State Tax Revenue Volatility and Its Impact on State Governments

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Acknowledgments

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Contents

Summary

Tax revenue volatility can be a major source of budget uncertainty. By analyzing and quantifying volatility, policymakers and their advisers can better anticipate its effects and understand how policy changes might manage its effects or reduce its magnitude.

There are different kinds of volatility, and different ways to measure volatility. Some measures quantify the extent to which tax revenue growth varies from year to year. Swings in growth can make annual budget forecasting difficult and create risks of intra-year shortfalls. Other measures quantify how far tax revenue deviates from its longer run trend. Deviations from trend may persist for several years in a row, stressing states with small reserve funds. Yet another kind of measure quantifies the extent to which revenue varies beyond what we might expect from changes in the economy. This "excess" variation, beyond that from the economy, can signal particularly large budgetary risk. Each measure can be useful, depending on the question at hand.

There is no such thing as "the volatility" of a tax or a state tax system. Tax revenue volatility depends upon economic conditions that change over time and vary across states. The volatility of a specific tax depends on its structure and tax rates imposed by the state, and on economic conditions. Differences across states in the volatility of total tax revenue depend on the mix of taxes imposed, the structure of those taxes, and the structure of state economies, all of which vary across states and can change over time.

Differences in how specific taxes are structured affects their volatility and growth. Income taxes can be volatile for several reasons. Exempting Social Security income has been found to increase volatility. Some sources of income included in the tax base, particularly capital gains, are more variable than the broader economy. Greater income inequality leads to greater overall tax revenue volatility.[1] This likely reflects the fact that if a large share of income is received by a small number of taxpayers, state tax revenue may be derived disproportionately from these taxpayers. Thus, tax revenue will depend heavily on economic activity of a smaller number of taxpayers whose incomes might be more variable than the average.

The evidence on capital gains and volatility is mixed, with two studies finding either no direct impact on volatility or the opposite of what many forecasters believe. Other studies, and forecast documents, suggest that capital gains are important in some states. Capital gains greatly increase volatility in California because, compared to other states, it has both a high tax rate on capital gains and high capital gains as a share of taxable income. Progressive tax rates can accentuate the revenue impact of swings in capital gains, bonuses, and stock options that are concentrated among high-income taxpayers, because the income is often taxed at high rates. The best reconciliation between large effects in some states and research indicating little or no systematic effect may be that capital gains increase income tax volatility in some states and some episodes, depending on their magnitude and how they are taxed, but not in wide fashion that applies to all states.

How a tax is structured affects its volatility. Progressive income tax structures increase volatility. Greater income tax progressivity has been found to lead to greater volatility in a state's overall tax system, for a given level of growth. For the sales tax, the economics literature has focused on the sales tax base, including whether food or clothing is taxed. States that tax these items benefit from lower tax revenue volatility. Other structures can be neutral – for example, greater taxation on services appears to have little effect on revenue volatility.

The volatility of individual taxes varies over time, but some generalizations have been quite stable. Kwak (2013) notes a widely held, but not universal, interpretation of research: "the findings of previous studies can be summed up thus: (1) income taxes are more volatile than sales taxes; (2) corporate income taxes are the most volatile, whereas tax revenues from sales of motor fuel, nondurable goods, and services are relatively stable over the business cycle; (3) revenue diversification contributes to revenue stability; (4) and at the local level, property taxes are more stable than sales taxes."[2] Severance taxes are extremely volatile but constitute only a small share of tax revenue in all but a few states. Although property taxes are stable, they are rarely used by states. There may episodic exceptions to these generalizations: For example, one recent study concluded that greater reliance on sales taxes during the Great Recession would not have reduced tax volatility in high-income-tax states.[3]

Tax revenue volatility rose dramatically in the decade of the 2000s. It subsided in the next decade but still was higher than it was in the 1990-99 decade. Two studies suggest that a substantial part of increased volatility in the 2000s was due to tax policy choices that states made – in one study, through decisions to limit tax increases during and after the 2001 recession and, in the other study, through movement toward more income-tax-heavy portfolios after the 2001 recession.[4]

Tax revenue volatility usually increases dramatically in and near recessions but there is no such thing as "the impact of a recession" on state taxes. Recessions heighten volatility but vary greatly in duration, depth, and other characteristics. There have been eight recessions in the last 50 years. The diversity is remarkable. The longest recession (the Great Recession) was followed by the shortest recession (the COVID-19 recession). Consumption fell more sharply than GDP in the COVID-19 recession but in the other recessions it fared better and even increased in three recessions. Unemployment rose sharply in the last two recessions but by considerably less in other recessions. Capital gains fell by double digits in the period surrounding five recessions but rose in three.[5]

Tax revenue in the median state fell much more sharply than GDP in periods surrounding the seven recessions for which we have tax data (not including the COVID-19 recession, for which complete tax revenue data were not available at the time of writing). The median state's income tax fell further than total tax revenue in all recessions. The depth of the income tax decline appears related to capital gains. Even in mild recessions, large income tax declines were associated with large capital gains declines.[6]

There can be a tradeoff between volatility and growth: some taxes tend to grow rapidly but are highly variable; some taxes grow slowly but are stable. There are exceptions to these relationships. Taxes do not move in a perfectly synchronized fashion with each other. In principle, this creates opportunities for governments to combine taxes in ways that maximize expected growth for a given level of volatility, as an investor might do with an investment portfolio. Of course, growth and stability are not the only important factors in choosing state tax policies: equity, administrability, and concerns about economic impact also are important and may trump the ideal combination of stability and growth in many policymakers' minds.

States vary greatly in their portfolios of taxes. Some states rely on just one or two taxes, while other states have more diverse tax structures. Washington state relies heavily on the sales tax and has no income tax, while neighboring Oregon relies heavily on the income tax and has no sales tax.

States generally do not have "efficient" tax portfolios – that is, they do not combine taxes in a way that maximizes potential revenue growth for a given level of volatility. There's some evidence that corporate income taxes not only have high volatility but also low growth. A recent study found that 18 states increased the riskiness of their tax portfolios since the Great Recession, accepting more volatility for greater potential growth.[7]

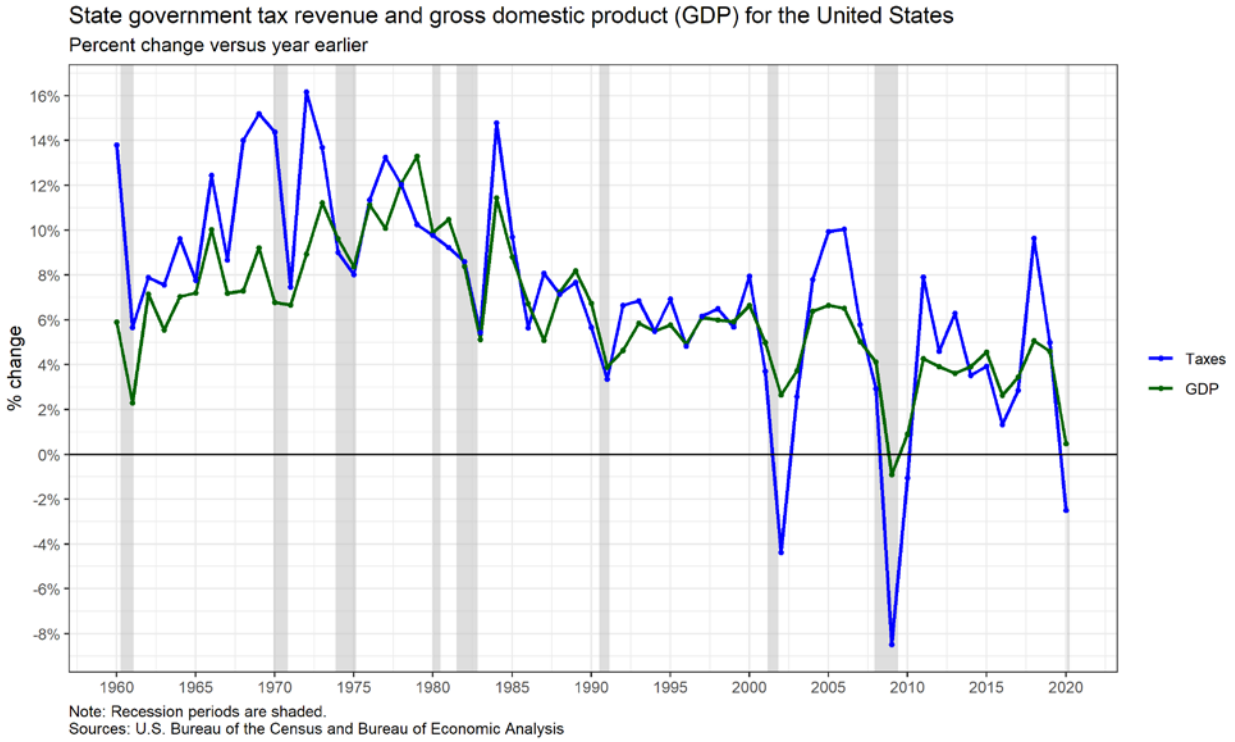
The research on tax portfolios is interesting and policymakers should be aware of it. Other goals of tax policy may be more important to some policymakers than efficient tradeoffs between growth and stability. Volatility often is greater with more progressive tax structures, often an important goal of tax policy. However, understanding the research on tax portfolios can help policymakers understand the volatility they face, understand possible trade-offs between volatility and progressivity, and lead them to use tools to manage volatility where it not practical or desirable to change volatility.

Introduction

Tax revenue volatility can be a major source of budget uncertainty. Volatile revenue sources generally are more difficult to forecast accurately than stable revenue sources. For example, Boyd and Dadayan (2014) showed that state revenue forecasters' errors and errors from models that forecasted revenue based on a revenue source's own history were larger in periods of increased volatility.[8] Other analysts and researchers have reached similar conclusions.[9] Thus, volatility makes it difficult for policymakers to balance annual budgets while maintaining desired services.

Tax revenue and its volatility is driven by the interaction between economic growth and tax structure. Volatility increased in the periods surrounding both the 2001 recession and the 2007 Great Recession; not only was the economy more volatile, but tax revenue relative to the economy became more volatile – that is, the difference between the percentage change in tax revenue and the percentage change in gross domestic product was much larger near the 2001 and 2007 recessions than in earlier periods (Figure 1). This increase in volatility led to budget shortfalls, spending cuts, and concerns that higher volatility was here to stay. By analyzing and quantifying tax revenue volatility, policymakers and their advisers can better anticipate and manage its effects and understand how policy changes might reduce volatility.

Figure 1 State tax revenue and GDP



The intended audience for this report is policymakers and their advisers. It addresses the following questions about tax revenue volatility:

- How should we measure tax revenue volatility?

- How does volatility vary by type of tax?
- How has tax revenue volatility varied over time?
- How do portfolios of taxes affect total revenue volatility?
- How does volatility vary across states?
- What lessons can we glean from the pandemic recession?

The report summarizes what we know from research, examines data to illustrate key points from research or to raise questions that may conflict with research, and offers lessons for policymakers.

How should we measure tax revenue volatility?

Dictionary definitions of volatility generally connote the idea of something that may change frequently and substantially. There is more than one kind of tax revenue volatility. Vasche and Williams (2005) note that there can be year-to-year fluctuations in growth that are frequent but of modest size, fluctuations that are infrequent but more dramatic, and other patterns. Some fluctuations are closely related to changes in the economy as traditionally measured, and others are not.[10]

I take as a given here that analysts are concerned with annual revenue volatility, rather than volatility of quarterly revenue or some other time period. Annual data align with the budget cycle (or with a single year of a biennial budget) and are appropriate for policy planning. Quarterly or higher frequency data are appropriate if the main concern is intra-year cash flow planning and management, which may be particularly important if volatility is high and the government does not have sufficient resources to manage it, such as internal or external borrowing and liquidity availability.

Policy analysts face three key questions when developing measures of annual tax revenue volatility:

1. What, if anything, should they control for? Should their volatility measures exclude variation in tax revenue that results from policy changes? Inflation? Variation in the economy?
2. How should they measure volatility for a single year? Should they examine year over year change, or deviation of revenue from longer-term trends, or something else?
3. How should they summarize volatility across time periods? Should they compute traditional measures such as the standard deviation, or should they compute measures that are more robust to outliers?

What do we know from research?

Research has not always been clear about how these three questions are addressed, or why a specific approach is used.

What should we control for?

Policy impacts

The first question is, should we adjust for policy changes? In concept the answer is a clear yes. Policymakers and analysts are interested in fluctuations in revenue that are caused by external sources, not by their own actions to raise or lower tax rates or alter bases. (Policy changes can add uncertainty when they are adopted, and possibly alter the volatility characteristic of a tax for the longer term. These issues deserve analysis in states, but that's not the issue here.)

Almost all papers appear to consider adjusting for policy changes important. However, in practice, this is extraordinarily difficult. Papers and reports generally have taken three approaches:

- Use detailed knowledge to adjust revenue data for known policy changes. This is easiest when looking at a single state, especially when the analyst works in that state. Vasche and Williams (2005) is an example of this.[11] Some studies that cut across states also do this, going to great lengths to develop specialized data sets, perhaps limited to just a tax or two. They have used approaches such as dividing tax revenue by tax rates to estimate the underlying base and gathering data from other organizations on when tax changes were made, allowing them to indicate whether changes were made but not necessarily their magnitude. For example, Bruce, Fox, and Tuttle (2006) divided sales tax revenue by sales tax rates.[12] Some, including The Pew Charitable Trusts, have used compiled estimates of the value of tax changes.[13] One challenge of this approach is that cross-state compendiums of the impacts of tax changes, such as those prepared by the National Association of State Budget Officers and the National Conference of State Legislatures are based on surveys of analysts in the states. Analysts in different states may have different interpretations of tax-change definitions and different methods of developing estimates; in addition the surveys are subject to nonresponse.[14]
- Use economic data as a proxy for the tax base. Most nationally collected economic data are intended to be comparable over time. Where available by state, these data generally are intended to be comparable across states. Thus, data on components of state personal income or the details of personal consumption sometimes may be a useful proxy for a state personal income tax base or sales tax base. Dye et al. (1991) is an example of this for many states; a presentation by Kalambokidis (2019) is an example of this for a single state.[15] One challenge of this approach is there can be very large differences between economic data and tax bases, such as the fact that state personal income does not include capital gains, an important component of taxable income in some states.
- Use unadjusted revenue data and examine them with methods that are not unduly influenced by outliers. Cornia and Nelson (2010) take this approach.[16] This is the approach I take in this report.

While it is right in concept to adjust for policy changes, whether to do so depends on the difficulty of the task, the importance of the changes, availability of resources, and the purpose of the study. An analyst conducting a single-state study, wishing to inform policymaking in that state, may have the data needed to make adjustments and may need to do so to properly consider how tax system changes have affected volatility. In most cases, analysts conducting cross-state studies and trying to understand the impact of volatility on budgeting in general are unlikely to have the resources to adjust well for policy changes. In these cases, other methods described above may be more appropriate.

Adjusting for inflation

Unlike adjusting for policy changes there is no single right answer in concept for whether to adjust for inflation. Some researchers have adjusted, and some have not.[17]

If policymakers care about volatility caused by price changes as well as by changes in the real economy, they should *not* remove those impacts. In periods when inflation is stable, adjusting should not make much difference. However, in periods when the rate of inflation is changing, or highly variable, there can be volatility in real revenue and additional volatility due to price changes. Inflation changed substantially in the 1970s and 1980s, and may be changing again now, so states may face volatility from changes in real tax revenue and from changes in inflation – an argument in favor of not adjusting for inflation. One state forecaster noted that "Budget policy is concerned with current dollars" and estimated volatility without removing the impact of price changes.[18]

Different tax revenue sources may be affected more or less by general inflation shocks, or by product or activity-specific price shocks. For example, property taxes might, in the long run, hedge much inflation risk if they rise with property values. Many excise taxes are based only on the quantity of goods sold (such as tax-per-gallon gasoline taxes) and so revenue does not benefit from price increases and may in fact move in the other direction. Severance taxes may be heavily influenced by price changes in the commodities they tax, but less so by general price changes.

Adjusting for economic variability

Sobel and Holcombe (1996) argue that "State policymakers trying to design tax structures that will be less sensitive to business cycle downturns would be severely misguided" by volatility estimates that do not adjust for the business cycle: "For policy purposes, cycle-related variability is more important because states tend to run into fiscal problems because of recession-related reductions in revenue growth rather than simply because revenues tend to fluctuate around the long-run trend."[19] The essence of their approach is to regress the year-to-year difference in the logarithm of tax revenue on the year-to-year difference in the log of GDP. (A log-difference is like a percentage change.) The residuals from this regression are a measure of how much tax revenue has changed after removing the effects of economic variation. The coefficient on the log-difference of GDP is the short-run elasticity of tax revenue with respect to GDP. (The standard error of the coefficient is an indication of how reliable the short-run

relationship is between GDP and tax revenue. A large standard error suggests there may be substantial year-to-year variation in tax revenue that is not systematically related to year-to-year variation in state GDP.)

Policymakers often will want to understand both effects: the total variability of their tax system, and the variability above and beyond that linked to economic variability. Economic variability is largely out of policymakers' control, but tax policy could be designed to reduce the short-run volatility in relation to the economy. Understanding the relationship to the economy can help policymakers to design appropriate policies. Vasche and Williams (2005) examined both kinds of measures in California.[20]

How should we measure volatility for a single year?

Researchers have used two main methods to measure how volatile or unusual revenue is at a given point in time.

One common way is to measure the year-over-year percentage *change* in revenue. For example, if revenue had been growing about 5% annually for the last 10 years, and then in the 11th year it grows 10%, that might be considered unusual. The focus is on year-over-year change.

Another approach is to compare the *level* (amount) of revenue in any given year to the trend in revenue. If average revenue had been rising steadily over the last 10 years at 5% annually and falls from $100 in year 10 to $90 in year 11 (versus $105 expected), year 11's level and percentage change are unusual. The difference between the two approaches can be seen if we extend the example for a year. If the long run trend in revenue had continued, by year 12 revenue would have been a bit above $120 (the $100 from year 10 plus two years of 5% growth). If actual revenue grew by 5% from the depressed year 11 revenue of $90, to about $95, then the year 12 growth *rate* is not unusual, but the year 12 revenue *level* is, because it would be about 25% below the long run trend. Often the difference between actual revenue and trend revenue is expressed as a percentage. There are many possible variants on this approach, such as how, precisely, to define a trend (for example, whether to use a Hodrick-Prescott filter, a polynomial regression, or some other approach), and how to measure deviations from the trend.[21] In practice the different methods of constructing a trend don't appear to make much difference.[22]

Researchers have used both approaches. Cornia and Nelson (2010) and Dauchy and Balding (2013) have used the growth approach.[23] The short-run elasticity measures discussed earlier are essentially a growth approach because they examine log-differences, which are like percentage changes. Kwak (2013) and Seegert (2015) have used the level approach.[24]

Which is more appropriate? There are clear conceptual differences. The growth approach appears to make more sense if policymakers are concerned about year-to-year variability, as when considering the risk of tax revenue forecast errors and when concerned about intra-year

budget management. The level approach appears to make more sense if policymakers are concerned about the potential for extended periods when revenue might fall below trend, even if, once revenue drops, it does not change significantly from year to year. This could be particularly important when thinking about how to manage budgets during recessions and the appropriate sizes for reserve funds.

How should we summarize volatility across time periods?

Researchers and state analysts often reach conclusions about how volatility has changed over time and varies over taxes by visual inspection of percentage change or deviation from trends. However, summary measures of volatility can be useful, allowing comparisons of different taxes, different states, and different time periods.

Some researchers use the standard deviation of percentage change or the standard deviation of the percentage deviation from trend as a summary measure of volatility. This is common in the finance literature and fits into the mean-variance framework of risk and growth.[25] When data are measured well and reliable, this can make a lot of sense. If data are not measured well, the standard deviation could be unduly affected by outliers.

Cornia and Nelson (2010) argue persuasively that the standard deviation is heavily influenced by outliers, and is inappropriate when data are measured poorly, as is the case with data not adjusted for policy changes. They use the interquartile range of percentage growth to summarize tax revenue volatility.

Other summary measures researchers have used include the mean of the absolute value of growth rates (absolute value is less influenced by outliers than the standard deviation), and the median of absolute values.

When researchers examine volatility relative to the economy, their summary measure usually is the short-run elasticity estimate, which indicates the magnitude of annual tax revenue growth relative to annual economic growth (when time periods are annual, which is usual). The standard error of that coefficient is an indication of how reliable the estimate of that relationship is.

Analysis and illustrations

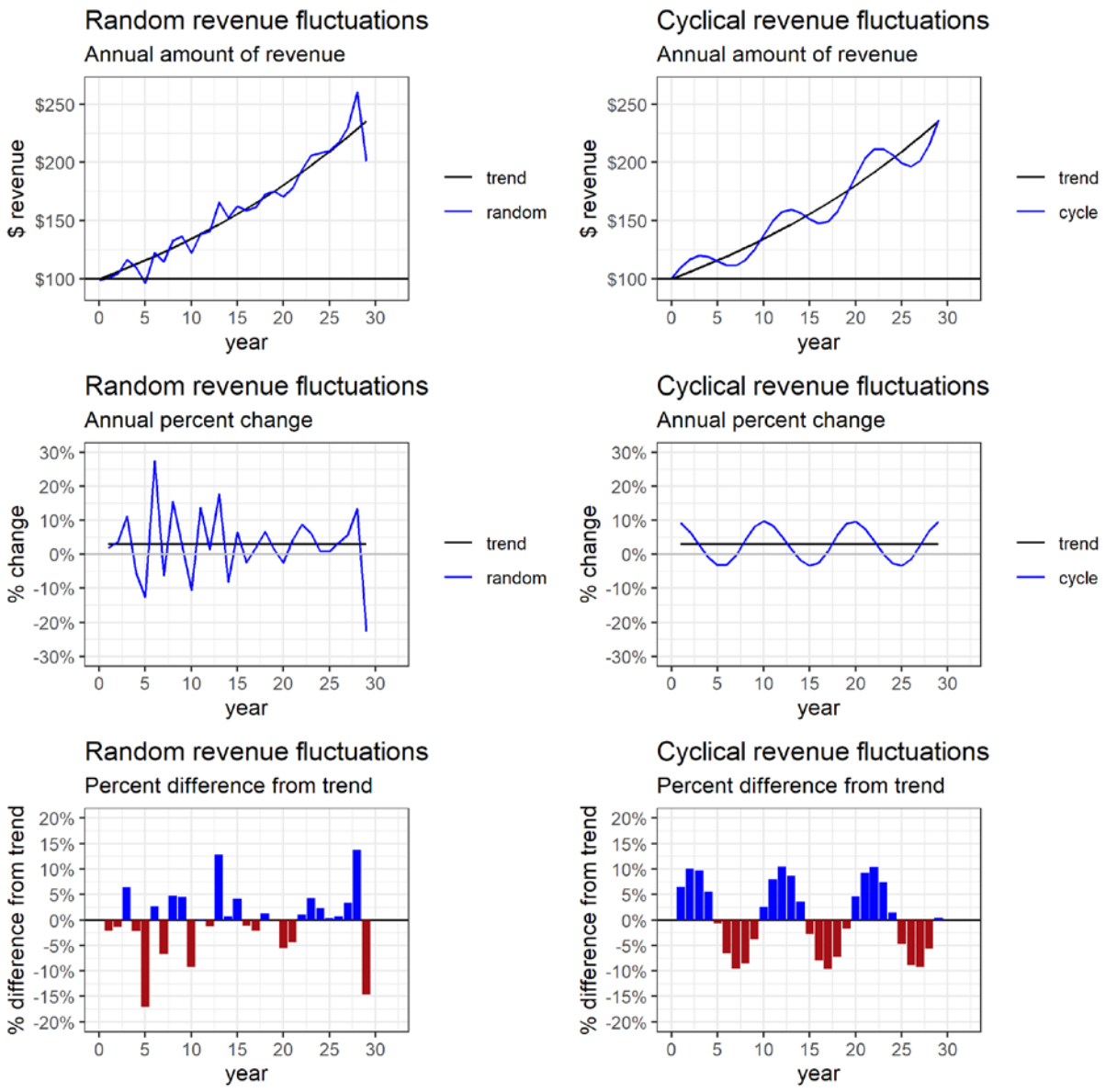
Kinds of volatility: Random and cyclical variation

Imagine three revenue sources that raise the same amount of revenue over 30 years, but with different variation. The first revenue source follows a smooth trend, growing 3% each year with no other variation. The second source grows 3% on average, but with random fluctuations. The third source also grows 3% on average but is cyclical, perhaps because of economic cycles.

Figure 2 shows three such revenue sources that I constructed to have these qualities.[26] The discussion is based on these constructed illustrative data. The top row shows annual revenue in dollars. The left column depicts the random revenue and the trend, while the right panel

depicts the cyclical revenue and the trend. The middle row shows the annual percentage change in each revenue source. The bottom row shows the percentage difference from the trend.

Figure 2 Illustration of random and cyclical revenue variation



Source: Illustrative data constructed by author, as described in the text

Both the random and cyclical revenue sources are volatile, but in different ways. How should policymakers think about these two kinds of revenue volatility?

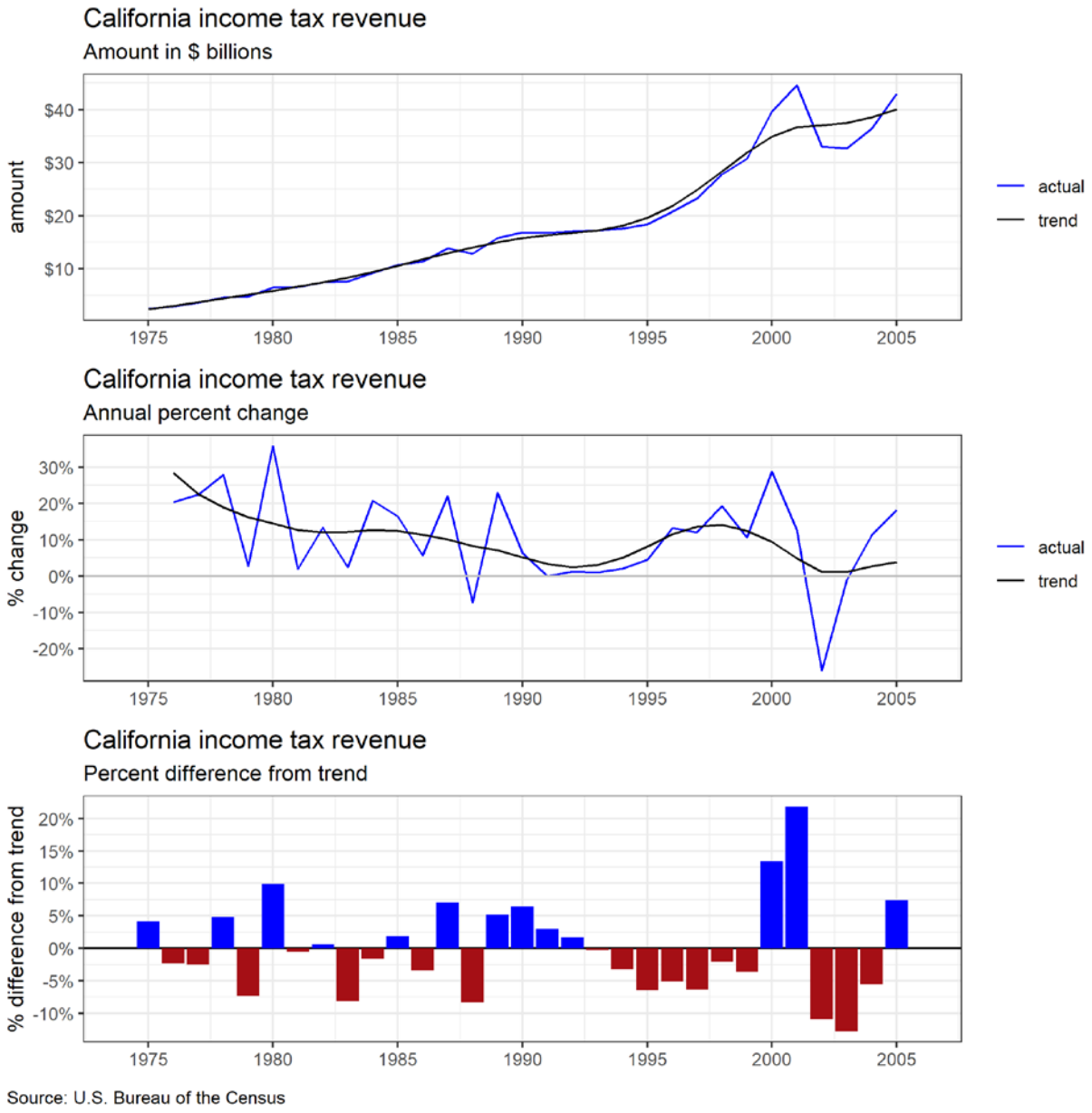
Judging by the percentage changes, the random revenue source appears far more difficult to predict. As constructed, its deviations from trend are slightly smaller on average than those of the cyclical source. However, unlike the cyclical source its year-to-year changes have no

discernible pattern and tend to be larger than those of the cyclical source. Its annual changes range from -23% to +27%, whereas the cyclical revenue changes range from about -3% to +10%, The cyclical changes appear more predictable because the magnitude of change often is similar to the prior year.[27] The random revenue might deliver some large intra-year budget surprises, but those large surprises are generally one-off events that do not persist for multiple years.

By contrast, judging by the percentage differences from trend, the cyclical revenue fluctuations could cause large multi-year budget difficulties. On three occasions, the revenue fell below trend for at least four years in a row, with a cumulative deviation in each case of about 25% to 30%. Policymakers might want a relatively large rainy day fund to help manage long periods of low revenue. Policymakers may also be concerned about revenue above trend. When revenues are above forecasts by large amounts or for many years, some policymakers may be concerned that taxes are too high and will call for tax cuts. This, in turn, could lead to budgets more in line with voters' wishes, or might lead to revenue shortfalls in the future.[28]

In practice, policymakers face both kinds of volatility. For example, Figure 3 shows the same three panels for the California income tax over 30 years from 1975 through 2005, along with a flexible trend that can vary over time.[29] In the first 15 years random fluctuations appear to dominate, while in the second 15 years cyclical fluctuations loom larger. While policymakers must contend with both kinds of volatility, the stylized examples above of pure random and pure cyclical variations help illustrate their different implications.

Figure 3 California income tax as example of cyclical and random fluctuation



Source: U.S. Bureau of the Census

Measuring volatility relative to the economy

Several researchers have analyzed tax revenue volatility relative to the volatility of a state's economy.

These papers generally use a method that is similar to comparing the annual percentage change in tax revenue to the annual percentage change in a broad-based measure of the state economy such as gross domestic product or personal income. Typically, these studies implement this by regressing the change in the logarithm of a tax base or tax revenue on the change in the logarithm of the economic measure.[30] In this standard formulation, the coefficient on the economic variable is the elasticity of the tax variable to the economic

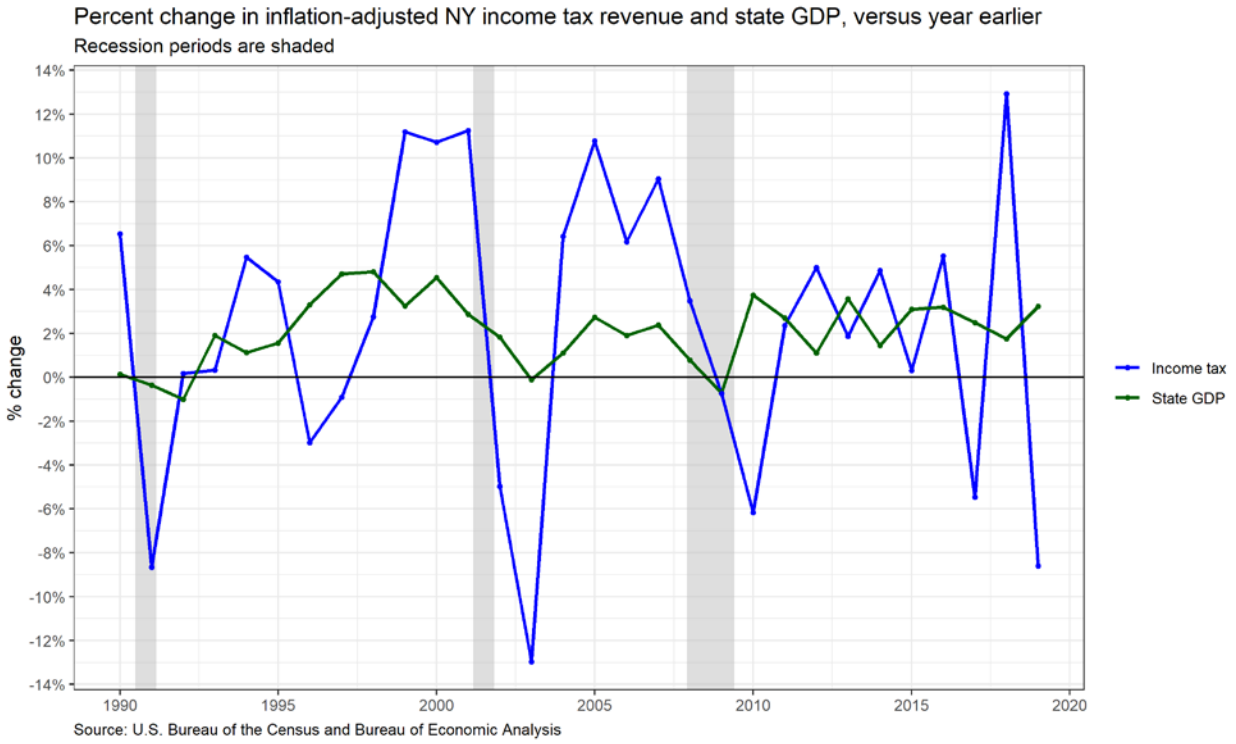
variable. When that elasticity is greater than one, the tax variable is more cyclical than the economic variable and when it is less than one the tax variable is less cyclical. In practice, if policymakers do not understand this measure properly, they can be misled in a situation where a tax has large total volatility even though its volatility does not coincide with economic volatility. Figure 4, discussed below, gives an example of this.

As discussed earlier, Sobel and Holcombe (1996) argue in favor of adjusting for economic variability, but they acknowledge that policymakers may be interested in separate measures of the random variation in tax revenue.[31] They point out that the standard error of the short run elasticity coefficient could serve as such a measure. The magnitude of the coefficient shows how much, on average, a tax will be affected by the economy, and its standard error shows how predictable this relationship is.

A look at the inflation-adjusted income tax in New York is a good example of these issues and why the short run elasticity measure must be interpreted cautiously. Figure 4 shows the annual percentage change in the inflation-adjusted New York income tax and in real state GDP over the last 30 state fiscal years, with national recession periods marked in grey. Clearly the tax is more volatile than the economy. There is some apparent relationship to the economy – for example, the tax slows and then declines sharply in and after the 2001 and 2007 recessions – but much of the tax variation appears unrelated to GDP. Although GDP is a broad measure of the economy, it clearly leaves out realized capital gains and other elements that are important to tax revenue. In addition, bonuses and other forms of variable compensation can be far more volatile than the economy, as discussed in Vasche and Williams (2005).

The short run elasticity for the New York income tax relative to GDP calculated with the regression described above is only 0.94, which suggests that on average, income tax variation is slightly less than corresponding economic variation. However, the standard error for this coefficient is 0.79, which is almost as large as the coefficient itself, meaning we can't be confident that this average relationship will hold in any given year. This suggests there may be a lot of annual variability in income tax revenue that is not related to economic variation. Unfortunately, the standard error does not provide information on the causes of this variation that is unrelated to economic variation.[32]

Figure 4 New York income tax revenue appears volatile relative to the economy



In any event, New York policymakers ought to be worried about such great volatility in their largest tax, even if a regression tells us that the volatility is not especially large relative to the state economy. Great volatility in the state's largest tax could lead to large forecast errors, possibly leading to unplanned cuts in services and tax increases.

In the analysis below, I primarily use a volatility measure based on the percentage deviation of state tax revenue from its long-term trend, but instead of using the standard deviation to summarize volatility over time periods, I use the interquartile range, based on convincing robustness arguments in Cornia and Nelson (2010).[33]

Lessons for planners and policymakers

What to control for

Analysts face important decisions about what to control for when analyzing volatility. For example, should they remove the impact of tax policy changes, inflation, and economic variability, and only focus on the portion of revenue volatility due to other factors?

Removing the impact of policy changes is right in concept. Policymakers are primarily interested in measures of their exposure to budgetary risk from outside forces, not from their own actions to change tax laws.

This is most appropriate for single-state studies conducted by in-state analysts if they have access to detailed high-quality policy-change estimates, but it will rarely be practical for multi-state studies. Why would policymakers who already understand volatility in their own state be

interested in multi-state studies, often conducted by academic researchers? Among other things, these studies can uncover how volatility differs when state tax structures, tax portfolios, and economic structures differ – issues that are not easy to get at in single-state studies. Thus, it is important to be able to address the issue of policy changes.

One alternative when high-quality adjustments for policy changes are not practical is to use economic data as proxies for tax bases. This will often understate revenue volatility because of differences between how tax bases and corresponding economic data are defined but is useful for understanding the relative volatility of different consumption components and different aspects of the economy. A third approach is to analyze unadjusted tax revenue data but summarize the data with robust measures not easily influenced by outliers.

Whether analysts should remove the impact of inflation depends on their purpose: do they care about total volatility, or just that which is unrelated to inflation? Most budget planners probably are concerned about total volatility and thus should not remove the impact of inflation. As a practical matter the choice has not made much difference for the past three decades when inflation was low and stable, but it could matter if inflation becomes resurgent.

Should analysts remove the impact of economic volatility? Doing so tells a state how much extra volatility they might expect, above and beyond that in the economy. This insight comes at the cost of not knowing how much volatility to expect in total. Because total volatility is what affects budgets, analysts need to understand the total. If resources permit, they should also analyze the extent to which volatility is greater or less than that in the economy under different conditions. Although policymakers cannot generally control the volatility of their economy, they can influence the extent to which their tax systems are more or less volatile than their economies, and they can design policies, such as reserve funds to help them manage the effects of volatility. This information can help policymakers make these choices.

How to measure annual volatility

Two main approaches to measuring volatility, for any single year, are calculating (1) how the level (i.e., amount) of revenue deviates from its longer-term trend, and (2) how the year over year growth rate in revenue differs from its longer-term growth-rate trend.

If deviations in revenue from trend are negative, large, and occur for several years in a row, that could cause significant fiscal stress. Thus, measuring sustained deviations from trend can be helpful in deciding on the appropriate size of reserve funds.

If year over year growth varies significantly from longer term trends in growth rates, this can indicate that revenue is particularly difficult to forecast. Although state revenue forecasters generally use more sophisticated methods than trend forecasts of growth, large and frequent deviations from trend growth suggest that a tax is difficult to forecast. This measure could be helpful in identifying risks of intra-year budget shortfalls.

In practice, the deviation-from-trend and year-over-year-growth methods usually yield similar conclusions. Still, because they differ in concept analysts should think carefully about their purpose. If they are primarily interested in whether they might face revenue significantly below trend, they probably should use a deviation-from-trend approach. If they are primarily interested in annual budget volatility, they probably should use a volatility-of-growth measure.

How to summarize measures

To compare volatility across tax types, time periods, or states, analysts need to summarize their volatility measures. One common measure is the standard deviation of annual variations, but it is sensitive to outliers. Because tax revenue data are noisy, robust measures less influenced by outliers may be more appropriate, such as the interquartile range of the annual variations.

How this report measures and displays volatility

Summary

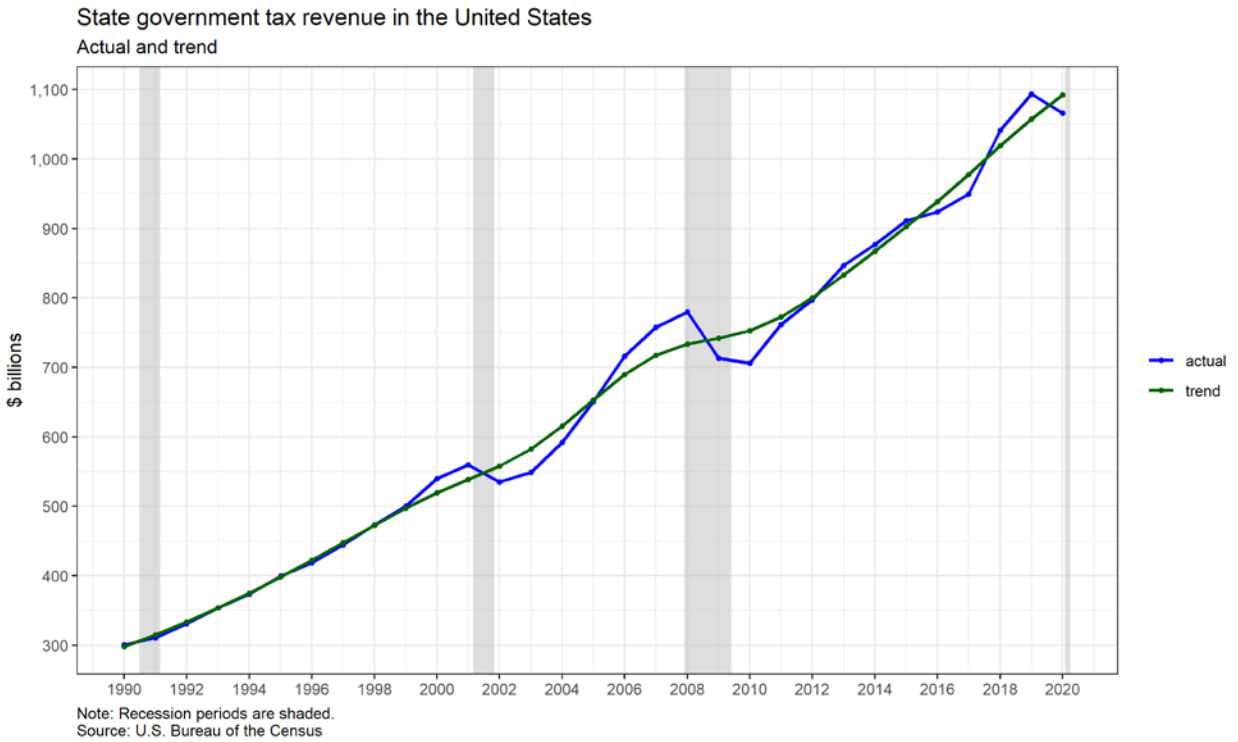
In this report I measure annual tax revenue volatility by calculating the percentage deviation of nominal state government tax revenue from its long-run trend. I use tax revenue data from the United States Census Bureau, Annual Survey of State Government Tax Collections, unadjusted for policy changes. I construct the trend using a Hodrick-Prescott filter. I summarize volatility for a tax type, time period, or state using the interquartile range of percentage deviations. I use these measures for reasons given in the body of the report, but believe that for most purposes, simpler measures will lead to very similar conclusions. In some sections, I compare results to other measures.

Details

A tax or economic variable that has large or frequent deviations from its trend is more volatile than one that does not. This measure is helpful in understanding whether budget planners might face periods of below or above-trend revenue, which could lead to the need for sustained budget cuts or large reserve funds. Each variable is measured annually, in nominal terms (not adjusted for inflation).

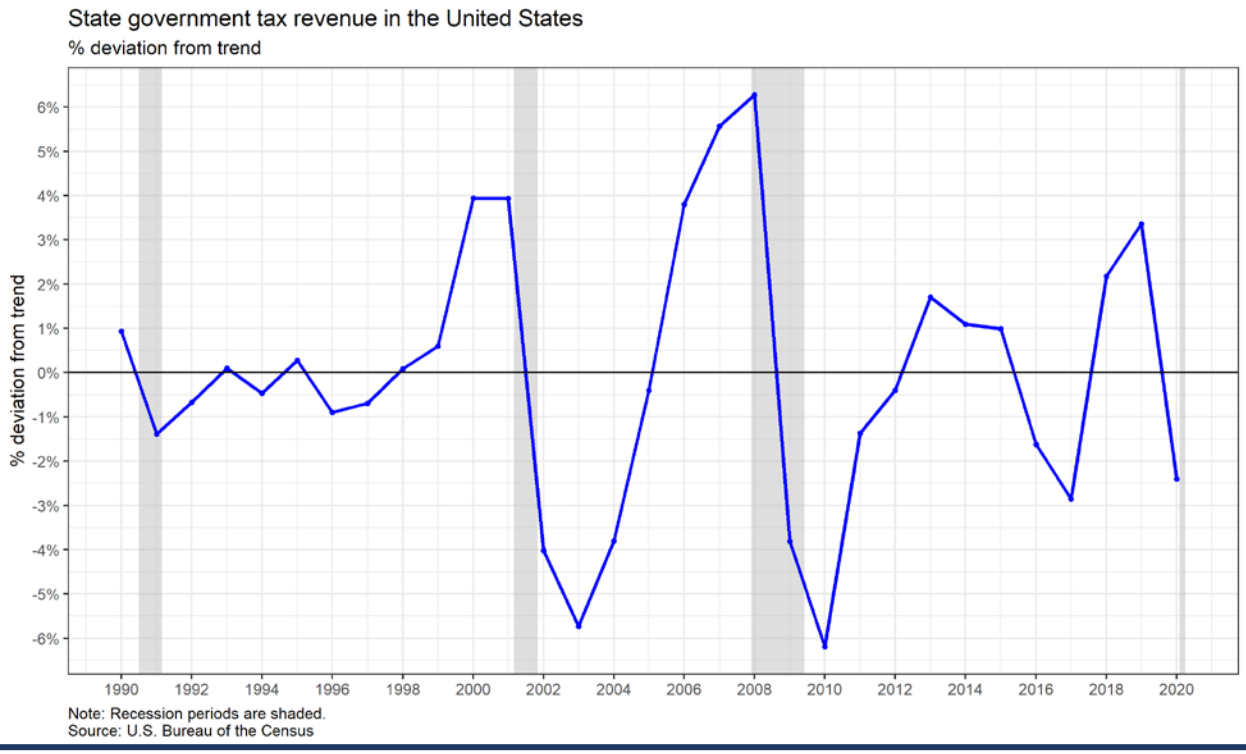
For each variable of interest, the first step is to calculate a smooth trend that runs through the data, changing slowly over time to reflect long-run changes. Figure 5 shows this for the 1990-2020 subperiod of the tax data underlying Figure 1. I show only the three most recent decades, to keep this figure and the next two figures easy to read. For the United States as a whole, state government tax revenue was not far from its trend in the period surrounding the 1990 recession, above trend before the 2001 recession, below trend shortly afterward, again above trend before the 2007 Great Recession, and well below trend in and shortly after the recession.

Figure 5 State government tax revenue, actual and trend



The second step is to calculate the percentage deviation from trend, shown in Figure 6. The difference between the 1990 recession and the two later recessions is stark.

Figure 6 State government tax revenue percentage deviation from trend



Finally, if we want to compare volatility across different tax types, time periods, states, taxes, or variables, it is useful to have a summary measure of percentage deviations from trend. The tax data are subject to measurement error, administrative adjustments, legislative changes, and other features that make them imperfect measures, so we want a summary measure that is not unduly influenced by a single bad number – for example, a mismeasured value or large change in tax revenue resulting from administrative factors – but rather captures broad patterns.[34]

I summarize volatility with a robust but simple measure known as the interquartile range, calculated as follows:

- Order the percentage-deviations-from-trend from smallest to largest (rather than by year). In the figure above, the smallest percentage deviation is minus 6.2%, in 2010, and the largest is 6.3%, in 2008.
- Determine the 25th and 75th percentiles (also known as the lower and upper quartile)– the point below which the 25% lowest observations fall and above which the 25% highest observations are found. While not easy to tell from looking at the figure above, these points are minus 1.5% and plus 1.4% respectively. In other words, one quarter of the percentage-deviations-from-trend are below minus 1.5%, one quarter are above plus 1.4%, and the remaining 50% fall between these two points.
- The range between the lower quartile and the upper quartile is an indication of how much volatility we have. If that range is large – for example, if 25% of our observations are far below trend and 25% are far above trend, then we have a lot of volatility. If the range is narrow, we have less volatility.
- The range between the lower and upper quartiles is called the *interquartile range*. In the figure above, this range is 2.9 percentage points (running from minus 1.5% to plus 1.4%).

Once we calculate the interquartile range of the percentage deviation from trend, we can compare this measure across tax types, states, time periods, or variables. Figure 7 shows the percentage deviations from trend over 1990-2020 for state government taxes and for GDP, using the data underlying Figure 1. The horizontal axis measures the percentage deviation from trend. The figure has two parts: the top shows percentage deviations for taxes and the bottom shows the deviations for GDP.

Each part has a box that ranges from the lower quartile to the upper quartile – for example, the box for taxes ranges from minus 1.5% to plus 1.4% – an interquartile range of 2.9 percentage points. The box for GDP is much narrower, ranging from minus 0.7% to plus 0.6%, or 1.3 percentage points.[35]

Thus, state taxes have been far more volatile than GDP over the 1990-2020 time period, telling a story with this summary data that is consistent with what we can see from the individual data points in Figure 1.[36]

Figure 7 State tax revenue was more volatile than GDP over 1990-2020

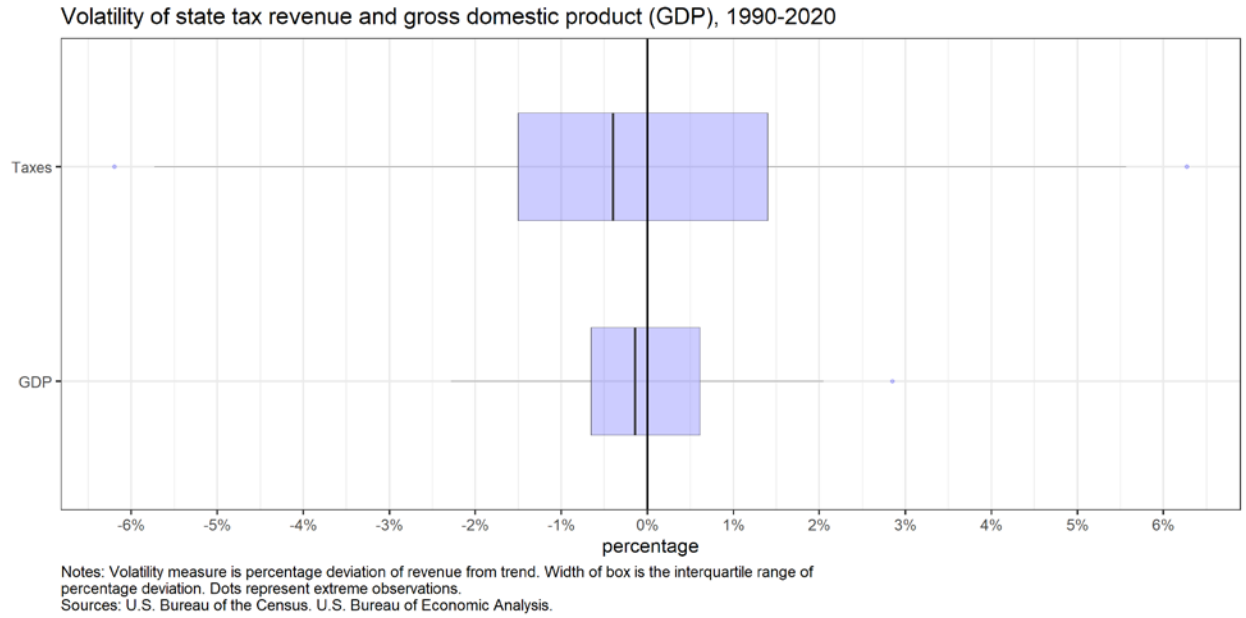


Figure 7 provides additional useful information about volatility. Each box has "whiskers" – lines that extend to the right and the left. Each line is up to 1.5 times the width of the box (shorter if none of the percentage deviations are that large or small). In addition, any extreme points beyond these whiskers are shown individually: the largest and smallest tax deviations (minus 6.2% and plus 6.3%) are shown, as is the largest GDP deviation (plus 2.8%).

How does volatility vary by type of tax?

Understanding volatility of individual taxes and what makes them more or less volatile is key to understanding how volatility has changed over time and how volatility varies across states. For a primer on the volatility measure used in this section and later sections, see "How this report measures and displays volatility."

What do we know from research?

Researchers have examined volatility by tax type extensively. The literature is succinctly summarized by Kwak[37]:

> "Overall, the findings of previous studies can be summed up thus: (1) income taxes are more volatile than sales taxes; (2) corporate income taxes are the most volatile, whereas tax revenues from sales of motor fuel, nondurable goods, and services are relatively stable over the business cycle; (3) revenue diversification contributes to revenue stability; (4) and at the local level, property taxes are more stable than sales taxes."

While there is broad agreement with this general statement, volatility of individual taxes depends on their structure and economic conditions, both of which can vary over time and

across place. Depending on the period examined, some studies have found the income tax more volatile than the sales tax, and some have found the opposite.[38]

Cornia and Nelson examined nine tax types, plus total tax revenue, over the 20 years from 1989 through 2009. They examined year-over-year percentage change in nominal quarterly state and local government tax revenue, without adjustment for policy changes.[39] They measured volatility by the interquartile of range of these growth rates. The corporate income tax was the most volatile individual tax, while selective sales taxes such as alcoholic beverage, motor fuels, and motor vehicle licenses, were least volatile. They noted that tobacco taxes were more volatile because of legislated tax changes that caused episodic sharp rises in revenue, highlighting one of the dangers of interpreting data that are not adjusted for policy changes.

Seegert (2015) examined volatility in the context of the tradeoff between revenue growth and volatility, focusing on how different tax system characteristics affect this tradeoff.[40] Among other things, he found that characteristics such as whether a state taxes groceries under the sales tax, and how progressive a state's income tax is, affect this tradeoff. Seegert concluded that aggregate tax revenue volatility increased dramatically in the 2000s as increased demand for tax revenues led states to hold riskier portfolios – often relying on more-volatile income taxes but in some cases, in his view, relying too heavily on sales taxes. Some states that did not have income taxes experienced increased volatility due to higher sales taxes.

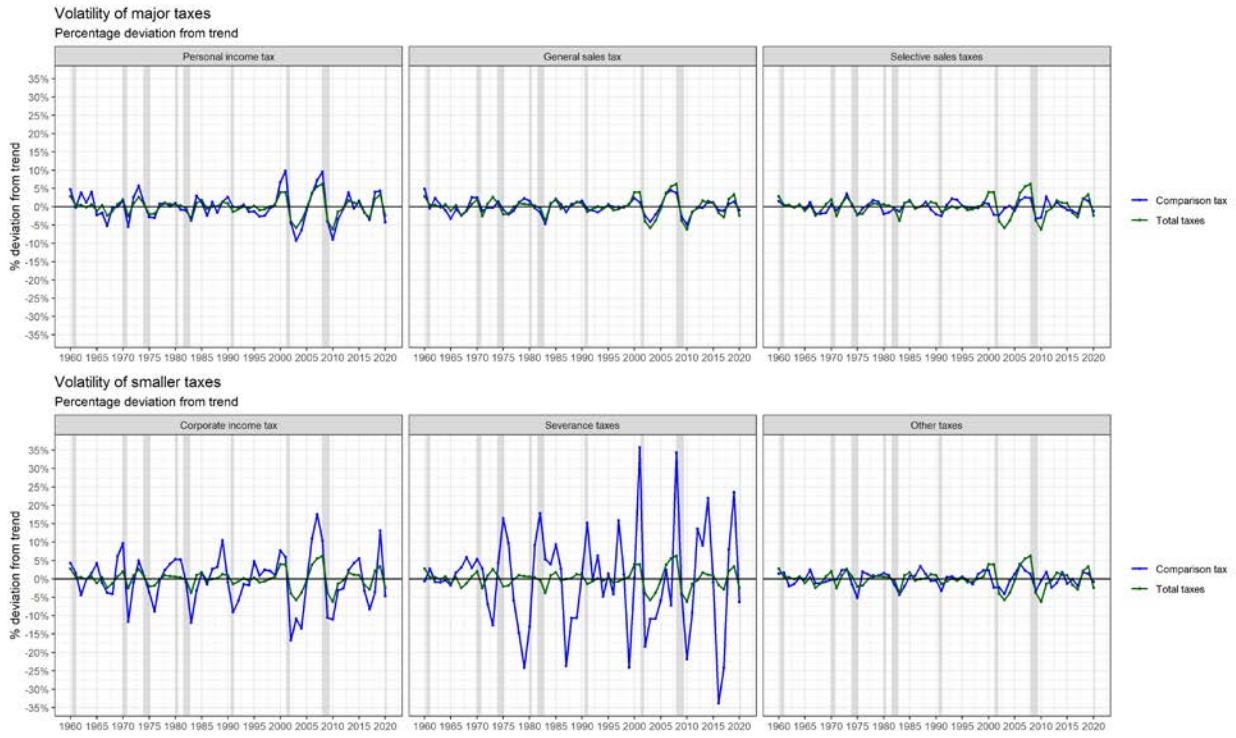
Based on examination of short-run elasticities of tax revenue growth to economic conditions as measured by growth in state coincident economic indexes, Mattoon and McGranahan (2012) concluded that "Corporate income tax revenue is the most cyclically sensitive revenue source, followed by personal income tax revenues, and sales tax revenues. Other tax revenues are the least responsive to economic conditions."[41]

Analysis and illustrations

Figure 8 and Figure 9 illustrate several conclusions from research.

Figure 8 shows the annual percentage deviation from trend over the last six decades for the U.S. as a whole for six tax categories, each compared to the deviation for total taxes. Three major tax categories are in the top panel and three smaller categories are in the bottom panel. The figure shows how much each tax deviates from its own trend, relative to total taxes, but does not take into consideration the tax's relative size. A tax can be highly volatile, but that volatility might not be of budgetary importance if the tax is small.

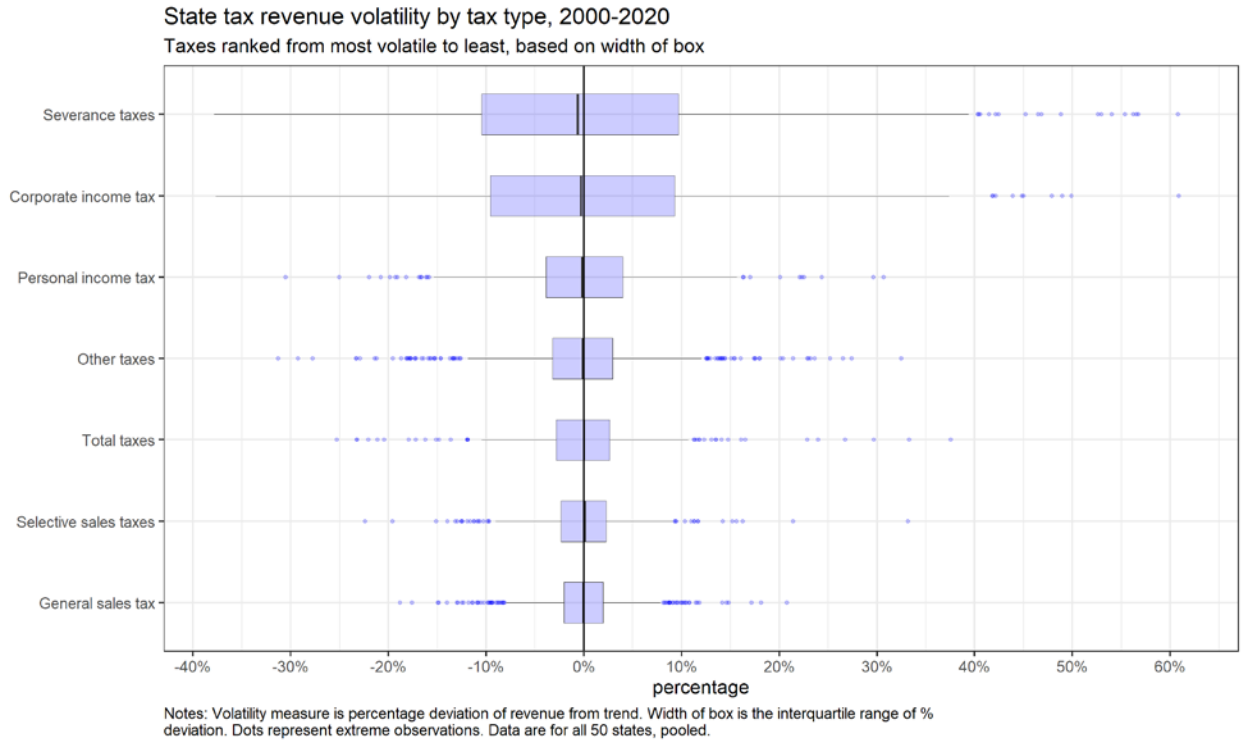
Figure 8 Personal Income tax appears to be the most-volatile large tax, while severance and corporate income taxes have been the most volatile of the smaller taxes



Severance taxes clearly are the most volatile, followed by corporate income taxes. This appears to be true for virtually all of the period shown. These taxes are of minor importance in most states. Income taxes appear to be the most volatile tax that states rely on heavily, followed by the general sales tax. Both were significantly more volatile near the 2001 and 2007 recessions. Selective sales taxes were more volatile then, too. Selective sales taxes often are imposed on the quantity of goods sold rather than value (for example, cigarette taxes commonly are imposed per pack rather than on the price of cigarettes), and associated tax revenue does not keep up with growth in prices. Legislatures often go for long periods without raising rates of these taxes, and then episodically raise rates substantially, resulting in increased volatility by some measures. Cornia and Nelson (2010) noted that much of the volatility in tobacco taxes may result from sporadic increases by legislatures, rather than from the underlying economic forces or from tax structure. They also noted sporadic increases in motor vehicle licenses.[42]

Figure 9 zooms in on the 2000-2020 period, showing boxplots of percent deviation from trend in nominal annual state government tax revenue using data for all 50 states. As discussed in the section on "How this report measures and displays volatility," the width of the box is a robust measure of volatility. The figure is truncated to the left and right so that the whiskers are shown, but some taxes – particularly severance taxes – have outlier observations that are outside the bounds of the figure. The boxes are sorted top to bottom from widest (most volatile tax) to narrowest.

Figure 9 Percent deviation from trend for major tax types



It would be wrong to conclude from this figure that "the income tax is *always* more volatile than the sales tax," or "selective sales taxes are *always* more volatile than the general sales tax." The proper conclusion is that these things are true for this time period, examining all states together, with this measure, using these data. It's a useful generalization, not a rule, but as shown in the section on how tax revenue volatility has varied over time, this has been true for much of the past 60 years.

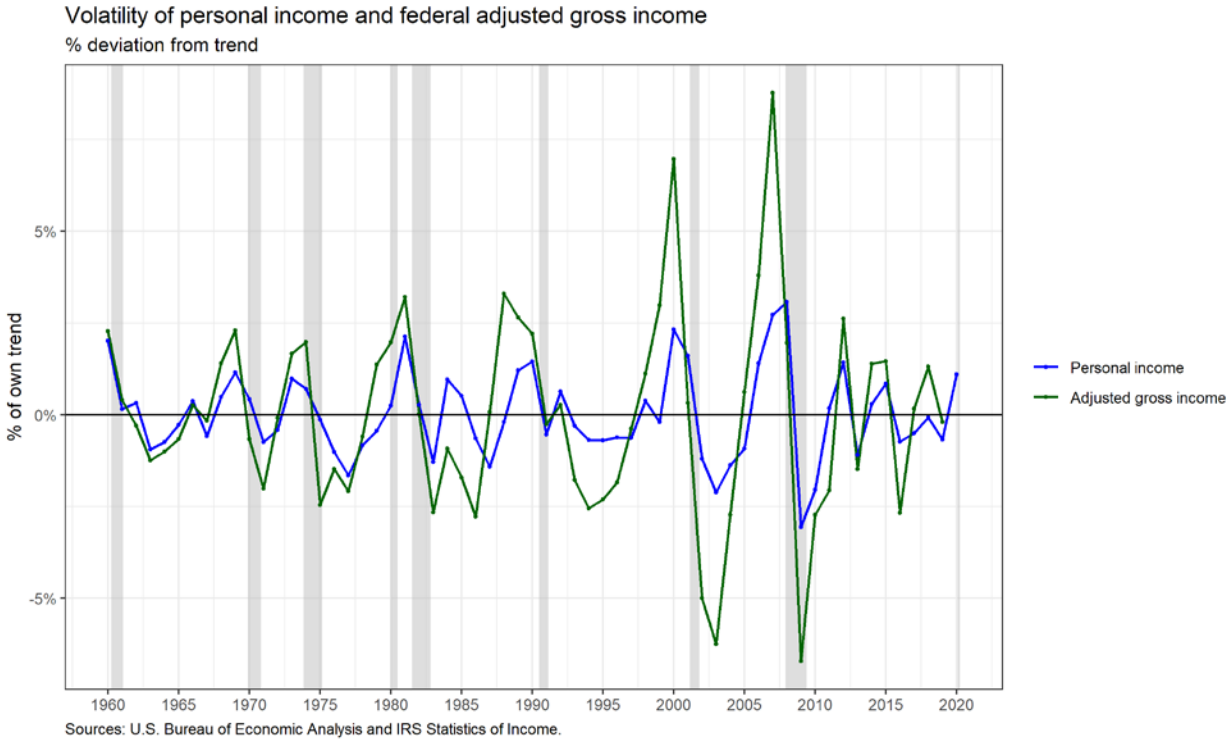
It is interesting for future research to consider why this has generally been true. Hypotheses might include one or more of the following:[43]

- Perhaps equity and enforcement concerns have led to greater use of income taxes relative to sales taxes, leading in turn to relatively higher income tax rates and more volatility.
- States may have increased reliance on income taxes in an effort to make taxes more progressive, through implementation of progressive income tax rate structures. These rate structures may lead to greater volatility.
- States may have chosen tax-base features such as income taxation of capital gains, possibly for equity reasons, which have the side effect of making the income tax relatively more volatile than the sales tax; States may have chosen progressive rate structures that make the income tax more volatile because certain volatile income sources such as capital gains and bonuses tend to be concentrated among high-income taxpayers subject to the highest rates.

Personal income tax

The personal income tax is not a tax on personal income, as measured by the United States Bureau of Economic Analysis. Rather, it is a tax on selected kinds of income and cash flow, measured in specific ways for tax purposes. These differences between personal income and taxable income mean that to analyze the volatility of the personal income tax we need to examine the sources of income subject to that tax, and how these sources of income are taxed. Figure 10 shows that adjusted gross income has been much more volatile than personal income, as measured by the percentage deviation from trend.

Figure 10 Adjusted gross income is far more volatile than personal income



Many researchers and analysts have emphasized the importance of volatility in underlying sources of income, particularly non-wage income. Dauchy and Balding (2013) examined the increase in federal income tax volatility after 2000. This is relevant to our analysis of states because state income taxes rely heavily on federal definitions. They attributed much of this increase to higher volatility of capital income and increased reliance on high-income taxpayers, for whom capital income is particularly important.[44] Because this was a study of the federal income tax, it does not provide information on the role of state tax policies. Vasche and Williams (2005) noted the large role of capital gains and stock options in the California income tax. This is important in some other states as well. While not a perfect indicator, it is also likely to be particularly important in Colorado, Connecticut, Massachusetts, and New York, all of

which, like California, have relatively high capital gains as a share of adjusted gross income (AGI), and high effective tax rates on capital gains.[45]

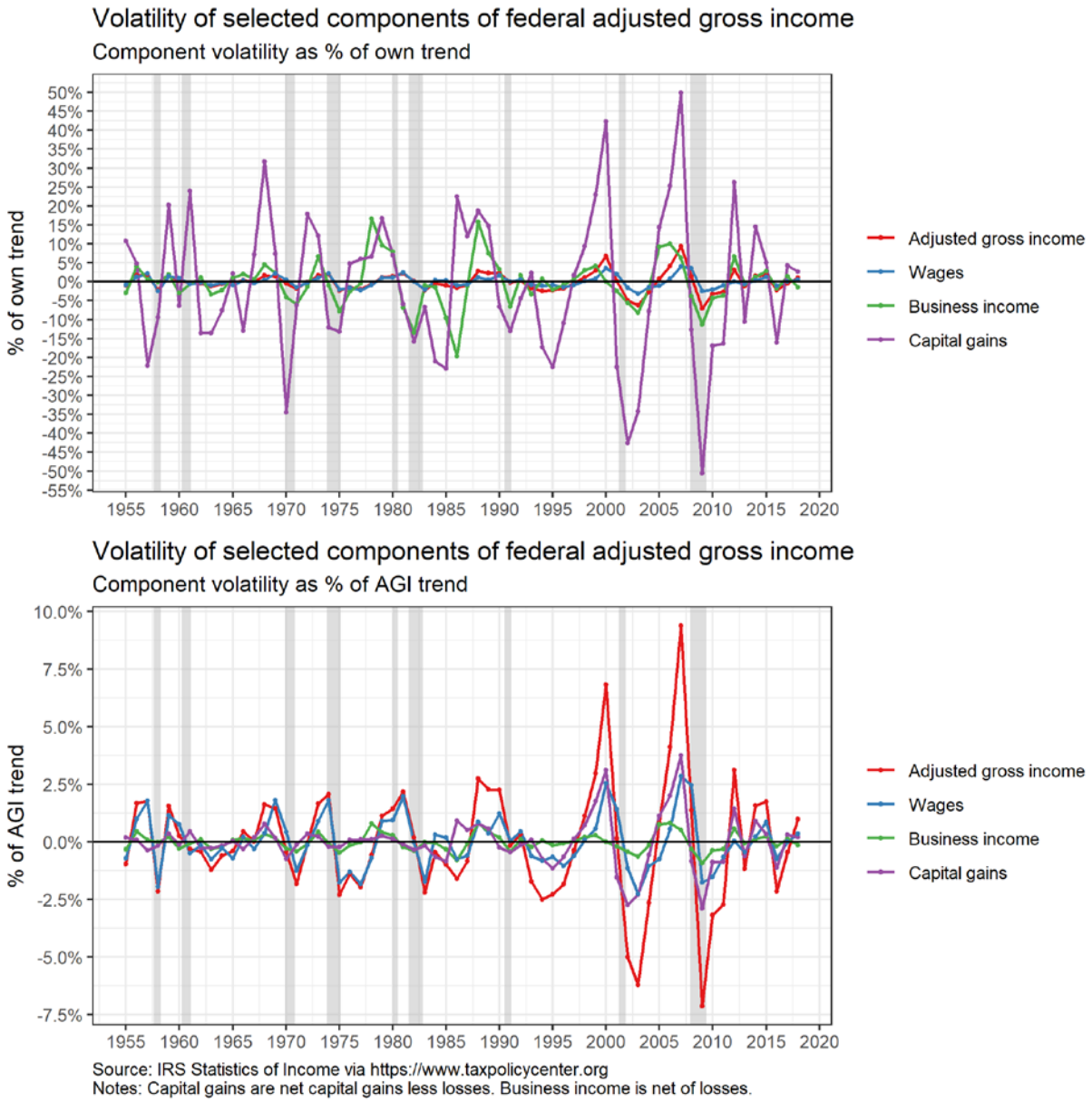
Sjoquist and Wallace (2003) examined the potential impact of capital gains on state income taxes over 1989 through 2000 and concluded that the underlying relationship between capital gains and state income taxes had not changed, but that gains had become larger and therefore more important to state income taxes.[46] Mattoon and McGranahan (2012) concluded that "increasing income cyclicality, in particular of capital gains, have made state revenues more responsive to the business cycle since the mid-1990s."[47]

While the above studies found that capital gains are important factors in state tax revenue volatility, Seegert (2015) focusing on shocks to revenues, found that changes in the tax base due to changes in capital gains had only small effects on tax revenue volatility.[48] These differences across studies are not yet resolved.

Major income components subject to income tax

Some elements of the income tax base are extraordinarily volatile. Figure 11 gives two perspectives on the volatility of adjusted gross income and three important components: wages, business income, and capital gains.[49] The top panel shows the percentage deviation from trend for each component – the measure generally used throughout this report. This shows whether volatility is large or small relative to the size of an income component. However, an income component could be highly volatile, but small enough that the volatility was not of budgetary concern. Thus, the bottom panel shows each income component's volatility as a percentage of adjusted gross income.

Figure 11 Volatility of selected major components of adjusted gross income



The top panel shows that capital gains have been dramatically more volatile than other income components, particularly near the 2001 and 2007 recessions. Business income has been more volatile than wages, but less so than capital gains. Wages and capital gains were far more volatile in the decade of the 2000s than in other decades; business income was more volatile in the 2000s than in all decades other than the 1980s.[50]

But what if capital gains are highly volatile but too small to be important? Capital gains were only 3.1% of adjusted gross income on average for the entire period shown, and only 6.8% for 2000 and later (measured as the median of annual percentages). The bottom panel addresses this. It shows each income component's deviation from trend as a percentage of the AGI trend.

In most of the years in which AGI deviations were large, capital gains were a large part of that deviation.

A closer look at capital gains and adjusted gross income

It is worth taking a closer look at capital gains from stocks, real estate, and other assets because they play an extremely important role in income tax revenue volatility in some states.

Table 1 breaks Figure 11 down for 2009, the year with the largest negative deviation of adjusted gross income from its trend during the 1955-2020 period shown in the figure.[51] The table shows the underlying data and adds a row for "other" adjusted gross income. The first numeric column is actual revenue, the second is trend revenue, and the third is deviation from trend. Adjusted gross income was $584 billion below its trend, and capital gains were $237 billion below their trend.

The next two columns show these deviations as a percentage of the income component's own trend and as a percentage of the AGI trend. The former is plotted in the top panel of Figure 11 and the latter is in the bottom panel. Adjusted gross income was 7.1% below its trend, and capital gains were 50.6% below their trend. Capital gains volatility was enormous relative to its own history, but was it large relative to overall income subject to tax? The percent-of-AGI-trend column answers that: the capital gains deviation was 2.9% of the AGI trend – larger, relative to adjusted gross income, than the deviation in wages, business income, or other income.

Table 1 Adjusted gross income in 2009

Adjusted gross income in 2009							
	Amount in $ billions			Deviation from own trend as % of:		Trend as %	Deviation as %
Income component	Actual	Trend	Deviation from trend	own trend	AGI trend	of AGI trend	of AGI deviation
Adjusted gross income	$7,626	$8,210	−$584	−7.1%	−7.1%	100.0%	100.0%
Wages	5,707	5,852	−145	−2.5%	−1.8%	71.3%	24.8%
Business income	590	665	−75	−11.3%	−0.9%	8.1%	12.9%
Capital gains	232	468	−237	−50.6%	−2.9%	5.7%	40.6%
Other	1,098	1,225	−127	−10.4%	−1.5%	14.9%	21.8%

The final two columns provide additional perspective. The first of the two, "Trend as % of AGI trend" is a measure of how large each component is relative to adjusted gross income after filtering out cyclical variation – wages were 71.3% of adjusted gross income, and capital gains were only 5.7%. But that 5.7% was powerful: the final column shows that the deviation of capital gains from its trend accounted for 40.6% of the total deviation of adjusted gross income from its trend – more than the deviation in wages accounted for, or business income, or other income components.

Capital gains and state income taxes

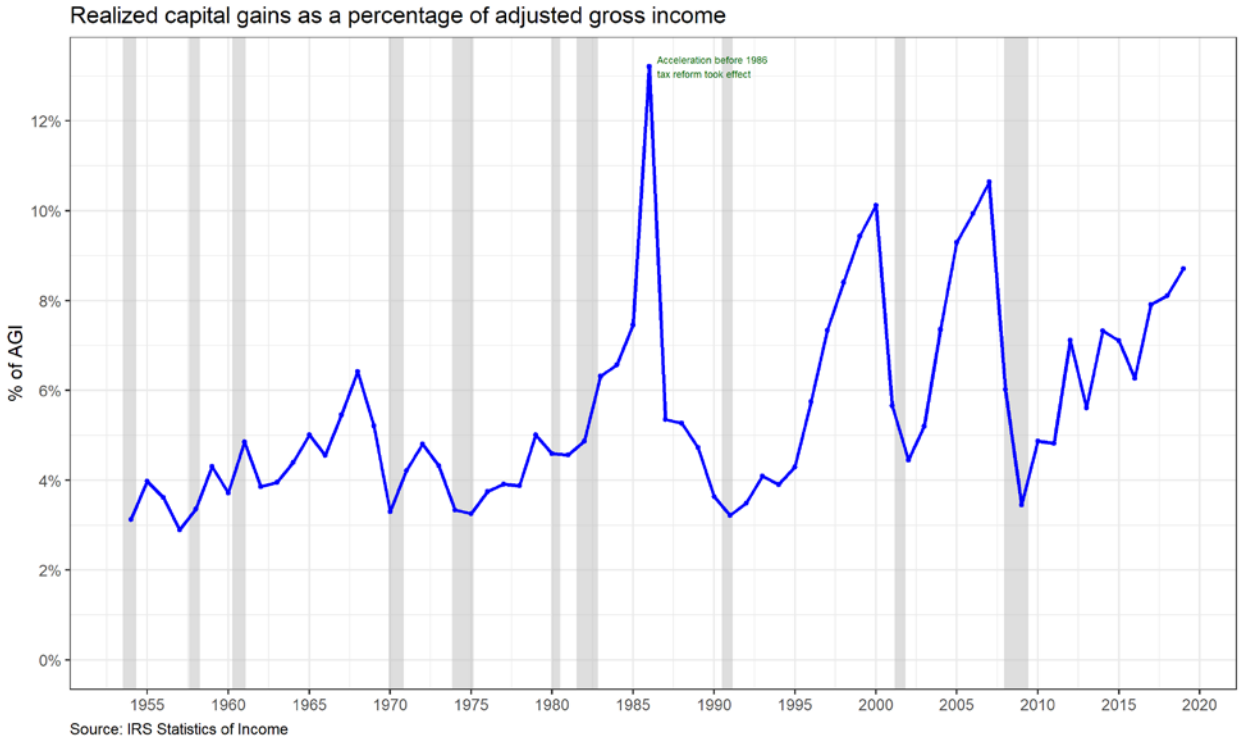
Most states with income taxes base their income treatment of capital gains on the federal treatment.[52] Capital gains are taxed on realization. This means, for example, that the gain on a stock is taxed when it is sold. If an individual holds a stock for 10 years and it increases in value each year, that person is wealthier each year but those additions to wealth, often thought of as income, are not taxed until the sale.

Selling stocks, real estate, or other assets is a decision about how to structure assets: often it involves an exchange of stock shares for cash. Many factors enter into that decision. For example, it might reflect an individual's desire for cash to help pay for a house or other needs. The decision reflects perceived current and future investment opportunities and may consider brokerage fees and other transaction costs. It also reflects tax factors such as current federal and state income tax rates and expected future rates.

In addition, capital gains from stocks and other assets reflect asset values determined in financial markets that are quite volatile. Decisions about whether to realize gains can be quick and sharp in response to changes in stock markets and expected tax law changes. Furthermore, relatively few individuals drive these decisions. In 2019, 65% of net capital gains in the United States were received by 378,000 taxpayers with adjusted gross incomes of $1 million or more, or about 0.2% of all federal income tax filers.[53]

Figure 12 shows realized net capital gains as a percentage of adjusted gross income for 65 years.[54][55] There is a clear increase in volatility after 1985. The federal Tax Reform Act of 1986, a sweeping reform enacted under President Reagan, increased the effective federal income tax rate on capital gains. Because this change was known in advance of its effective date, taxpayers had an opportunity to accelerate gains into 1986 that otherwise would have been realized and taxed in later years and would have been newly taxed at higher effective rates. This is the primary cause of the spike in 1986 and the subsequent trough.[56] There were several other notable periods of rising capital gains followed by declines. In the late 1990s capital gains rose rapidly during the dot-com boom then fell at the start of the 2001 recession. Gains rose again in the late 2000s' real estate and stock market booms that preceded the Great Recession, after which they again plummeted. Capital gains rose in 2012 and fell in 2013 in response to anticipated and enacted changes in tax rates.

Figure 12 Capital gains became more volatile in and after 1986



Because gains are so heavily concentrated among very high-income taxpayers, they generally are subject to the highest federal and state income tax rates except where granted special preferences.[57] High effective rates, increased volatility, and an increased share of adjusted gross income means that capital gains variation have big impacts on state income taxes. Furthermore, realized capital gains are not included in official economic measures such as personal income. As a result, swings in capital gains can cause income tax variations that would not be expected based solely on traditional economic data. State revenue forecasters generally appear to understand this and build forecasting models that consider these issues.

Highly concentrated income combined with progressivity can make a tax more volatile. In New York, which has a combination of high capital gains and progressive tax rates, the state comptroller recently noted, "The top 1% of taxpayers pay an average of 40% of New York's personal income tax liability; since high earners rely more extensively on capital gains, the change [a tax increase on high-income taxpayers] could make state revenues more volatile." (Phrase in brackets added)[58][59]

General sales tax

Seegert (2015) notes that "Theory predicts that states that exempt goods with low-income elasticities, such as groceries and clothing, will have to accept more volatility for a given increase in revenues."[60] Theory also predicts that if states exempt high-income-elasticity goods such as soda, they are likely to be able to collect more revenue for given level of volatility.

Fox and Campbell (1984) estimate the sales tax elasticity for 10 disaggregated taxable sales categories and find the elasticities vary by sales category, have a weighted long-term average of 0.59, and are widely variable on an annual basis.[61] They note that "Hawaii's tax base was 92.6% of GSP in 2000 while Rhode Island's base was only 27.5% of GSP in the same year."[62] [63]

We can gain insight into how different items subject to tax may affect sales tax volatility by examining the volatility of major consumption components.[64] Figure 13 shows the percentage deviation of consumption components from their longer term trends consumption of durable goods, nondurable goods, and services. It also shows this deviation for general sales tax revenue. The figure suggests that the general sales tax is less volatile than consumption of durable goods and considerably more volatile than consumption of services.

Figure 13 The general sales tax is less volatile than consumption of durable goods, but far more volatile than consumption of services

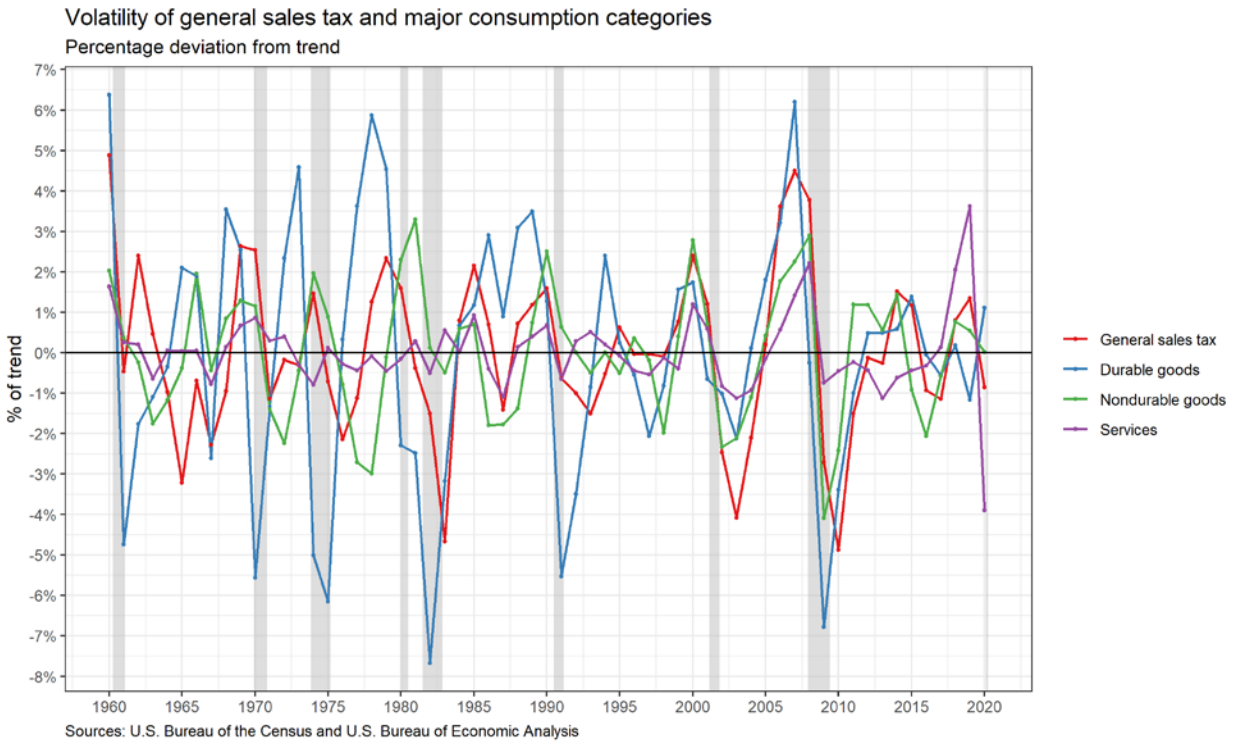


Table 2 shows the main volatility measure used in this report (the interquartile range of the percentage deviation from trend) for selected major consumption items. Personal consumption of motor vehicles and parts – a major component of durable goods – is the most volatile, followed by durable goods in general. The volatility of the general sales tax for the United States as a whole is included next, followed by selected major consumption items other than durable goods. The sales tax is more volatile than all of these other consumption items. Services are least volatile; they are taxed relatively infrequently by states.

Table 2 Personal consumption expenditures on motor vehicles and parts are highly volatile, while consumption expenditures on services are stable

Volatility of selected major components of consumption, 1970-2020		
Consumption component	Volatility[1]	Component as % of consumption[2]
Motor vehicles and parts	4.4%	3.9%
Durable goods	3.4%	11.5%
General sales tax	2.4%	—
Nondurable goods	2.1%	21.6%
Food and beverages purchased for off-premises consumption	2.0%	8.2%
Personal consumption expenditures (total)	0.9%	100.0%
Household consumption expenditures (for services)	0.9%	63.2%
Services	0.9%	66.9%

[1] Interquartile range of percentage deviation from trend.

[2] Consumption components are not mutually exclusive; percentage shares sum to more than 100%.

Sources: U.S. Bureau of the Census and U.S. Bureau of Economic Analysis

Lessons for planners and policymakers

One type of tax is not inherently more volatile than another type. A tax source's volatility depends on its base, its tax rate structure, and underlying economic conditions. Researchers and analysts have identified several key features that can make revenues more volatile.

Progressivity can make taxes more volatile for two reasons. First, it amplifies the impact of changes in the tax base so that a given percentage increase in the base will result in a larger percentage increase in tax revenue.

Second, it can cause the tax to be highly reliant on a narrow group of taxpayers. A state with a progressive income tax may rely disproportionately on income and decisions of a small group of very high-income taxpayers. This can increase volatility because high-income taxpayers have significant opportunities to shift the timing and types of income and expenses. They can choose whether to take deferred compensation, to delay realization of capital gains, or to accelerate deductible expenses into years in which they will face high-tax rates. Taxpayers with only wage

income don't have these opportunities, so their actions don't create volatility. Relying heavily on small groups of high-income taxpayers can increase the risk of large forecast errors because the behavior of these taxpayers can be hard to predict. Policy changes that affect these taxpayers may lead them to alter their behavior, and little research or data may be available to help predict these changes.[65] (Kalambokidis 2022)

Stability is one important goal of tax policy. There are trade-offs between stability and other common tax policy goals.

Relying on more volatile elements of the economy, such as durable goods, capital gains, and natural resources can lead to higher tax revenue volatility. This is one of the reasons that economists often recommend broad bases and low rates.

Most states rely heavily on the income tax, or the sales tax, or a combination of the two. The income tax, which accounted for 36% of state tax revenue in the United States in 2020 according to data from the United States Census Bureau, has been the most volatile large tax. In most economic environments the income tax has been more volatile than the general sales tax, which is the second-largest state tax revenue source and accounted for 32% of overall state tax revenue.

Selective sales taxes, which accounted for 16% of overall state tax revenue according to data from the United States Census Bureau, generally are relatively stable. Some of their volatility is attributable to large but infrequent rate changes.

Corporate income tax is the most volatile revenue source relied upon by large numbers of states. Over the past two decades it has been more than twice as volatile as the personal income tax. While 45 states have a corporate income tax, only three rely on it for more than 10% of their tax revenue, according to data from the United States Census Bureau. For the United States as a whole, it accounts for just under 5% of state tax revenue. Despite its relatively small size, the corporate income tax can take on outsize political importance. In 2021 43 states under-forecast the corporate income tax, with an average under-forecast of 37.9%.[66] One state revenue forecaster noted that legislators may see under-forecasts as an indication that forecasters are deliberately under-estimating the revenue, or as an indication that the state is over-taxing businesses.

Severance taxes, which rely on a volatile and relatively narrow slice of economic activity, have been the most volatile tax revenue source. These taxes are important in a few states but account for only 1% of state tax revenue in the United States as a whole according to data from the United States Census Bureau.

How has tax revenue volatility varied over time?

What do we know from research?

State tax revenue volatility increased dramatically in recent decades, a phenomenon discussed by many analysts and researchers.

Vasche and Williams (2005) analyzed volatility in California from 1980 through 2004, examining the 1980-1991 and 1992-2004 periods separately. They concluded that volatility increased markedly after 1990, driven primarily by an increase in income tax volatility. Total income tax volatility, measured by the standard deviation of the percentage change in revenue, and volatility relative to the economy, measured by the short-run elasticity, both increased. The most important factor was the "extraordinary boom and bust in stock-market-related revenues from stock options and capital gains." (Realized capital gains are not included in standard measures of the economy, so when they surge or plummet, tax revenue that depends upon these sources may rise or fall in ways not indicated by traditional economic data.) Revenue from these sources increased eight-fold between 1996 and 2001, then fell about 70% by 2003.

Mattoon and McGranahan (2012) examined quarterly state tax revenue for all states, from 1980 through 2011, to examine the extent to which declines in state taxes after the 2001 recession were related to changes in policymaking, increased reliance on capital gains, and changes in the tax base outside of capital gains.[67] They analyzed changes in the short-run elasticity of taxes and found a sharp increase beginning in 2000 in tax revenue volatility relative to the economy. The increase was especially large for individual and corporate income taxes. They focused on the reasons for individual income taxes because it is much larger than the corporate income tax. They concluded that the increase in income tax cyclicality relative to the economy reflected (a) a more cyclical tax (primarily capital income) and (b) policy choices that were less countercyclical than in the past (states choosing not to raise tax rates, or even lowering them, in the face of recession). They estimated that about 69% of the change in cyclicality was due to tax base changes and 31% due to changes in tax-rate policy.

Dauchy and Balding (2013) examined the increase in federal income tax volatility over the two decades before their paper. Because state income taxes generally follow the same structure as the federal income tax, their work is relevant to states. They examined income tax data from 1966 through 2006 and noted a marked increase in volatility in 2000-2006 relative to earlier years in the period. They regressed the percentage change in income tax liability by quintile on the percent changes in wage and capital income by quintile and selected economic variables. They concluded that "the personal income tax has become increasingly dependent on volatile capital income, due primarily to an increasing dependence on high income taxpayers and income sources that are highly volatile."[68] This issue is important and has been of great concern to forecasters and policymakers.

Volatility depends on both tax policy and underlying economic volatility. If you have a very risky tax portfolio but no economic volatility, tax revenue would be stable. If you have volatile

economic conditions but lump sum taxes, tax revenue would be stable. By definition, the interaction of tax policy and economic volatility cause tax revenue volatility. How can you separate the effect of that interaction? Seegert (2016) applied a method known as Oaxaca-Blinder decomposition to separate these impacts. He concluded that changes in tax policy explained about three-quarters of the increase in income tax volatility from the 1970-2000 period to the 2001-2014 period, changes in economic uncertainty explained about 18%, and variation in tax bases explains the rest.[69] [70]

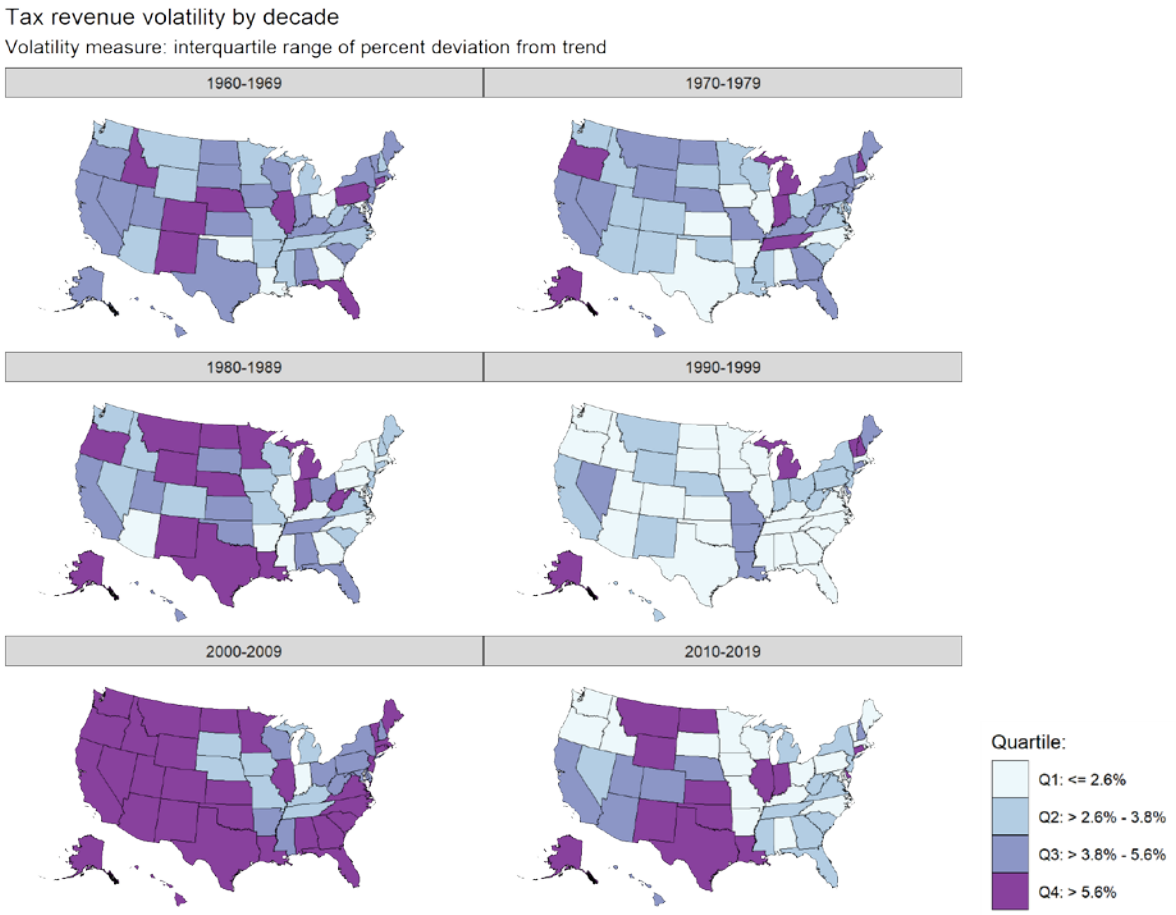
While both the Mattoon-McGranahan and Seegert papers concluded that tax policy changes accounted for a substantial part of the tax volatility increase, it is difficult to compare the magnitude of this effect directly because the methodologies, time periods, and taxes compared differ.

Analysis and illustrations

Tax revenue volatility across the decades

The next several figures illustrate and update some of the trends examined by researchers. Figure 14 shows total tax revenue volatility by decade. For details, see the section, “How this report measures and displays volatility.”

Figure 14 Tax revenue volatility by decade



High volatility was widespread in the 2000-2009 period, with about two-thirds of states having high enough volatility to place them in the top quartile for the 60-year periods. Alaska is almost always highly volatile due to their dependence on severance taxes.

The next two figures show volatility by tax type and decade.

Figure 15 shows the taxes within each decade, making it easy to see which tax is most volatile within a decade and which is least volatile. The taxes are ordered the same way in each panel of the figure, from highest to lowest based on volatility over the entire 50-year period. It is clear that severance taxes and the corporate income tax are number one and number two in every decade, although sometimes their order might differ. The personal income tax has been more volatile than the sales tax in every decade.

Figure 15 State tax revenue volatility by tax type and decade

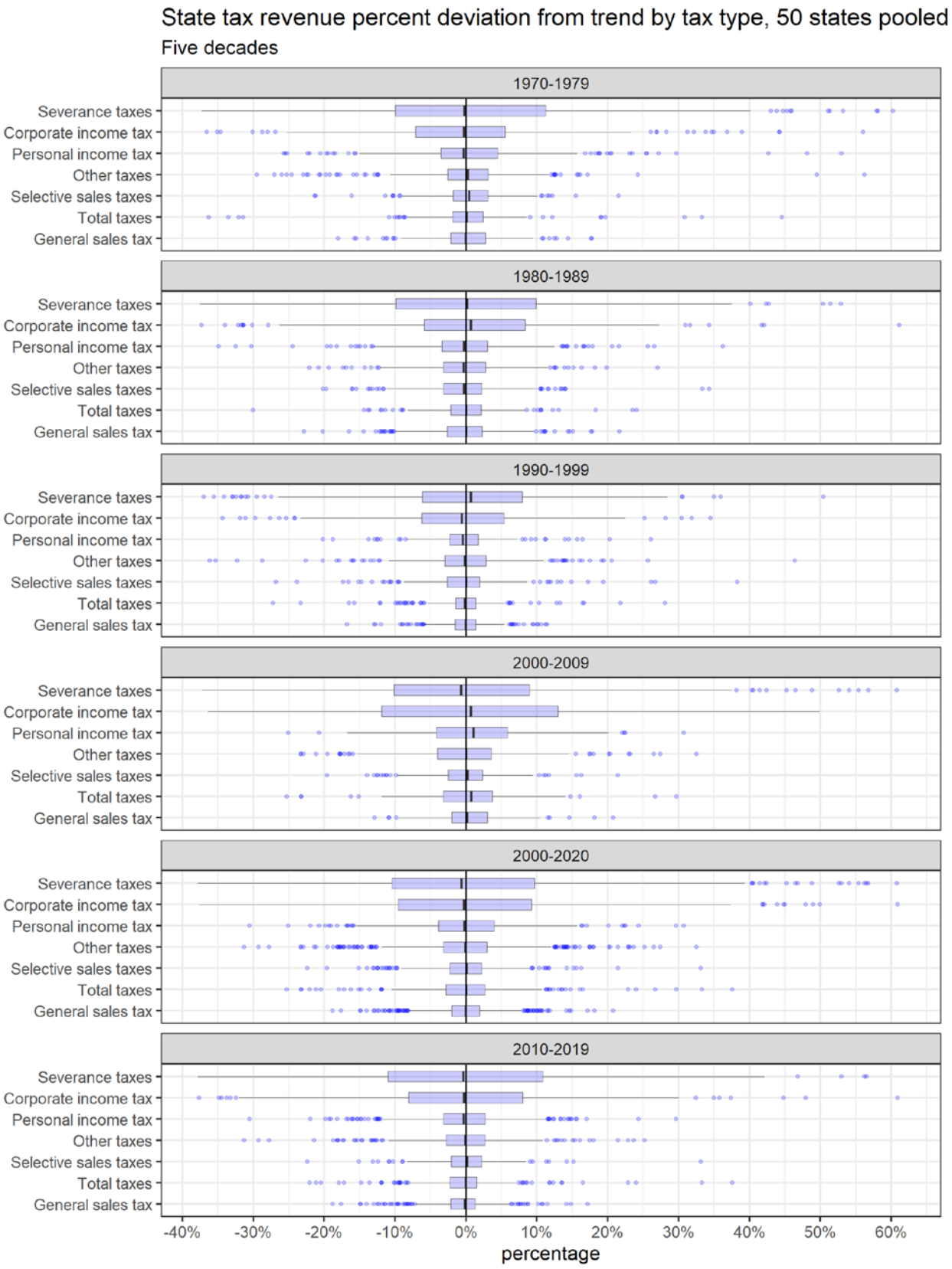
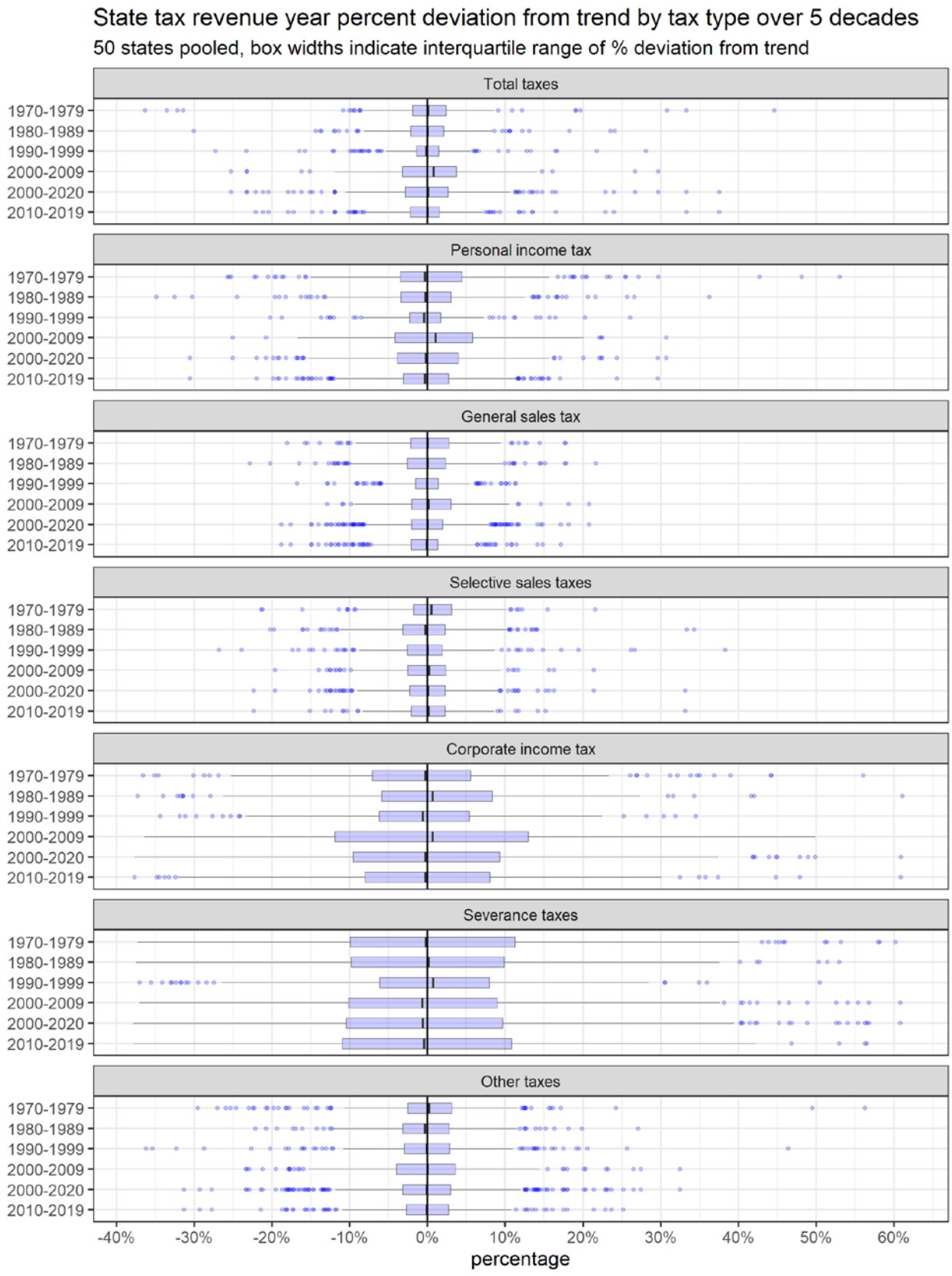


Figure 16 shows the same data with decades grouped within each tax, making it easier to see trends over time. Income tax volatility fell in 1990-1999, rose in 2000-2009 then diminished slightly in 2010-2019. Nonetheless, volatility in 2010-2019 remained greater than in 1990-1999 but was similar to earlier decades. Corporate, severance, and other taxes all became more volatile in 2000-2009, contributing to a substantial increase in total tax volatility in 2000-2009 that fell in 2000-2019. Volatility increased for most tax types but because of its size the income tax increase had the greatest consequence for overall tax volatility.

Figure 16 Volatility increased substantially in 2000-2009



Tax revenue volatility across recessions

Next, we examine changes in volatility, focusing on periods surrounding recessions. This is important because revenue declines tend to be large enough to cause deep fiscal distress in many of these periods and because it is especially difficult to forecast revenue accurately in these periods.

Table 3 shows selected characteristics of the eight recessions in the last 50 years. Recession periods are as defined by the National Bureau of Economic Research. Economic data are from U.S. Bureau of Economic Analysis, National Income and Products Accounts. Capital gains are from the Internal Revenue Service, Statistics of Income. Tax revenue data are from the United States Census Bureau, adjusted for inflation. At the time of writing, tax revenue data for the 2020 recession were not available. The figures for total taxes and the individual income tax are for the median state.

The diversity is remarkable. The longest recession (the Great Recession) was followed by the shortest recession (the COVID-19 recession). Consumption fell more sharply than GDP in the COVID-19 recession but in the other recessions it fared better and even increased in three recessions. The unemployment rate rose in each recession, but experienced the sharpest increases in the last two recessions. Capital gains fell by double-digit percentages in five recessions but rose in three.

Tax revenue in the median state fell much more sharply than GDP in the seven recessions for which we have tax data. The median state's income tax fell further than total tax revenue in all recessions but the 1969 recession. The depth of the income tax decline appears partly related to capital gains – even though the 1969, 1990, and 2001 recessions were milder than other recessions (measured by changes in GDP and unemployment), capital gains declined substantially, contributing to large income tax declines.

Table 3 Characteristics of recent recessions

Selected characteristics of the last 8 recessions							
		% change, recession peak to trough:					
Initial year of the recession	Duration (months)	Real GDP	Real personal consumption	Unemployment rate % point change[1]	% change in national capital gains[2]	Total taxes	Individual income tax
1969	11	−0.2%	1.7%	2.6%	−41.4%	−8.0%	−7.3%
1973	16	−3.1%	−0.7%	4.1%	−15.8%	−6.2%	−10.2%
1980	6	−2.2%	−1.2%	4.2%	0.9%	−7.2%	−7.7%
1981	16	−2.5%	2.8%	3.3%	9.2%	−7.4%	−7.4%
1990	8	−1.4%	−1.1%	2.4%	−31.4%	−3.4%	−5.1%
2001	8	0.5%	2.2%	2.2%	−58.3%	−5.4%	−12.1%
2007	18	−3.8%	−2.3%	5.5%	−67.0%	−12.6%	−19.5%
2020	2	−8.9%	−9.7%	9.4%	11.5%	—	—

[1] Highest quarterly value within 1 year of start minus lowest value within 2 years of trough.
[2] % change from highest annual value within two years of start to lowest value in 2 years after start.

In the two figures that follow I combine the 1980 and 1981 recessions and label them as 1980. I do not include the 2020 recession because we don't yet have data for the post-recession period. I calculate the percentage deviation from trend for nominal tax revenue in each year from five years before a recession's start through five years after, for each state and tax. I calculate tax revenue volatility as the interquartile range of these percentage-deviation values.

Figure 17 maps this measure of volatility across recession periods. The variation is remarkable. Substantial volatility was widespread in the Great Recession. Earlier recessions had very different patterns: the 1980 recession hit the middle of the country hard, while the 2001 and 2007 recessions, which were much more affected by financial events and reliance on capital gains, hit California especially hard.

Figure 17 Tax revenue volatility around recessions

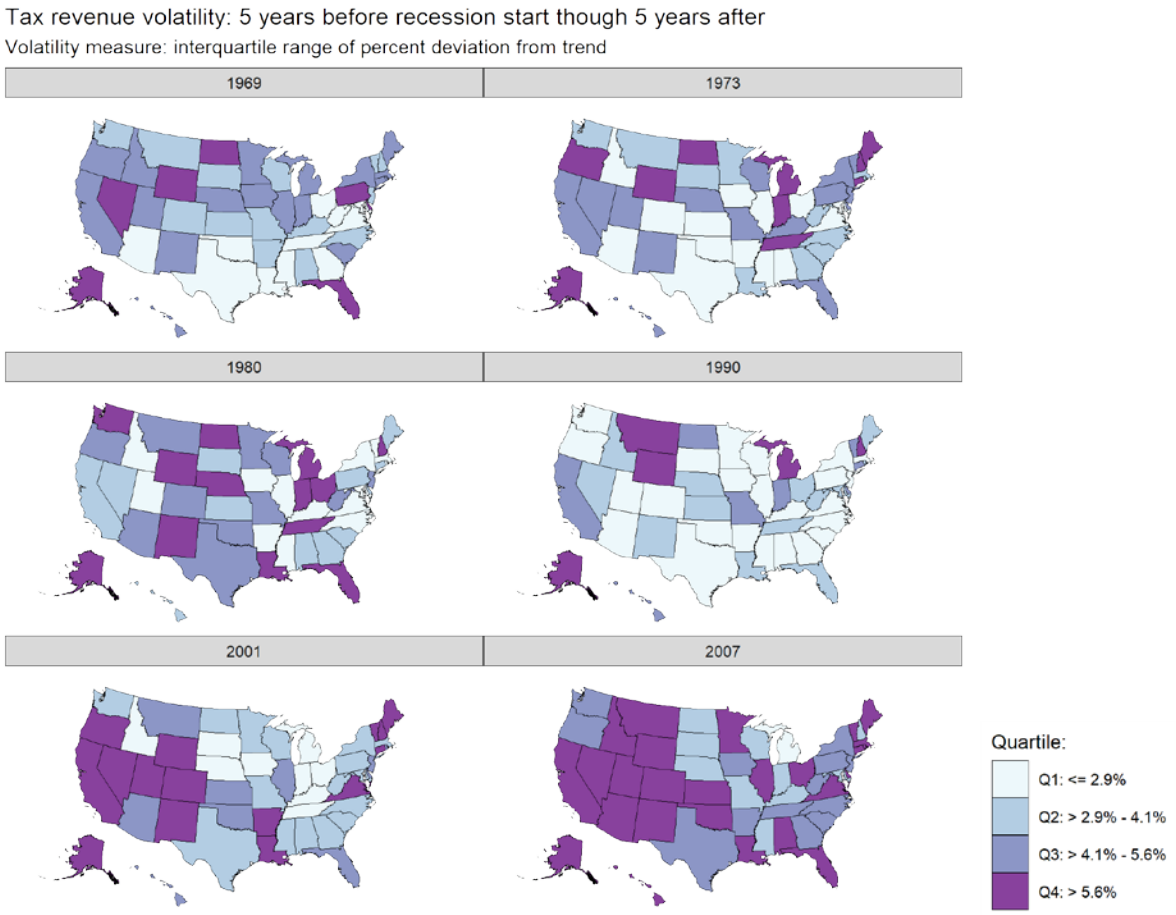
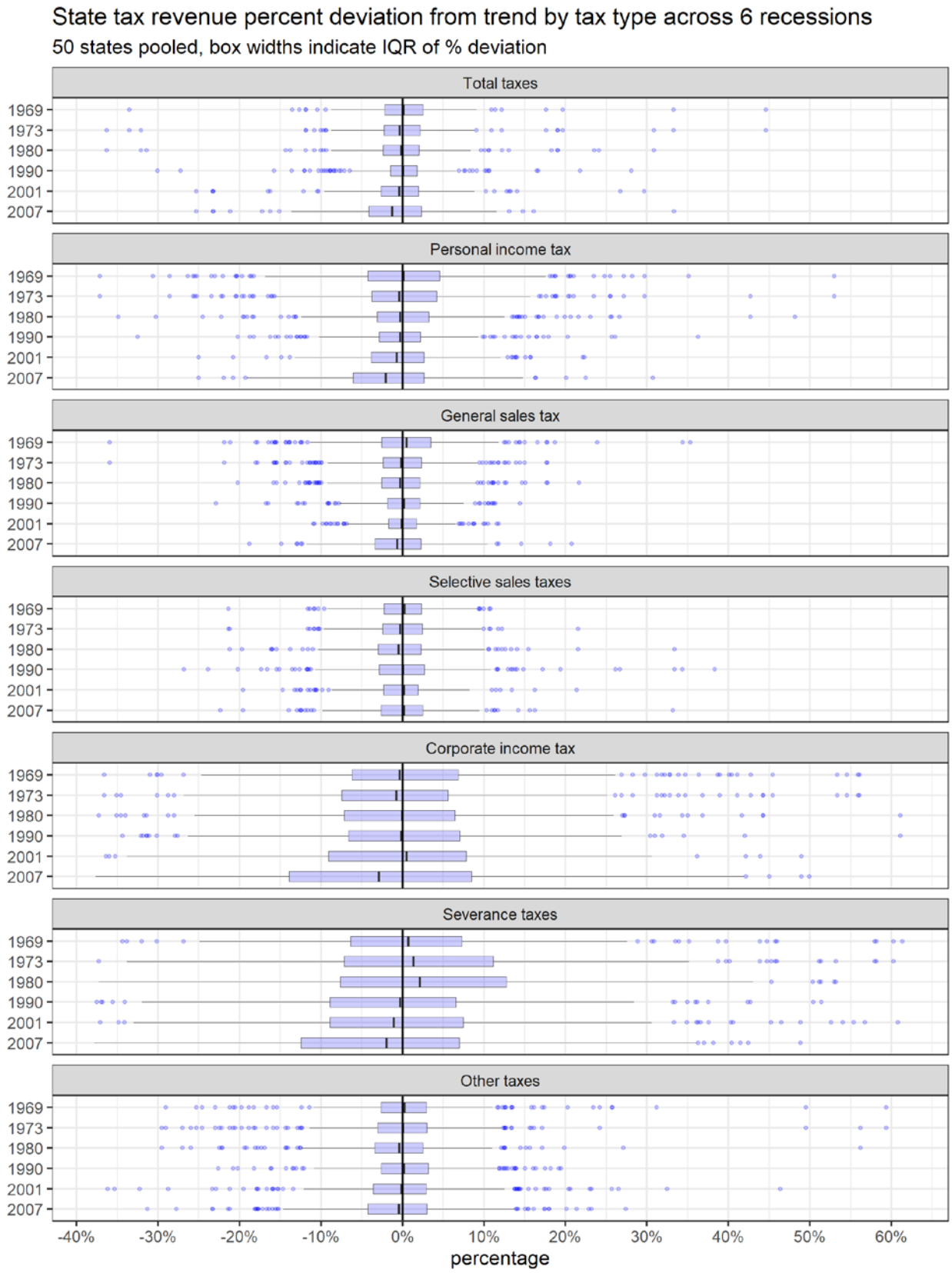


Figure 18 summarizes these data for each tax and recession. The recession periods are defined as five years before the start of a recession through five years after the start. The widths of the boxes correspond to the interquartile range of the percentage changes – i.e., to revenue volatility.

Figure 18 Tax revenue volatility rose in the period surrounding the Great Recession



Tax revenue volatility rose substantially around the Great Recession, which began in 2007. The increase was especially large for individual and corporate income taxes, but volatility of other taxes increased as well.

While we don't yet have data for the full period surrounding the 2020 COVID-19 recession, it is clear that this recession was very different. The shutdown in economic activity coupled with massive federal assistance to individuals, businesses, and government, and the ability of many middle and upper-income workers to work remotely, meant that the recession was sharp but brief. Tax revenue fell nowhere near as much as forecasters initially expected and recovered strongly.

Tax revenue volatility in recessionary versus non-recessionary periods

Table 4 show tax revenue volatility by tax type in all recessionary and non-recessionary periods from 1960 through 2020. I define a recessionary period as the year before a recession starts through the year after its trough. All tax types except the "all other" category have been considerably more volatile in recessionary periods than in non-recessionary periods.

Table 4 Tax revenue is more volatile in recessionary than non-recessionary periods

Tax revenue volatility in recessionary and non-recessionary periods[1]
1960 through 2020

	Volatility: Interquartile range of % deviation from trend		Recessionary minus non-recession	Ratio of recessionary to non-recessionary
	Non-recessionary	Recessionary		
Total taxes	3.3%	5.2%	1.9%	1.57
Personal income tax	5.3%	8.7%	3.4%	1.65
General sales tax	3.6%	5.1%	1.5%	1.42
Selective sales taxes	4.2%	5.1%	0.9%	1.23
Corporate income tax	13.0%	17.3%	4.3%	1.33
Severance taxes	17.4%	22.2%	4.8%	1.27
Other taxes	5.6%	6.0%	0.4%	1.07

[1] Recessionary periods defined as the year before a recession starts through the year after the trough, to allow for a lag between economic activity and revenue.

Lessons for planners and policymakers

Tax revenue volatility is not static. It changes over time in response to changes in economic conditions and changes in tax structure. Tax revenue volatility increased substantially in the 2000-2009 decade compared to earlier decades but was somewhat lower in 2010-2019.

The volatility increase was particularly large for the personal income tax and for the corporate income tax; other taxes had smaller increases. Despite the increase in income tax volatility, it remained far less volatile than severance taxes and corporate income taxes.

Much of the 2000-2009 volatility increase was related to the 2001 and 2007 recessions. Two studies pointed to changes in state tax policies as partial or significant causes of the volatility increase, particularly greater reliance on personal income tax and other efforts to increase revenue.[71] A third study concluded that if high-income-tax states had reduced their reliance on income taxes they would have had *higher* revenue volatility in the 2007 recession, not lower volatility.[72] Capital gains clearly played a role in the increased tax volatility, in at least some states, but other factors were at work, too.

Recessions play a key role in tax revenue volatility, with greater volatility in and around these periods. Different recessions have different characteristics. Some have led to sharply reduced consumption, hitting sales tax hard, while others have not. Some have led to sharp declines in the stock market and capital gains, with large negative impacts on income taxes, as occurred in 2001 and 2007, while others have not. The 2020 COVID-19 recession was sharp but also the shortest on record. The economy and tax bases were boosted significantly by massive federal aid. Tax revenue plummeted initially but recovered strongly. Thus, we cannot speak of "the impact" of recessions on revenue. It depends on the kind of recession.

These historical lessons mean we cannot assume that the 2000-2009 period ushered in a "new normal" of higher volatility, nor can we say that the lower volatility of 2010-2019 is here to stay. As economic conditions change, volatility will change. The wrong kind of recession can lead to particularly bad outcomes for states. The COVID-19 recession showed us that tax revenue can do well in a short-sharp recession coupled with significant federal assistance. Unfortunately, we cannot predict with confidence what the next recession will look like.

How do portfolios of taxes affect total revenue volatility?

What do we know from research?

Several researchers have examined state tax revenue volatility in the context of an analytic framework used in finance, in which there is a tradeoff between growth and volatility.[73] It is commonly used to examine the prices of assets such as stocks and bonds. The concepts are familiar to most investors: First, assets that have higher expected long-run growth usually are expected to be more volatile than assets that do not. For example, tech stocks may have great potential for growth, but they also carry great risk of loss or underperformance. U.S. Treasury bills have low yields, but they are safe assets with almost no risk of loss. Second, asset prices don't all move together in lockstep – that is, they are not perfectly correlated. Thus, it may be possible to construct an "optimal" diversified portfolio that has the highest expected return for a given level of risk.[74] An asset, or portfolio of assets, that has the maximum expected growth for a given level of volatility is said to be on the efficient frontier.

The translation of these concepts to tax revenue is straightforward. An income tax may be like the risky asset, expected to grow rapidly over the long run because of its progressive rates, but also swinging wildly in recessions due to its progressivity and volatile income sources. A sales tax imposed solely on necessities such as food for home consumption (if such a tax existed)

might be like the safe asset, with very low volatility because people always need food even in recessions, but with low growth potential because as the economy grows and people are better off, they may spend increasing shares of their income on luxuries. It may be possible to combine taxes into a diversified portfolio that has maximum expected growth for a given level of volatility.

While this translation makes technical sense, whether it makes sense from a policy perspective is another matter.[75] Do policymakers want the maximum amount of expected revenue growth for a given level of volatility? Undoubtedly some do, but that certainly is not true for all politicians or the people who elected them. Many voters would not consider maximum expected tax revenue growth a good thing and would prefer politicians to have to vote for higher taxes to get more tax revenue.

In any event, several researchers have examined potential trade-offs between tax revenue growth and volatility, and variants of these concepts. In these analyses, it is common to plot the expected or historical growth of a tax revenue source on the vertical axis, and the volatility on the horizontal axis, as is done in growth-volatility analyses asset prices.

Cornia and Nelson (2010) plotted growth of selected state government tax sources against a measure of volatility for the 1988-2009 period and concluded that two excise taxes (alcohol and motor fuels) had low growth and low variability, while the income tax had high growth and high variability and that all three were on the efficient frontier. (I would call this the "potentially efficient frontier" because they could only observe the portfolio choices states made, and not those that could have been made.) By contrast, the retail sales tax was in the interior of the frontier and the corporate income tax had the undesirable quality of being highly volatile with relatively low growth.[76] They plotted a similar growth-volatility space for total taxes by state and, among other things, concluded that Alaska had extremely high volatility and relatively low growth. Their results for some states are considerably different from those discussed in this report for the 2000-2020 period.

Seegert (2015) examined the trade-off between the level of tax revenue (rather than its growth rate) and volatility and simulated alternative tax portfolios for each state to examine how the trade-off between volatility and revenue changed during and after the Great Recession.[77] Among other things, he concluded that states with greater income inequality would have to accept more volatility to obtain higher levels of expected tax revenue. He concluded that, between 2007 and 2013, 18 states increased the riskiness of their tax portfolios, while only six decreased riskiness. States seeking more revenue may need to accept more risk so the increase in riskiness isn't necessarily surprising. An interesting question Seegert asked was whether states were taking additional risk inefficiently. He developed the concept of unnecessary risk – volatility above and beyond what was needed for a given level of revenue. If a state increased the amount of unnecessary risk, then it was increasing risk inefficiently. He found states increased their riskiness, but most did so relatively efficiently.

Chernick and Reimers (2019) analyzed state tax revenue losses in the Great Recession.[78] Counter to conventional wisdom, they concluded that if high-income-tax-reliance states had relied less on income taxes and more on consumption taxes, approximating national average shares, they would have had greater revenue losses than actually observed. This suggests that higher income tax reliance does not necessarily lead to higher revenue volatility.

In their analysis, reducing reliance on the income tax and increasing reliance on consumption taxes would have shifted combined income and consumption tax burdens, particularly from the top 5% income group to the next 15% (the 80th to 95th percentiles), changing how the recession would affect revenue. Their model predicted that lower burdens on the top 5% would mean lower recessionary revenue losses from this group.

The model also predicted that higher burdens on the next 15% – the 80th to 95th percentiles -- would have led to greater recessionary revenue losses from this group. In most high-income-tax-reliance states these greater revenue losses would more than offset the reduced revenue losses from the top 5%. The net effect would be greater recessionary revenue losses for most high-income-tax-reliance states if they instead had national-average income tax reliance.

According to Chernick and Reimers, an important feature of their analysis is that it reflected behavioral responses by states: states with high income taxes and highly graduated rates were more likely to raise their top rates, thus offsetting static revenue losses from the Great Recession.[79] This raises important policy questions. For example, do we want states to raise tax rates in recessions? And if a state with volatile revenue that falls sharply in a recession raises rates to offset the fall, is that any worse than if a state with stable revenue simply maintains its revenue by doing nothing? And does it matter if the volatile-revenue state raises rates on the top end of the income distribution, or the bottom?[80]

They used parameters from this model to simulate counterfactual changes in tax burden for states with high income taxes relative to consumption taxes and states with low income taxes relative to consumption taxes and concluded that, counter to conventional wisdom, if high-income-tax-reliance states had instead relied less on the income tax, their revenue losses, on average, would have been greater than observed.

Chernick and Reimers stressed that their results applied to just one recession – a recession in which consumption was reduced sharply, as shown in Table 3 - and emphasized that their insights were gained by examining how tax burdens would be affected across the distribution of income.

Analysis and illustrations

Figure 19 presents updated growth-volatility estimates by type of tax, similar to the method used by Cornia and Nelson (2010) but with more current data from the United States Census Bureau, as discussed in the section, “How this report measures and displays volatility.”[81] It

yields broadly similar conclusions: several excise taxes are low-growth low-volatility, the income tax is a high-growth high-volatility tax, and the corporate income tax is high volatility for relatively little growth. The solid line depicts what is sometimes called the efficient frontier – the greatest growth for a given level of volatility.

Figure 19 Growth and volatility of selected state taxes

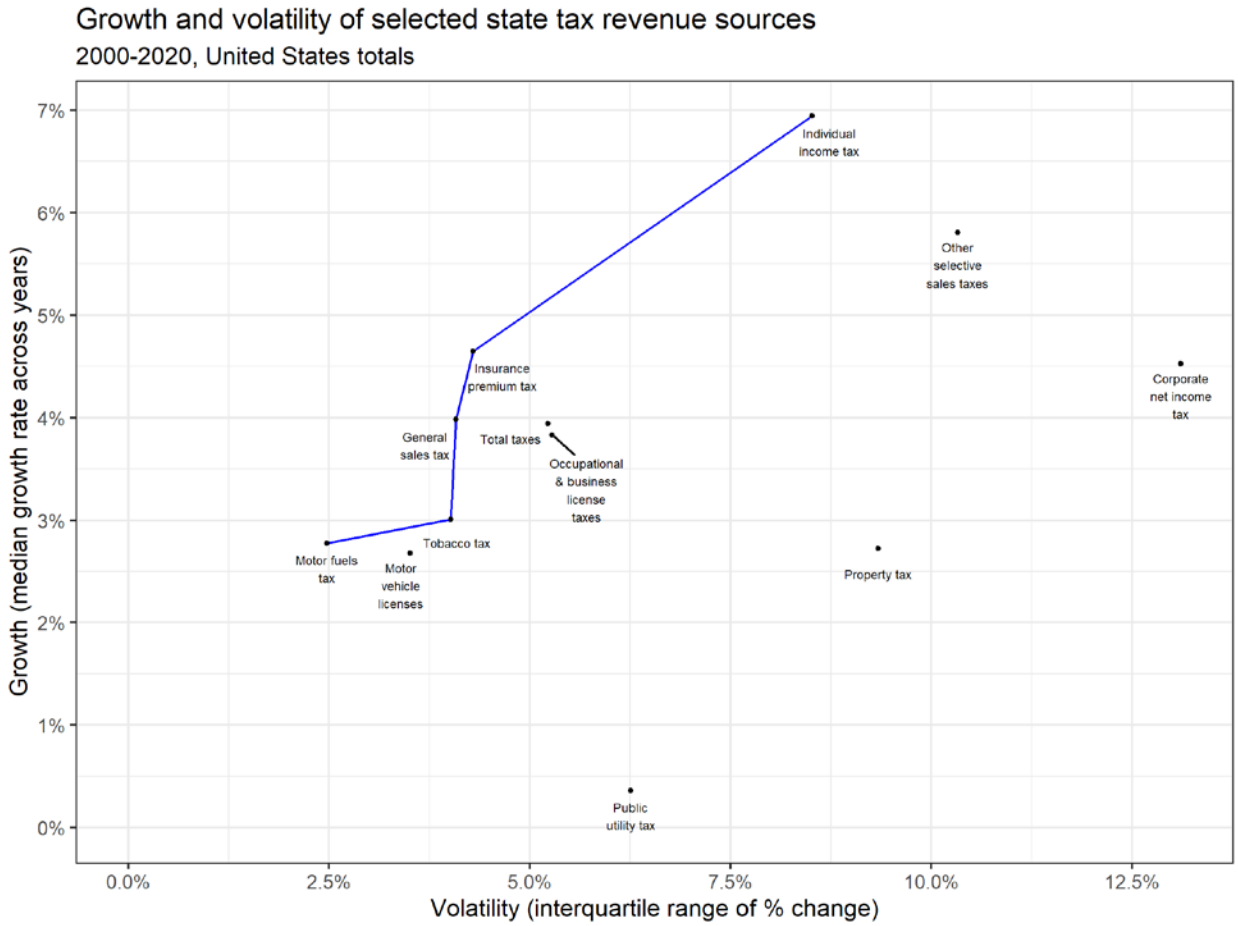
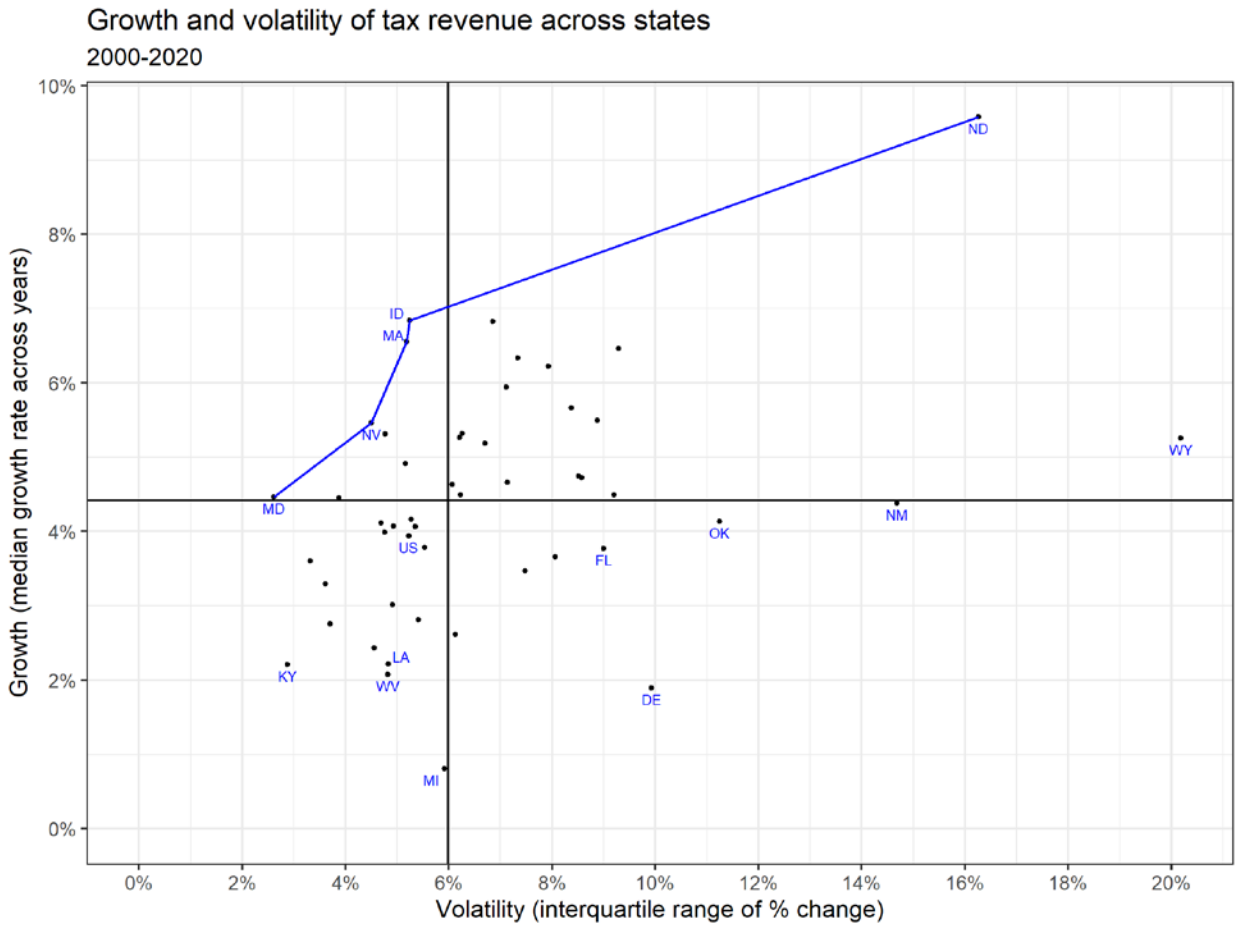


Figure 20 presents the same growth-volatility information for states, leaving Alaska out because its extraordinarily high volatility with relatively little growth would make the rest of the figure unreadable. Wyoming is high-growth high-volatility, as it is in Cornia and Nelson (2010), and Michigan is low-growth with moderate volatility. Many other states are in different positions than in the Cornia and Nelson. Given the time period, measure, and data source differences, this may not be surprising. It is a good reminder that volatility is not static, and states can change positions over time, depending on economic conditions and their own tax structures. The solid line in this figure shows states that have had the highest observed growth for a given level of volatility, but it should not be interpreted as an efficient frontier – the maximum growth that any state could achieve for a given level of volatility – because states generally would not have the economic structures needed to support these tax portfolios. (For example,

if Rhode Island had the excise taxes that North Dakota has, it would not necessarily have the revenue growth that North Dakota has.)

Figure 20 Growth and volatility total state tax revenue across states



Lessons for planners and policymakers

Taxes do not move in lockstep with the economy or with each other. Some tax types are far more volatile than the economy, while other taxes are about as volatile or even less volatile. Policymakers need to understand how taxes are correlated with each other and with the economy. Variation in volatility across taxes provides opportunity for states to design portfolios of taxes that reduce volatility, or portfolios that maximize expected revenue growth for a given level of volatility. However, other goals of tax policy are important, too, and may conflict with the desire to keep volatility low. States may intentionally choose to have progressive tax structures and accept higher volatility as a result. States with significant volatility that causes budget disruptions need to have rainy day funds and other management tools that allow them to manage this volatility.

How does volatility vary across states?

What do we know from research?

Several studies have presented estimates of state tax revenue volatility for most states in the nation or for regional subsets. It is not particularly useful to make direct comparisons of specific estimates because the studies use different time periods, different data sources, and different measures of volatility. However, interested readers may wish to examine some of these estimates. Bruce, Fox, and Tuttle (2006) presented estimates estimated over 1967-2000 of the short-run elasticity of personal income and sales taxes, allowing elasticity to differ between below-equilibrium and above-equilibrium periods.[82] Cornia and Nelson (2010) estimated state-by-state volatility over 1995-2009 using quarterly United States Census Bureau data, and measured volatility as the interquartile range of the year-over-year percent change.[83] They found the five highest volatility states to be Alaska, Wyoming, New Mexico, Nevada, and Michigan. The lowest volatility state was Pennsylvania, although the United States as a whole was less volatile than any state.[84]

Analysis and illustrations

I caution that these data are not adjusted for legislative changes because of the impracticality of doing so, as discussed earlier. Unadjusted data still allow us to examine variation over time and across taxes because state legislative changes do not generally occur en masse (although they tend to concentrate near recessions). However, comparisons across states are far more challenging because if an individual state changes its tax policy erratically it can cause substantial volatility in revenue collections not due to the underlying tax structure or economy. Illinois is a good example of this, as I discuss below. Cross-state differences in volatility that persist for long periods are likely to reflect economic and tax-structure factors affecting tax revenue volatility, but episodic volatility in a single state has a greater likelihood of being attributable to tax policy changes.

Figure 21 shows volatility by state over 2000-2020, measured as the interquartile range of the percentage deviation from trend.

Figure 21 Tax revenue volatility across states

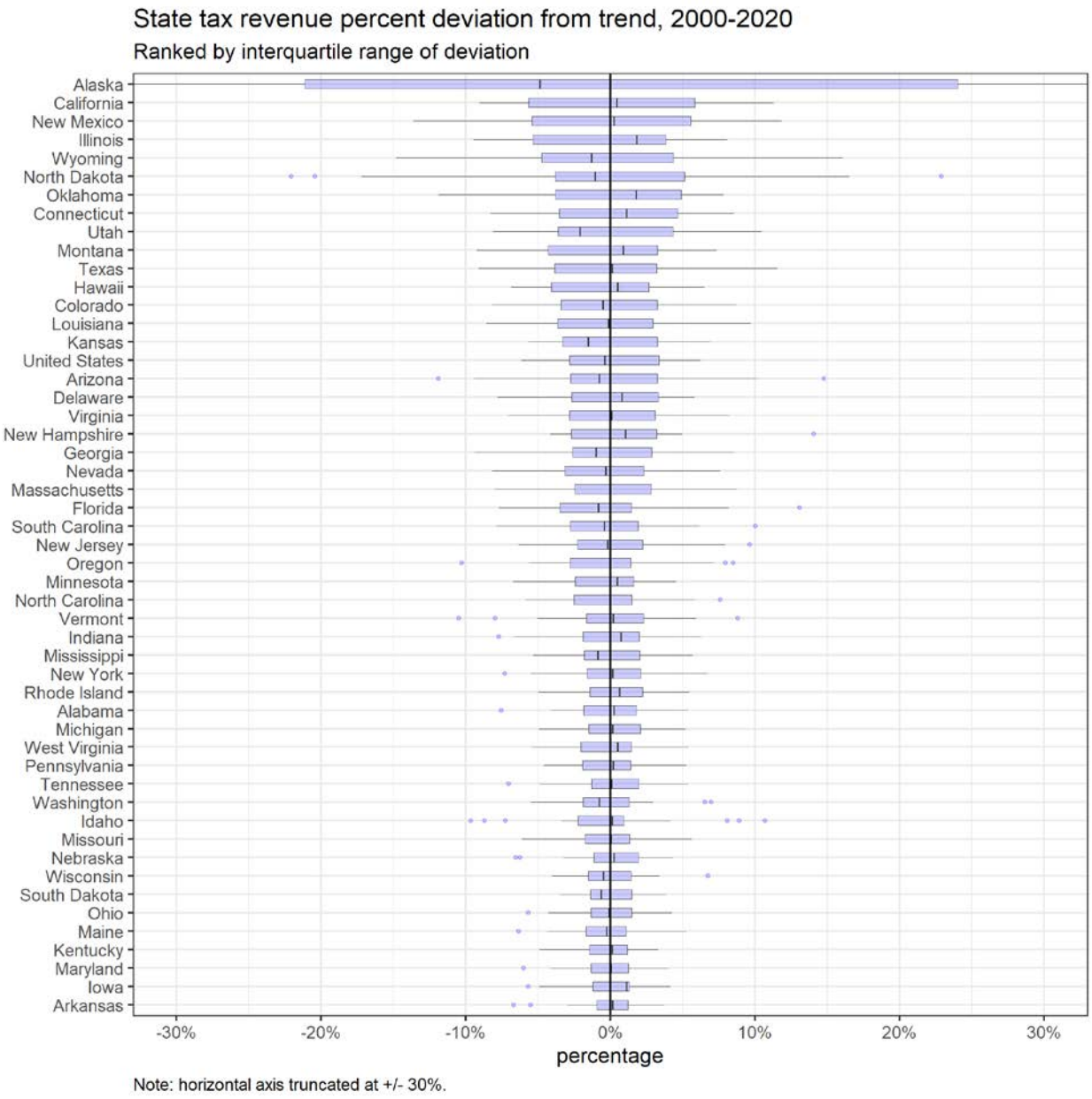


Table 5 offers insight into tax revenue in the top 10 high volatility states. Every state has either disproportionate reliance on the income tax or on severance taxes. (Oklahoma is not especially high on either but its economic volatility is quite a bit higher than average.) Alaska is an outlier even in this group. Its volatility is driven by its high reliance on extremely volatile severance taxes. Even though North Dakota has about the same reliance on severance taxes, Alaska's severance taxes are more than twice as volatile as North Dakota's. In addition, its economy is quite volatile.

Table 5 Selected characteristics of high-volatility states

Selected characteristics of top 10 tax-volatility states in 2000-2020										
	Volatility: Interquartile range of percent deviation from trend								Share of tax revenue in 2020:	
	Total tax	State GDP	Personal income tax	General sales tax	Selective sales taxes	Corporate income tax	Severance taxes	Other taxes	Personal income tax	Severance taxes
50-state medians	4.3%	1.7%	7.2%	3.8%	4.3%	18.0%	21.4%	6.3%	35.9%	0.1%
Alaska	45.1%	4.0%	-	-	3.6%	34.9%	51.1%	6.0%	0.0%	46.2%
California	11.4%	2.0%	17.8%	5.1%	6.4%	14.2%	21.5%	4.5%	49.1%	0.1%
New Mexico	11.0%	2.1%	12.1%	10.1%	8.0%	57.7%	31.8%	12.0%	17.2%	19.8%
Illinois[1]	9.1%	1.6%	11.8%	5.8%	5.8%	32.9%	-	2.9%	39.7%	0.0%
Wyoming	9.1%	4.6%	-	12.1%	6.5%	-	20.6%	8.0%	0.0%	25.7%
North Dakota	8.9%	3.2%	9.8%	7.9%	7.2%	24.7%	23.9%	5.4%	8.7%	48.1%
Oklahoma	8.7%	3.6%	6.8%	6.1%	5.4%	21.6%	26.7%	6.3%	32.8%	8.1%
Connecticut	8.2%	2.1%	11.0%	6.2%	8.8%	16.4%	-	5.4%	44.4%	0.0%
Utah	7.9%	1.9%	11.0%	6.9%	3.9%	25.9%	23.5%	12.4%	42.8%	0.6%
Montana	7.5%	2.0%	9.4%	-	4.0%	27.9%	18.8%	3.8%	42.3%	5.5%

[1] High volatility likely due to policy actions. See text for details.

The following discussion is based on details underlying the table (not shown).

Over the last 21 years, Alaska has had the greatest tax revenue volatility by far, with an interquartile range of 45%. (Tax revenue was 21% below trend at the 25th percentile and 24% above trend at the 75th percentile.) Alaska's high tax volatility has been persistent over long time periods: in Figure 14, presented earlier, Alaska was in the highest-volatility quartile for five of the last six decades. Fortunately for Alaska budget managers, taxes account for only 21% of general revenue, compared to 47% in the typical state.[85]

Alaska is followed, at great distance, by California, with an interquartile range of 11.4%, ranging from 5.6% below trend at the 25th percentile to 5.8% at the 75th percentile. In several studies, California's tax revenue has been found to be exceedingly volatile. Vasche and Williams (2005) attribute California's high volatility to a combination of economic and tax-structure factors.[86] Paraphrasing their report, the economy has large cyclical industries like high technology and housing, and large fluctuations in domestic in-migration. The income tax, which is the state's largest tax, is highly volatile because of its progressive rate structure and its full taxation of capital gains. They conclude that the state's third largest tax, the corporate income tax, is highly volatile due in part to fluctuating profits in technology, finance, and construction industries.

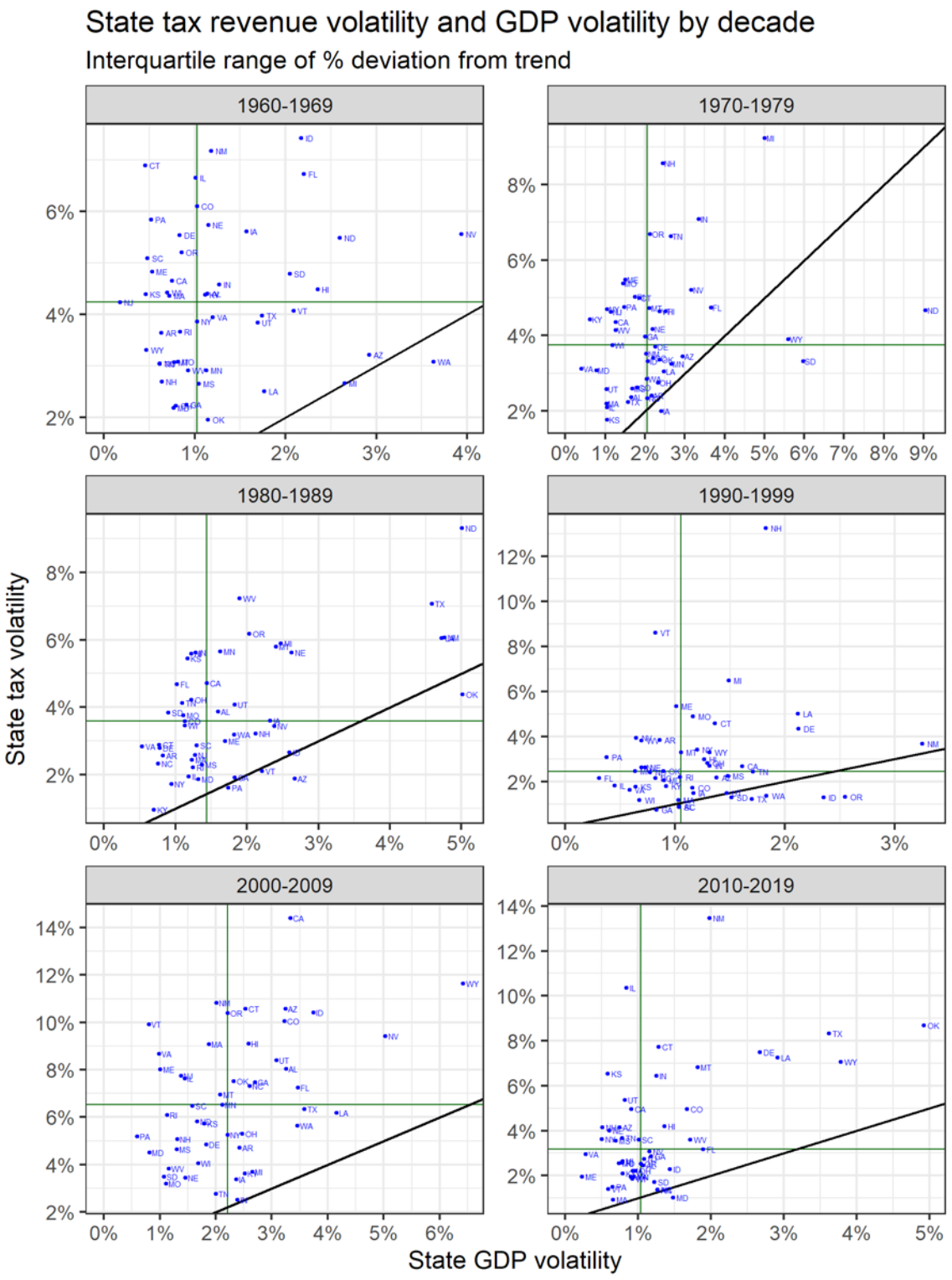
Illinois' high volatility in Figure 21 appears to be an artifact of tax policy changes. Graphical analysis of individual taxes (not shown) suggests the state's high volatility is attributable primarily to its income tax. Although the Illinois income tax is a flat-rate tax, and thus likely to be less volatile than progressive income taxes, policymakers varied the rate substantially over 2000-2020 in response to perennial budget problems. The rate was 3% for 2000-2010, 5% for 2011-2014, 3.75% for 2015 through mid-2017, and 4.95% from mid-2017 through 2020.[87]

Most states in Table 5 have understandable stories, although the table doesn't get behind those stories – it doesn't tell us why Alaska's severance taxes are more than twice as volatile as North Dakota's, for example. There may be something about the structures of severance taxes in these states – the products they apply to, or rates or other features that explain these differences.

While economic volatility plays a role in differences in state revenue volatility, it is only one factor. Figure 22 shows tax volatility relative to GDP volatility for each of the last six decades. To keep the figure easy to interpret, I exclude several outliers: Alaska is excluded from all decades, North Dakota is excluded from 2010-2019, and Wyoming from 1980-89.

The volatility of state GDP is on the horizontal axis and the volatility of tax revenue is on the vertical axis. The upward sloping line is the 45-degree line at which tax and GDP volatility would be equal. Green horizontal and vertical lines show the medians for each decade (Alaska, North Dakota, and Wyoming are included in these calculations). It's important to pay close attention to axis scales in interpreting differences across decades, because the horizontal and vertical scales vary across panels.

Figure 22 Tax revenue is more volatile than the economy in almost every state, almost every decade



In most decades, almost every state is above the 45-degree line, meaning that tax revenue volatility generally is greater than GDP volatility. Median tax revenue volatility in 2000-2009 is

6.5%, up four percentage points from the 2.5% median in 1990-1999 and up 3.3 percentage points from the 3.2% median in 2010-2019. By contrast, median GDP volatility was 2.2% in 2000-2009, up about 1.1 percentage points from the two surrounding decades. Thus, median tax revenue volatility was much higher in the 2000-2009 decade than surrounding decades, but median GDP volatility was only a little bit higher: revenue volatility increased relative to the economy.

While Alaska has a very volatile economy, it is not as volatile as two other oil-based economies, Louisiana and Wyoming. But its tax revenue is more than four times as high as either of those states, so other factors are at work. And California, with the second-highest tax revenue volatility, has only moderate economic volatility, as noted elsewhere.[88]

Lessons for planners and policymakers

Tax revenue volatility varies across states as a result of differences in their economies and tax-structure choices. It is more difficult to compare states with the available data, unadjusted for policy changes, because some states have made repeated changes to their tax structures during periods of interest that may distort their volatility measures. Still, it is possible to make some generalizations.

Alaska, the highest-volatility state by far, relies heavily on severance taxes. However, taxes are a relatively small share of its overall revenue structure. The other high-volatility states over the last 21 years rely disproportionately on the income tax or severance taxes.

Tax revenue has been more volatile than the state economy in almost all states in each of the last six decades. This reflects the fact that tax bases include only subsets of economic activity, and some of these subsets, such as durable goods, capital gains, and natural resource production, are far more volatile than the economy as a whole.

Conclusions

Tax revenue volatility presents great challenges to policymakers and fiscal managers. Measuring and understanding volatility is an important step in preparing to reduce or manage volatility.

Tax revenue volatility increased substantially in the decade of the 2000s prompting fear that a "new normal" of heightened volatility had arrived. Volatility subsided moderately in the 2010s, until COVID-19 appeared, perhaps raising hopes that the new normal would be low volatility. Neither is likely true. Volatility depends on economic conditions and tax structures. In the "right" conditions, tax revenue will be volatile. The diverse nature of past recessions suggests that those conditions will arise again.

Some aspects of tax revenue volatility are within policymakers' control. A broad income tax base with less progressive rates can reduce its volatility. A broad sales tax base, including taxation of food, can reduce sales tax volatility. Some portfolios of taxes are more volatile, for a

given level of revenue growth, than others. The corporate income tax appears to provide a particularly unattractive mix of low growth and high volatility, although it may further some state policymakers' progressivity goals.[89] Tax revenue volatility-reducing policies may conflict with tax policy goals related to equity and progressivity. On the other hand, volatile revenue and budget deficits can undermine progressive spending policies. Understanding volatility can help policymakers consider these choices knowingly.

Where volatility cannot be reduced, it can be managed. Tools for managing volatility are outside the scope of this report, but they include reserve funds and conservative budgeting.

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[4] Rick Mattoon and Leslie McGranahan, "Revenue Bubbles and Structural Deficits: What's a State to Do?," Working Paper (Federal Reserve Bank of Chicago, 2012), http://www.ssrn.com/abstract=1310789.
[5] See the table, "Characteristics of recent recessions," in the body of the report.
[6] Author's analysis of data from the United States Census Bureau and U.S. Bureau of Economic Analysis, as described in the section, "How this report measures and displays volatility."
[7] Seegert, "The Performance of State Tax Portfolios During and After the Great Recession."
[8] Donald Boyd and Lucy Dadayan, "State Tax Revenue Forecasting Accuracy: Technical Report" (Rockefeller Institute of Government, September 2014).
[9] For example, see Pew Trusts, "Volatile State Tax Collections Make Budgeting Difficult," *Fiscal 50: State Trends and Analysis* (blog), October 14, 2021, https://www.pewtrusts.org/en/research-and-analysis/data-visualizations/2014/fiscal-50#ind6.
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[12] Donald Bruce, William F. Fox, and M. H. Tuttle, "Tax Base Elasticities: A Multi-State Analysis of Long-Run and Short-Run Dynamics," *Southern Economic Journal* 73, no. 2 (October 1, 2006): 315, https://doi.org/10.2307/20111894.
[13] See the methodology section at Pew Trusts, "Volatile State Tax Collections Make Budgeting Difficult."
[14] For recent reports, see National Association of State Budget Officers, "The Fiscal Survey of the States: Fall 2021" (National Association of State Budget Officers, 2021), https://higherlogicdownload.s3.amazonaws.com/NASBO/9d2d2db1-c943-4f1b-b750-0fca152d64c2/UploadedImages/Fiscal%20Survey/NASBO_Fall_2021_Fiscal_Survey_of_States_S.pdf. and National Conference of State Legislatures, "2020 State Tax Actions" (National Conference of State Legislatures, May 2021), https://www.ncsl.org/Portals/1/Documents/fiscal/2020-State-Tax-Actions_v02_web.pdf.
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[16] Gary C. Cornia and Ray D. Nelson, "State Tax Revenue Growth and Volatility," *Regional Economic Development*, Federal Reserve Bank of St. Louis, 2010.
[17] For example, Dye and McGuire, "Growth and Variability of State Individual Income and General Sales Taxes." adjust for inflation; Estelle P. Dauchy and Christopher Balding, "Federal Income Tax Revenue Volatility Since 1966," June 1, 2013, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2351376. and Seegert, "The Performance of State Tax Portfolios During and After the Great Recession." do not.
[18] Kalambokidis, "Minnesota Revenue Volatility and Budget Reserve Target."
[19] Russell S Sobel and Randall G. Holcombe, "Measuring the Growth and Variability of Tax Bases Over the Business Cycle," *National Tax Journal* 49, no. 4 (December 1996): 19.
[20] Vasche and Williams, "Revenue Volatility in California."
[21] Kwak, "Tax Base Composition and Revenue Volatility."

[22] I examined polynomial trends and HP-filter trends and did not find much difference. Kwak examined deviations from trend using orthogonal distances (OD) and vertical distances (VD) and found that "results obtained from OD approach and the ones from VD approach do not differ much in individual statistical significance of the key explanatory variables." Kwak.
[23] Cornia and Nelson, "State Tax Revenue Growth and Volatility."; Dauchy and Balding, "Federal Income Tax Revenue Volatility Since 1966."
[24] Kwak measures the orthogonal distance from the trend. Most other researchers measure the traditional vertical residual between actual revenue at a point in time and trend at that same point. Kwak, "Tax Base Composition and Revenue Volatility."; Seegert, "The Performance of State Tax Portfolios During and After the Great Recession."
[25] Glenn Hegar, "H.B. 32 Report" (Texas Comptroller of Public Accounts, September 30, 2016), https://comptroller.texas.gov/transparency/reports/hb32/96-1792.pdf.; Kevin Lembo, "Stabilizing Connecticut's Revenue Stream with the Budget Reserve Fund" (Office of the State Comptroller, c 2015), https://www.osc.ct.gov/brf/BudgetReserveFund_PolicyBrief.pdf.
[26] I constructed the data to illustrate fluctuations observed in tax data and are not intended to represent any specific tax or state. The random data are from a normal distribution and have a 7.5% standard deviation.
[27] Author's calculations.
[28] Thanks to reviewer Laura Kalambokidis for this point.
[29] Data are from the United States Census Bureau, Annual Survey of State Government Tax Collections. The trend was calculated with a Hodrick-Prescott filter with lambda=6.25, a commonly recommended setting for annual data.
[30] Bruce, Fox, and Tuttle, "Tax Base Elasticities."
[31] Sobel and Holcombe, "Measuring the Growth and Variability of Tax Bases Over the Business Cycle," 546.
[32] The authors of the paper point out that the standard error of the elasticity coefficient provides information on this revenue variability that is not systematically related to economic variability. Sobel and Holcombe, "Measuring the Growth and Variability of Tax Bases Over the Business Cycle."
[33] Cornia and Nelson, "State Tax Revenue Growth and Volatility."
[34] For an excellent discussion, see Cornia and Nelson, "State Tax Revenue Growth and Volatility."
[35] Author's calculation, not shown.
[36] That figure showed year over year percentage change rather than percentage deviation from trend. In this example, the two measures tell a similar story.
[37] Kwak, "Tax Base Composition and Revenue Volatility."
[38] See Dye and McGuire, "Growth and Variability of State Individual Income and General Sales Taxes."; Sobel and Holcombe, "Measuring the Growth and Variability of Tax Bases Over the Business Cycle."; Bruce, Fox, and Tuttle, "Tax Base Elasticities."
[39] The discussion of their data source, and the discussion of tobacco tax at bottom of p.32 and top of p.33 makes this clear.
[40] Seegert, "The Performance of State Tax Portfolios During and After the Great Recession."
[41] Mattoon and McGranahan, "Revenue Bubbles and Structural Deficits: What's a State to Do?"
[42] Cornia and Nelson, "State Tax Revenue Growth and Volatility."
[43] Thanks to Nathan Seegert for spurring thinking about this.
[44] Dauchy and Balding, "Federal Income Tax Revenue Volatility Since 1966."
[45] For recent capital gains as a share of adjusted gross income, see Elizabeth McNichol, "State Taxes on Capital Gains," Center on Budget and Policy Priorities, June 15, 2021, https://www.cbpp.org/research/state-budget-and-tax/state-taxes-on-capital-gains. For recent effective tax rates on capital gains, see Emily Potosky, "How High Are Capital Gains Taxes in Your State?," Tax Foundation, July 25, 2016, https://taxfoundation.org/how-high-are-capital-gains-taxes-your-state/.
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[47] Mattoon and McGranahan, "Revenue Bubbles and Structural Deficits: What's a State to Do?"

[48] Seegert, "The Performance of State Tax Portfolios During and After the Great Recession."
[49] The data are from IRS Statistics of Income via https://www.taxpolicycenter.org.
[50] Based on calculations not shown here, the interquartile range of the percentage deviation from trend was larger for all three of these sources than in any other decade.
[51] The data are from IRS Statistics of Income via https://www.taxpolicycenter.org.
[52] Sjoquist and Wallace, "Capital Gains: Its Recent, Varied, and Growing (?) Impact on State Revenues."
[53] "Table 1.4. All Returns: Sources of Income, Adjustments, and Tax Items, by Size of Adjusted Gross Income, Tax Year 2019 (Filing Year 2020)" (IRS, Statistics of Income Division, November 2021), https://www.irs.gov/pub/irs-soi/19in14ar.xls.
[54] The data are for total realized capital gains (for example, gains on assets that were sold), regardless of whether those gains were included in adjusted gross income. For some time periods, only a portion of capital gains was included in adjusted gross income.
[55] Source: IRS Statistics of Income.
[56] Leonard E. Burman, Kimberly A. Clausing, and John F. O'Hare, "Tax Reform and Realizations of Capital Gains in 1986," *National Tax Journal* 47, no. 1 (March 1994): 1–18, https://doi.org/10.1086/NTJ41789050.
[57] Effective capital gains taxes vary widely across states. Some states fully tax capital gains while others provide preferential exclusions or tax rates. For example, see Kyle Pomerleau, "The High Burden of State and Federal Capital Gains Tax Rates" (The Tax Foundation, February 2014), https://taxfoundation.org/high-burden-state-and-federal-capital-gains-tax-rates/.
[58] Office of the New York State Comptroller, "Opinion: Seize Chance to Improve NY Finances" (Newsday, August 30, 2021), https://www.newsday.com/opinion/commentary/new-york-budget-s98157.
[59] Comptroller DiNapoli was referring to a tax increase on high income taxpayers enacted in the state's budget. For details, as discussed in Grant Thornton, "New York State Enacts Tax Increases in Budget," April 30, 2021, https://www.grantthornton.com/library/alerts/tax/2021/SALT/K-O/NY-state-enacts-tax-increases-budget-04-30.aspx.
[60] Seegert, "The Performance of State Tax Portfolios During and After the Great Recession."
[61] William F. Fox and Charles Campbell, "Stability of the State Sales Tax Income Elasticity," *National Tax Journal* 37, no. 2 (June 1, 1984): 201–12, https://doi.org/10.1086/NTJ41791946.
[62] Bruce, Fox, and Tuttle, "Tax Base Elasticities."
[63] At the time of the research, the U.S. Bureau of Economic Analysis's broadest measure of state economic activity was known as gross state product. The broadest such measure is now known as state gross domestic product.
[64] State sales taxes do not apply just to components of personal consumption. States generally also tax some business purchases. Still, we have good data on consumption and there are insights to be gained by examining these data.
[65] This paragraph is based almost verbatim on comments from reviewer Laura Kalambokidis: Laura Kalambokidis, "Comments on Draft Revenue Volatility Paper," April 2022.
[66] National Association of State Budget Officers, "The Fiscal Survey of the States: Fall 2021."
[67] Mattoon and McGranahan, "Revenue Bubbles and Structural Deficits: What's a State to Do?"
[68] Dauchy and Balding, "Federal Income Tax Revenue Volatility Since 1966."
[69] Nathan Seegert, "Tax Revenue Volatility: Evidence from US States," *SSRN Electronic Journal*, 2016, https://doi.org/10.2139/ssrn.2789889.
[70] Nathan Seegert helped clarify this paragraph.
[71] Mattoon and McGranahan, "Revenue Bubbles and Structural Deficits: What's a State to Do?"; Seegert, "The Performance of State Tax Portfolios During and After the Great Recession."
[72] Chernick and Reimers, "Consumption Taxes, Income Taxes, and Revenue Sensitivity."
[73] This is often referred to as a mean-variance framework. One example is Cornia and Nelson, "State Tax Revenue Growth and Volatility."
[74] Under Modern Portfolio Theory (MPT), it is possible to reduce portfolio risk by holding combinations of assets that are not perfectly positively correlated. The seminal paper on MPT is Harry Markowitz, "Portfolio Selection,"

The Journal of Finance 7, no. 1 (1952): 77–91, http://onlinelibrary.wiley.com/doi/10.1111/j.1540-6261.1952.tb01525.x/full.

[75] Thanks to Nathan Seegert for discussions on this point.

[76] Cornia and Nelson, "State Tax Revenue Growth and Volatility."

[77] Seegert, "The Performance of State Tax Portfolios During and After the Great Recession."

[78] Chernick and Reimers, "Consumption Taxes, Income Taxes, and Revenue Sensitivity."

[79] This important point, emphasized in an email from Howard Chernick to the author, May 4, 2022, is stated almost verbatim here.

[80] Nathan Seegert raised these questions in my email discussions with him.

[81] The volatility measure in their method was the interquartile range of the year over year percentage change in quarterly tax revenue. The measure here is the interquartile range of the percentage deviation from trend in annual tax revenue.

[82] Bruce, Fox, and Tuttle, "Tax Base Elasticities."

[83] Cornia and Nelson, "State Tax Revenue Growth and Volatility."

[84] If the conclusion that tax volatility for the United States as a whole is lower than for individual states holds up more generally (not just for 1995-2009), it would mean – in concept – that state taxes could be pooled and shared, hedging idiosyncratic state risks and resulting in overall lower risk. Of course, that would not be very attractive to politicians who voted for state-specific tax systems. My review of data over time indicates that the volatility of state taxes for the United States as a whole was lower than the volatility for all or most states in four of the last six decades. In the 2000-2009 and 2010-2019 decades, state taxes for the United States were more volatile than many states. This appears to be have driven by a volatility increase in California, which pulled up overall U.S. volatility.

[85] United States Census Bureau, "Annual Survey of State and Local Government Finances" (United States Census Bureau, 2019), https://www.census.gov/programs-surveys/gov-finances.html.

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[88] Cornia and Nelson, "State Tax Revenue Growth and Volatility."

[89] This depends on the incidence of the corporate income tax, a topic subject to dispute.