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Tax Structure and Revenue Instability: The Great Recession and the States

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Abstract

Though the great recession has had the most severe overall effect on state tax revenues of any downturn since the Great Depression, impacts varied widely across states. Tax revenues were affected through two different channels. The first is due to the collapse in realized capital gains income following the sharp decline in the stock market. State tax bases are affected in proportion to pre-recession reliance on capital gains income, in turn closely associated with the degree of income concentration. Largely due to capital gains income, the income of high-income taxpayers is more cyclically sensitive than that of lower-income taxpayers. The second channel, the differential effect on state output and employment, has its greatest impact on incomes below the top 5 percent of the distribution.

We hypothesize that variation in revenue impact across states is due to differences in the severity of the income shocks at different levels of income, the degree of income inequality, the importance of capital gains in top incomes, and the level and progressivity of tax burdens. Progressive states are likely to be more vulnerable to revenue losses in economic downturns. Progressivity and income volatility may interact to amplify the recession's fiscal impact.

To test these hypotheses, we construct a measure of potential revenue exposure by state for 2007-2009. We disaggregate revenue exposure by income quantile, summing state-specific changes in federal AGI per return by AGI quantile, multiplied by the effective tax burden by quantile. We simulate the effects of replacing state-specific economic shocks, average tax burdens, and tax progressivity with national averages. We find the variation in potential revenue exposure to be less than half as large as the variation in actual revenue changes. The dominant factor in potential revenue exposure is the shock to a state's tax base, particularly for the top 5 percent of filing units.

We then estimate a multiple regression model of revenue changes as a function of the components of revenue exposure and their interactions, and use the estimated coefficients to simulate the effect of a "race to the middle" for the most and least progressive states. We find that on average, states with relatively progressive tax systems are *not* more vulnerable to recessions than less-progressive states. While actual revenue changes are affected by both initial tax burdens and changes in AGI for the top 5 percent, the net effect depends on the interaction between these two factors. Given the weak correlation between income volatility and tax progressivity, larger drops in top incomes do not systematically lead to larger drops in tax revenue.

In sum, we find that the net effect of greater tax-base volatility at the top is not volatility-enhancing. In the majority of states, tax structures serve to *dampen*, not amplify revenue impacts of the change in capital gains. And surprisingly, higher tax burdens on the 80th to 95th percentiles of a state's income distribution tend to mitigate the recession-induced decline in tax revenues.

Tax Structure and Revenue Instability: The Great Recession and the States

The 2007-2009 great recession precipitated the sharpest decline in state tax revenues in the post-war period. Between fiscal years 2007 and 2010 nominal tax revenues declined by 7.6 percent. It was only in 2011, four years after the onset of the recession, that state taxes regained their prior nominal peak.[1] Even with offsetting federal aid increases, these revenue reductions have led to sharp decreases in state employment and state aid to local governments.[2] The decline in state aid, primarily to school districts, has been a major factor in the unprecedented decline in local government employment.[3] Despite the sharp overall decline, there has been considerable variation across states in the revenue impact of the recession. While 36 states had declines in state tax revenue, 12 states had increases in tax revenue during this period.

Has the sharp drop in state tax revenues been due mainly to the severity of the great recession, or have other changes in the U.S. economy exacerbated the impact?

[1] In real terms, state tax revenues in 2012 were 5 percent lower than in 2008. In the 2001 recession, nominal tax revenues declined for only one year, showing a 4.3 percent drop from 2001 to 2002. By 2004, three years after the onset of the recession, nominal revenues were 5.7 percent higher than the previous peak in 2001. A year later, in 2005, tax revenues were 16.3 percent higher than in the year of the recession. In the double dip recession of 1980-1982, 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] Through 2011, about 40 percent of the decline in state revenues was offset by increased federal assistance through the American Recovery and Reinvestment Act of 2009 (ARRA). The major vehicles for this aid were an increase in the federal matching rate for Medicaid, providing $87 billion in increased support for Medicaid, and a $48 billion increase in education funding. Reflecting the increased federal assistance and declining own-revenues, the federal share of state spending went from 26 percent to 30 percent in 2009. However, nearly all of the ARRA funds for fiscal relief to states were scheduled to be spent by June of 2011. Thus, despite some recovery in revenues, the fiscal pressure facing states in the 2012 fiscal year was even more acute than in the previous three years. According to newspaper reports, governors across the country have responded with a wave of additional spending cuts (*New York Times*; January 17, 2011, January 29, 2011).

[3] From its peak in 2008 through May 2012, local government employment has fallen by 528,000, or 3.6 percent (U.S. Bureau of Labor Statistics 2012).

Between 2007 and 2009 average real family income fell by 17 percent, by far the largest overall drop since the great depression (Saez, 2012). However, real income for the top percentile fell much faster, decreasing by 36 percent. The major source of this greater decline is the concentration of capital gains income among high-income taxpayers, and the high volatility of realized capital gains income. Before the recession, 38 percent of realizations in 2007 were received by the top one tenth of one percent of taxpayers. Aggregate realizations then plummeted, from $913 billion in 2007 to $48 billion in 2009.[4] In the preceding decades, income has grown much rapidly at the top than for most families.[5]

Have the secular increase in the concentration of income, particularly from capital gains, and the high volatility of income from capital gains increased overall state fiscal exposure to recessions? If so, have these income trends increased the vulnerability of states with higher or more progressive tax burdens, relative to those states with lower or more regressive burdens? These are the questions addressed in this paper.[6]

To assess the relative impact on state revenues of the aggregate income shock versus the effects of tax progressivity, income concentration, and capital gains volatility, we decompose the sources of revenue volatility, not by separate taxes as has been done in the past (Dye, 2004), but by income level. We are able to do this by drawing on state-by-state estimates of the tax burden by income quantile from the Institute for Taxation and Economic Policy (2009) to estimate potential revenue exposure as a weighted sum of the

[4] This is the amount reported on individual tax returns before loss carry-forwards from previous years and loss limitations (Lurie and Pierce, 2012).

[5] Between 1993 and 2010, average real family income grew by 58 percent for the top one percent of families, versus 6.4 percent for the other 99 percent of families (Saez, 2012).

[6] Here we focus on the official recession years 2007-2009, and do not address the longer run fiscal problems associated with the very weak recovery from the great recession.

changes in adjusted gross income (AGI) by quantile, where the weights are the effective tax burdens by quantile. This alternative approach to the study of tax volatility adds to our insight into the effect of state tax structures on the very important fiscal goal of revenue stability over time.

We find that, while potential revenue exposure is on average higher in more progressive states, the major source of variation in revenue exposure was not state tax structure, but differences across states in both their exposure to the sharp national decline in capital gains income and the state-specific severity of the great recession. Regression analysis of actual changes in state tax revenues on the components of fiscal exposure shows that the interaction between sharper drops in income among top taxpayers and higher tax burdens on these groups can potentially lead to bigger decreases in tax revenue. However, because the correlation between recession-related changes in the income of top taxpayers and the relative tax burden on top taxpayers is weak, the overall quantitative importance of tax progressivity in exacerbating the fiscal impact of the recession is small. California is the leading example of a state with a relatively progressive tax structure that suffered a large decrease not only in potential but also in actual tax revenues. However, the revenue impact of the recession was much greater in Nevada and Florida, two of the most regressive states in the U.S.

The plan of the paper is as follows. Section I presents the conceptual basis for calculating revenue exposure, the steps taken to implement the concept for state taxes, and the comparison of revenue exposure to both the actual change in taxes and to counterfactual measures. The regression analysis of actual tax changes and the regression-based simulations are presented in section II. Section III concludes.

I. Potential revenue exposure

A. Salient Facts

Four facts are most salient to our analysis. The first is the variation across states in the severity of the recession and in its impacts on revenue. Between 2007 and 2009, the standard deviation of the change in nominal personal income was as large as the mean (3.8 percent). The range was from a 4.1 percent decline in Michigan to a 14.5 percent increase in North Dakota. Though aggregate state tax revenues fell by six percent, the unweighted average change for the 48 contiguous states was only three percent, indicating that states with larger revenues had larger percentage drops. Thirty-six states had declines in state tax revenue, with an average decline among this group of 7.1 percent. The biggest declines were in Arizona (22.7 percent) and Florida (17.4 percent). Twelve states had increases in tax revenue, with an average increase of eight percent. The biggest increases were in North Dakota and Wyoming, in both of which tax revenues grew by more than 35 percent. These two states, as well as Texas, West Virginia and South Dakota, have benefitted from significant increases in severance tax revenues on minerals.

Second, tax progressivity varies substantially across states. Drawing on multiple years of data from both the Institute for Taxation and Economic Policy (ITEP) of the Citizens for Tax Justice and other studies, Chernick (2005) shows that progressivity, defined as the ratio of the tax burden on the top 5 percent of families to the bottom 20 percent, ranges across states by almost three to one. In 2007, according to the ITEP model, the ratio of the burden on the top 5 percent to the average burden ranged from 0.94 at the 90th percentile to 0.57 at the 10th percentile (Institute for Taxation and

Economic Policy, 2009). For the income tax, which has an important effect on state tax progressivity, the ratio ranged from 1.58 to 1.02.[7] We expect that the greater the progressivity of a state's tax system, the more volatile or elastic are tax yields, for a given cyclical shock to a state's economy.[8]

The third fact is the longstanding secular trend towards increased income inequality, both for the U.S. overall and within states. National trends, particularly for the very top of the income distribution, are well documented (Saez, 2012). Equally fine income breakdowns by state are not available, but our analysis shows that just in the five-year period from 2002 to 2007 the average share of state AGI received by the top 5 percent of tax filing units grew from 30 percent to 34 percent. Equally important to our analysis is that income inequality also varies considerably across states. At the 90th percentile of income concentration (as measured by the share of a state's aggregate income received by the top 5 percent), the top 5 percent of filing units received 42 percent of total AGI in 2007, as compared to 29.5 percent at the 10th percentile.

In and of itself, the increased concentration of income does not necessarily imply greater volatility of tax revenue over the business cycle. However, if the income of the top taxpayers is more volatile than the rest of the distribution, then by a simple compositional argument, the increased share of total income received by high-income taxpayers would imply an increase over time in the cyclical sensitivity of the state tax

[7] The structure of the income tax varies widely across states. As discussed by Dye (2004), nine states have either no income tax or only a narrow-based tax. Of the 41 states that do use broad based income taxation, 19 states have either a flat rate or a rate structure that taxes most income at a single rate. In the 34 states that have a graduated rate structure, there is considerable variation in both the top rate and the degree of graduation.

[8] Dietz et al (2010) argue that reliance on more cyclically sensitive taxes has increased the budgetary exposure of particular states to cyclical economic fluctuations. Boyd (2010) makes a similar point in terms of the recovery from the great recession. However, Dye (2004) did not find a significant difference between the income and the sales tax in terms of short-run revenue elasticities.

base for an overall economic shock of any given magnitude. If the *relative* volatility of the income of top taxpayers compared to lower income taxpayers is growing over time, then the cyclical volatility of the overall tax base would be increasing at an even faster pace.

Hence, the fourth pertinent fact in explaining both the mean and the variation of changes in state tax revenues pertains to the volatility of the income of top taxpayers. As discussed above, the decline in average real income per family was more than twice as large for the top percentile as for the average. This pattern of greater cyclical volatility in top incomes is typical of past recessions as well. In the 2001-2002 recession, average income of the top one percent fell by 31 percent, while for the other 99 percent income fell by 12 percent (Saez, 2010).

The sharp drop in top incomes in the 2007-2009 recession is largely due to the importance of capital gains in the income of top taxpayers and the cyclical volatility of realized capital gains. In the great recession, aggregate capital gains realizations reported on individual tax returns (before loss carry-forwards from previous years and loss limitations) decreased from $913 billion in 2007 to $202 billion in 2008 and $48 billion in 2009. A similarly sharp change in realizations occurred in the 2001 recession, dropping from $700 billion in 2000 to $126 billion in 2002 (Lurie and Pierce, 2012).

Capital gains income is not only cyclically volatile, but also highly concentrated in a relatively small number of tax returns. In 2007, over 80 percent of all capital gains were realized by the top 5 percent of taxpayers, of which about 38 percent were realized by the top one tenth of one percent of taxpayers. While the share of capital gains realized by the top 5 percent of returns has remained relatively constant over time, the share of the top one tenth of one percent has both increased over time and fluctuated more during recessions. Because most states with income taxes tax capital gains income at ordinary income tax rates, capital gains income is likely to be taxed at the highest state marginal tax rate.

Given the volatility of capital gains income, a key point for our analysis is that capital gains income varies in importance across states. In 2007, among the top 5 percent of filers in a state, the mean share of AGI from capital gains realizations was 21 percent, with a coefficient of variation of 0.25. The share ranged from 13 percent in West Virginia to 39 percent in Wyoming. If finer breakdowns were available, they would undoubtedly show even greater variation across states in the capital gains share for the top one percent or higher of a state's AGI distribution. If states with higher concentrations of capital gains at the top of the income distribution are also states with more overall income inequality, then the impact of the volatility of capital gains will be greater in such states, implying greater potential revenue shocks from the recession. Changes in capital gains realizations may also interact with tax structure, to amplify revenue fluctuations. This would occur if states with greater capital gains income tax that income at relatively high rates.

These points suggest that to analyze the revenue shock to states from the great recession, it is necessary to take account of four factors: the overall economic shock to the state's economy, the state's overall tax burden, differences in the economic shock at different positions in the state's income distribution, and the tax burdens imposed at those different positions. Differences in revenue exposure between progressive and regressive state tax systems may be reinforced (or offset) by the differential shocks by income level.

For example, if the income decline associated with the recession is concentrated among high-income taxpayers, then the potential revenue effects will be magnified for states with the most progressive systems – i.e., the highest top-bracket rates. If the income decline is concentrated among middle- or lower-income taxpayers, then states that rely more on progressive income taxation may be spared the worst effects of the recession.

B. Conceptual Measure of Exposure and Its Uses

To explain variation in the potential shock to state revenues, we measure revenue exposure in terms of the overall economic shock, differences in the magnitude of the shock across a state's income distribution, and the structure of the state's tax system. Specifically, a state's potential revenue change in each income quantile is measured by the change in federal adjusted gross income in that quantile, multiplied by the pre-recession state-specific tax burden in that quantile. The potential change in aggregate tax revenues is then computed as the weighted average of the potential revenue change by income quantile, where the weights are the shares of the aggregate tax base in each quantile. We call this measure "potential revenue exposure." Revenue exposure is calculated for all state taxes and for the income tax alone.

We then simulate the change in potential revenue exposure if each state, given its tax structure, were to experience the national average economic shock at each income quantile, or if it experienced its actual economic shock but had the national average tax structure. These counterfactual simulations allow us to analyze one at a time the effects on revenue exposure of variation across states in the economic shock, the average tax burden, and the progressivity of tax burdens.

We then turn from potential revenue exposure to actual revenue changes, estimating a set of regression models to explain changes in tax revenues from 2007 to 2009. The independent variables in this exercise are the individual components of the potential revenue exposure. We use the coefficients from our preferred specification of the tax change model to simulate the effect on state revenue changes of altering the progressivity of state tax systems, reducing top rates in the most progressive states and raising top rates in the least progressive states. In the conclusion, we use the results from the two methods of analysis -- simulations of potential revenue exposure and regression estimates -- to provide an overall assessment of the effect of tax progressivity on state tax revenues.

C. Actual Tax Changes, Policy Offsets, and Exposure

The change in tax revenue in state j resulting from a cyclical downturn is equal to

$$\Delta \text{Tax Revenue}_j = \textstyle\sum_i \left[(\Delta \text{Base}_{ij} \cdot \text{Rate}_{ij}) + (\text{Base}_{ij} \cdot \Delta \text{Rate}_{ij}) + (\Delta \text{Base}_{ij} \cdot \Delta \text{Rate}_{ij})\right] \qquad (1)$$

where i indexes the various state taxes. The major state tax sources are the individual income tax, the general sales tax, the corporation income tax, and excise taxes on tobacco, alcohol, and gasoline. The base change in (1) may be divided into a recession component and a policy offset.

$$\Delta \text{Base}_{ij} = \Delta \text{Base}_{ij,\text{Recession}} + \Delta \text{Base}_{ij,\text{policy}} \qquad (2)$$

The first term in (2) is the change in the tax base due to the recession, with policy unchanged. For the sales tax, for example, the recession-induced change in the tax base would be the decline in taxable sales.

A recession-induced change in the tax base may be offset (or reinforced) by policies which change the base and/or the rates. For example, a state might add items to its sales tax base (e.g., clothing in NY State) or increase a tax rate. For example, Michigan increased the effective income tax rate on low-income taxpayers by reducing the size of the state supplement to the federal Earned Income Tax Credit. As of July 2009, 30 states had increased at least one state tax rate, as compared to their pre-recession level (Center on Budget and Policy Priorities, 2010). The policy offset is equal to

$$\text{Rev Offset}_{j,policy} = \Delta\text{Base}_{ij,policy} \cdot (\text{Rate}_{ij} + \Delta\text{Rate}_{ij,policy}) + (\text{Base}_{ij} \cdot \Delta\text{Rate}_{ij,policy}) \quad (3)$$

Conceptually, we define potential revenue exposure as (1) minus (3), i.e. the recession-induced change in the tax base, multiplied by tax rates at the onset of the recession:

$$\text{Potential Revenue Exposure}_j = \textstyle\sum_i (\Delta\text{Base}_{ij\ Recession} \cdot \text{Rate}_{ij}) \quad (4)$$

D. Empirical Measure of Exposure

To assess the effects of differences in income distributions and capital gains receipts across states, we compute a disaggregated measure of revenue exposure that takes account of differential changes in the tax base, not for particular taxes, but by income level. For comparability across states, potential revenue exposure is scaled by the number of federal tax returns in 2007. For the recessionary period 2007-2009, our measure is computed as

$$\text{Potential Rev Exp} = \textstyle\sum_{q=1,n} t_{q,07}[\Delta\ \text{Base}_{q,07\text{-}09}] = \sum_{q=1,n} [(t_{q,07}/t_{bar})\ t_{bar}] \cdot [\Delta\ \text{Base}_{q,07\text{-}09}] \quad (5)$$

In expression (5), the subscript q denotes the quantile of income, while t_{bar} is the average tax burden. By definition, the average tax burden is the income share-weighted sum of the quantile tax burdens, i.e.

$$t_{bar} = \sum_{q=1,3} t_{q,07} \text{ (SHR BASE)}_{q,07} \quad (6)$$

Based on available IRS data and our special focus on the effect of income changes at the high end of the income distribution, families are divided into three income quantiles: the top 5 percent, the next 15 percent, and the bottom 80 percent. The rate t_q represents the effective tax burden on quantile q; i.e., the average share of income paid by families in quantile q. The empirical implementation of (5) is given by

$$\begin{aligned} \text{Revenue Exposure} = [&(t_{top5}/t_{bar}) \cdot \Delta AGI_{top5}/Ret_{top5,07}) \\ &+ (t_{nxt15}/t_{bar}) \cdot \Delta AGI_{nxt15}/Ret_{nxt15,07}) \\ &+ (t_{nxt80}/t_{bar}) \cdot \Delta AGI_{nxt80}/Ret_{nxt80,07})]\ t_{bar} \quad (7) \end{aligned}$$

Effective tax burdens t by income quantile in (7) are produced by the 50-state tax incidence model from the Institute for Taxation and Economic Policy (2009). The model assigns taxes to families based on patterns of income and consumption. Changes in the tax base by income level within a state are measured by the change in adjusted gross income (AGI) for that quantile. The data source for AGI by state is the published IRS Statistics of Income data on adjusted gross income by AGI category.

The CTJ measures tax burdens by simulating taxes paid based on the structure of state income taxes, the rates and coverage of general and specific sales taxes, and rates of the corporation income tax. Income taxes are assumed to be borne by taxpayers, while consumption taxes are mainly shifted forward to consumers. State corporate income taxes are assumed to be borne mainly by capital within the state, with some portion exported to residents of other states. The CTJ measures do not take account of taxes imported into a state. Income tax incidence depends on bracket widths and marginal tax rates. Given the small amount of revenue most states raise from the corporation income tax, estimated tax burdens for the high end of the state's income distribution are largely a function of the structure of the personal income tax, including the top marginal rate, bracket widths, and the tax treatment of capital gains.[9] Consumption tax burdens are assigned according to spending patterns of taxed items by income class.

In addition to the tax burden estimates, the CTJ data also provide estimates of average family income by income quantile by state for 2007. The quantiles are the first four quintiles, the next fifteen percent, the next four percent, and the top one percent. In contrast, the published IRS data provide AGI, realized capital gains income, and number of returns by AGI bracket, state, and year. The brackets are (in thousands): less than $50, $50-$75, $75-$100, $100-200, $200 and above. To combine the IRS data on changes in income with the CTJ data on tax burdens, we need to express the IRS data in terms of quantiles. Given the share of returns that is in each AGI bracket, we use linear interpolation to assign a percentage of the AGI and capital gains amounts within each bracket to the respective quantiles.[10] However, we could not estimate AGI or capital gains amounts for the top one percent, because the open-ended top AGI bracket contains more than one percent of the returns in every state. A disproportionate share of the income and capital gains in this bracket belong to the top one percent, but we have no way of estimating what that share is, on a state-by-state basis. Given the particular importance of the top end of the income distribution for revenue changes, we therefore

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[9] A number of states allow tax capital gains at rates which are different from ordinary income.

[10] Linear interpolation implicitly assumes that the AGI and capital gains amounts are uniformly distributed within an AGI bracket. However, AGI is concentrated at the lower end and capital gains at the upper end of each bracket. Therefore, linear interpolation overstates AGI and understates capital gains in the top 5 percent of returns, and therefore understates the capital-gains share of AGI in that quantile.

decided to collapse the CTJ data into three quantiles; the top 5 percent, the next 15 percent, and the bottom 80 percent.[11]

E. Results

Table 1 shows the actual change in tax revenues from 2007 to 2009 and potential revenue exposure.[12] The upper panel shows the measures for total state taxes, while the lower panel is for the income tax alone. The first row of the upper panel of table 1 highlights the wide range in the effect of the great recession on state tax revenues. While the mean change in state tax revenue per return was a drop of $138, the standard deviation is more than four times as large as the mean. The average percentage decline in total tax revenue was 3.1 percent, again with a standard deviation which is three times as large as the mean. In percentage terms, the biggest decline in state taxes was in Arizona (-23 percent), while the biggest increase was in Wyoming (+36 percent). At the 10th percentile, the percentage change was equal to -12.6 percent, while at the 90th percentile it was +24 percent.

The last row in the first panel of Table 1 shows summary statistics for potential revenue exposure. While the mean values of actual changes and exposure are both negative, average exposure was almost twice as large as average revenue change. This difference suggests a potentially important role for state policy offsets in mitigating the loss in state tax revenues resulting from the recession. The state at the 10th percentile, California, was at risk for a revenue decrease of $617 per return, while West Virginia at

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[11] In 2007 and 2009 fewer than 5 percent of returns were in the top AGI bracket ($200,000 or above) in every state but one (New Jersey, with 5.1 percent in 2007 and Connecticut, with 5.1 percent in 2009). We treat the top AGI bracket as equivalent to the top 5 percent in New Jersey in 2007 and Connecticut in 2009.

[12] Actual state tax revenues come from U.S. Census Bureau, various years.

the 90th percentile was at risk for a $74 increase. Notably, the standard deviation of revenue exposure is less than half that of actual tax changes. It is not surprising that actual revenue performance varies more than potential exposure, given the variation across states in the importance of policy offsets, as well as other factors such as changes in severance tax revenues, which are not included in our measure of potential revenue exposure.[13]

The second panel of Table 1 shows summary statistics for the personal income tax. Six of the lower 48 states have no income tax. Not surprisingly, the income tax exposure measure tracks the actual change in income tax revenues much more closely than in the case of all taxes combined. However, the pattern from the top panel is replicated for the income tax, with mean potential income tax revenue exposure equal to -$171, 44 percent larger than the mean actual change (-$119).

The standard deviation of revenue exposure for the income tax is much closer to the standard deviation of actual income tax revenues than is the case for all taxes, as are most of the outliers. The smaller difference reflects the exclusion of revenues from mineral extraction. Moreover, seven states have zero or very low income taxes, including at least two, Florida and Nevada, that experienced exceptionally large reductions in revenues. More generally, we would expect that the relationship between the change in federal AGI in a state, which is the basis for our exposure measure, and the actual change in a state's income tax base is likely to be much stronger than the relationship between the changes in AGI and in the composite income-consumption tax base that determines the overall revenue change.

[13] For example, both California (-$617) and New York (-$751) had large potential revenue exposure. Whereas the actual change in California was -$780, in New York an increase in the top marginal income tax rate for high earners caused state tax revenues to increase by $161.

Table 2 shows actual revenue changes and potential revenue exposure for the top and bottom ten percent of states, ranked according to various criteria. The first two columns compare the most progressive and least progressive states, as measured by the ratio of the tax burden on the top 5 percent to the average tax burden. As expected, both actual revenue decreases and potential revenue exposure are greater for the more progressive states. As shown in the first row of Table 2, revenues dropped by 6.7 percent for the most progressive states, but went up by 1.2 percent for the most regressive group. Potential revenue exposure is also much closer in value to the actual revenue change for the progressive states than for the regressive states. Notably, revenue exposure is negative (predicting a decline in tax revenues) for both groups, whereas actual revenue changes were slightly positive for the regressive states. This suggests that either policy offsets or changes in types of taxes that are not well captured by the revenue exposure measure (e.g., severance taxes) were more important for the regressive states. As indicated by the "NA" in the third and fourth rows of column 2, the regressive states are distinguished from the progressive states by the absence of state income taxes.

The third and fourth columns of Table 2 compare high- and low-tax states, as measured by the average tax burden. As expected, both actual revenue reductions and potential revenue exposure are greater for the high-burden than the low-burden states. It is notable that the actual drop in revenues for high average-burden states (column 3, row 1) is substantially smaller than for the most progressive states (column 1, row 1). Revenue exposure is also smaller for states with the highest average tax burdens than for the most progressive states, though the difference is not as great as the divergence in actual revenue changes. These comparisons suggest that a relatively high tax burden at the top of the income distribution was more important than a high overall burden in determining potential revenue exposure to the recession.

Columns 5 and 6 of Table 2 compare states with the largest actual revenue decreases and increases. Notably, revenue exposure would predict a revenue decrease for both groups. For both groups, the absolute value of the actual change in revenues is much greater than the revenue exposure measure, again reflecting state-specific factors which are not captured by the exposure measure. However, for the revenue-increase group, there is a much greater divergence between potential exposure (-$102) and the actual increases ($1031). Because mineral tax revenues are likely to play a role in this latter result, the last column of Table 2 shows revenue performance in eight states with substantial severance tax revenues. On average, these states realized an eight percent increase in tax revenues, but also had very low revenue exposure.

Table 3 compares the revenue exposure measure to a set of counterfactuals that standardize in turn the average tax rate, the degree of progressivity, and the economic shock, replacing state-specific values by national averages across the 48 states (42 states for the income tax). The standardization of progressivity substitutes the national average burdens on the top five percent of taxpayers and the next 15 percent, relative to the average burden in the state. The standardization of the economic shock replaces each state's quantile-specific actual change in AGI per return with the national average change for that quantile.

Not surprisingly, the mean value of revenue exposure changes very little across simulations because the effects of the state-specific factors are averaged out. It is more informative to look at the standard deviations, which tell which factor most affects the variance in exposure. For the upper panel with all taxes, the most notable result is that neither imposing a uniform average tax rate (upper panel, Simulation I), nor uniform progressivity (upper panel, Simulation II) has much effect on the variation in fiscal exposure. However, imposing a uniform economic shock reduces the standard deviation dramatically (upper panel, Simulation III). The coefficient of variation goes from 0.84 to 0.32. This result indicates that by far the most important source of variation across states in fiscal exposure to the great recession is the magnitude of the economic shock, rather than the rate and structure of taxation.

The lower panel of Table 3 shows the revenue exposure measures for the income tax alone. As for all taxes, the greatest reduction in the variation in income tax exposure across states is produced by imposing the national-average shock to each AGI quintile, while retaining the state-specific tax structure (lower panel, Simulation III). The coefficient of variation drops from 0.76 to 0.35. In contrast to the result for all taxes, imposing a uniform average income tax rate on all states, while maintaining the state-specific relative burdens (lower panel, Simulation I) does reduce somewhat the variation in fiscal exposure, with the coefficient of variation decreasing from 0.76 to 0.63. However, imposing uniform progressivity while maintaining the state-specific average income tax burden (lower panel, Simulation II) actually leads to a small increase in the variation in fiscal exposure.

The above analysis shows the primary role of differences in the economic shock to states in explaining differences in revenue exposure. To understand the nature of the income shock, we regressed the difference between potential revenue exposure (Base Case) and exposure under a uniform tax base change (Simulation III) on the change in tax base by quantile. That analysis indicates that the difference in AGI change for the top 5 percent of a state's tax filing units is more important than differences in the rest of the income distribution in explaining differences in fiscal exposure.[14] As shown below in Table 8, column (1), variation in the degree of income concentration and in the share of capital gains in the income of the top 5 percent explain almost all of the variation in the change in AGI across states. Thus the counterfactual revenue exposure with uniform AGI change is approximately equivalent to computing exposure if all states had the same distribution of income, and the same concentration of capital gains income.

Table 4 compares fiscal exposure to a hypothetical state with the national average economic shock, the national average progressivity, and the national average rate of taxation. Results are shown for the 5 states that are closest to the national average and the 6 states that are furthest from it. New York, New Jersey, and Connecticut are all among the high-exposure states. Similarities in these three states are primarily a reflection of similarities in income concentration and capital gains receipts, rather than similarities in tax structure.[15] States that look most like the nation as a whole are spread across the country. Of the six states that are furthest from the national average in fiscal

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[14] The Base Case and Simulation III are defined in the notes to Table 3. The regression, with *t* statistics in parentheses, is:

$$(\text{Base Case} - \text{Simulation III}) = 220 + \underset{(14.3)^{***}}{.003\Delta AGI_{top5,07\text{-}09}} + \underset{(1.88)}{.009(\Delta AGI_{nxt15})} + \underset{(4.41)^{***}}{.074(\Delta AGI_{nxt80})}$$

N= 48, Adj R^2 = .9

***: Statistically significant at the one percent level

Elasticities of the difference between base case and uniform shock, evaluated at mean values, are much higher for changes in top 5 AGI than for changes in AGI for the rest of the distribution.

[15] Under a nationally uniform decrease in AGI, revenue exposure drops by 44 percent, 36 percent, and 66 percent in NY, NJ, and CT respectively. Under uniform progressivity, or uniform average tax rates, the decrease in revenue exposure in these states is typically less than half as large. Connecticut stands out in this regard, because its tax structure is similar to the national average, but it experienced the largest decrease in the nation in AGI per return among the top 5 percent of taxpayers.

exposure, four have much greater exposure (New Jersey, California, New York and Connecticut), while two (Lousiana and North Dakota) stood to *gain* revenue. The former states have high concentrations of income at the top, while the latter two have substantial revenues from mineral taxation.

Table 5 presents Spearman rank correlation coefficients between actual revenue changes, potential exposure, and the various counterfactual measures of revenue exposure, both for all taxes and for the income tax alone. Revenue exposure is significantly positively correlated with actual changes in taxes. Not surprisingly, correlations are stronger for the income tax than for all state taxes.[16] The rank correlation between potential exposure and actual revenue change is virtually unchanged if all states are assumed to have the same degree of progressivity. However, imposing a uniform economic shock on all states causes the correlation between potential exposure and actual changes in revenue to become insignificant, despite the fact that the hypothetical measure with the national-average economic shock remains strongly correlated with revenue exposure. Thus, Table 5 reinforces the prior conclusion that the variation in great-recession-induced revenue changes has been much more heavily influenced by differences in the magnitude of the economic shock than by differences in tax structure.

II. Explaining the Actual Change in State Tax Revenues

A. Model

[16] We also computed, but do not show here, the Pearson partial correlation coefficients between these various measures. Comparing the two types of correlations, the rank coefficient between potential exposure and actual revenue changes is somewhat larger than the Pearson coefficient, reflecting the greater weight the latter measure puts on the tails of the two distributions. In contrast to the rank correlation coefficient, the Pearson correlation coefficient between revenue exposure with average progressivity and actual revenue changes is statistically insignificant, suggesting that average progressivity affects the level of revenue exposure more than it does the ranking among states.

The above simulations vary the factors affecting potential revenue exposure one at a time, substituting the national average for the actual state-specific values. This involves a change that varies by state for each income quantile and factor. In this section we turn from these summary measures of fiscal exposure to multivariate regression models of the change in tax revenue, which yield estimates of the effect of changing each component of fiscal exposure by a given amount. Because correlations between the tax structure and changes in the tax base are likely to be important in determining actual revenue performance, the independent variables include interaction terms as well as the disaggregated components of potential revenue exposure: change in income by quantile, tax burden by quantile, and average tax burden. We then use the coefficients from our preferred specification to perform a second type of simulation, in which we compress progressivity downward in the most progressive states and upward in the most regressive states.

The dependent variable in this analysis is the 2007-2009 change in state tax revenues per 2007 return. Independent variables are the change in AGI by income quantile, effective tax burdens (i.e., taxes paid divided by income) in 2007 by income quantile, interaction terms between change in AGI and tax burden by quantile, and average tax burden overall. All dollar values are in nominal terms and are scaled by the number of federal tax returns in 2007. The general specification is given by

$$\Delta Rev_j = a_0 + \Sigma_q (a_{1q} \cdot \Delta AGI_{qj} + a_{2q} \cdot BURD_{qj} + a_{3q} \cdot \Delta AGI_{qj} \cdot BURD_{qj}) + a_4 \cdot AVGBURD_j + e_j \quad (8)$$

In (8), j indexes the 48 contiguous states, while q indexes three quantiles of adjusted gross income: the top 5 percent, the next 15 percent, and the bottom 80 percent.

Because AVGBURD is a linear combination of the three $BURD_q$'s, we must omit one of these four variables from the regression model. In the potential revenue exposure calculation in section I, we separated the tax effect into a progressivity effect, measured by the ratio of top burdens to the average burden, multiplied by the average burden. In the regression analysis we include each component separately: both the average burden and the burdens on the top 5 percent and top 15 percent of the income distribution. We expect the coefficients on ΔAGI to be positive and the coefficients on BURD to be negative (if the average shock is negative). Coefficients on the interaction terms are expected to be positive; that is, the revenue impact of an economic shock at a given income level is greater, the higher the tax burden imposed at that income level.

The model in (8) is not an attempt to fully explain state-by-state changes in tax revenues. Rather, it expresses the concept of fiscal exposure as the sum of its components, as opposed to capturing all of the effects in a single measure. Policy changes in particular states, such as rate or base changes, are excluded. While the average effect of offsetting (or reinforcing) policy changes is reflected in the constant term, state-specific policy changes are reflected in the error term. The sign predictions for the variables in (8) assume that that policy offsets are not systematically larger in states with greater potential revenue exposure (that is, the error term is uncorrelated with the components).[17] Analysis of the relationship between revenue exposure and actual revenue changes in the prior section helps to justify this assumption. In those few states with substantial revenues from severance taxes on mineral extraction, changes in mineral

[17] In this respect, our model is different from that of Poterba (1994), who presents evidence for 1988-1992 showing that the offsetting state tax response to an unexpected negative deficit shock is proportional to the magnitude of the shock. Poterba finds that there is an increase in states taxes after two years approximately equal to the shock.

prices are also likely to impact tax revenues. To the extent that changes in extraction activity are translated into changes in income, the effects are at least partially captured by changes in the tax base (AGI). Hence, some though not all of the revenue impact of windfall increases in severance tax revenue are captured by the model.

B. Results

Table 6 presents descriptive statistics for the variables in the regression analyses, and Table 7 presents the analysis of the change in tax revenues. Column (1) of Table 7 includes only the measure of potential revenue exposure discussed in section I.D above. Not surprisingly, there is a significant positive relationship between potential exposure and the actual change in revenues, with a one dollar change in exposure implying a one dollar change in revenues. Thus, potential exposure is an unbiased predictor on average. However, it explains only a small portion of the variation in revenue changes (adjusted $R^2 = 0.12$). Recall that revenue exposure is measured as $\sum_{q=1,3} \Delta AGI_q \cdot BURD_q$. Hence, this measure may be thought of as a measure of the change in fiscal capacity of the state. The estimated coefficient implies that a change in fiscal capacity is associated with an equal change in revenue outcomes, under the restriction that each quantile-specific weighted revenue exposure will have the same effect on tax revenues, regardless of the income quantile.

The next two columns in the table relax this restriction, by including as separate covariates the various terms in the fiscal exposure measure and their interaction effects. Column (2) includes as separate covariates the change in AGI and the tax burden for the three quantiles. The only AGI change which has a significant effect on tax revenues is that for the 80th-95th percentiles of the AGI distribution. The tax burden effects are largely insignificant. The explanatory power of the regression, while greater than in column (1), is still weak.

Column (3) adds interactions between tax burdens and changes in AGI for the top two quantiles, and includes the average tax burden. (We exclude the change in AGI and burden for the bottom 80 percent because the average burden is a linear combination of burdens for the three quantiles.) This specification improves the explanatory power of the regression immensely, and produces more readily interpretable estimates of the effect of tax structure.

The interaction terms in (3) reveal that the effect on revenue change of the tax burdens on the rich depends importantly on how the tax base itself changes; and conversely, the effect of income changes at the top of the income distribution depends on the tax burdens on those quantiles. Among the more-progressive states, those with bigger negative (or smaller positive) income shocks to the top 5% had bigger losses (smaller gains) in revenue; but among the less-progressive states, those with bigger negative (or smaller positive) income shocks to the top 5% had smaller losses (bigger gains) in revenue. Conversely, among the 11 states with the biggest drops in top-5% income (more than $108,000 per return), the more progressive ones had bigger drops (or smaller gains) in revenue; but among the 37 states with smaller drops in top-5% income (or gains), the more progressive ones had smaller drops (or bigger gains) in revenue.[18] At

[18] Controlling for the average tax burden in a state and the burden on the next 15 percent, the effect on revenue of a 100 percentage-point increase in the tax burden (i.e., from 0 to 1) on the top 5 percent equals $(32650 + .3025 \cdot \Delta AGI_{top5})$. Setting this expression equal to zero implies that, for states with a decrease in AGI among the top 5 percent of more than $108,000 per return, higher tax rates on this quantile exacerbated the decline in revenue. However, for states with smaller declines (or gains) in AGI, higher top tax rates were associated with smaller declines in revenue, or actual increases.

the mean change in AGI (-$84,000), a higher tax rate on the top 5 percent would imply a smaller decline (or an increase) in revenues.

As hypothesized, the recession's effect on state tax revenues is magnified in those states that had both the highest pre-recession tax burdens at the top and experienced the largest income shocks at the top. However, only three states -- California, New York, and New Jersey -- are in this category, with both tax burdens and declines in AGI for the top 5 percent in the upper 25 percent of states. To be sure, these are important states, raising 28 percent of all state tax revenues in 2007.[19] But among all states, the correlation between the top-5 tax burden and the change in AGI, while positive, is insignificant ($\rho = .165$). Taking a broader sample, for the 18 states with an AGI decrease for the top 5 percent that exceeded $84,000, the combined effect on the change in tax revenues of the income shock and the tax burden is positive – i.e., predicts a revenue increase (or smaller decrease) on average, rather than a bigger decrease.[20] Moreover, the estimated effect of the top burden is positive at the mean change in AGI for the top 5 percent. These results suggest that, while in principle more progressive tax structures could exacerbate the revenue shock to states, in fact higher rates at the top of the income distribution did not have a pronounced destabilizing effect on revenues during the recession.

Contrary to expectations, the revenue effect of the effective tax burden on the 80^{th}-95^{th} percentile is the opposite of the effect for the top 5 percent. The negative

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[19] Note however that in one of the three high-exposure states, New York, tax revenues actually increased. This is because the state increased the top marginal tax rates, thus offsetting the large potential revenue exposure.

[20] The calculation that gives this result is dtax = -0.0203*(-128,789) + 32,650*0.062 + 0.3025*(-128,789*.062) = +2223.

coefficient on the interaction term implies that the greater the decrease in AGI, the smaller the decrease (larger the increase) in revenue.[21] States that were subject to a larger economic shock in this quantile would see the effect of higher tax burdens diminished. Evaluated at the mean change in AGI (-$5,257 per return), states with higher tax burdens in the 80th-95th percentiles had *smaller* decreases in tax revenue, or actual increases. Moreover, as is the case for the top 5 percent, the correlation between tax burden and change in AGI for the next 15 percent is insignificant (ρ = -0.112). Thus, the overall effect of tax burdens on the next 15 percent on revenue changes is muted.

These results suggest that the relationship between tax progressivity and revenue volatility is weak and even counterintuitive. While higher tax burdens at the very top of the income distribution increase the potential fiscal risk from recession for states where income at the top is very volatile, empirically the actual effect is small. In the next 15 percent of the distribution, higher tax burdens actually reduce revenue volatility at the mean income shock. Thus higher burdens in this part of the income distribution may be viewed as providing a kind of fiscal insurance to states, in that they typically act to limit the decline in tax revenues during a recession.

C. Explaining the Economic Shock to States

The change in a state's tax base is equal to the weighted average of the change in tax base by quantile, where the weights are the shares of the total base in each quantile. Hence, the distribution of income and the volatility of income by quantile are

[21] From column (3), the effect of a 100 percentage-point increase in $BURD_{nxt15}$ is given by (-15492 - $6.754 \cdot \Delta AGI_{nxt15}$). Setting this term to zero implies that if the decrease in AGI for the 80th-95th percentile is larger than $2294, higher tax burdens on the next 15 percent, holding the average burden and burden on the top 5 percent constant, are associated with a *smaller* reduction in state tax revenues.

potentially important in the overall volatility of a state's tax base. The results from the fiscal exposure simulations and the regression analyses highlight the dominant role of changes in the fiscal base in both potential revenue exposure and actual revenue changes. In this section, we present a set of regression models that explore the extent to which income inequality and capital gains concentrations at the outset of the recession are correlated with the decrease in the state tax base.

The dependent variables are the change in AGI for the top 5 percent and for the next 15 percent. Covariates include the quantile's share of total AGI, the share of capital gains in income, and the tax burden for the respective quantile. Column (1) of Table 8 shows that in 2007-2009, both a higher degree of income concentration and a larger share of capital gains in top incomes are associated with a larger drop in AGI per return in the top 5 percent of the income distribution. From column (2), a 10 percentage-point increase in income concentration in the top 5 percent was associated with an additional decrease in AGI per return of $64,350. A comparable increase in the capital gains share of income is associated with an additional $37,900 decrease in AGI among the top 5 percent. Given the high correlation between income concentration and the share of income from capital gains in the top 5 percent ($\rho = +0.75$), it is noteworthy that the regression shows a statistically significant effect for each factor separately.

Column (2) of Table 8 also shows that, controlling for income concentration and capital gains shares, larger decreases in AGI were significantly correlated with higher tax burdens at the top. This tax effect, together with the result that the capital gains share has a significant (negative) effect on the change in AGI, would, ceteris paribus, lead to the expectation that states with relatively high tax burdens on the top five percent, and/or a high concentration of capital gains income, would have both greater potential revenue exposure, and greater actual decreases in tax revenues. However, because the tax burden and the change in AGI among the top 5 percent have an interactive effect on actual revenue changes (Table 7, column 3), states whose fiscal base is at risk due to the concentration of income and the recession-induced volatility of capital gains did not necessarily suffer larger declines in tax revenue. Similarly, states with relatively high tax burdens on the rich are not necessarily more subject to tax shocks than less progressive states.

In contrast to the models of AGI change in the top 5 percent, the models of AGI change in the next 15 percent are unable to explain any of the variation. While states with more income concentrated in the top 5 percent of the distribution, and with more of that income coming from capital gains, suffered greater decline in their tax base at the top, the change in AGI for the next 15 percent was unrelated to the concentration of income in that quantile, or to variations in the share coming from capital gains. The change in the tax base below the top 5 percent is likely to be more closely related to the state-specific recessionary shock. Given that sales taxes play a much greater role in determining total tax burdens for taxpayers below the top 5 percent, state-specific economic shocks to output and employment are likely to impact tax revenue with a longer lag and perhaps greater variation across states.

To summarize this section, states with the most unequal incomes and the greatest reliance on capital gains had their fiscal base most exposed to the nationally uniform shock due to the collapse of the stock market. However, our analysis shows that the link between decline in the tax base and decline in tax revenues is substantially attenuated by the fact that top tax rates are only weakly correlated with changes in the high end fiscal base. Below the top 5 percent, higher tax burdens do not have a systematic effect on revenue changes, again because base changes are uncorrelated with tax burdens.

D. Simulation Analysis

In this section, we use the regression coefficients in column 3 of Table 7 to simulate the effect on revenue changes of altering the tax structure. The results are shown in Tables 9 and 10. We focus on a scenario that would reduce top tax burdens in the most progressive states and raise top burdens in the least progressive. Specifically, for the top 5 percent, burdens that are above the 75^{th} percentile (i.e., the highest 12 states) are lowered to the 75^{th} percentile and those that are below the 25^{th} percentile (i.e., the lowest 12 states) are raised to the 25^{th} percentile. An analogous exercise is performed for burdens on the next 15 percent. Among the 12 states with the highest burdens on the top 5 percent, the CTJ estimate of the average burden is 8.7 percent, while the burden at the 75^{th} percentile is 8.06 percent. Hence the average reduction is 0.64 percentage points, or a 7.4 percent reduction in tax burdens. The maximum reduction is in New York, where the top 5 percent burden is reduced by two percentage points, from 10.1 percent to 8.06 percent (a 20 percent reduction in tax burdens).

Among the 12 states with the lowest burdens on the top 5 percent, the simulation raises the average effective burden by 1.7 percentage points, from 4.0 percent to 5.7 percent, which is a 43 percent increase in percentage terms. The state experiencing the biggest tax increase under this scenario is Wyoming, with the burden going from 2.3

percent to 5.7 percent. The burden on the top 5 percent in Texas, the largest state in this group, is raised from 4.1 percent to 5.7 percent.

Since the average tax burden is calculated as the weighted sum of the burdens on the three quantiles of income (with AGI shares as weights), changing the burden on the top quantile(s) will automatically change the average burden. Therefore, in the simulation exercise we also adjust the average tax burden -- downward for the most progressive states, and upward for the least progressive states. Thus, we are not simulating revenue-neutral changes in progressivity, but reducing both progressivity and average tax burdens in progressive states, and doing the opposite in regressive states. However, we are able to isolate the effect of the change in progressivity from the change in average tax burden, by decomposing the difference between the simulation and the base model into components due to the change in the relevant tax burden and the change in average tax rates. One might think of this simulation as a "race to the middle," rather than a "race to the bottom."

The results are shown in Tables 9 and 10. The tables show 2007 tax revenues per return (column 1), the actual change in revenues from 2007 to 2009 (column 2), the change predicted by model (3) in Table 7 (column 3), the simulated change using the coefficients from model (3) and the progressivity compression scenario(s) described above (column 4), and the difference between the simulated and predicted change (column 5). The last three columns break down the difference in column (5) into the effects of changing the burden on the top 5 percent (column 6), the next 15 percent (column 7), and the average tax burden (column 8). Positive numbers in columns 5-8 indicate a smaller revenue reduction under the reduced-progressivity scenario, while negative numbers indicate a larger reduction. The top panel of Table 9 shows the effect of compressing burdens in the most progressive states, while the bottom panel shows the most regressive states.

Column 2 of Table 9 shows that the actual average change in tax revenues was -$206 per return in the progressive states, and +$206 in the regressive states. On its face, this pattern would imply greater fiscal exposure in more progressive states. However, the average for the regressive states is pulled up by the small mineral states of Wyoming (+$2596) and North Dakota (+$1838). Weighted by state population, regressive states also lose revenue and the difference between progressive and regressive states narrows. Reflecting the importance of California, the average decrease among the progressive states expands to -$352, while in the regressive states the change goes from +$206 to -$205. As a share of 2007 tax revenues, the (weighted) average decrease is 6.1 percent in the 12 states with the highest tax burdens on the top five percent of filing units, versus 5.2 percent in regressive states. Thus the aggregate impact of the great recession on state tax revenue is roughly the same for the most progressive and least progressive states. This result for actual tax changes is consistent with the findings from the revenue exposure simulations in Table 2, which found that tax progressivity was much less important than the recession shock in explaining revenue exposure.

Column 3 shows that model (3) in Table 7 yields a predicted change of -$251 in the most progressive states, versus +$120 in the most regressive states. Column 4 shows that the most progressive states would have experienced a smaller revenue shock had their top burdens (and therefore their average tax burdens) been closer to the national average. The weighted average in row 2 of column 5 indicates that the revenue shock would have been $213, or 50 percent smaller per return. The decomposition of this change (columns 6 and 8) indicates that about a third (75/213) of this reduction comes from the decrease in the top burden alone, while two thirds (137/213) results from the reduction in the average tax rate implied by lowering the burden on the top 5 percent. In other words, if instead of allowing the average tax burden to decline with the decline in the burden at the top, we had raised rates on the bottom 80 percent to offset the decrease for the top 5 percent, the effect of the simulation exercise in the progressive states would have decreased from 3.7 percent of initial tax revenues (213/5796) to 1.3 percent (75/5796).

Rows 3 and 4 of Table 9 show the effect on the most progressive states of reducing the burdens not only on the top 5 percent but also on the next 15 percent, again with offsetting adjustments to the average tax rate. Rather than further reducing the predicted revenue reduction, this simulation leaves the predicted revenue change much closer to the predicted change from the model. The reason for this result is that, while the reduction in the top 5 percent burden reduces the predicted tax decline, the reduction for the 80^{th}-95^{th} percentile acts as an offset. Comparing column 4, row 4 with column 4, row 2 indicates that reducing the burden on the next 15 percent would have increased the predicted tax decline by $139, or 2.4 percent of 2007 tax levels.

The bottom panel of Table 9 looks at the effect of the simulation on the most regressive states. Raising the lowest burdens on the top 5 percent to the 25^{th} percentile would have changed the predicted average revenue shock from an increase to a decrease. The change is equal to 5.3 percent (208/3944) of initial tax revenues. However, all of the effect comes through the increase in the average tax rate rather than the increased progressivity. This suggests that an average-burden-neutral increase in the lowest effective tax rates on the upper tail of the income distribution would have little or no effect on revenue stability. A broader reform in the most regressive states that raised tax rates on the top quintile of the income distribution (both the top 5 and the next 15 percent) to the 25th percentile would still have led to a revenue decline instead of the increase predicted by the model (-$57 instead of +$63), but as in the case of the progressive states, the change is smaller than that from just reducing the burden on the top 5 percent.

Table 10 shows the simulation results for selected more- and less-progressive states. The states are chosen based on population and distinctiveness of their fiscal structure. California, New Jersey, and New York all had large negative predicted impacts of the recession on state tax revenues. However, while the actual change in California and New Jersey was close to the prediction, New York offset the potential revenue shock by raising its top tax rate, resulting in an actual revenue increase of $161 per return, in contrast to a predicted loss of $623. Given its relatively heavy burden on the top 5 percent and its high average burden, the progressivity-compression scenario reduces predicted volatility more in New York than in any other state. As discussed in the previous section, California and New Jersey represent the clearest cases of states that were heavily exposed to the recession due to their high tax rates on the top slice of the income distribution and the sharp decrease in top incomes, and both experienced large actual decreases in state taxes.

Among the more regressive states, Florida and Nevada stand out for their very large declines in actual tax revenue, both in dollar amount and as a percentage of tax revenues (17 and 11 percent, respectively). While both states would have experienced an even greater fiscal shock had they had more progressive tax structures, the actual fiscal experience of these two states makes it clear that an extremely regressive tax structure (both states lack a state income tax) provides very incomplete fiscal insurance against a deep recession.

III. Conclusion

This paper starts with four empirical observations. First, the impact of the great recession on state tax revenues has been very severe, with the depth and persistence of the decline greater than any other downturn in the post-war period. Second, since the 1970s income inequality has increased enormously, both nationally and within states. Third, the income of high-income taxpayers is more volatile and cyclically sensitive than for those with lower incomes. Fourth, states vary substantially in both their average tax burdens and the progressivity of their tax systems. The question addressed is, "To what extent is the first observation a function of the other three?" Our hypothesis was that more progressive states are more vulnerable to revenue losses in economic downturns, and this greater volatility may have been amplified by the secular change in the income distribution.

To test these hypotheses, we first constructed a measure of potential revenue exposure for each state for the recession period 2007-2009, which is equal to the sum of the state-specific changes in federal AGI per return by income quantile, multiplied by the state's effective tax burden by quantile. Tax burdens by income quantile are obtained from a 50-state study of tax incidence by Citizens for Tax Justice. We use this measure of potential revenue exposure to simulate the effect of changing the economic shock to a state, its average tax rate, and its tax progressivity, in turn, to the national average across states. We then estimate a multiple regression model of revenue changes over the recessionary period 2007-2009, as a function of the components of revenue exposure and their interactions. We use the coefficients from the regression model to perform a second type of simulation exercise, in which we modify the tax structures of the most- and least-progressive states to be closer to national averages.

We find that the variation in potential revenue exposure across states is less than half as large as the variation in actual revenue changes. Hence, our potential revenue exposure measure alone can explain only 12 percent of the variation in actual changes. The dominant factor in the variation in potential revenue exposure is the economic shock to the tax base in a state, particularly among the top 5 percent of filing units, as opposed to variations in tax burdens or tax progressivity. This result holds both for all state taxes and for the income tax alone.

In contrast to the potential exposure measure, the regression model can explain more than half of the variation in actual taxes. However, it does not give a clear and unambiguous answer to whether tax progressivity amplifies the fiscal shock from a deep recession. We find that while both tax burdens and the change in AGI for the top quintile of a state's income distribution do influence actual tax changes, the effects depend importantly on interactions between the tax burden and the AGI change. While states with a high degree of income concentration are more vulnerable to the extreme volatility in capital gains income exhibited in the recession, the resulting large changes in AGI of the top 5 percent do not translate into systematically sharper drops in tax revenue.

Because income volatility and tax progressivity are weakly correlated across U.S. states, the potential revenue exposure implied by large drops in the top end of the income tax base tends not to be reinforced by high effective tax rates at the top. Similarly, states with relatively progressive tax systems are not on average more vulnerable to recessions than less progressive states.

This finding holds despite the fact that the most progressive states did tend to have larger tax declines than the most regressive states. However, there are some notable exceptions to this pattern. For example, Florida and Nevada, though they have highly regressive state tax systems, also have a high degree of income concentration at the top. Both states suffered among the largest reductions in state tax revenues, both in absolute and percentage terms. New York had a large predicted decline in tax revenues due to its high degree of income concentration, a large capital-gains-related shock to the incomes of high-income individuals, and its relatively progressive tax structure. However, in contrast to California, which suffered a large decrease in tax revenue due to the same factors, New York raised its top marginal income tax rates enough to offset the predicted revenue decline.[22]

The impact of the recession on state tax revenues operates through two different channels. The first is through the national impact of the sharp decline in stock market valuations, and the attendant collapse in capital gains income. State tax bases are affected by this component in proportion to their pre-recession reliance on capital gains

[22] California was contrained by its requirement of a constitutional amendment to raise taxes and did not raise tax rates during the recession. As a result, state tax revenues declined by 12 percent, while they actually rose in New York State. However, faced with a fiscal crisis of major proportions, on November 6, 2012 California voters by a wide margin chose to emulate New York State, and offset their fiscal exposure by raising tax rates on those with incomes greater than $250,000, as well as an increase in the general sales tax rate from 7.25 percent to 7.5 percent.

income, which in turn is closely associated with the degree of income concentration. In a small number of states, progressive tax structures amplified the fiscal impact of large drops in capital gains income. However, our regression results suggest that in a larger group of states, tax structures served to dampen the revenue impact of the change in capital gains. Hence, the net effect of greater tax base volatility at the top is not revenue-volatility enhancing.

The second channel through which the national recession impacts state tax revenues is though its differential effect on output and employment by state. This channel has a greater impact on incomes below the top 5 percent of the distribution than on the top 5 percent. Our findings for this group are surprising. Higher tax burdens on the 80^{th} to 95^{th} percentiles of their income distributions, rather than exacerbating the recession-induced decline in tax revenues, tended to mitigate the decline. Such tax structures in effect tended to insulate states from the revenue risks of the great recession.

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Table 1. Change in State Tax Revenue 2007-2009
Divided by Number of Federal Tax Returns in 2007

	Mean	Std Dev	10th percentile	90th percentile
All Taxes (N = 48)				
Actual revenue change[1]	-138	582	-712	335
(Percent change)*	(-3.1)	(10.2)	(-12.6)	(24)
			(N Mex)	(Iowa)
Potential revenue exposure[2]	-255	215	-617	74
			(Calif)	(W Va)
Income Tax (N= 42)				
Actual revenue change[3]	-119	157	-389	155
(Percent change)*	(-6.2)	(8.7)	(-18)	(17)
			(Conn)	(N Dak)
Potential revenue exposure[4]	-171	130	-422	-11
			(Calif)	(Tenn)

Notes:
* Percentage change in revenues, 2007-2009.
1. Change in total state tax revenues, 2007-2009, per number of 2007 federal tax returns.
2. Potential change in total state tax revenues per federal tax return, 2007-2009, given actual change in AGI and 2007 total state tax burdens by income quantile.
3. Change in state income tax revenue, 2007-2009, per number of 2007 federal tax returns.
4. Potential change in state income tax revenue per federal tax return, 2007-2009, given actual change in AGI and 2007 state income tax burdens by income quantile.

Table 2. High and Low States: Change in Actual Tax Revenue vs. Potential Revenue Exposure

	5 most progressive states[3]	5 most regressive states[4]	5 Highest average tax burden states[5]	5 lowest average tax burden states[6]	5 largest decreases in state revenues[7]	5 largest increases in state revenues[8]	8 states with high mineral revenues[9]
Change in state tax revenue (% change)	-400 (-6.7)	232 (1.2)	-73 (-2.6)	296 (2.2)	-782 (-14.6)	1031 (17.7)	480 (7.9)
Potential revenue exposure (total state taxes)[1]	-466	-189	-321	-178	-459	-102	-9
Change in state income tax revenue	-272	NA	-42	-13	-381	19	-21
Potential Revenue exposure (income taxes)[2]	-306	NA	-218	-16	-304	-70	-38
Progressivity: top5 burden/avg burden	0.98	0.54	0.85	0.56	0.78	0.77	0.75
Average tax burden	0.084	0.057	0.102	0.052	0.08	0.071	0.079

Notes:

1. Defined as the sum of the change in AGI 2007-2009 per federal return in 2007 by AGI quantile, multiplied by 2007 effective tax burden by quantile. Quantiles are top 5 percent, next 15 percent, and bottom 80 percent.
2. Defined as the sum of the change in AGI 2007-2009 per federal return in 2007 by AGI quantile, multiplied by 2007 effective income tax burden by quantile. Quantiles are top 5 percent, next 15 percent, and bottom 80 percent.
3. California, New Jersey, Oregon, Delaware, Vermont.
4. Washington, South Dakota, Wyoming, Nevada, Florida.
5. New York, Wisconsin, Ohio, Maine, Arkansas.
6. Wyoming, Nevada, New Hampshire, South Dakota, Florida.
7. Arizona, California, New Mexico, Florida, Connecticut.
8. Wyoming, North Dakota, Iowa, Indiana, Montana.
9. Wyoming, West Virginia, Texas, Oklahoma, North Dakota, Montana, Louisiana, New Mexico.

Table 3. Alternative Measures of Potential Revenue Exposure

	Mean	Std Dev	Min	Max
All State Taxes				
Base case[1]	-255	215	-874	214
Simulation I[2]	-251	201	-781	253
Simulation II[3]	-251	197	-866	219
Simulation III[4]	-262	85	-421	-78
Income Tax				
Base case[5]	-171	130	-555	28
Simulation I[6]	-150	95	-413	52
Simulation II[7]	-178	131	-602	28
Simulation III[8]	-175	61	-295	-12

Notes:
1. Simulated potential change in tax revenues - actual change in AGI, 2007 state tax progressivity, 2007 state tax rate.
2. Simulated potential change in tax revenues - actual change in AGI, 2007 state tax progressivity, 2007 national average state tax rate.
3. Simulated potential change in tax revenues - actual change in AGI, 2007 national average state tax progressivity, 2007 state tax rate.
4. Simulated potential change in tax revenues - national average change in AGI, 2007 state tax progressivity, 2007 state tax rate.
5. Simulated potential change in income tax revenues - actual change in AGI, 2007 state income tax progressivity, 2007 state income tax rate.
6. Simulated potential change in income tax revenues - actual change in AGI, 2007 state income tax progressivity, 2007 national average state income tax rate.
7. Simulated potential change in income tax revenues - actual change in AGI, 2007 national average state income tax progressivity, 2007 state income tax rate.
8. Simulated potential change in income tax revenues - national average change in AGI, 2007 state income tax progressivity, 2007 state income tax rate.

Table 4. Comparing Potential Revenue Exposure to the National Average, 2009

	Potential Revenue Exposure	Potential Revenue Exposure minus National Average (absolute value)
National average*	-$255	
Closest to average exposure		
Maine	-258	2
South Carolina	-244	12
Missouri	-241	15
Utah	-271	16
Delaware	-276	21
Farthest from average exposure		
New Jersey	-615	360
California	-617	362
Louisiana	190	446
North Dakota	214	469
New York	-751	495
Connecticut	-874	619

* Calculated as (national average AGI change) x (national average progressivity) x (national average average tax rate).

Table 5. Spearman Rank Correlation Coefficients between Actual Revenue Change 2007-2009, Potential Revenue Exposure, and Simulated Measures of Revenue Exposure

All State Taxes (N=48)	**Actual Revenue Change**	**Measures of Potential Revenue Exposure**			
		Base Case	Natl Average Tax Rate	Natl Average Progressivity	Natl Average Shock
Actual revenue change	1.00				
Potential revenue exposure					
Base case	0.46*	1.00			
Natl avg tax rate	0.06	0.47*	1.00		
Natl avg progressivity	0.47*	0.95*	0.23	1.00	
Natl avg shock	-0.03	0.36	0.88*	0.18	1.00

Income Tax (N=42)	**Actual Revenue Change**	**Measures of Potential Revenue Exposure**			
		Base Case	Natl Average Tax Rate	Natl Average Progressivity	Natl Average Shock
Actual revenue change	1.00				
Potential revenue exposure					
Base case	0.61*	1.00			
Natl avg tax rate	0.51*	0.74*	1.00		
Natl avg progressivity	0.58*	0.96*	0.68*	1.00	
Natl avg shock	0.18	0.65*	0.23	0.59*	1.00

* Significant at the one percent level.

Table 6. Definitions and Means, Minimum and Maximum Values of Variables in Regression Models (N = 48)

Variable	Definition	Mean	Min	Max
pret_chg_tax_tot	Change in total state tax revenue 2007-2009, per 2007 return	-138	-1,128	2,596
pret_dtax_stagi_prst_atrst	Potential revenue exposure	-255	-874	214
pret_dagi_state_top5	Change in AGI per return in top 5% of returns, 2007-2009	-83,774	-237,197	-10,729
pret_dagi_state_nxt15	Change in AGI per return in next 15% of returns, 2007-2009	-5,257	-11,571	5,633
pret_dagi_state_nxt80	Change in AGI per return in bottom 80% of returns, 2007-2009	1,108	-821	2,938
burdtop5	Total state tax burden on top 5%, 2007 (CTJ)	0.066	0.023	0.101
burdnxt15	Total state tax burden on next 15%, 2007 (CTJ)	0.085	0.045	0.127
burdnxt80	Total state tax burden on bottom 80%, 2007 (CTJ)	0.093	0.060	0.116
atr_ctj_st	Average state tax burden, 2007 (CTJ)	0.082	0.042	0.112
agi_shr_top5	Share of total AGI in top 5% of returns, 2007	0.338	0.278	0.486
agi_shr_nxt15	Share of total AGI in next 15% of returns, 2007	0.289	0.221	0.316
shr_kgains_agi_top5	Capital gains share of AGI in top 5% of returns, 2007	0.209	0.126	0.389
shr_kgains_agi_next15	Capital gains share of AGI in next 15% of returns, 2007	0.033	0.018	0.054

Table 7. Regression Models for Change in Total Tax Revenue per Return

Dependent Variable: pret_chg_tax_tot
[t-statistics in brackets]
*p<.10, **p<.05, ***p<.01

Variable	**(1)**	**(2)**	**(3)**
Potential Revenue Exposure	1.015 ***		
	[2.74]		
Chg AGI per return, top 5%		-0.0013	-0.0203 ***
		[-0.69]	[-5.09]
Chg AGI per return, next 15%		0.0916 **	0.6478 ***
		[2.29]	[5.44]
Chg AGI per return, next 80%		0.0756	
		[0.54]	
Tax burden on top 5%		-17077	32650 ***
		[-1.35]	[3.41]
Tax burden on next 15%		26227	-15492
		[1.30]	[-0.76]
Tax burden on next 80%		-23143 *	
		[-1.90]	
Chg AGI * Burden, top 5%			0.3025 ***
			[5.18]
Chg AGI * Burden, next 15%			-6.7538 ***
			[-4.51]
Average tax burden			-30864
			[-1.48]
Constant	121.15	1216.53 *	1831.16 **
	[0.99]	[1.98]	[2.40]
No. of observations	48	48	48
Adjusted R-squared	0.122	0.247	0.573

Notes:

Marginal effect of a 1 percentage-point increase in tax burden on top 5%, Model 5:

At the mean chg agi per return for the 12 most progressive states (burden on top 5 percent greater than 75th percentile)	68
At the mean chg agi per return for the 12 least progressive states (burden on top 5 percent less than 25th percentile)	37

Marginal effect of a 1 percentage-point increase in tax burden on next 15%, Model 5:

At the mean chg agi per return for the 12 most progressive states (burden on top 5 percent greater than 75th percentile)	235
At the mean chg agi per return for the 12 least progressive states (burden on top 5 percent less than 25th percentile)	152

Table 8 - Regression Models for Change in AGI per Return by Quantile

Dependent Variable: Change in AGI per return 2007-2009, top 5% or next 15%
[t-statistics in brackets]
*p<.10, **p<.05, ***p<.01

Variable	(1) chg agi per return top5	(2) chg agi per return top5	(3) chg agi per return next15	(4) chg agi per return next15
Share of total AGI in top 5% of returns, 2007	-677927 ***	-643475 ***		
	[-8.35]	[-8.17]		
Capital gains share of AGI in top 5% of returns, 2007	-294081 ***	-378969 ***		
	[-4.17]	[-4.97]		
Tax burden on top 5%		-381995 **		
		[-2.36]		
Share of total AGI in next 15% of returns, 2007			13499	14802
			[0.61]	[0.66]
Capital gains share of AGI in next 15% of returns, 2007			-3336	-15821
			[-0.06]	[-0.29]
Tax burden on next 15%				-24120
				[-0.89]
Constant	206540 ***	237904 ***	-9053	-6972
	[9.79]	[9.86]	[-1.28]	[-0.93]
No. of observations	48	48	48	48
Adjusted R-squared	0.832	0.847	-0.035	-0.040

Table 9 Predicted Change in Total Tax Revenue per Return, 2007-2009, Compared with Simulated Change with Compressed Tax Progressivity

		Total tax revenue per return in 2007	Actual Change	Predicted Change[1]	Simulated Change[1]	Simulated minus Predicted Change[2]	Decomposition of column 5 into components		
Progressive States (burden on top 5% greater than 75th percentile nationally)						Gain from lower burdens	Lower burden on top 5%	Lower burden on next 15%	Lower average tax burden
					Compress top 5% burden only to 25-75 percentiles				
	Unweighted	5477	-206	-251	-163	88	12	not applicable	77
	Weighted by Population	5796	-352	-430	-217	213	75	not applicable	137
					Compress top 5% and next 15% burdens to 25-75 percentiles				
	Unweighted	5477	-206	-251	-268	-16	12	-150	122
	Weighted by Population	5796	-352	-430	-356	73	75	-190	188
Regressive States (burden on top 5% less than 25th percentile nationally)						**Loss from higher burdens**	**Higher burden on top 5%**	**Higher burden on next 15%**	**Higher average tax burden**
					Compress top 5% burden only to 25-75 percentiles				
	Unweighted	4292	206	120	-132	-252	-59	not applicable	-193
	Weighted by Population	3944	-205	63	-145	-208	0	not applicable	-208
					Compress top 5% and next 15% burdens to 25-75 percentiles				
	Unweighted	4292	206	120	-4	-124	-59	207	-272
	Weighted by Population	3944	-205	63	-57	-120	0	145	-264

Notes:
1. For coefficients see Table 7, Model 3.
2. Positive values indicate that under the particular simulation the **reduction** in state taxes would have been **smaller** than the regression prediction, or the **increase** in state taxes would have been **larger** than the regression prediction.
Negative values indicate that under the particular simulation the **reduction** in state taxes would have been **larger** than the regression prediction, or the **increase** in state taxes under the regression prediction would have been **smaller** than the regression prediction.

Table 10. Individual States: Predicted Change in Total Tax Revenues per Return, 2007-2009, Compared with Simulated Change with Compressed Tax Progressivity

	Total tax revenue per return in 2007	Actual Change	Predicted Change	Simulated Change[1]	Simulated minus Predicted Change[2]	Decomposition of column 5 into components		
Progressive States (burden on top 5% greater than 75th percentile nationally)					**Gain from lower burdens**	**Lower burden on top 5%**	**Lower burden on next 15%**	**Lower average tax rate**
				Compress top 5% burden only to 25-75 percentiles				
California	6519	-780	-640	-373	267	82	not applicable	185
New Jersey	6443	-503	-554	-299	256	82	not applicable	174
New York	6368	161	-623	-6	617	317	not applicable	300
Ohio	4200	-286	-122	-132	-10	-33	not applicable	23
				Compress top 5% and next 15% burdens to 25-75 percentiles				
California	6519	-780	-640	-373 [3]	267 [3]	82	0 [3]	185
New Jersey	6443	-503	-554	-319	235	82	-32	185
New York	6368	161	-623	-620	3	317	-820	506
Ohio	4200	-286	-122	-296	-174	-33	-214	73
Regressive States (burden on top 5% less than 25th percentile nationally)					**Loss from higher burdens**	**Higher burden on top 5%**	**Higher burden on next 15%**	**Higher average tax rate**
				Compress top 5% burden only to 25-75 percentiles				
Florida	4007	-697	-257	-819	-563	-243	not applicable	-320
Nevada	4678	-514	-68	-1028	-960	-568	not applicable	-392
New Hampshire	3006	-68	-643	-739	-96	151	not applicable	-247
Texas	3574	130	697	714	17	203	not applicable	-185
				Compress top 5% and next 15% burdens to 25-75 percentiles				
Florida	4007	-697	-257	-477	-220	-243	405	-383
Nevada	4678	-514	-68	-210	-142	-568	959	-533
New Hampshire	3006	-68	-643	-298	345	151	564	-370
Texas	3574	130	696	529	-167	203	-128	-242

Notes:
1. For coefficients see Table 7, Model 3.
2. Positive values indicate that under the particular simulation the **reduction** in state taxes would have been **smaller** than the regression prediction, or the **increase** in state taxes would have been **larger** than the regression prediction.
Negative values indicate that under the particular simulation the **reduction** in state taxes would have been **larger** than the regression prediction, or the **increase** in state taxes under the regression prediction would have been **smaller** than the regression prediction.
3. The burden on the next 15% in California is at the 75th percentile nationally, so is not reduced by the simulation.