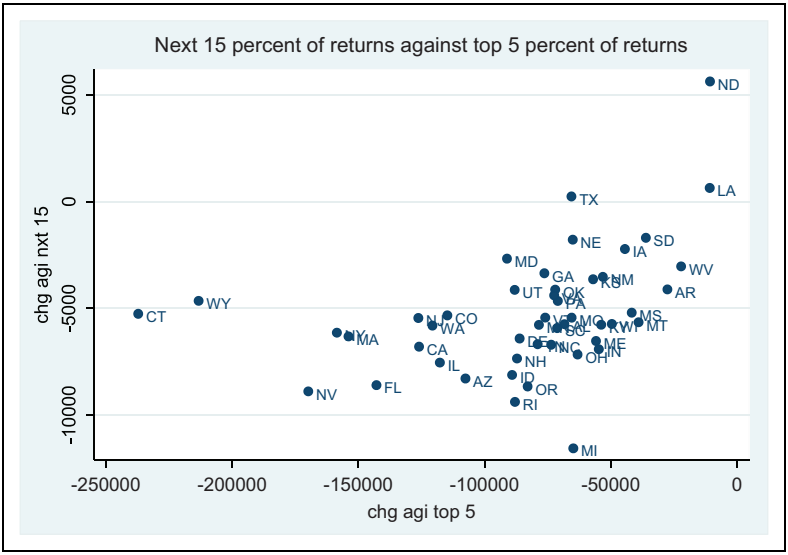

Figure 1. Change in adjusted gross income per return, 2007 to 2009.

the effect of income changes at the upper end of the income distribution, tax filing units are divided into the top 5 percent of AGI, the next 15 percent, and the bottom 80 percent. Online Appendix 1 provides more detail on the division into three income classes. Changes in the tax base within a state are measured by the change in AGI between 2007 and 2009 for each income class. The data source for AGI by state and AGI bracket is the published IRS Statistics of Income data (IRS, 2007 and 2009).

If the income changes during the Great Recession were uniform across the distribution within a state, decomposing the tax base by income class would yield little additional insight. However, the data reveal that this is not the case. The correlation between dollar changes in AGI per return for the top 5 percent and the next 15 percent, while statistically significant, is relatively low ($\rho = .4$).

Figure 1 plots the change in AGI per filing unit for the next 15 percent of the AGI distribution against the change for the top 5 percent. The figure shows that the largest decreases in the top 5 percent of the income distribution occurred in Connecticut, Wyoming, Nevada, New York, Massachusetts, and Florida. Only two of these states, Nevada and Florida, were among the twelve states with the largest decreases in the next 15 percent of the AGI distribution. The two largest losses in this second income class

occurred in Michigan and Rhode Island, manufacturing states that have been subject to secular decline.

Figure 1 also highlights how much larger was the shock to the top of the income distribution than to the next 15 percent. This difference suggests that the potential effect of the recessionary shock on tax revenues could be substantially higher in states with relatively high tax burdens on the top income class versus the next fifteen income class. Both the overall magnitude of the shocks to the two segments of the top income quintile and their variation across states, together with differences across states in relative tax burdens within the top quintile, provide a justification for our income distribution-based analysis of revenue volatility and for breaking down the top quintile into two classes.[9]

In contrast to the relatively weak top five–next fifteen correlations, the within-state correlation between the change in the next 15 and the bottom 80 percent of the AGI distribution is very strong ($\rho = .74$). There is undoubtedly some variation across states in the distribution of the income shocks within the bottom 80 percent. However, given our focus on the top end of the income distribution and the fact that AGI per return rose for the bottom 80 percent in all but three states while it fell for the top 5 percent everywhere and for the next 15 percent in all but three states, we lump the bottom 80 percent into a single lower income class.

Tax Burdens by Income Class

In the tax revenue change model, AGI changes in each income class are multiplied by 2007 tax burdens by income class. The estimated tax burdens come from the fifty-state microsimulation model of the ITEP (2009).[10] ITEP measures tax burdens by assigning taxes paid based on the structure of state income taxes, the rates and coverage of general and specific sales taxes, and the amounts raised from taxes whose initial incidence is on firms. The ITEP model is an economic incidence model that uses standard assumptions about tax shifting. Income taxes are assumed to be borne by taxpayers, while consumption taxes are mainly shifted forward to consumers. Consumption taxes are imputed to families using regression-based estimates from annual expenditure patterns from the Consumer Expenditure Survey (CEX), updated to reflect changes in relative prices.[11] Separate estimates are made for durables and six categories of nondurables. A more detailed description of the ITEP model is provided in Online Appendix 1.

Using the tax burden from the ITEP model assumes that multiplying AGI change times the effective tax burden will approximate actual tax revenue

changes. The key question is whether the use of tax burdens is appropriate for explaining changes in tax revenues. In the ITEP estimates, taxes on firms in state 1 that are exported to state 2 will not show up in the burden estimates for either state. The dependent variable in our analysis is the overall change in tax revenue within a state. This change consists of two parts: the change in taxes whose incidence is borne domestically (i.e., by residents of the state) and the change in the portion of total taxes that is exported to out-of-state residents. The variables in the regression model—changes in AGI and tax burdens on residents from taxes that are borne domestically—are designed to explain the change in domestic taxes, while the change in exported taxes is absorbed in the error term for the tax change model.

The econometric question is whether the exported tax component of the error term is correlated with the ITEP tax burden estimates. Because the burden estimates depend on both the overall level of taxes in the state and the division between domestic and exported taxes, we do not expect the change in the exported portion to be correlated with the tax burdens. A state could have a high exported share, which would reduce estimated burdens, and at the same time, a high overall level of taxes, which would raise estimated burdens. The change in exported taxes depends on the change in the exported share of consumption and profits, which could be relatively high or low depending on changes in national market demand.[12]

Another source of tax exporting is federal deductibility of income and sales taxes. The ITEP burden estimates used in this article ignore the federal offset for tax deductibility. We use the gross rates because our goal is to explain the change in state tax revenues that results from a given change in the tax base rather than the impact on federal plus state taxes of the base change.

Overall, the extent of tax exporting is relatively small, equal to between 5 percent and 10 percent for most states.[13] The exceptions are states that rely heavily on tourism, such as Nevada and Florida. As expected, given that the ITEP analysis does not include severance taxes, the ratio of taxes raised to estimated burdens is relatively high in states that rely heavily on severance taxes.

States vary substantially not only in their overall tax burdens but also in their reliance on different types of taxes and in the resultant distribution of tax burdens by income level. Table 1 shows the shares in total state tax revenue of the personal income tax, taxes on consumption, and severance taxes, for the year 2007. In that year, 35 percent of the median state's tax

revenue came from the personal income tax, while 45 percent came from general sales and excise taxes.

Of the forty-eight contiguous states, six (Texas, Florida, Washington, Nevada, South Dakota, and Wyoming) have no income tax, while two (Tennessee and New Hampshire) have very limited income taxation.[14] Of the forty states that use a broad-based income tax, the rate structure varies widely. Nineteen states tax most income at a single rate. For the rest of the income tax states, there is considerable variation in both the top rate and the degree of graduation (Dye 2004). At the beginning of the recession in 2007, the highest top marginal rate was in California at 10.3 percent for taxable income above US$1 million (Tax Foundation 2014).

Differences in the structure of the income tax translate into substantial variations in progressivity of the income tax across states. The ITEP estimates indicate that the ratio of the income tax burdens on the top 5 percent to the bottom 80 percent in a state ranges from 0.94 to 5.8, with an average of 1.84 and standard deviation of 0.95. While nominal rates for the general sales and excise taxes are typically uniform within states (with some minor variation across counties), effective consumption tax rates vary by income level because of differences in the share of taxable consumption in income. Based on data from the Current Expenditure Survey, the elasticity of consumption of taxable items with respect to annual income is substantially below one (Poterba 1989).[15] ITEP estimates an average ratio of effective consumption tax burdens on the top to middle quintile equal to 0.53. Variation around this average across states is small (standard deviation = .03), suggesting that variation across states in the taxable base has relatively little effect on the incidence of consumption taxes, at least in the upper part of the income distribution.

Model Estimates: Change in Tax Revenues as a Function of Income Changes and Tax Burdens by Income Class

Descriptive statistics for all variables used in the various regressions are given in table 1. An important issue in assessing the usefulness of our equation (2) model is the extent to which there are offsetting tax policy changes by states, and in particular, whether any such offsets are correlated with the potential fiscal exposure. Therefore, we estimated linear regressions of the likelihood of a tax rate offset for the income and sales tax. We found that an income tax rate increase was more likely the greater the potential revenue

Table 1. Descriptive Statistics.

Variable	Mean	Standard deviation	Minimum	Maximum
Change in total state tax revenue 2007–2009 (dollar per 2007 return)[a,b]	−138	582	−1,128	2,596
Total state tax burden on top 5 percent, 2007[c]	0.066	0.019	0.023	0.101
Total state tax burden on next 15 percent, 2007[c]	0.085	0.016	0.045	0.127
Total state tax burden on bottom 80 percent, 2007[c]	0.093	0.014	0.06	0.116
Personal income-tax shares of total tax revenue, 2007	0.322	0.173	0	0.723
Consumption taxes shares of total tax revenue, 2007	0.467	0.156	0.101	0.813
Selective sales (excise) taxes share of total tax revenue, 2007	0.164	0.056	0.063	0.337
General sales tax share of total tax revenue, 2007	0.303	0.144	0	0.610
Severance-tax share of total tax revenue, 2007	0.029	0.071	0	0.397
Corporation income-tax share of total tax revenue, 2007	0.067	0.04	0	0.270
Average state tax burden, 2007[c]	0.082	0.015	0.042	0.112
Dollar change in AGI per federal return in top 5 percent of returns, 2007–2009[b]	−83,774	46,787	−237,197	−10,729
Dollar change in AGI per return in next 15 percent of returns, 2007–2009[b]	−5,257	2,857	−11,571	5,633
Dollar change in AGI per return in bottom 80 percent of returns, 2007–2009[b]	1,108	787	−821	2,938
Income tax increase[d] =1 if any increase in income-tax rates, 2007–2009; =0 otherwise	0.188	0.394	0	1
Income tax decrease[d] =1 if any decrease in income-tax rates, 2007–2009; =0 otherwise	0.146	0.357	0	1

(continued)

Table 1. (continued)

Variable	Mean	Standard deviation	Minimum	Maximum
Sales tax increase[e] =1 if any increase in general sales tax rates, 2007–2009; =0 otherwise	0.250	0.438	0	1

Note: AGI = adjusted gross income.
[a]US Census Bureau (2007, 2009).
[b]Internal Revenue Service (2007 and 2009) and authors' calculations.
[c]Institute for Taxation and Economic Policy (2009).
[d]Tax Policy Center, Urban Institute and Brookings Institution (2007) and Tax Foundation (2009).
[e]Tax Policy Center, Urban Institute and Brookings Institution (2007) and Tax Foundation (2009).

exposure (tax burden times change in AGI, which was negative) for the top 5 percent of a state's AGI distribution. This result indicates that the income tax rate increase dummy should be included in the tax change model. None of the variables included in our tax change model had any significant effect on income tax rate decreases or sales tax increases.[16]

Table 2 shows estimates of the full tax change model. The dependent variable is the dollar change in state tax revenues from 2007 to 2009, divided by the number of federal tax filing units in 2007.[17] The two specifications in the table are the same, except that column (1) includes the three indicator variables for tax rate changes. None of the three indicators is significant. Comparing the two columns, the point estimates and significance levels are almost identical.[18] This suggests that, despite evidence that high-income-tax states that were hit by large decreases in top 5 percent income were more likely to respond by raising their income tax rates, the cross-section model of tax revenue change is unaffected by the exclusion of the indicator variables.[19]

In interpreting the results from table 2, we emphasize the marginal impact of differential tax burdens and differential AGI changes across states for each of the three income classes. Manipulating the estimated coefficients in column (2) of table 2, the marginal impact by income class is equal to

$$\begin{aligned}\partial(\Delta \mathrm{Tax}_s) = {} & (16277 + .296 \times \Delta \mathrm{AGI}_{\mathrm{top5},s}) \times \partial(\mathrm{Burd}_{\mathrm{top5},s}) \\ & + (-9935 - 6.116 \times \Delta \mathrm{AGI}_{\mathrm{nxt15},s}) \times \partial(\mathrm{Burd}_{\mathrm{nxt15},s}) \\ & + (-16339 - 3.114 \times \Delta \mathrm{AGI}_{\mathrm{nxt80},s}) \times \partial(\mathrm{Burd}_{\mathrm{nxt80},s}). \qquad (3)\end{aligned}$$

Table 2. 2007 to 2009 Change in State Tax Revenues (Dollar per Federal Return), as a Function of AGI Changes and Tax Burdens by Income Class.

	Tax revenue change	
Independent variable	(1)	(2)
Change in AGI in top 5 percent of returns, 2007–2009 (dollar per federal return)	−0.0207 (−5.22)***	−0.0204 (−5.10)***
Change in AGI in next 15 percent of returns, 2007–2009 (dollar per federal return)	0.574 (3.18)**	0.575 (3.34)**
Change in AGI in bottom 80 percent of returns, 2007–2009 (dollar per federal return)	0.587 (0.61)	0.403 (0.43)
Total state tax burden on top 5 percent, 2007	15,808 (1.35)	16,276.5 (1.41)
Total state tax burden on next 15 percent, 2007	−6,705.3 (−0.33)	−9,934.6 (−0.50)
Total state tax burden on bottom 80 percent, 2007	−16,104 (−1.37)	−16,339 (−1.38)
Change in AGI × burden, top 5 percent	0.316 (5.24)***	0.296 (5.00)***
Change in AGI × burden, next 15 percent	−5.989 (−2.90)**	−6.116 (−3.11)**
Change in AGI × burden, bottom 80 percent	−5.179 (−0.55)	−3.114 (−0.34)
Income tax increase, 2007–2009 (dummy)	179.1 (0.86)	
Income tax decrease, 2007–2009 (dummy)	−228.5 (−1.30)	
Sales tax increase, 2007–2009 (dummy)	−35.99 (−0.26)	
Constant	1,062.9 (0.61)	1,181 (0.69)
Observations	48	48
Adjusted R^2	.590	.583

Note: t-statistics are in parentheses. AGI = adjusted gross income.
*$p < .05$.
**$p < .01$.
***$p < .001$.

In equation (3), ΔTAX is the 2007 to 2009 dollar change in tax revenue, ΔAGI is the change in AGI for the respective income class, and Burd is the tax burden for the income class. We expected that, given the change in AGI,

a higher tax burden at any point in the income distribution would be associated with a greater change in tax revenues. Similarly, given the burden, the greater the change in the tax base (i.e., AGI) at any income level, the greater the expected revenue response.

Table 2 shows that the burden and base change effects are nonlinear, depending on the interaction between the two, and that the direction of effect differs across the income distribution. For states where top five AGI fell by US$55,000 per return or more, the higher the tax burden, the greater the decrease in total tax revenues. At the mean change in AGI for the top 5 percent (–US$84,000 per return), a one percentage point increase in the tax burden would increase the revenue loss by US$86 per return, nearly two-thirds again as much as the average reduction of US$138. Despite the fact that the average change in AGI was *positive* for the bottom 80 percent, in contrast to the rest of the distribution, the effect of higher tax burdens on this slice, like the effect for the top 5 percent, is to exacerbate the decline in total tax revenues. At the mean change in bottom eighty AGI of +US$1,100 per return, a one percentage point increase in the tax burden is associated with a US$198 (per return) larger reduction in total tax revenues.

By contrast, states with higher tax burdens on the next 15 percent, all else equal, experienced a *smaller* hit to tax revenues. The second term in equation (3) implies that for states with reductions in next fifteen AGI of US$1,625 per return or more (which was the case for all but three states), the net effect of a higher next fifteen burden is positive, that is, to *reduce* the revenue loss. At the mean change in next fifteen AGI (−US$5,260 per return), a one percentage point increase in the next fifteen burden corresponds to a US$222 (per return) smaller loss (or larger gain) of tax revenues.

The counterintuitive result for the next fifteen tax burden may be due to unobserved factors that are correlated with that burden. One such possibility is correlation with corporate tax revenues, which, though small, are extremely volatile. However, when we excluded the corporation income tax (CIT) from our measure of the change in taxes, the results were unaffected. As shown in table 2, the coefficients for the next fifteen are also robust to the inclusion of a limited set of controls for tax policy responses. In the simulation analysis which follows, we address the sensitivity of our results to variation in the estimated coefficients of the tax change model.

Simulation Analysis

In this section, we consider the question of how alternative mixes of personal income taxation and consumption taxation—general and selective

sales taxes—would have affected the revenue performance of states during the Great Recession. The previous analysis shows that a straightforward regression of tax revenue change on tax shares was uninformative (see Online Appendix 2). However, as shown in table 2, the combination of tax burdens and base changes by income class proved powerful in explaining the change in tax revenues of states during the first two years of the recession. To perform the simulation exercise using this model, we need to translate policy choices over the mix of taxes into tax burdens by income class. We do this via a set of regression models in which state tax burdens by income class are a function of the state's tax mix. We use the estimated coefficients from these regressions to predict the effect on burdens of altering the tax mix. The predicted burdens are then entered into the tax revenue change equation (table 2, column 2) to simulate the difference in tax revenue changes under alternative tax structures.

The policy experiment that we simulate is to vary the mix of consumption and income taxes. We recognize that this is a rough characterization of tax policy, and that states do not typically make explicit choices in these broad terms. Policy changes are typically incremental and are often propelled by fiscal pressure to maintain revenues in economic downturns. While there are frequent adjustments in nominal excise tax rates, changes in the sales tax rates or income tax rates or bases are infrequent. Adjustments in the structure of taxes on firms, for example, revision of credits or deductions, are likely to be at least as frequent as adjustments to direct taxes.[20] However, given that the major revenue sources for most states are income, sales, and excise taxes, tax debates inevitably revolve around the relative role of each type of tax.

Tax Burdens and Tax Mix

To translate the tax mix into tax burdens, we regress burdens by income class on tax shares. With states indexed by s and income class by i, we estimate equations of the form

$$\text{Burd}_{is} = a_{0i} + a_{1i}\text{SHR}_{\text{pit},s} + a_{2i}\text{SHR}_{\text{cons},s} + a_{3i}\text{SHR}_{\text{sev},s} + a_{4i}\left(\frac{\text{Tottax}}{\text{Income}}\right)_s + \text{error}_{is}. \quad (4)$$

The dependent variable Burd_i is the effective tax burden on the ith income class, SHR_{pit} is the share of total tax revenue from the personal

income tax, SHR_{cons} is the share from sales and excise taxes, SHR_{sev} is the share from severance taxes, and Tottax/Income is the ratio of total state taxes to personal income.[21] While in most states, taxes on consumption and personal income contribute the preponderance of state tax revenue, a few states are heavily dependent on severance taxes. Because tax shares are correlated by construction, omitting severance taxes would bias the estimates of the income tax effect and consumption tax effect. The total tax burden is included as a measure of the size of the state's public sector, with the expectation that a larger public sector is associated with higher tax burdens on all income classes.[22]

Estimates of the tax burden models are shown in table 3.[23] Variation in tax shares is most closely linked to variation in burdens for the top quintile, with an adjusted R^2 equal to .76 for the top 5 percent, compared to .65 for the next 15 percent, and .43 for the bottom 80 percent. The coefficient estimates show the effect on burdens of substituting each of the listed taxes for the omitted category, which is "other" taxes, including the CIT and license fees, while holding the ratio of taxes to personal income constant. Notably, the income tax shares has a significantly positive effect on all burdens across the income distribution, with the effects on the top five and next fifteen burdens almost equal, and only slightly larger than the effect on the next eighty burden. Thus, the main effect of a higher personal income tax shares is to increase estimated state tax burdens across the board, with relatively small differences across the income distribution.

Since the regressions control for the state taxes as a share of personal income, at first glance, the across the board increase of a higher personal income tax shares might seem surprising. The explanation lies in the assumptions about tax shifting that underlie the ITEP methodology. Since the income tax is assumed to be borne completely by state residents, whereas the other taxes are partially shifted out of state, an increase in reliance on the income tax increases the calculated ITEP burden. That the effect is about equal across the distribution reflects the fact that in many states, there is little graduation in rates.

Greater reliance on consumption taxes has a regressive impact, with an insignificant effect on the top five burden, but an increase in the next fifteen and bottom eighty burdens that are from two to three times as large as for the top 5 percent. The contrast between the incidence across income classes is notable. Compared with raising the consumption tax shares, raising the personal income tax shares has four times the effect on the top five burden, about twice the effect on the next 15 percent, but a slightly smaller effect on the bottom 80 percent.

As shown in row 3 of table 3, a higher severance tax share is associated with lower burdens on the top quintile of the AGI distribution but has no significant effect on the burden on the bottom 80 percent. Severance tax revenues are determined by mineral prices in world markets and by the available supply, given the state of technology. The results in table 3 suggest that states tend to use these revenues to reduce tax burdens on the top quintile, as opposed to the rest of the income distribution.

The overall tax burden is a measure of preferences for public services.[24] A higher overall tax burden is associated with higher tax burdens across the income distribution (table 3, row 4). However, the effect of the overall burden is greater the higher the income slice, suggesting that a more progressive tax structure accompanies a larger public sector.

Simulation of Alternative Mixes of Income and Consumption Taxes

We use the estimated coefficients from the revenue change and tax burden regressions (tables 2 and 3) to predict how the recession-induced change in tax revenues in each state would have been affected if the mix of income and consumption taxes had been equal to the national average, taking account of each state's share of tax revenues that come from taxes other than those on income and consumption. First, we use the predicted tax burdens from the regressions in table 3, conditional on actual 2007 tax shares, together with the coefficient estimates from table 2, to generate baseline simulations of the 2007 to 2009 change in tax revenue. We then simulate the burdens when we replace the state-specific income tax shares and consumption tax shares (of their combined total) with the 2007 averages for all states. We use these simulated burdens with the coefficients from the revenue change regression (table 2) to simulate the state-by-state change in tax revenue under the hypothetical balanced system. Details of the analysis are described in Online Appendix 3. While a nationally uniform system of income tax shares and consumption tax shares is of course unrealistic, and actual adjustments in tax shares are likely to be incremental, we believe there is considerable insight to be gained from an examination of this case.

Table 4 shows the key results from our analysis. States are divided into two groups based on the personal income tax shares of combined income and consumption taxes. Other taxes, including severance, corporate, and inheritance taxes, are outside the scope of our analysis, hence are taken as exogenous. In table 4A, we consider states whose income tax shares is above the median. Table 4B includes states whose income tax shares is

Table 3. Tax Burdens by Income Class, as a Function of Tax Shares, 2007.

Independent variable	Burden on top 5 percent[a]		Burden on next 15 percent[a]		Burden on bottom 80 percent[a]	
	(1)	(2)	(3)	(4)	(5)	(6)
Personal income-tax shares	0.0895*** (6.30)	0.0901*** (5.15)	0.0837*** (5.61)	0.0903*** (4.94)	0.0683*** (4.34)	0.0643** (3.33)
Consumption-tax shares	0.0227 (1.50)		0.0428* (2.69)		0.0732*** (4.37)	
Severance-tax share	−0.0562* (−2.38)	−0.0555* (−2.12)	−0.0501* (−2.02)	−0.0430 (−1.57)	−0.0296 (−1.13)	−0.0339 (−1.17)
Average state tax burden	0.0616*** (5.54)	0.0618*** (5.29)	0.0468*** (4.01)	0.0489*** (4.01)	0.0318* (2.59)	0.0306* (2.37)
General sales tax share		0.0230 (1.43)		0.046** (2.74)		0.0713*** (4.02)
Selective sales (excise) tax share		0.0250 (0.62)		0.0677 (1.60)		0.0584 (1.30)
Constant	−0.0136 (−0.93)	−0.0144 (−0.72)	0.00754 (0.49)	−0.00126 (−0.06)	0.0162 (1.00)	0.0215 (0.98)
Observations	48	48	48	48	48	48
Adjusted R^2	.762	.757	.645	.640	.434	.422

Note: t-statistics are in parentheses.

[a]Dependent variables are the tax burdens gross of federal tax deductibility, by adjusted gross income class.

*$p < .05$.

**$p < .01$.

***$p < .001$.

Table 4. Simulated Tax Revenue Change 2007 to 2009 and Means of Other Variables, under Alternative Scenarios.

Type of tax change	Average	Standard deviation	Average tax burden	Personal income tax shares of total taxes	Consumption tax shares of total taxes	Tax burden, top 5 percent of returns
(A) States with Above-median PIT shares of combined PIT + consumption taxes ($n = 24$)						
Actual	−246	276	.088	.450	.375	.077
Predicted w/ predicted burdens, actual PIT and consumption tax shares	−218	164	.088	.450	.375	.076
Predicted w/ predicted burdens, national average PIT shares of PIT + consumption, allowing average burden to change	−252	129	.084	.329	.496	.068
(B) States with Below-median PIT shares of combined PIT + consumption taxes, excluding North Dakota and Wyoming ($n = 22$)						
Actual	−233	330	.078	.204	.571	.057
Predicted w/ predicted burdens, actual PIT and consumption tax shares	−228	333	.078	.204	.571	.058
Predicted w/ predicted burdens, national average PIT shares of PIT + consumption, allowing average burden to change	−202	298	.081	.309	.466	.065

Note: PIT = personal income tax.

below the median, excluding the two states with the highest severance tax share of revenue, for the reason discussed in note 18. The simulation exercise assigns all states the national average income tax shares of income plus consumption taxes. Hence, states in table 4A would get a smaller share of tax revenue from the personal income tax, while states in table 4B would get a larger share. If income tax revenues were more volatile in response to the recession than consumption taxes, one would expect the states in table 4A to see a smaller revenue loss under the simulation, while states in table 4B would see a bigger loss.

The first row of tables 4A and 4B shows the actual tax revenue change for the two groups of states. It is noteworthy that the average changes, a decrease of US$246 per return for the high-income-tax-share states and a decrease of US$233 for the low-income-tax states, are quite similar in sign and magnitude.[25] Row 2 shows predicted changes in tax revenues using predicted tax burdens from our model. Predicted tax changes under the simulation model with national average income tax shares and consumption tax shares are shown in row 3.

Substituting national averages for actual tax shares affects both the incidence of state tax systems and the overall tax burden. As shown by comparing rows 2 and 3 in the last column, for high-income-tax states (table 4A) predicted top five burdens fall by almost a percentage point. For states with low income-tax shares (table 4B), predicted top five burdens rise by roughly the same amounts as they fall for high-income-tax states.[26] Reducing the income tax shares makes the tax system more regressive, while increasing the income tax shares reduces regressivity.

The main results are shown in the first column of row 3 in tables 4A and B. Table 4A shows that smaller-income-tax shares would have resulted in a *greater* average drop in tax revenues than predicted by the actual mix of taxes, with the simulated decrease going from −US$218 to −US$252. Table 4B shows the opposite effect for the low-income-tax-share states. Substituting national average consumption and income tax shares *reduces* the average predicted tax hit from the recession from −US$228 to –US$202.

These results are quite remarkable. They suggest that, contrary to the conventional wisdom, low-income-tax states would have had better revenue performance during the Great Recession with a tax structure more heavily weighted toward the income tax, while high-income-tax states would have had worse performance had their tax systems been more weighted toward consumption taxes.

The key to explaining these results is the effect on a state's revenue change of the tax burden on the 80th to 95th percentiles of the income

distribution. Table 2 shows that across states, a greater burden on the top 5 percent (ceteris paribus) is associated with an *increased* revenue loss for the state with average change in top five AGI, but a greater burden on the next 15 percent is associated with a *reduced* revenue loss for all but three states. A greater burden on the bottom 80 percent is also associated with an increased revenue loss for the average state, because the average change in AGI for the bottom 80 percent was positive. Thus, if all tax burdens are reduced due to a lower personal income tax shares, the reductions in the top 5 and bottom 80 percent reduce the revenue loss, but the smaller burden on the next 15 percent increases the loss.

Our results suggest that the increase from the next fifteen income class outweighs the reductions from the top 5 and bottom 80 percent, with the net result that the revenue drop in high-income-tax states would have been larger had the personal income tax shares been reduced. For states below the median personal income tax shares, when the personal income tax shares is increased, the regression coefficients indicate that the reduced revenue loss associated with the next 15 percent outweighs the increased loss associated with the top 5 and bottom 80 percent, so that the overall loss is smaller.

The simulation raises the share of consumption taxes in the total tax burden for high-income-tax states, while lowering its share for high-consumption-tax states. An important question to ask is whether changes in consumption behavior during the Great Recession can explain the simulation results. Evidence is mixed on consumption behavior during the Great Recession, particularly as it would affect our results. Petev and Pistaferri (2012) show that consumption dropped relative to income in the first year of the recession, as wage and salary income was augmented by increased transfer income. Mian, Sufi, and Trebbi (2011) find that housing foreclosures had a strong effect on consumption. Baker (2014) finds that the worsening in household debt positions during the Great Recession had a strong effect on consumption behavior. All of these papers imply the possibility that states with greater reliance on consumption taxes than income taxes, hence higher tax burdens on the lower part of the income distribution would have experienced greater revenue volatility during the Great Recession.

By contrast, CEX data (US Bureau of Labor Statistics 2007, 2009) indicate a slight decrease in consumption relative to income for the top two quintiles of the national income distribution (from 61 percent to 60 percent for the top quintile between 2007 and 2009) and an increased consumption share for the bottom three quintiles. This mixed evidence indicates that our results cannot be explained by changes in aggregate consumption share by income class.

Sensitivity Analysis

The above simulation results—that lower income-tax shares among high-income-tax states are associated with *increased* sensitivity of tax revenues to the recession shock, while higher income tax shares shares among low-income-tax states are associated with *decreased* sensitivity of tax revenues—are obtained from two sets of regression results: first, tax burdens by income class as a function of income tax shares and consumption tax shares and, second, changes in tax revenue as a function of initial tax burdens and changes in the tax base by income slice. How sensitive are our results to variation in these estimated regression coefficients?

To investigate this question, we make two simplifying assumptions: first, that the tax burdens as a function of tax shares are predicted without error and, second, that the effects on the change in tax revenues of the tax burdens on the other segments of the income distribution are estimated without error. We then ask, how likely are the coefficients on the next fifteen burden and its interaction term in the tax revenue change regression (table 2) to be far enough from their point estimates to reverse our results, given the standard errors and covariance of these estimated coefficients? In table 4A (states above the median income tax shares), what coefficient values would be required to make the simulated revenue drop under national average tax shares (row 3) *smaller than* the estimated drop with actual tax shares (row 2), and how likely are the coefficients to have these values? Conversely, in table 4B (states below the median income tax shares), what coefficient values would be required to make the simulated revenue drop in row 3 *exceed* the estimated drop in row 2, and how likely are the coefficients to have these values?

According to the calculations shown in Online Appendix 4, the coefficients on the next fifteen burden and its interaction term would have to be more than 0.80 standard error below their point estimates to make the difference between rows 3 and 2 in table 4A positive. In table 4B, the analogous critical value is −0.63 standard error. The probabilities of errors this large are 11 percent and 15 percent, respectively. When we substitute the top five burden for the next fifteen burden, the answers are nearly the same (12 percent and 15 percent, respectively). These results are reassuring and suggest that even rather unlikely deviations in the estimated effects of a burden would not change our main results.

Conclusion

The Great Recession was notable both for its overall severity and for differential impacts across states and income groups. While state tax revenues

took a major hit during the Great Recession, the effect varied widely across states. Thirty-six of the forty-eight contiguous states experienced losses, and by 2014, real tax revenues were still below 2007 levels in many states. While over a third of state tax revenue comes from the personal income tax and a little less than half from taxes on consumption, states vary widely in their relative reliance on each of these taxes. Conventional analyses have attributed interstate differences in the cyclical sensitivity of state tax revenues to differences in their relative dependence on these two types of taxes, based on the notion that the income tax base is more volatile than the consumption tax base.

We propose an alternative model based on the distributional impacts of the recession and the distribution of tax burdens by income segment. Given the overall growth in inequality of incomes and the greater importance of capital gains to top incomes, differences across states in income inequality, and the disparate impacts of the recession by income level, we argue that analysis by segment of the income distribution enhances our understanding of the effect of this extreme business cycle on state tax revenues. We therefore analyze revenue changes as a function of the interaction between the distribution of income changes and the distribution of tax burdens by income level.

We estimate the relationship between changes in tax revenue between 2007 and 2009 and changes in the AGI base for three income classes: the top 5 percent, the next 15 percent, and the bottom 80 percent, as measured by federal AGI. Changes in AGI by income class were interacted with tax burdens by income class. The model is successful in explaining a substantial proportion of the variation in tax revenue changes. By contrast, a model that uses the shares of various taxes at the outset of the recession is unable to explain the changes. Thus, on both conceptual and empirical grounds, we argue that our approach provides a useful supplement to the typical tax-by-tax analysis.

We expected differential shocks by income level to translate into shocks to tax revenue that were proportional to initial tax burdens. Our expectation was confirmed for the top 5 percent and the bottom 80 percent of the AGI distribution. However, for the 80th to 95th percentiles, the effect of a higher tax burden goes in the opposite direction. For most states, a higher tax burden for this income class was associated with a *smaller* revenue drop or a *larger* increase. Inclusion of a set of controls for tax rate responses of states between 2007 and 2009 does not alter these results.

To link state tax structures to the income-distributional effects of the recession, we estimate regressions of the tax burdens for three segments of

the income distribution, as a function of the shares of tax revenue from income, consumption, and severance taxes, and the overall ratio of taxes to income. This analysis shows that a higher income-tax shares is associated with higher tax burdens throughout the income distribution, while a higher consumption-tax shares does not affect the burden on the top 5 percent but leads to higher burdens for the rest of the distribution.

Using our estimated coefficients to simulate the revenue effects of a hypothetical change in state tax structure, we find that for states with income tax shares above the median, setting income tax shares and consumption tax shares equal to the national averages would have resulted in a *larger* drop in tax revenues than predicted by the actual mix of taxes. Equally counterintuitive simulation results are obtained for states with below-median income tax shares. These states would have had a *reduction* in the average tax hit from the recession if they had national average shares. Sensitivity analysis showed these results to be relatively robust to statistical variation in the key coefficients in the model of tax revenue change.

The result for the high-income-tax states reflects the offsetting effects of reducing the tax burdens within the top quintile of the income distribution. When the income tax shares is reduced, the smaller revenue loss associated with lower burdens on the top 5 percent is more than offset by the larger loss associated with lower burdens on the next 15 percent. Among low-income-tax states, raising the income tax shares raises burdens on the top quintile. This leads to greater losses from the top 5 percent, but these are more than offset by smaller losses from the next 15 percent.

Our results imply that the differential shocks to state tax revenues during the Great Recession were *not* the result of heavy reliance on one form of taxation or another. If states were to shift their tax mix away from income taxes and toward consumption taxes, their tax structures would become more regressive, and average tax burdens on residents would fall. Our income-distributional approach to the analysis of revenue sensitivity during the Great Recession finds little or no offsetting benefit in terms of revenue stability.

Finally, we emphasize that our model of revenue stability is applied to a single, albeit important, recessionary episode. Not only was the Great Recession both deeper and longer lasting than previous recessions, it was also marked by financial crisis, with particularly strong effects on higher income households, and a housing crisis that was concentrated in particular regions and states. An important next research step would be to see whether the revenue stability results from our analysis generalize to previous recessions as well as periods of economic recovery.

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Notes

1. In real terms, state tax revenues in 2012 were 5 percent lower than in 2008. By contrast, in the 2001 recession nominal tax revenues declined for only one year. By 2004, three years after the onset of the recession, nominal revenues were 5.7 percent higher than the previous peak in 2001. In the double-dip recession of 1980 to 1982, state tax revenues continued to grow in nominal terms throughout the recession and its aftermath. By 1985, five years after the onset of the first of the double-dip recessions (and three years after the official end of the second), state tax collections were up 57.4 percent.
2. Between 2007 and 2009 average real family income fell by 17 percent, while real income for the top percentile fell by 36 percent (Saez 2012). Aggregate capital gains realizations plummeted from US$913 billion in 2007 to US$48 billion in 2009 (Lurie and Pearce 2012). For filing units with adjusted gross income (AGI) of US$200,000 or more, representing a little less than 5 percent of all returns, capital gains fell by 73 percent between 2007 and 2009. Interest payments fell by 44 percent and dividends by 40 percent.
3. While the average value of a city-based housing price index fell by fifty points from 2006 to 2011, it fell by at least seventy-seven points for cities in Arizona, California, Nevada, and Florida (Chernick, Reschovsky, and Newman 2016).

Residential foreclosure rates in these cities increased by five percentage points, as opposed to one percentage point in other cities.

4. Mian, Suffi, and Trebbi (2011) find strong effects of foreclosures on housing prices and on the real economy. They estimate that from 2007 to 2009, foreclosures were responsible for 20 percent to 30 percent of the decline in house prices, 15 percent to 25 percent of the decline in residential investment, and 20 percent to 35 percent of the decline in auto sales.
5. We also estimated an alternative model that corresponds more closely to prior analyses. In this alternative model, the change in tax revenues is a function of the initial shares of income and consumption taxes. This model provides a straightforward test of whether states that relied more on income taxes than consumption taxes experienced more volatility in tax revenues during the Great Recession. The model and results are presented in Online Appendix 2. Overall, the results do not support the proposition that greater reliance on income taxes led to greater revenue instability in the Great Recession. Initial tax shares are unable to explain differences in the decrease in state tax revenues from the recession.
6. We need to scale the changes in AGI and tax revenue to make large and small states comparable. Because population by AGI class is not available, we scale these changes by the number of returns in each class. To assure that the dependent and independent variables are scaled in the same way, we divide the change in tax revenue by the number of returns rather than state population as well. Between 2007 and 2009, the number of returns fell by an average of 9 percent. Since the decline in the number of returns itself reflected the severity of the recession in the state, scaling by the initial number of tax returns is the most accurate way to measure the magnitude of the recession shock to AGI and tax revenue. Dividing by the contemporaneous number of returns would systematically understate, and dividing by the average of 2007 and 2009 would systematically overstate, the decline in AGI and tax revenues in states that were harder hit by the recession.
7. Increases varied in magnitude. For example, New York added two top brackets, from 6.85 percent for taxable income greater than US$200,000, to 7.85 percent from US$200,000 to US$500,000, and 8.97 percent above US$500,000. By contrast, California increased its top marginal tax rate from 10.3 percent to 10.55 percent without altering bracket widths. Campbell and Sances (2013) find that states with legislatures controlled by Democrats were more likely to increase rates. A regression analysis that explains the pattern of state income and sales tax rate changes is available on request.
8. The total amount of state tax revenues from selective sales increased by 1.3 percent from 2007 to 2009.

9. Capital gains receipt, which is a major source of income volatility, is more concentrated than income in the top 1 percent of the income distribution. However, the published IRS data by state are not detailed enough to allow estimates of AGI shares for the top 1 percent of the income distribution. Hence, the top bracket in our analysis is the top 5 percent. Details are provided in Online Appendix 1.
10. The Institute for Taxation and Economic Policy (ITEP) is the research arm of the better-known tax advocacy group Citizens for Tax Justice. Henceforth, we will refer to the incidence data as the "ITEP data."
11. For very low-income families, for whom the estimates produce extraordinarily high ratios of consumption to income, an upper bound of 1.5 is arbitrarily imposed. For the small number of filing units whose income exceeded the maximum income range from the Consumer Expenditure Survey, a separate function is fitted.
12. We tested for correlation by regressing the error in the tax revenue change equation on the overall ITEP tax burden and on the component ITEP burdens by income class. We also regressed the error term on the ratio of the ITEP overall tax burden to the ratio of state taxes to personal income. The latter ratio should be lower in states that are able to export a larger share of their taxes. Neither the tax burdens nor the ratio measure was statistically significant.
13. These figures are based on personal communication with Matthew Gardner, senior fellow at ITEP.
14. Tennessee levies a 6 percent tax on dividends, interest, and some capital gains income, while New Hampshire has a 5 percent rate on interest and dividend income.
15. There is a long-running debate concerning the long-run income class incidence of consumption taxes. A number of economists argue that the ratio of taxable consumption to income varies much less when one measures income over a time period longer than a year. For example, Poterba (1989) finds that the gasoline tax is substantially less regressive when one uses annual consumption as a proxy for permanent or longer-run income than when one uses annual income. In contrast, Chernick and Reschovsky (1997), using eleven years of panel data on individual families, find that the gasoline tax is only slightly less regressive over the intermediate term than when one uses annual income.
16. Other specifications included the tax burdens and the change in AGI for the bottom 80 percent as independent variables. All were insignificant.
17. Because the dollar change in taxes and the percentage change are almost perfectly correlated ($\rho = .97$), the results, though estimated less precisely, are basically unaffected if we replace the dollar amount of tax change with the percentage change. In terms of policy interpretation, we believe the dollar change per return is more relevant.

18. In an alternative specification that includes dummy variables for North Dakota and Wyoming (outliers with huge increases in revenue from severance taxes), the adjusted R^2 increases to .87. That model is discussed more fully in Chernick, Reimers, and Tennant (2014).
19. A regression analysis that explains the pattern of state income and sales tax rate changes is available on request.
20. For example, in 2007, Michigan replaced its single business tax, essentially a value added tax on services consumed, with the Michigan Business Tax, which was composed of tax on the net income of firms plus a modified gross receipts tax. This change led to a substantial reclassification of Michigan state tax revenues in the Census of Governments, with a big increase in the sales and gross receipts category, and a more than 50 percent decline in the corporation income tax (CIT).
21. The major tax omitted from equation (4) is the CIT, which in the aggregate provided less than 7 percent of state tax revenues. A portion of each state's CIT is borne by the owners of capital in other states. Because the goal of the ITEP analysis is to estimate the burdens on residents of own-state taxes, taxes that are shifted out of state are not included in the burdens. Inclusion of the CIT share in the analysis did not change the basic results.
22. The coefficients in equation (4) represent the *average* relationship between the revenue share from each tax and the burden on a particular income class, holding constant the shares of the other taxes (except the corporate income tax). The equation potentially underestimates the burden on the top 5 percent in states where the income tax is substantially more graduated than the typical state. On the other hand, it may overestimate the burden on the top 5 percent for states such as Connecticut, which have an average degree of income tax progressivity but an unusually high proportion of total AGI in the top income class. We tested for misprediction of the top five income tax burden by regressing the difference between the actual and the predicted top five tax burden on the degree of progressivity of a state's income tax and the share of AGI received by the top 5 percent. Income tax progressivity was significant at the 10 percent level, indicating that the top five burden is somewhat underestimated in highly progressive states. For example, in California, the actual burden on the top 5 percent was 9.6 percent versus a predicted burden of 8.2 percent. The AGI share was insignificant, suggesting that the degree of income concentration does not bias the tax burden estimates.
23. Table 3 shows alternative specifications for consumption taxes, first combined and then divided between general sales and selective sales taxes. The results are robust to these specifications. The general sales tax share effect on the burdens is identical to the combined consumption share, while the selective sales tax effect is insignificant.

24. This statement is subject to the caveat that higher state taxes may be at least partially offset by lower local taxes.
25. The exclusion of the two highest severance tax states, Wyoming and North Dakota, is key to the result for the low-income-tax states. Both of these states experienced substantial increases in tax revenue during the Great Recession due mainly to large increases in severance tax revenues from expanded oil, gas, and coal production. Including these states would reduce the average revenue decline for the below-median income tax states from −US$233 to −US$29.
26. Although not shown in the tables, predicted next fifteen burdens fall by about half a percentage point in the high-income-tax states and rise by a comparable amount in the low-income-tax states. Bottom eighty burdens are unchanged for both sets of states.

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