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– work in progress –

Abstract

Combining a variety of survey and administrative data, this paper measures the progressivity of taxes and transfers for each of the US states and contrasts it to progressivity at the federal level. Our findings are fourfold: (i) the tax and transfer system is progressive at the federal level; (ii) state and local tax and transfer systems are close to proportional, on average: the regressivity of state consumption and property taxes neutralizes the progressivity of state income taxes and transfers; (iii) there is substantial heterogeneity across states, and its key determinant is the choice of the tax base (sales and property vs income); (iv) Democrat-leaning states tend to have more progressive systems, but richer and more unequal states tend to me more regressive.

Keywords: Tax and Transfer Progressivity, State and Local Taxes

JEL Classification: H2, H7, R5

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1 Introduction

Income inequality has risen sharply in the United States and other countries during recent decades. This trend has rekindled interest in using government redistribution through taxes and transfers as a policy tool to potentially address adverse aspects of inequality. A natural first step is to measure the redistribution already taking place through the current government tax- and transfer system. Most of the US debate has focused on redistribution at the federal level. But tax revenue at the state and local level is also large, amounting to around 7% of GDP compared to 8% for federal income taxes and 6% for payroll taxes during the last decades. Moreover, there is large variation across US states in terms of the level of per capita tax revenue, in terms of the choice of tax base, and in terms of the level and composition of spending.[1] Thus, one might expect substantial differences across states in terms of how much redistribution the tax and transfer system delivers.

This paper studies taxes and transfers at the state and local levels and contrasts it to progressivity at the federal level. We address three questions. First, how do state and local taxes and transfers impact overall fiscal redistribution? Second, how much variation is there across US states in tax and transfer progressivity? Third, what are the key correlates of this progressivity?

We measure progressivity at the state level taking into account a wide array of taxes and transfers including income taxes and credits, consumption taxes (sales and excise taxes), property taxes, and a range of transfers such as unemployment insurance and disability benefits. Our primary data source is the Annual Social and Economic Supplement (ASEC) – the March supplement of the Current Population Survey (CPS). We supplement this with a range of additional data sets, including the IRS Statistics of Income (SOI), the Consumer Expenditure Survey (CEX), and the American Community Survey (ACS).

Using the ASEC micro data, we calculate income taxes for each household using the Census Bureau tax model.[2] The ASEC data also reports a range of transfers received. However, the ASEC data does not provide self-reported information on sales taxes, excise taxes or property taxes paid. We impute sales and excise taxes using state-level data on tax rates, combined with Engel curves which we use to estimate expenditure levels by income using CEX data. We impute property taxes by matching households to similar households in the ACS, where property taxes are self-reported (we also impute property taxes to renters, implicitly assuming

[1] Figure 51 in the appendix illustrates the differences in tax bases and tax levels across US states.

[2] See for example O'Hara (2006) for a description of this model and Wheaton and Stevens (2016) for a comparison with other tax imputation models such as the NBER's TAXSIM.

that the incidence falls on them). Finally, we partition transfers into those provided by the federal government and those provided by non-federal (state and local) governments.

One challenge in measuring income and taxes at the top of the household income distribution is that the ASEC data is top-coded. In addition, realized capital gains are an important source of income at the very top, and these are not reported in ASEC except for a small number of years. We therefore use state-level data from the IRS SOI to impute incomes and taxes to households above a high income threshold.

There are a variety of possible ways to characterize the amount of redistribution embedded in the tax and transfer system. We start by pursuing a non-parametric approach where we estimate the average taxes net of transfers for each percentile of households in the pre-tax income distribution and provide a scatter plot of pre-tax income against income net of taxes and transfers for these percentiles. We do so using our ASEC data and after calculating taxes and transfers as described above.

Figure 1 shows that the relationship between pre-government income and post-government income is approximately log-linear, both on the federal level and on the state and local level. At the state and local level, this approximation is extremely accurate. It is also accurate at the federal level except for the bottom four percentiles and the top two percentiles where the effective net tax rate is lower than suggested by a linear relationship.

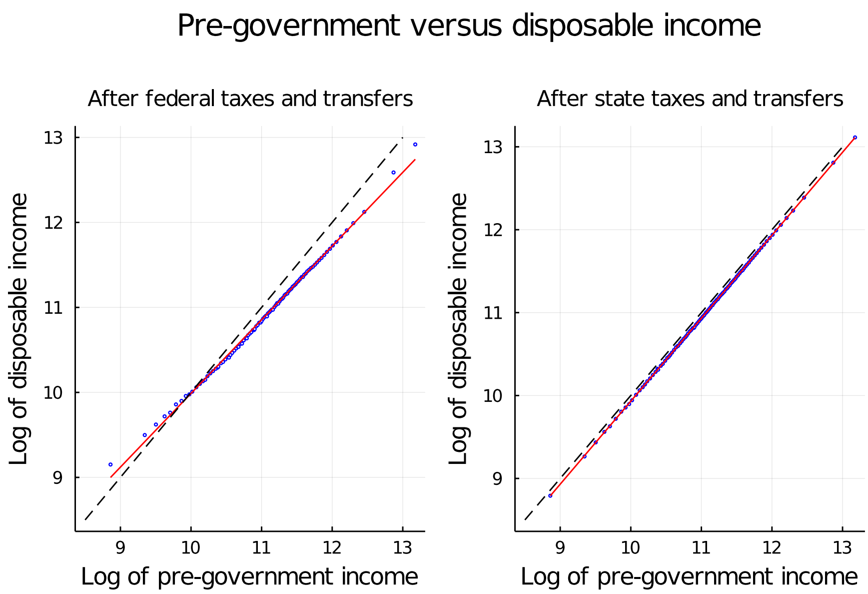

Figure 1: Scatter plot of pre-government versus post-government income for federal taxes and transfers (left panel) and state and local government taxes and transfers (right panel). Post-government income is defined as pre-government income minus taxes plus transfers. Each dot represents the average within one percentile of households, where households are ranked according to pre-government income. Source: ASEC and own calculations.

Given this near log-linear relationship, we follow Heathcote, Storesletten, and Violante (2017) and approximate the tax and transfer system by a log-linear function and denote the slope of this function $1 - \tau$

$$\tilde{y} = \lambda y^{(1-\tau)}$$

where y is pre-tax income and $\tilde{y}$ is income net of taxes and transfers. A steeper slope implies lower progressivity and, hence, less redistribution. This approximation allows for progressivity to be captured by a single parameter τ. Namely, when $\tau > 0$, the tax- and transfer system is progressive in the sense that the marginal net tax rate is always larger than the average net tax rate. The larger is τ, the larger is this difference and the greater the effective redistribution. Moreover, $\tau = 0$ implies a flat tax system and $\tau < 0$ implies a regressive tax system.

The key findings from the paper can be summarized as follows. First, the tax and transfer system is progressive at the federal level. The estimated value for τ (when $\tilde{y}$ is defined as pre-government income plus federal transfers minus federal taxes) is positive, the effective marginal net tax rate (taxes net of transfers) is always increasing in pre-government income, and marginal tax rates always exceed average tax rates. To see this, consider that the slope between any two percentiles in figure 1 is never larger than one.

Second, state and local tax and transfer systems are close to proportional, on average: the dots in the right panel of figure 1 are parallel to the 45-degree line.[3] Specifically, sales taxes, excise taxes and property taxes are regressive to such an extent that they neutralize the progressivity in state income taxes and transfers.

Third, while state and local tax systems are close to proportional on average, there is substantial heterogeneity across states. And the proximate cause of this variation is the choice of tax base. States and local governments relying on sales, excise or property taxes tend to have regressive tax and transfer systems. In contrast, states relying on income taxes tend to have progressive systems. Thus in states relying on sales and property taxes, the state tax system undercuts the progressivity delivered through federal taxes and transfers, while in states relying on income taxes, the state system reinforces federal progressivity.

Fourth, we have also explored, through a multivariate regression analysis, how a variety of more fundamental state characteristics correlate with state tax progressivity. We find that Democrat-leaning states tend to have more progressive systems, and that more ethnically diverse states are also more progressive. At the same time, richer states (proxied by median

[3]Note that our analysis abstracts from redistribution through the provision of local public goods and services such as schools, fire protection, and local law enforcement.

household income) tend to be less progressive. And several measures of income inequality also correlate negatively with progressivity. In particular, states in which a larger share of total income accrues to the top one percent of households tend to be less progressive, as do states in which a larger share of households live below the poverty line.

We include as many taxes as possible in our investigation of cross-state differences in tax progressivity. We do so because of evidence provided by other studies, for example Baker, Janas, and Kueng (2020), which show that differences in state taxes have been growing over time. Moreover, this comprehensive approach allows us to investigate if there are progressivity trade-offs between taxes at the state and local level; states with very regressive property taxes might provide more progressive income taxes and transfers. Our analysis shows that these tradeoffs are negligible.

Another strand of the research on state taxation, for example Kosar and Moffitt (2017) and Fleck and Simpson-Bell (2019) focus on the role of state policies as key elements of the American social safety net. While their focus is on (permanently) low income households, our group of interest are households with labor force attachment. These groups are distinct in their earnings capacity and differ profoundly with respect to their lifetime tax and transfer incidence. Moreover, we make specific adjustments to allow our analysis to include high income households as they account for a large share of total taxes paid while they receive few (no) transfers.

Furthermore, in comparison to earlier papers, our measures of progressivity provide a sharper perspective on the differences between states. First, we measure these differences using the parametric tax function of Heathcote, Storesletten, and Violante (2017) which allows a consistent comparison across states and over time. Second, we do not only characterize the taxation aspect of state fiscal policy but we also include transfer spending when measuring progressivity. Finally, we conduct a comprehensive empirical account of both direct and indirect state and local taxes. Specifically, we complement our empirical analysis with data from the Survey of State and Local Government Finances of the Census Bureau to construct precise measures of excise tax rates. In addition, as we find property taxes to be exceptionally regressive, we pursue several different approaches to construct household measures of property taxes paid.

We also study the empirical correlates of state characteristics and our state-level progressivity measures. First, more left-wing states are more progressive. This finding is corroborated by earlier studies on state tax policy and political leaning, for example Chernick (2005). Second, more unequal states tend to be more progressive. This observation is in line with the implication of the standard Downsian median voter model but runs against the common observation from evidence across countries that more unequal countries have less redistribution than countries that are more equal. Finally, richer states are more progressive. A possible explanation for this last feature is that the federal system provides a lot of transfers to people in poor states, but not so much support for relatively poor people in rich states. Accordingly, rich states might want to do more redistribution towards their relatively poor residents.

The remainder of this paper is organized as follows. In section 2, we present our sample. In sections 3 and 4, we describe our progressivity estimation methodology and present its results. In section 5, we investigate the relationship between our state specific progressivity measures and other state characteristics such as average incomes and political color. Section 6 concludes.

2 Data

Sample Our primary data source is the Annual Social and Economic Supplement (ASEC) to the Current Population Survey (CPS). The unit of observation is the household, and we follow the same sample selection criteria as Heathcote, Perri, and Violante (2010). Specifically, we select households with heads aged between 25 and 60 in which at least one spouse had at least an earned income of working part-time at the federal minimum wage (equivalent to $5,150 in 2005 and $7,250 in 2016). This income requirement implies we drop 4.1% of households in the 25-60 age range. We focus on three two-year periods: 2005-06, 2010-11, and 2015-16.[4] As we will shortly describe, we supply our ASEC data with income and tax data for very high income households from the IRS SOI state-level tables.

Income Definition Our measure of gross pre-government income is similar to Heathcote, Storesletten, and Violante (2017). It includes pre-tax income from wages and salaries, business and professional practice, farming and cropping, interest, dividends and mutual funds, rents and royalties, as well as assistance from friends and relatives. We also include realized capital gains for high income households.[5]

Income Taxes Post-government income is pre-government income plus transfers minus taxes. The federal-level taxes we include are federal income taxes and federal payroll "FICA" taxes. For employees, we add the employer-paid portion of payroll taxes to pre-government household income, and include both the employer and employee portions in taxes.[6] The state and

[4]We pool observations over two adjacent years to increase the sample size; recall that our analysis is at the state level.

[5]Capital gains are not available in the ASEC data, but they are reported in the IRS SOI data.

[6]Note that we do not attempt to impute federal corporate taxes to households.

local level taxes are state and local income taxes, property taxes, sales taxes, and excise taxes and user charges.

The ASEC dataset contains measures for federal and state income taxes (including earned income and child tax credits) which are provided by the Census Bureau tax model. This model is similar to the NBER TAXSIM model, but one advantage is that the Census model integrates confidential IRS data to deliver sharper estimates of some income components (such as capital gains), exemptions, credits and deductions. We impute sales taxes, excise taxes and property taxes following a procedure which we describe below.

Transfers Transfers are almost all self-reported in ASEC. Transfers we include at the federal level are income from survivor's benefits, income from disability benefits, and income from SNAP (food stamps). At the state and local level we have income from unemployment benefits and TANF (Temporary Assistance for Needy Families) has both federal and state components, which we partition between the two levels of government. Those are all the transfer components we include in our baseline narrow measure of transfers.[7]

We will also consider a broader measure of transfers which adds income from veteran's benefits and worker's compensation as well as supplementary security income and two more components: (1) an estimate for the value of Medicaid benefits received (which again have both federal and state components), and (2) an estimate for the present value of future social security benefits associated with payroll taxes. We impute social security benefits following the same procedure as Heathcote, Storesletten, and Violante (2017).[8] Table 1 summarizes the federal versus state and local components of taxes and transfers, and reports the average values for those taxes and transfers relative to average pre-government household income in 2010 and 2011.

One could in principle consider even broader measures of transfers, including, for example, estimates for the value of public education – spending on which varies significantly across states. However, much state and local government spending has a large public-good component. For example, public education reduces crime and unemployment, implying that the social value of public schooling exceeds its private value. That is precisely why many local government services are publicly-provided. The gap between the private value of public spending and the dollar cost of that spending is likely to be especially large for low income households, who are forced to over-consume education and health care, relative to other goods and services. Thus,

[7]For households living in Alaska, we also include income from the Alaska Permanent Fund. We explain in section A.4 how we impute this dividend income.

[8] This involves calculating the marginal increase in the discounted value of social security transfers, assuming the current earnings are part of an average life-cycle profile of earnings and that the household members expect average longevity. See "Imputation of social security benefits" in their appendix for details.

	Federal		State & Local	
		% inc		*% inc*
Taxes	Income	*10.99*	Income	*3.26*
	FICA	*6.47*	Property	*2.89*
			Sales	*0.86*
			Excise + User Charges	*0.61*
Transfers	Medicaid*	*1.19*	UI	*1.12*
	Survivors Insurance	*1.13*	Medicaid*	*0.58*
	SNAP	*0.33*	Workers' Comp.	*0.15*
	SSI	*0.21*	TANF*	*0.01*
	Veteran's Benefits	*0.19*		
	DI	*0.17*		
	School Lunch	*0.16*		
	TANF*	*0.01*		

Table 1: Classification of federal and state and local taxes and transfers. Taxes and transfers are reported as shares of pre-government income. Transfers marked with an asterisk have both federal and state components.

counting the value of spending on public schools as a transfer would exaggerate the value of public income support low income households receive. Note that this challenge also applies to Medicaid spending, which is why we have excluded that component from our baseline transfer measure.[9]

Property Taxes We impute property taxes to households who are home owners using a matching procedure which links households in our ASEC sample to similar households in the American Community Survey (ACS). The advantage of the ACS is that it contains self-reported data on house values, rents, and property taxes.[10] We match each ASEC household with the household's k nearest neighbors in the ACS. We insist that matched households reside in the same state (and the same county where county is reported) and look for households that are as similar as possible in terms of demographics and household income. We then impute property taxes as the median ACS property tax reported by these k matched ACS households (see the Appendix for more details).

Renters do not pay property taxes directly, but there is evidence, for example in Tsoodle and Turner (2008), that property taxes that are nominally paid by landlords in practice are mostly

[9]It also arguably applies to food stamps, though food stamps are likely closer substitutes to cash than is public health insurance or free schooling.

[10]In contrast, the raw ASEC data has only an imputed value for property taxes, and the Census imputation procedure has been changed over years and does not use location information, which is critical for assessing variation in tax rates across states.

passed through to tenants. That evidence is consistent with models in which new housing can be elastically supplied at a constant marginal cost, and in which landlord-investors must earn a fixed market return. In our ASEC data we can identify renters, but we not observe rent paid, nor what portion of this rent constitutes pass-through of property taxes. Our imputation procedure proceeds as follows. First, we match ASEC renters to renters in the ACS following a similar matching procedure to the one for owners. This gives us estimates for rents paid at the household level. Second, we translate rents into estimates for house values using state-specific price-to-rent ratios from Zillow. Third, given estimated house values we estimate property taxes using state average property tax rates.

Figure 2 plots estimated home values (for homeowners) and rents (for renters) as a function of pre-government income. If housing consumption was proportional to income, one would expect a linear relationship between home values / rents and income, with a slope equal to unity when plotted in log space. However, the figure indicates a very different empirical relationship. Home values increase less than proportionally to income, especially at low income levels where home values are essentially flat at around $160,000 up to annual incomes of around $35,000. Because property taxes are typically proportional to home values, this implies that property taxes will be strongly regressive, especially at low income values. At higher income levels, home values and rents do rise with income, and home values are nearly proportional to income over a wide range of income values. But at the very top of the distribution, home values again rise more slowly. In particular, as income more than doubles from $160,000 to $330,000, average home value only increases by less than 50%, from $440,000 to $660,000. That is why property taxes account for a relatively small share of total taxes paid by the very rich (see figure 5).

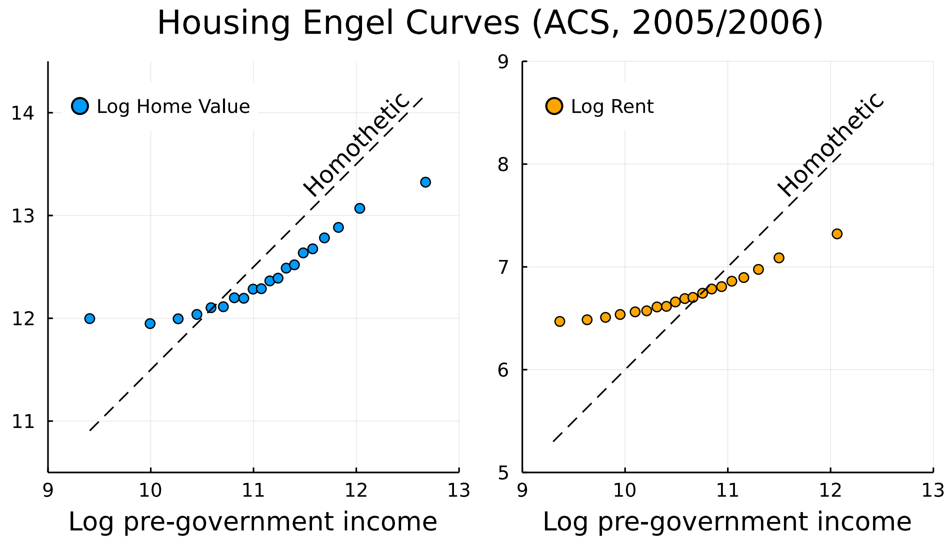

Figure 2: Home values (for owners) and rents (for renters) by pre-government income. Each dot represents the average within one vingtile of households, where households are ranked according to pre-government income. Source: ACS

Sales and Excise Taxes Finally, we impute consumption and excise taxes using expenditure-specific (linearized) tax rates as well as spending shares constructed from the CEX. In particular, we use the CEX to estimate economy-wide expenditure shares by income on goods subject to sales taxes, and on goods subject to excise taxes. Excise taxes apply to tobacco, alcohol, gasoline, and various utilities. We then estimate state-specific sales tax rates and excise tax rates and apply these to our CEX-based expenditure estimates to impute tax payments at the household level. Our data on sales tax rates are from the Book of States and (for local sales taxes) the Tax Foundation. Our methodology for excise taxes is similar, with two adjustments. First, in practice excise taxes are applied on a per unit basis: we convert them to tax rates by dividing the per unit tax by the pre-tax retail price. Second, goods subject to excise taxes are typically also subject to sales taxes: we take care not to double count the latter.[11]

Figure 3 plots average CEX expenditure on sales and excise taxable goods, as a percentage of pre-government income, for different income groups. Spending on sales taxable goods is declining in income, reflecting the fact that savings rates tend to increase with income. Thus sales taxes, though proportional relative to spending, are effectively regressive relative to income.

[11] Appendix A.5 provides a more detailed description of our procedure to estimate excise taxes. Moreover, in section A.1 of the appendix, we provide a comprehensive description of our ASEC sample and compare it to external measures of gross income. To facilitate comparison with the PSID sample used by Heathcote, Storesletten, and Violante (2017), we also provide an analogous description of their sample.

The pattern for excise taxable goods is even more extreme, reflecting the fact that these goods tend to account for larger shares of total consumption for poorer households. Thus excise taxes will be even more regressive than sales taxes. Figure 4 decomposes excise-taxable spending into its sub-components. Utilities are the biggest single component, followed by gasoline. Note that expenditure shares on utilities and on tobacco decline especially rapidly with income, implying that taxes on those goods will be the most regressive.

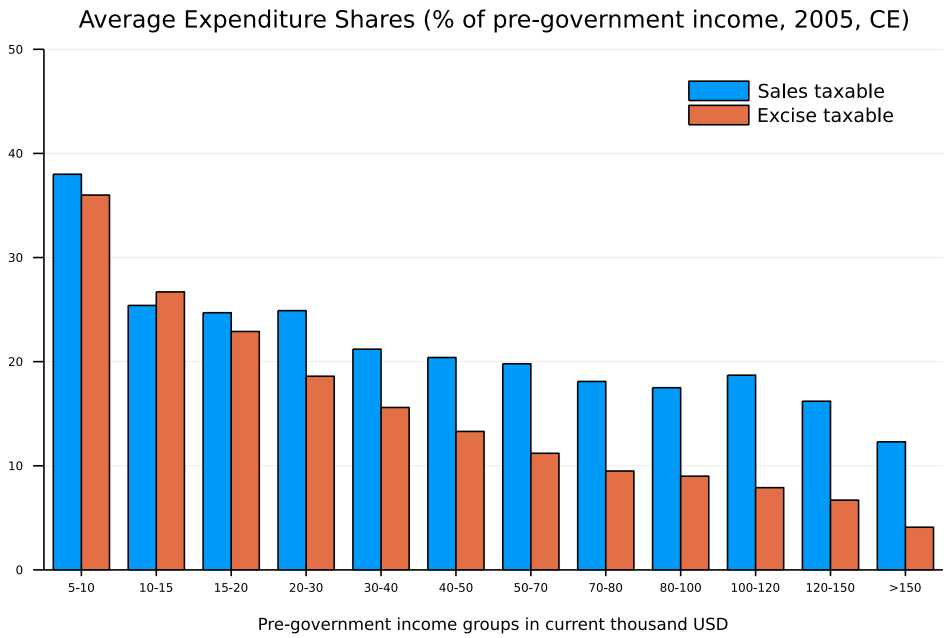

Figure 3: Sales and excise taxable expenditure as a share of income. Source: CEX 2005

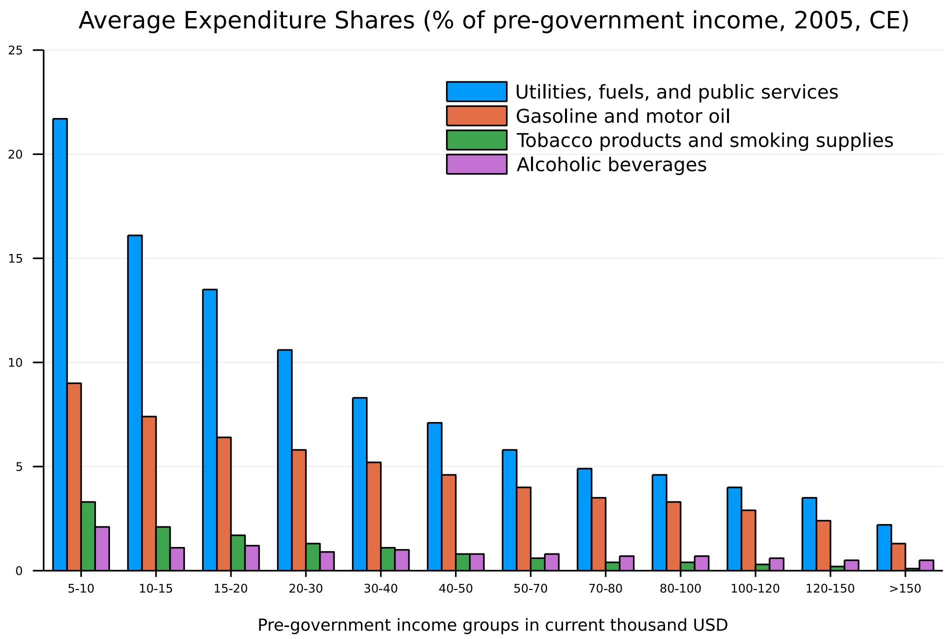

Figure 4: Subcomponents of excise taxable expenditure as a share of income. Source: CEX 2005

High Income Households The main limitation of the ASEC for measuring income received and taxes paid is that both income and taxes are top-coded. This makes it challenging to measure the progressivity of the tax and transfer system at the top. That is a concern, because a small share of high income households account for a large share of total taxes paid. For example, IRS SOI data indicate that tax filers with Adjusted Gross Income exceeding $500,000 in 2010 accounted for only 0.58% of all tax returns, but 29.5% of federal income taxes paid.

To address this concern, we turn to the state level tabulations for income and taxes provided by the IRS SOI program. These data have several advantages. Income includes realized capital gains, and income taxes capture actual federal income and payroll taxes paid. In addition, because the vast majority of high income households itemize, and deduct state income taxes and property taxes, we can also use the SOI data to estimate state income taxes and property taxes paid.[12] We use the IRS SOI tables, which report average values for measures of income and taxes for different bins of the AGI distribution. For example, the top three bins for 2010 are $200,000 to $500,000, $500,000 to $1m, and $1m plus. We merge the ASEC and SOI data by replacing ASEC households with pre-government income exceeding $200,000 with synthetic households from the SOI tables, drawing from the three top SOI income bins in proportion to their respective shares of all tax returns.

Figure 5 plots average tax rates by state for households in the $500,000 to $1m AGI bucket in the SOI. Federal income taxes are the dominant tax for this high income group, accounting for around 25 percent of income. FICA taxes are relatively small, because the social security portion of FICA taxes is capped. There is significant variation in the top rate across states, driven by differences in income tax rates across states. For example, households in this income bin pay around 30% of income in taxes in Florida, but 40% in New York. Nine of the ten lowest tax states are states which do not have a state income tax.[13]

[12]For example, 93.3% of households with AGI exceeding $200,000 itemized in 2005. The number of itemizers declined post the 2017 TCJA (Tax Cut and Jobs Act) which introduced caps on deductions.

[13]New Hampshire taxes interest and dividends. Note that households in states without a state income tax might still pay some state income taxes if they earn income in other states.

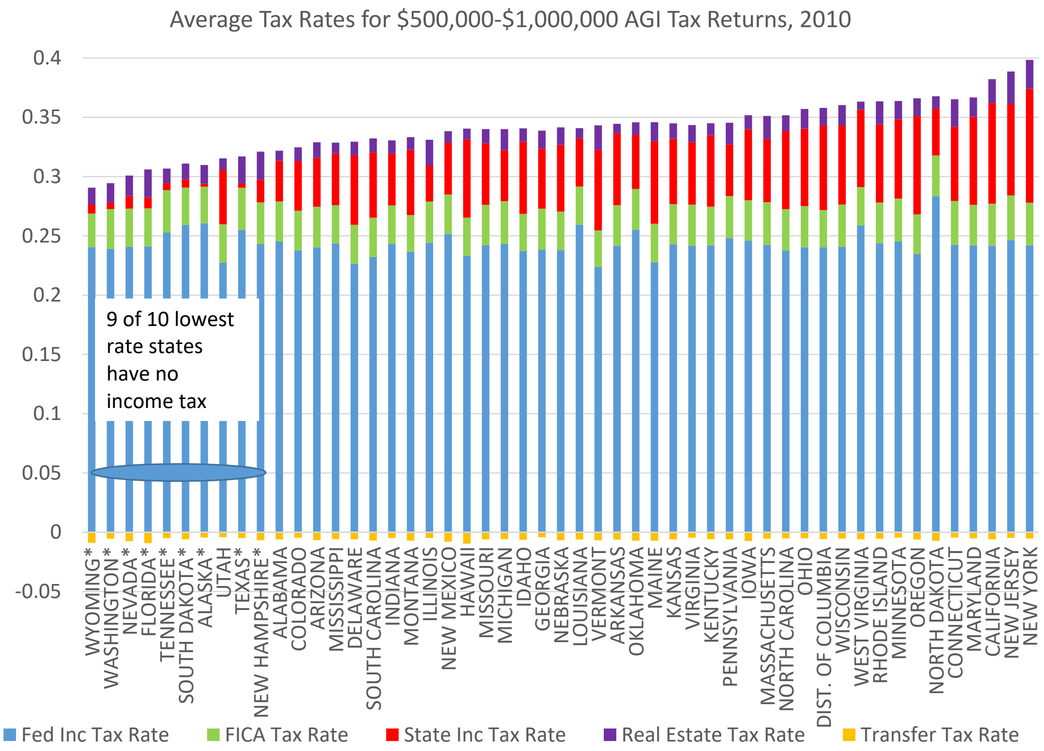

Figure 5: Tax rates for households with income between \$500,000 and \$1,000,000. Source: IRS SOI 2010

3 Estimating Progressivity

Our estimation follows closely Heathcote, Storesletten, and Violante (2017). Specifically, we measure progressivity as the coefficient estimate of τ in the following regression

$$\log(y_i - T_i) = \lambda + (1 - \tau)\log(y_i) \tag{1}$$

where i indexes households, y_i denotes pre-government income, and T_i denotes taxes net of transfers.

However, our analysis departs from Heathcote, Storesletten, and Violante (2017) in that we will consider a range of different measures of T_i and thus construct different estimates for τ. First we include only federal taxes and transfers in T and estimate a coefficient for federal progressivity, τ^f. Then we do the same thing, but using only state and local taxes and transfers to estimate state progressivity, τ^s. Finally we include all taxes and transfers to estimate overall progressivity τ.

Contrary to Heathcote, Storesletten, and Violante (2017) we do not subtract deductions and exemptions from our income measures in this estimation (we do, of course, incorporate how they impact taxes paid). The reasons are twofold. First, it is difficult to accurately measure deductions in the ASEC data because Adjusted Gross Income and Taxable Income are both top-coded. Second, our focus is on measuring redistribution (rather than quantifying distortions), and for quantifying redistribution the gap between *total* income before and after taxes and transfers is more relevant than the gap between *taxable* income.

We will be very interested in exploring differences in tax progressivity across states. If the tax and transfer system in each state was perfectly represented by equation (1) then one could safely estimate state-specific values for τ by least squares. In practice, of course, this simple specification does not perfectly fit the data (recall figure 1). For example, disposable income at very low income levels is higher than the best linear-fit would predict. As a result, one might expect to estimate higher values for τ in states with more poor households, even if tax and transfer rules were identical across states. To avoiding confounding differences in true tax progressivity with differences in state income distributions, we reweight household observations state by state, so that the reweighted state income distribution for each state resembles the national distribution. We then estimate state specific $\tau's$ using this reweighted data. See Appendix B.2 for more details.[14]

4 Results

Figure 6 reports average state tax rates by state for our sample, defined as total state taxes net of transfers paid by all households relative to total pre-government income. In addition, total net taxes are broken down into state income taxes, sales taxes, excise taxes, property taxes and transfers (which enter negatively).

The first clear message is that net tax rates vary enormously across states. Net taxes are actually negative in Alaska, but exceed 10 percent of household income in New Jersey and New York. Second, states that do not levy income taxes tend to have much lower average net tax rates

[14] Note that despite using a different dataset and making some different measurement choices (including focusing on actual rather than taxable income) the log linear relationship between gross income and disposable income captured by equation (1) remains superior to other functional forms such as affine tax-and-transfer functions (see appendix B.1).

overall – the zero income tax states are marked with an asterisk. Third, in addition to significant variation in income tax revenue, there is also large cross-state variation in property tax revenue, and states with the highest taxes overall, including New York and New Jersey, tend to levy high property taxes. Conversely states that do not levy income taxes do not appear to make up for lost revenue by imposing especially high property taxes. Fourth, while sales taxes, excise taxes, and transfers all vary across states, they are all relatively small components of the overall net tax burden. An exception is Alaska, where very large transfers – the Alaska Permanent Fund Dividend – translate to a negative net tax rate.

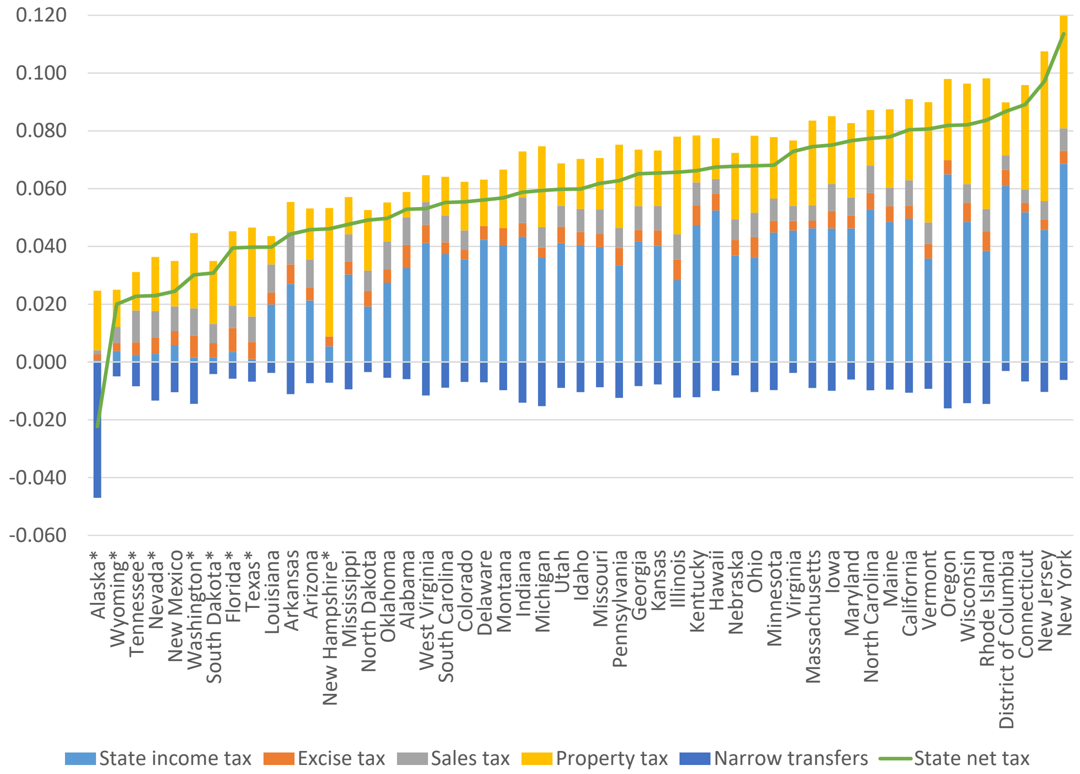

Figure 6: Average tax rates by state

Next we turn to how the distribution of the net tax burden across the income distribution varies across states. To set the stage, we start with two states with quite different tax structures – California and Texas – and dig into what drives differences in progressivity between their respective systems. Figure 7 plots taxes paid, as a share of pre-government income, for each quintile of the income distribution, as well as for the top one percent for 2010 and 2011.

California is blue, and Texas is red (naturally). The top left panel indicates that California has a strongly progressive state income tax, while Texas has no state income tax. The bottom left panel indicates that sales and excise taxes are similar across all income bins in the two states.[15] Property taxes are also quite similar, albeit slightly higher in Texas. Transfers, in contrast, are generally much larger in California, especially at the bottom of the income distribution. It is clear from these plots that overall California has a much more redistributive tax and transfer system than Texas: the poorest households in California receive much larger transfers, while the richest pay much higher taxes.

Figure 7: Average tax and transfer rates for California (blue) and Texas (red).

Table 2 reports overall estimates for federal and state tax and transfer progressivity. Here we pool households across all states, and estimate the summary progressivity parameter τ using different measures of taxes and transfers. In the top part of the table we include only federal taxes and transfers. We find, as in Heathcote, Storesletten, and Violante (2017), that the federal tax system is quite progressive. With only federal taxes, we estimate $\tau = 0.119$. Adding our narrow transfer measure boosts the progressivity estimate to 0.154, while adding social security

[15]The sales tax rate in Texas is 6.25% compared to 7.25% in California.

and Medicaid transfers raises progressivity further to 0.200. The baseline estimate in Heathcote, Storesletten, and Violante (2017), who also focussed on federal taxes and transfers was similar at $\tau = 0.181$.

	Narrow	*Broad*
Federal		
Income Taxes	0.119	
+ Transfers (τ^f)	0.154	0.200
State		
Income taxes	0.011	
+ Transfers	0.035	0.053
+ Property taxes	0.018	0.037
+ Sales taxes	0.014	0.033
+ Excise taxes (τ^s)	0.008	0.027
State + Federal (τ)	0.166	0.227

Table 2: Estimates for progressivity τ from pooled national sample.

The middle panel of the table isolates the progressivity embedded in state taxes and transfers. We start with just including state income taxes in our measure of post-government income, then add transfers, and then add, cumulatively, property taxes, sales taxes and excise taxes. The message is that state income taxes, on average, are very weakly progressive, while state transfers add a modest amount of redistribution. In contrast, property taxes, sales taxes, and excise taxes are all regressive, in the sense that when they are incorporated in the measure of post-government income, estimated progressivity declines. Overall state tax and transfer systems, on average, are close to proportional, with an estimated τ (for the narrow transfer measure) of 0.008.

Figure 8 translates these τ estimates (and the corresponding λ estimates) into profiles for marginal and average tax rates. The dotted red lines show tax rates implied by federal taxes and transfers. The dashed green lines show the effect of adding state income taxes and transfers, which increase marginal tax rates by around 5 percentage points. The solid blue lines add property and consumption taxes. These do not increase tax rates much overall, but they flatten the marginal tax rate schedule, reflecting the fact that these taxes tend to be regressive.

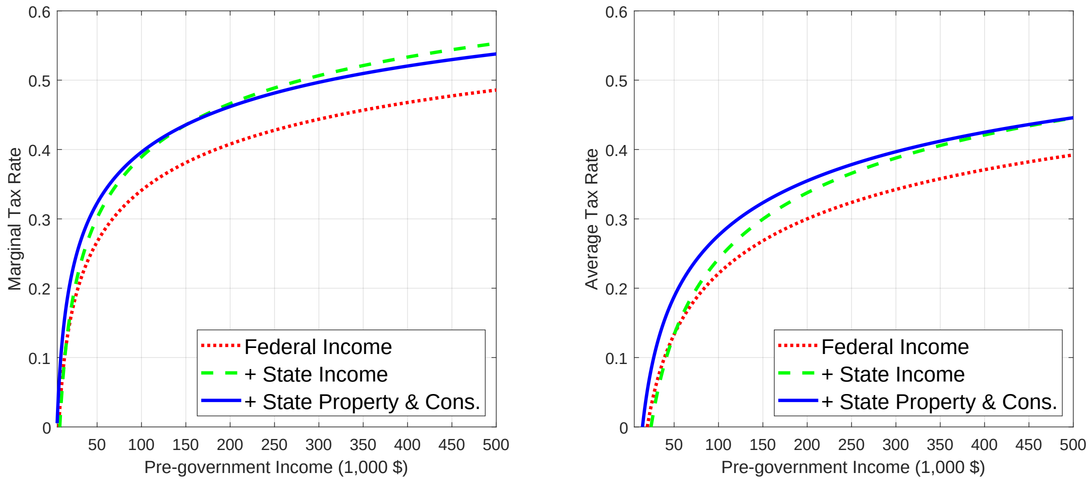

Figure 8: Average economy-wide marginal and average tax rate schedules for different measures of taxes and transfers.

Figure 9 plots estimates for the progressivity of state taxes and transfers, τ^s, for all US states. For each state, we report estimates using the narrow and broad measures of transfers (see section 2). States are ranked from the least to most progressive, according to the narrow transfers definition.

The first message from this figure is that there is a lot of cross-state variation in progressivity. For every state, progressivity is larger using the broad measure of transfers. While the transfer measure used changes the progressivity ranking slightly, the two different sets of τ estimates are strongly positively correlated.

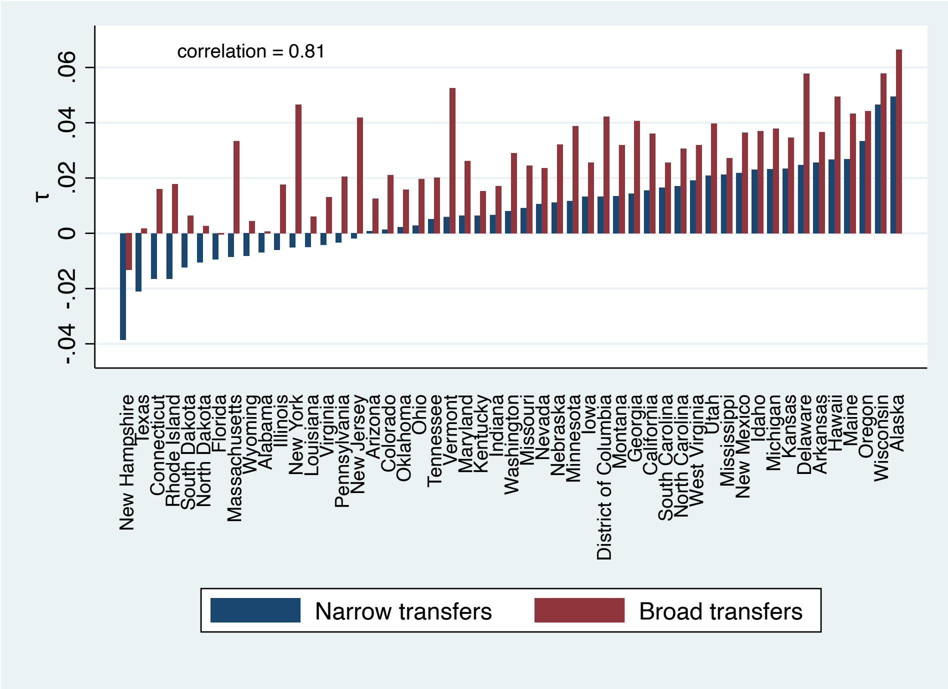

Figure 9: Progressivity of state tax and transfer systems. Progressivity is estimated using narrow (blue) and broad (red) measures of transfers (as defined in section 2).

Figure 10 plots contributions to progressivity from different types of taxes and from transfers (narrow definition) for each state.[16] State income taxes contribute positively to progressivity in all states, but the progressivity of those taxes varies across states, and is zero or near zero in the states that do not levy income taxes. Transfers also contribute positively to progressivity, again with significant variation across states. For example, transfers deliver more redistribution in Alaska, Wisconsin and New Jersey than in Texas or Florida. Apart from income taxes, all other state taxes are regressive. Property taxes are especially regressive. In fact, if they did not levy property taxes, almost all states would have progressive tax and transfer systems.

[16]For example, the contribution of sales taxes to progressivity in New Hampshire is estimated by regressing log household pre-government income minus sales taxes for New Hampshire households on a constant and log pre-government household income. The black dots sum the contributions of the τ estimates for different tax / transfer components. Note that the overall progressivity estimate τ^s is not identical to the sum of these separate components, so the ranking of states in figure 10 differs slightly from that in figure 9.

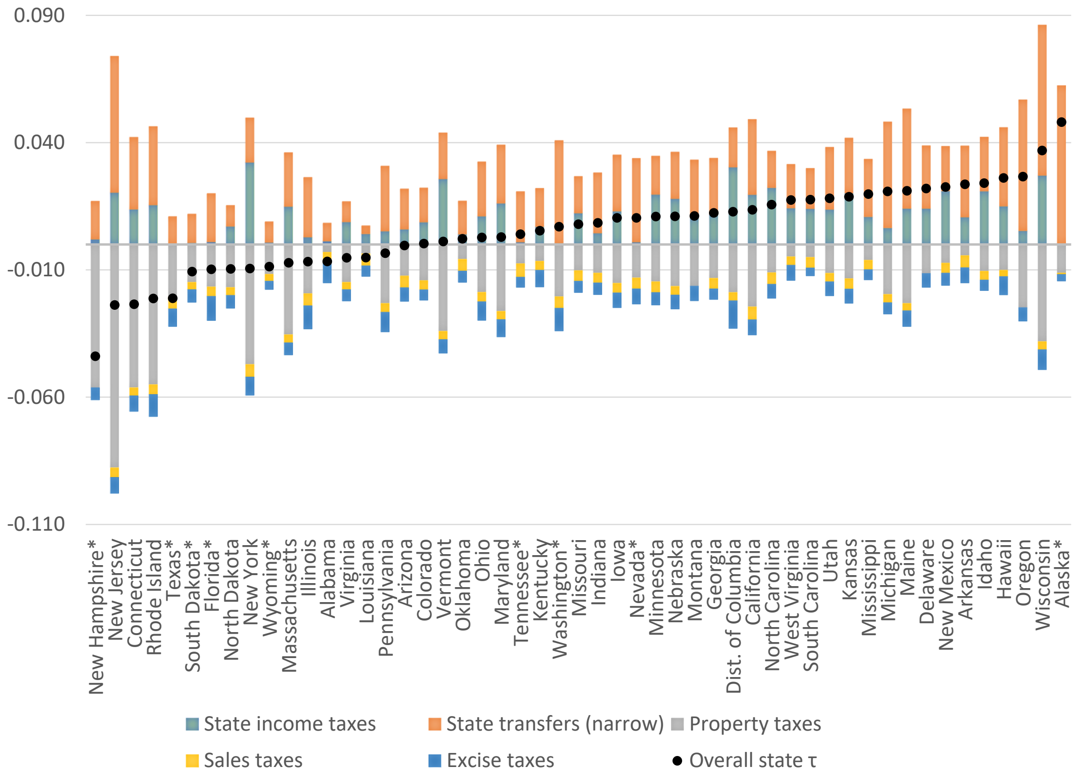

Figure 10: Decomposition of progressivity estimates at the state level.

What are the characteristics of the least (and most) progressive states? First, they tend to be states that do not have income taxes, which are typically a source of progressivity. Note that there is another reason why the no-income-tax states tend to be less progressive, which is that those states tend to provide lower transfers and thus deliver less progressivity via transfers.[17] In particular, figure 6 indicates that average state transfers are especially low in Florida and Texas (the two biggest zero-income-tax states) while figure 10 indicates that transfers contribute little to progressivity in those same states. An exception to this pattern is Alaska, which is able to fund very generous transfers without imposing an income tax, thanks to its oil revenues.

A second characteristic of low progressivity states is that they tend to have high property taxes. For example, New Jersey and New York have regressive tax systems overall, even though they have progressive state income tax systems, because they levy high property taxes.

[17] In turn, one reason transfers are lower in the no-income-tax states may be because those states collect less total tax revenue.

Figure 11 illustrates the geographical variation in state tax and transfer progressivity.

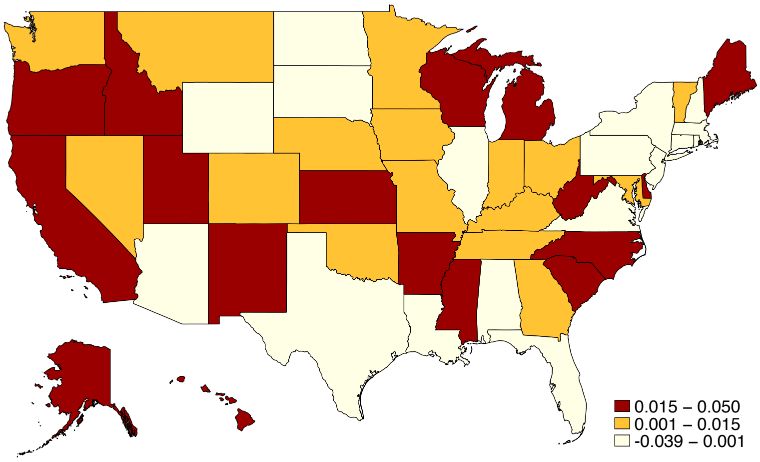

Figure 11: Variation in tax and transfer progressivity across US states

Figure 12 plots marginal and average tax rates for California (a progressive state) and for Texas (a regressive state). Income taxes and transfers are strongly progressive in California. Adding property taxes makes the California less progressive, and adding sales and excise taxes makes it less progressive still, but the system remains progressive overall, as reflected in increasing marginal and average rates. In Texas, in contrast, income taxes and transfers deliver very limited redistribution, and overall regressivity is driven by regressive property and consumption taxes. Thus, low income households pay a higher share of their income in tax in Texas than in California, while high income households pay much less tax in Texas.

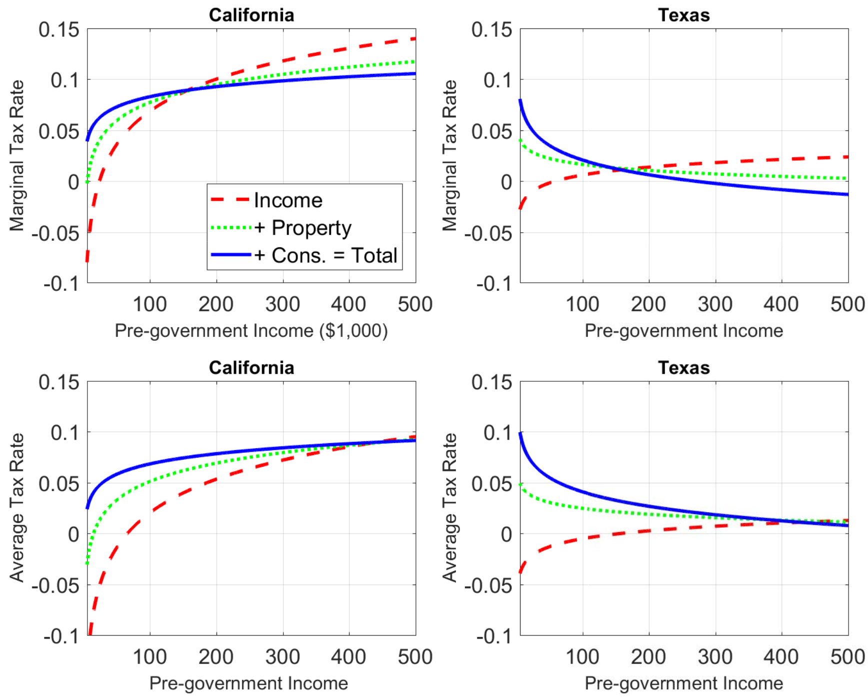

Figure 12: State tax and transfer schedules for California and Texas. The top two panels show marginal tax rates, while the bottom panels show average tax rates. The red dashed lines include only state taxes and transfers. The green dotted lines show the effect of adding property taxes, while the solid blue lines also add sales and excise taxes.

5 State Characteristics and Tax Policy

In addition to estimating state tax progressivity, we also compute state mean total tax rates as

$$\bar{t}_s = \frac{T_s - B_s}{Y_s} \tag{2}$$

where T_s are the sum of all state taxes (i.e. sum of income, sales, excise and property taxes) while B_s is the sum of all state transfers and Y_s denotes state total gross income.

Figure 13 shows a scatter plot of state progressivity against mean tax rates.

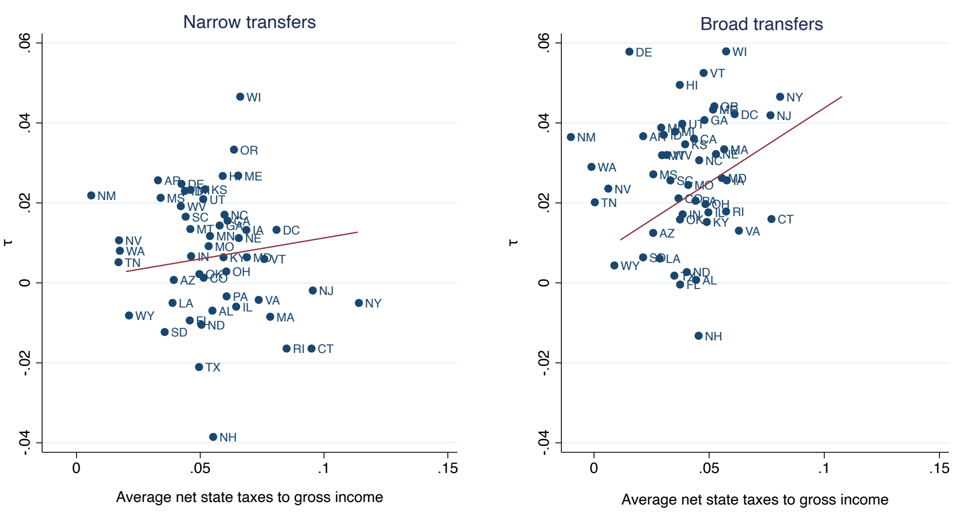

Figure 13: State mean tax rates versus state progressivity estimates (Alaska excluded)

Next, we study the relationship between a number of state characteristics and tax progressivity. We regress our estimated value for τ^s on the following state characteristics: (i) an indicator of the political color of the state, i.e. whether the state has a democratic or a republican governor; (ii) state demographics, i.e. an index of ethnic diversity of the state, the share of Black people in the state, and the share of college educated residents; (iii) measures of urbanization, i.e. the share of urban residents; (iv) measures of state well-being, i.e. median income and the share below the poverty line; (v) various indicators of income inequality, i.e. the share of income held by the top 1%, the 90-50 income ratio, and the 50-10 income ratio.

Table 3 reports the variables for which we found statistically significant coefficients. More democratic-leaning states and more ethically diverse states tend to have more progressive tax systems. Instead, richer states and states with more top and bottom inequality tend to have more regressive tax systems. Results are robust to the inclusion of division fixed effects.

Political Color See appendix E.1 how we measure political color (red, blue, purple) of each state. Out of all 51 states, 18 (35%) are classified as Democrat (blue), 24 (47%) as Republican (red) and 9 (17%) as swing (purple).[18]

To measure the association between political color and progressivity, we split states into low, middle and high progressivity groups. Next, we compute the share of states which are Democrat leaning in each progressivity group using the two different progressivity measures. The results are displayed in table 4.

[18]The purple states are Colorado, Florida, Iowa, Nevada, New Hampshire, Ohio, Pennsylvania, Virginia and Wisconsin.

	Mean (SD)	(1)	(2)
Democratic (0/1)	0.35	0.026	0.028
	(0.48)	(0.007)	(0.007)
Ethnic Diversity	0.52	0.096	0.093
	(0.16)	(0.044)	(0.048)
Log Median Income	11.02	−0.120	−0.098
	(0.14)	(0.044)	(0.049)
Income Share of Top 1%	0.17	−0.193	−0.217
	(0.04)	(0.057)	(0.071)
Share of Population in Poverty	0.14	−0.440	−0.478
	(0.03)	(0.175)	(0.191)
Share of Urban Population	0.74	−0.041	−0.063
	(0.15)	(0.028)	(0.030)
Census Division Fixed Effects		N	Y
N		50	50
R-squared		0.49	0.62

Table 3: Correlates of state tax and transfer progressivity, τ^s. The first column reports the mean value and standard deviation for each state characteristic. The second column reports coefficients from a regression of τ^s on the set of state characteristics. Other (statistically insignificant) controls included in the regression include the 90-50 income ratio, the 50-10 income ratio, the share of black residents, and the share of college educated residents.

	Share Democratic States
Progressivity	
Low	23.53
Middle	25.0
High	55.56
Average Tax Rate	
Low	17.65
Middle	23.53
High	64.71

Table 4: Share of Democrat states in different progressivity groups (%)

Democratic states are over-represented in the high progressivity and high mean tax rate group indicating that these states tend to implement more progressive tax and transfer policies and to collect more revenues.

Income: Mean, Median and Inequality See appendix E.2 how we compute state mean and median income as well as income inequality (table 17 and figures 43 and 44 show the complete results). As table 5 shows, there is a positive relationship between mean and median state income and tax progressivity as well as average taxes. For the inequality measures, this relationship is even larger. Thus, states with higher incomes tend to have more progressive tax systems and higher average tax rates. The same is true for state with more unequal pre-tax incomes.

Income Measure	Progressivity	Average Tax Rate
Mean	0.097	0.266
Median	0.074	0.225
Gini	0.225	0.192
90/10	0.32	0.146
90/50	0.216	0.291
50/10	0.346	-0.018

Table 5: State income measures, tax progressivity and average taxes (correlation coefficients).

Public Goods See appendix E.3 how we measure state spending for public good provision. We use two different scales: per capita and as a fraction of GDP. Both measures indicate that states which spend more on public goods have more progressive taxes but lower average tax rates.

Public Spending Measure	Progressivity	Average Tax Rate
% of GDP	0.568	-0.087
per capita	0.534	-0.269

Table 6: State spending on public goods, progressivity and average tax rates (correlation coefficients; excludes Washington DC)

Balanced Budget Rules See appendix E.5 how we measure the stringency of state balanced budget rules - we use the "ACIR" index of Poterba and Rueben (2001). States with stricter balanced budget rules have more progressive taxes. For the average tax rate, this relationship is negative. The correlation is small in both cases.

Balanced Budget Stringency Measure	Progressivity	Average Tax Rate
ACIR	0.042	-0.019

Table 7: State balanced budget stringency, progressivity and average tax rates (correlation coefficients; excludes Washington DC)

6 Conclusion

In this paper we provided a comprehensive assessment of tax progressivity in the US by separating progressivity into federal and state contributions. We included all major state and local taxes such as sales, excise and property taxes. We documented the relative importance of each of them. Also, we investigated the correlation of state tax progressivity and average tax rates with other characteristics.

Following Heathcote, Storesletten, and Violante (2017) we measure progressivity by estimating a log-linear pass through of pre-government income to post-government income. We find that taxes net of transfers are progressive at the federal level and slightly regressive at the state and local level. State and local income taxes net of transfers contribute to progressivity, while excise taxes, sales taxes, and property taxes are regressive. Quantitatively, the most important driver of regressivity are property taxes.

A possible explanation for why local taxes are less progressive than federal taxes is that states and local authorities may worry about tax competition through migration. Namely, they may worry about losing the high income taxpayers and attract low-income citizens who benefit from generous transfers and progressive taxes. While both the federal government and state and local governments are concerned about progressivity distorting labor supply and skill investments, the progressivity at the federal level does not cause any pressure for internal migration across state and local borders.

We also find that there is a large dispersion across US states in the degree of progressivity. A multivariate regression analysis of the determinants of state-level progressivity of the tax and transfer system implies that progressivity is higher in Democrat-leaning and more ethically diverse states. Controlling for these characteristics, it is lower in richer states and in states with more income inequality.

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Appendix

A Sample

A.1 Summary statistics

	Gross Income	Transfers	SS Benefits	Ded. + Ex.	FICA	Federal Taxes	incl. Credits	State Taxes	incl. Credits
Mean	75654	683	3064	16678	4928	9442	8979	2616	2501
Minimum	5200	0	0	0	0	0	-12042	-4483	-4486
25pctl	35000	0	1177	8200	2448	1405	1261	177	0
Median	58962	0	2401	16400	4208	4615	4570	1448	1342
75pctl	93002	0	4243	22800	6799	10709	10667	3230	3093
Maximum	1118740	89064	21499	125753	100705	180867	180867	104622	104471

Table 8: ASEC Sample (2005 and 2006, current USD, CB tax model variables in gray)

	CBO Income	Gross Income	Transfers	SS Benefits	Ded. + Ex.	FICA	Federal Taxes	incl. Credits	State Taxes	incl. Credits
I	9900	20107	1274	1421	13623	1494	820	-737	344	264
II	35200	39755	692	2343	17451	2912	2586	2115	999	911
III	59800	59354	571	3223	20740	4347	4921	4761	1725	1611
IV	92500	85337	464	4216	22812	6169	9064	9002	2827	2689
V	269400	174802	394	4191	9100	9815	29890	29862	7220	7061

Table 9: ASEC Sample: means of gross income quintiles (2005 and 2006, current USD, CB tax model variables in gray)

Note: Deductions and Exemptions (Ded. + Ex.) are constructed as the difference between two topcoded variables. Hence, this variable has a strong bias to zero and we do not use it in our estimation.

Also note: CBO income refers to the entire population (including retirees, non-working, etc) in 2007. It is a broad measure of market income and includes ”labor income, business income, capital gains, capital income (excluding capital gains), income received in retirement for past services, and other sources of income.” Our sample only includes the active population i.e. households with labor force attachment. Our gross income measure includes labor, business, farm, interest, dividend and rental income as well as private transfers.

	All	1	2	3	4	5	6	7	8	9	10
Gross Income	75654	14399	25869	34949	44192	54060	64748	77185	93308	117942	230098
Labor Income	70545	14224	25312	33964	42716	51954	61939	73297	88215	109412	204848
Other Income	5109	175	557	985	1476	2106	2809	3888	5092	8530	25250
Transfers	683	1625	920	749	640	595	546	458	469	470	320
SSI	99	316	153	107	101	69	67	44	48	45	32
SNAP	73	451	140	63	30	16	9	4	2	2	0
VP	128	166	97	134	112	138	133	133	142	122	108
UI	258	423	331	297	275	269	226	199	200	210	140
WC	102	159	168	122	107	87	105	74	72	87	38
TANF	22	110	33	25	15	15	6	4	5	4	1
Deductions + Exemptions	16678	11824	15443	16676	18161	20167	21324	22296	23319	13805	4512
Adjusted Gross Income	62717	15873	27106	36455	45578	55469	65889	77974	92830	103648	108948
at topcode (%)	23	0	0	0	1	1	2	4	23	95	99
Taxable Income	46038	4049	11663	19779	27418	35302	44565	55678	69511	89842	104436
at topcode (%)	14	0	0	0	0	1	1	2	5	37	95
FICA	9856	2138	3847	5103	6489	7928	9476	11203	13446	16200	22968
SS Benefits	3064	1079	1766	2154	2517	3111	3337	3876	4548	4802	3597
Income Taxes	11480	-1256	316	2181	3808	5398	7365	9842	13498	20484	52931
Federal	8979	-1356	-113	1440	2740	3990	5546	7490	10479	16402	42978
at topcode (%)	1	0	0	0	0	0	0	0	0	0	13
State	2501	100	429	741	1068	1408	1819	2352	3019	4082	9953
at topcode (%)	0	0	0	0	0	0	0	0	0	0	0
Sales Taxes	800	252	389	473	540	710	724	863	1001	1246	1819
Excise Taxes	585	319	418	482	523	599	601	648	697	746	831
Property Taxes	1798	974	1165	1256	1392	1814	1782	1986	2319	2431	2898
Owners (%)	72	41	49	59	67	73	78	83	87	90	92
Joint Filers (%)	62	31	38	44	53	62	67	74	79	82	86
HH Head Filers (%)	12	30	23	19	14	11	9	7	5	4	3
Single Filers (%)	26	38	39	37	33	27	24	19	16	14	11
Age	43	41	41	41	42	42	42	43	43	45	46
Size	2.9	2.5	2.5	2.6	2.7	2.9	3.0	3.1	3.2	3.2	3.3
White (%)	82	72	76	79	81	83	83	85	86	87	88
N	134180	13784	13638	13042	14008	13518	13184	12847	13137	13340	13678

Table 10: ASEC weighted household sample (2005 and 2006). Deciles refer to Gross Income. All variables in decile means and in current $ or %. N in thousands. Other Income comprises: business, farm, interest, dividend, rental, private transfers, capital gains (losses). ”At topcode” indicates the respective variable of at least one household member is at its topcode. After imputing federal taxes for topcoded observations (using the average rate of non-top coded observations in top 5 percentiles), mean federal taxes in the top decile are $55,341. FICA is sum of employee and employer portion. Age and white refers to the household head.

	All	1	2	3	4	5	6	7	8	9	10
Gross Income	77681	15034	26478	35173	44666	54461	64892	76859	92675	117865	243856
Labor Income	72478	14152	25143	33401	42314	51828	61706	73497	88143	111118	220504
Other Income	5203	882	1335	1772	2352	2632	3187	3362	4532	6747	23353
Transfers	829	1514	1141	1042	973	919	664	643	599	477	324
Deductions	20618	8932	13686	15969	17444	18211	19141	22945	24663	25482	39580
FICA	9867	2167	3871	5138	6520	8004	9549	11347	13501	16249	22080
SS Benefits	3002	944	1628	2108	2817	3341	3604	4077	4695	4253	2504
Income Taxes (Federal)	9187	-2549	-756	643	1884	3358	4991	6495	9625	15455	51206
Joint Filers (%)	69	23	35	46	64	73	82	87	91	94	94
HH Head Filers (%)	9	26	20	16	10	5	4	2	1	1	1
Single Filers (%)	22	51	45	37	26	22	14	10	7	5	5
Age	41	38	39	39	40	41	41	41	43	45	46
Size	2.8	2.3	2.4	2.5	2.8	2.8	2.9	3.1	3.1	3.2	3.2
N	13778	1378	1378	1309	1435	1383	1384	1351	1403	1378	1378

Table 11: PSID sample (2000, 2002, 2004 and 2006). Deciles refer to Gross Income. All variables in decile means (except N) and in current $. FICA is sum of employee and employer portion. Age refers to husband.

A.2 State population shares

Figure 14 displays the number of observations in our sample by state, including their home ownership status. Figure 15 shows that, when using proper sample weights, the state population shares of our sample coincide with the shares computed from full population count data provided by the Census Bureau.

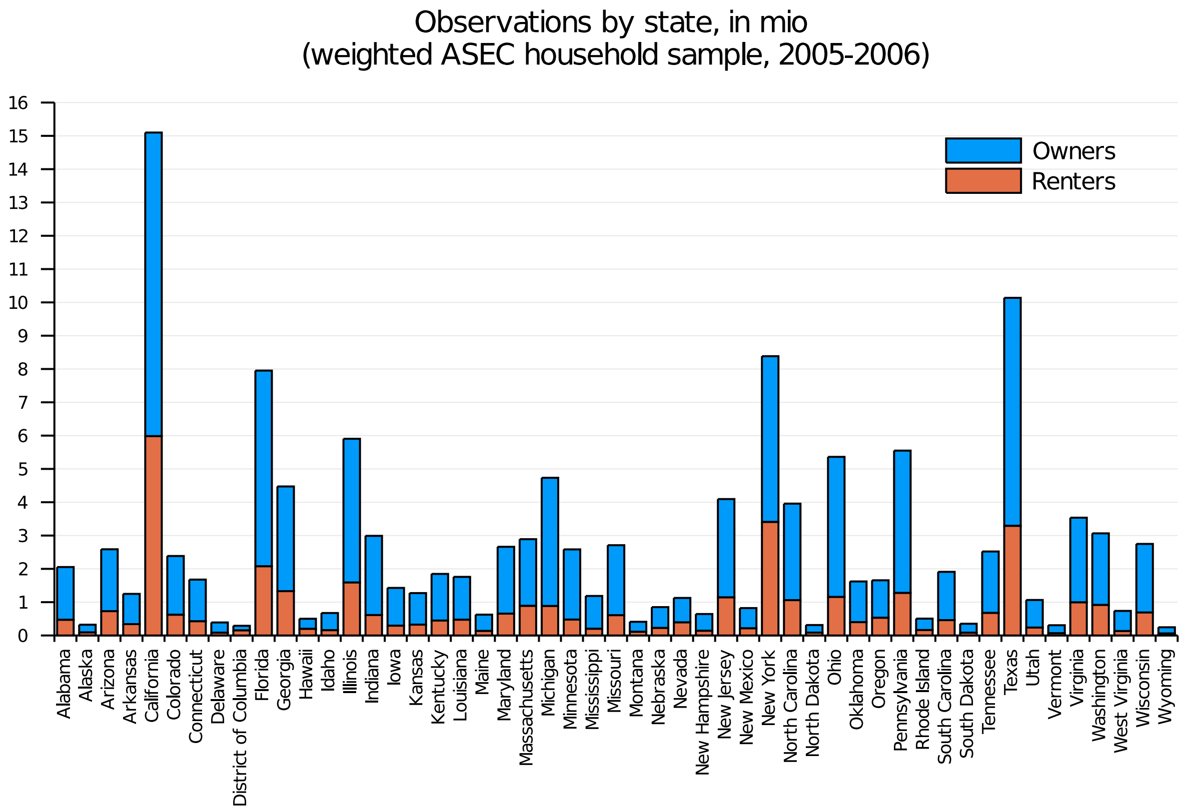


Figure 14: ASEC sample: observations by state

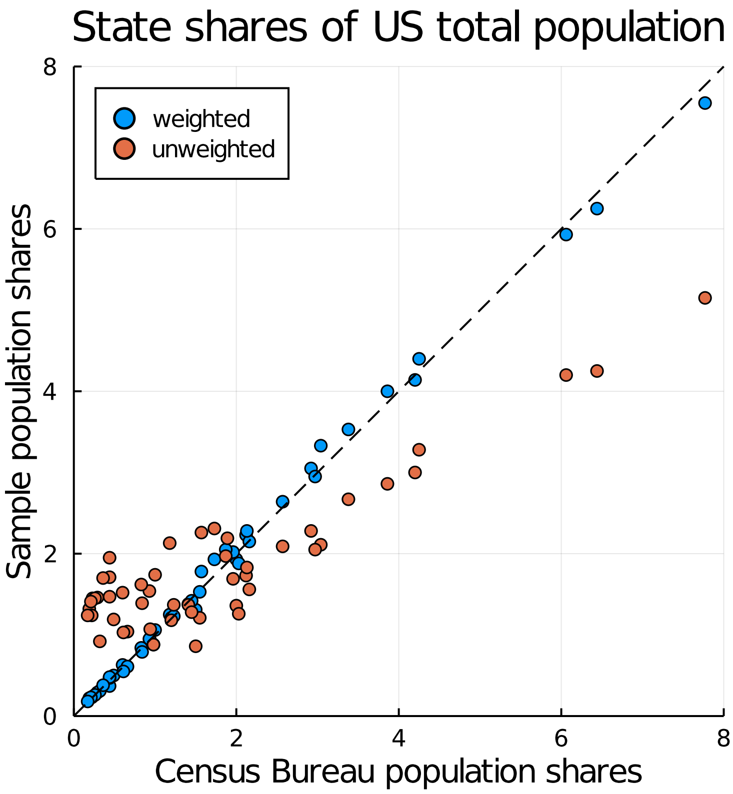


Figure 15: ASEC sample: observations by state

A.3 Assigning federal and state transfers

Transfer Program	Federal	State
Supplemental Security Income (SSI)	x	
Supplemental Nutrition Assistance Program (SNAP, "Food Stamps")	x	
Veteran's Benefits (VP)	x	
Unemployment Insurance (UI)		x
Worker Compensation (WC)		x
Temporary Assistance for Needy Families (TANF)	f_s^{TANF}	$1 - f_s^{TANF}$

Table 12: Assigning transfers to federal and state

SNAP ("Food Stamps") We assign SNAP to the federal government following information provided in Hoynes and Schanzenbach (2015). "SNAP is a federal program with all funding (except 50 percent of administrative costs) provided by the federal government, eligibility and benefit rules determined federally, and comparably few rules set by the states (particularly prior to welfare reform)." ["In other public assistance programs such as TANF and Medicaid, states determine fundamental parameters such as the income eligibility cutoffs and (for TANF) benefit levels."]

"The eligibility rules and benefit levels vary little within the US, and are largely set at the federal level. Eligible households must meet three criteria: gross monthly income does not exceed 130 percent of the poverty line, net income (income after deductions) does not exceed the poverty line, and "countable" assets do not exceed $2,250 (or $3,250 for elderly, disabled)."

Within this tight set of constraints, state governments have "state options" which they can use to i) increase participation by using eligibility criteria which are more generous than federal parameters, i.e. allow higher income and asset limits and include people who already qualify for TANF or Medicaid ("categorical eligibility"). ii) make it easier/harder to apply for SNAP, e.g. by testing eligibility of people who file for UI, by reducing application costs, by insisting on drug tests etc. This leads to different take up rates across states. See figure 4 here: https://www.annualreviews.org/doi/pdf/10.1146/annurev-publhealth-040119-094143

But no matter how they use these options, the funding is federal (except the 50% admin cost).

Temporary Assistance for Needy Families (TANF) Transfers disbursed to households from the Temporary Assistance for Needy Families (TANF) program have both a federal and state component. During the welfare reform of 1996, TANF replaced Aid to Families with Dependent Children (AFDC). Unlike for its predecessor, federal funding contributions to TANF spending occur through through block grants. The sizes of these grants were determined by a state's historical spending on welfare programs related to AFDC. Hence, historical state discrepancies on welfare spending perpetuated into TANF and became permanent. Moreover, since per capita AFDC spending varied greatly across states, the relative size of the TANF block grants differ substantially as well.[19]

In addition, the blocks have not been adjusted ever since so the federal funding of TANF is invariant with respect to changing economic conditions, the number of household in need of assistance specifically. For example, as of 2014, the size of the federal TANF block grant relative to the number of children living in poverty is "The average TANF block grant per child living in poverty is $1,190, ranging from $293 in Texas to $3,154 in Washington, DC." (Hahn, Aron, Lou, Pratt, and Okoli (2017), page 21)

For each state s, we compute the federal and state TANF[20] shares (f_s^{TANF} and $1 - f_s^{TANF}$). To compute these shares, we obtained program data from the Office of Family Assistance (OFA) website[21]. Specifically, we obtain figures on federal and state assistance and non-assistance ex-

[19]Hahn, Aron, Lou, Pratt, and Okoli (2017) provide an excellent summary of reasons for TANF variation across states.

[20]We measure TANF benefits using the ASEC variable INCWELFR.

[21]https://www.acf.hhs.gov/ofa/programs/tanf/data-reports

penditures from the "TANF Financial Data - FY 2010" spreadsheet. For 2010, total expenditures are in table B.1., total federal spending is in C.1.a. and state spending in C.2.a. The resulting federal shares f_s^{TANF} range from 29% (Washington) to 83% (West Virgina) with a mean (median) of 59% (60%).

Note, however, that even conditional on receiving the same per capita amount of federal funding, the actual use of TANF expenditures vary drastically across states. This is because, unlike its predecessor, TANF has many more state options; within broad federal guidelines, each state sets its own rules on eligibility, generosity and duration. To receive the federal block grant, states must only continue to spend a fraction of their historical amounts (Maintenance of effort (MOE) requirement which is about 75% of AFDC spending) but conditional on spending MOE compliant resources, states are free to determine how to spend the sum of MOE and the federal grant block.

As a result, there is great variation in terms of actual TANF spending. Some illustrations from different years: i) "In 1998, for every 100 families with children in poverty, California provided cash assistance to more than three times as many families as Texas did. By 2013, the corresponding factor had grown to 13 times as many families." Hahn, Aron, Lou, Pratt, and Okoli (2017), page 4. ii) as of 2007, across all states, 30% went to basic assistance to poor people while the remainder was either spend on programs to help people find work or tax credits, prekindergarten education, child welfare etc. iii) as of 2014: "The maximum monthly benefit for a family of three with no other income averages $436 and ranges from $170 in Mississippi to $923 in Alaska. New Hampshire offers the second-largest monthly benefit, up to $675" (Hahn, Aron, Lou, Pratt, and Okoli (2017), page 9).

Finally, Hahn, Aron, Lou, Pratt, and Okoli (2017) demonstrates that the three dimensions TANF state discretion (generosity, restrictiveness, duration) do not reflect trade offs but consistently point in the same direction in each state. "In general, we find that states with more lenient or strict policies along one dimension are also more lenient or strict in other areas. States that set less generous TANF policies across the board, for example, also tend to limit benefit receipt to shorter periods," (page 13). Other research found that the main determinant of TANF state choices are socioeconomic characteristics such as the relative size of a state's African American population.

A.4 Imputing Alaska Permanent Fund Dividends - TBC

Using data from the Alaska Permanent Fund Corporation, Berman and Reamey (2016) report that more than 90% of Alaska residents receive Alaska Permanent Fund dividends (APFD) every year. Moreover, for the years 2005 and 2006, they report per capita dividend payments of $846 and $1,107 respectively. However, ASEC does not have a specific variable for APFD payments. Moreover, APFDs are disbursed to Alaska residents independent of their age but ASEC does not collect incomes of respondents below 15.

Berman and Reamey (2016) report that many Alaskan respondents report APFDs in the ASEC variable "Other Income." Indeed, in our sample, the mean of this variable is about $700 in Alaska while it is $50 in all other states. But it is unclear if parents report dividends received on behalf of their children. Furthermore, only about 30% of our sample households in Alaska report non-zero "Other Income". This is consistent with Berman and Reamey (2016) who note that "only about one-third of CPS ASEC households reported any other income".

It is possible that recipients report APFDs in one of the other ASEC income variables. To investigate, we compute the share of Alaskan households who report amounts within a range of $500 relative to their entitled amounts (see above) in all four ASEC non-labor income variables.[22] These shares are 7, 0.4, 1.8 and 3.4%. Hence, our takeaway from this investigation is that using ASEC income variables does not do justice to this aspect of the Alaskan tax and transfer system.

To address this shortcoming, we pursue two different approaches to augment the incomes reported by Alaskan households in our sample.

1. Note that entitled APFD amounts per household are straightforward to impute using the per capita amounts reported by Berman and Reamey (2016) as well as the number of household members. Thus, for each Alaskan households, we impute the amount and treat it as a state transfer.
2. For each of the four non-labor income ASEC variables, we compare if reported amounts are at least as large as APFD entitlement less $250. If yes, we assume the household has reported the APFD, subtract the amount from household income and classify it as a state transfer. If no, we proceed as in 1.

We compare the effect of both approaches on estimated progressivity in Alaska. (The former approach constitutes an upper bound.)

[22] In addition to INCOTHER ("Other Income"), they are INCRENT, INCDIVID and INCINT.

A.5 Imputing consumption taxes

In the US, state and local consumption taxes are labeled ”Sales and Gross Receipts” taxes. They fall into two categories: sales taxes and excise taxes. Sales taxes are the most significant revenue source for state governments; they made up about one third of total state revenues in 2006 while excise tax revenues accounted for about 15%. However, while some states (5) did not have sales taxes, all states (and some local) governments use excise taxes.[23]

Neither sales or excise taxes paid are reported in the ASEC data. Hence, we impute them using a relationship between pre-tax income and spending on sales and excise taxable goods and services. We use data from the Consumer Expenditure Survey (CE) to construct an empirical measure of this relationship. Specifically, for different pre-tax income groups, we collect mean annual expenditures on sales and excise taxable goods.[24]

Figure 16 displays the spending towards sales and excise taxable goods for different income groups as a fraction of total consumption spending for 2005. As this figure illustrates, the exposure of relative consumption spending to excise taxes falls with income while it gradually rises for sales taxes but remains constant above incomes of about $20,000. In other words, for low income households, a larger share of consumption spending is subject to excise taxation than for high income households. Conversely, the share subject to sales taxation is larger for high income households.

[23] See https://www.ncsl.org/documents/fiscal/statefederalandlocaltaxes.pdf

[24] The CE spending categories we select for sales taxable items are: ”Food away from home”, ”Housekeeping supplies”, ”Household furnishings and equipment”, ”Vehicle purchases (net outlay)”, ”Maintenance and repairs”, ”Fees and admissions”, ”Pets, toys, hobbies, and playground equipment”. These choices reflect that services are generally sales tax exempt. ”Other lodging” measures domestic travel and tourism related expenditures and is generally considered an excise taxable service. We include it in the sales taxable expenditure share as we do not have a specific linearized rate which we require for our imputation procedure (see below). For excise taxable items we choose: ”Alcoholic beverages”, ”Utilities, fuels, and public services”, ”Gasoline and motor oil”, ”Tobacco products and smoking supplies”. This choice is similar to Barro (2017) and accounts for the fact that expenditures on food at home and prescription drugs are generally exempt from taxation. (Most of the few states which tax them have dedicated tax credits to compensate low income households. See Book of States 2006, table 7.15.)

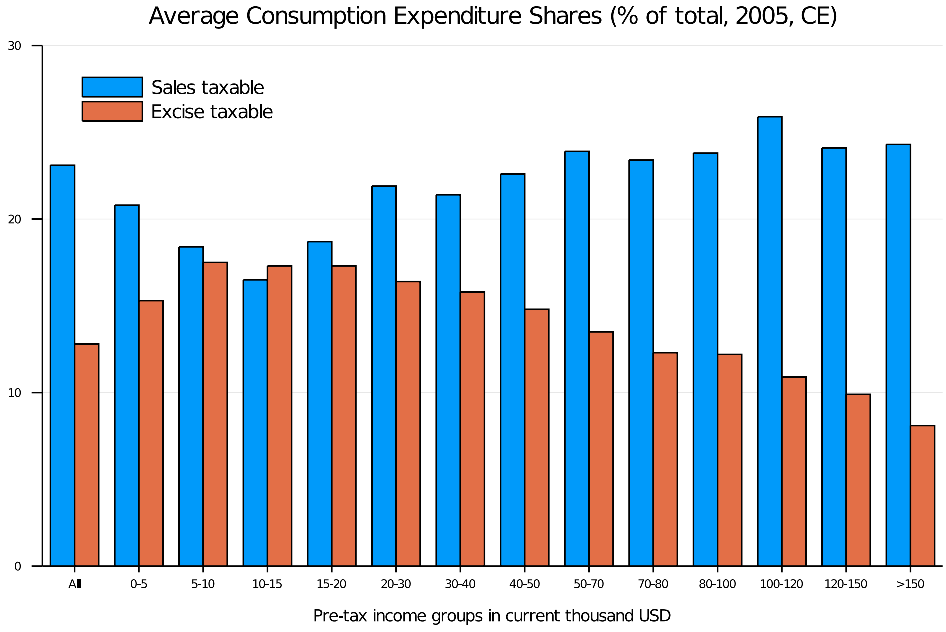


Figure 16: Consumption expenditure shares

In figure 17, we provide a more detailed breakdown of the excise taxable spending categories. For all income groups, spending on utilities (including water, gas and electricity supply as well as phone and internet services) is the largest component. However, the share of spending on utilities sharply decreases with income while it remains more constant for alcoholic beverages. Spending on gasoline and tobacco evolves similar to utilities.

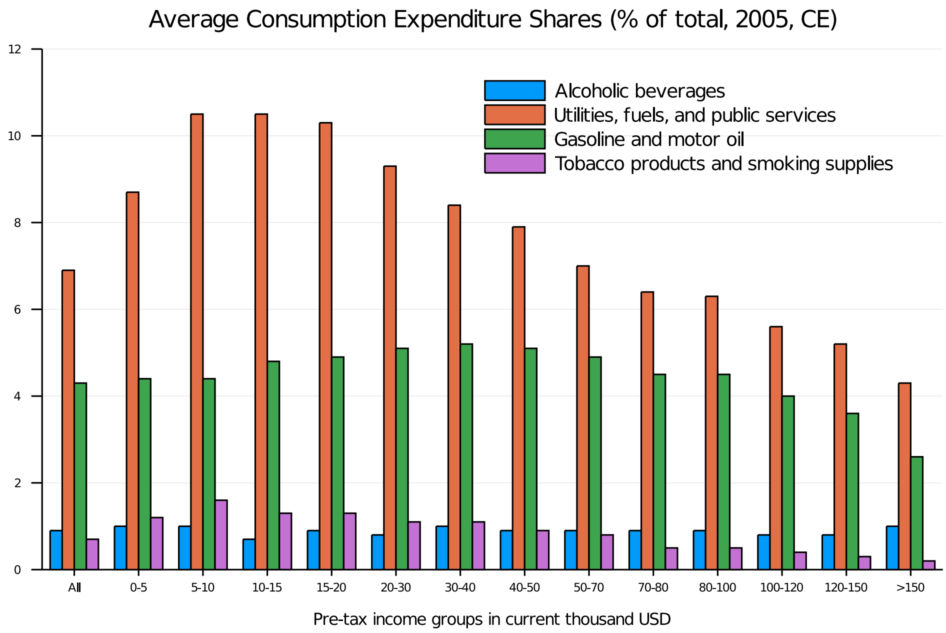


Figure 17: Excise taxable expenditure shares

Finally, figure 18 displays the expenditure categories as a share of average pre-tax income for different income groups. As expected, both shares decrease rapidly in income (as the savings rate increases) but the decline is more pronounced for excise taxable spending.[25]

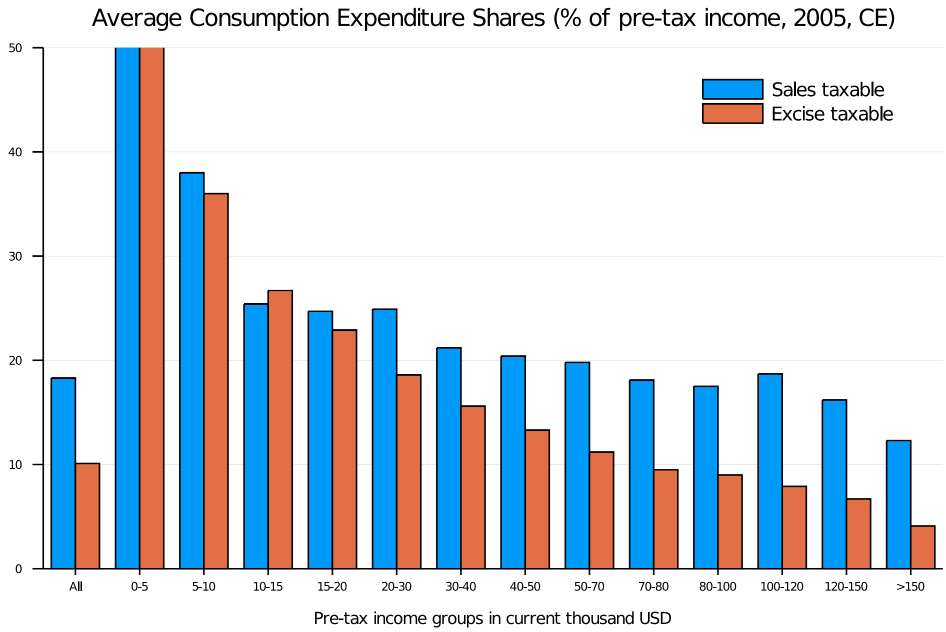


Figure 18: Excise taxable expenditure shares

We approximate the relationship between sales-taxable expenditures of pre-tax income groups reported in the CE and their paid sales taxes as follows:

$$\text{Sales Taxes Paid}_{s,t,k} = Y_{t,k} \times f_{t,k}^{Sales} \times \tilde{t}_{s,t}^{Sales} \tag{3}$$

where s indexes states, t years and k pre-tax income groups. $Y_{t,k}$ represents mean spending in each group and $f_{t,k}^{Sales}$ are the year and income group specific spending shares, shown for 2005 in figure 18. Finally, as the CE reports after-tax expenditures, $\tilde{t}_{s,t}^{Sales}$ are state and year specific sales tax relative to *after-tax prices*. They are computed from sales tax rates $t_{s,t}^{Sales}$ (which are reported relative to pre-tax prices) as

$$\tilde{t}_{s,t}^{Sales} = \frac{t_{s,t}^{Sales}}{1 + t_{s,t}^{Sales}} \tag{4}$$

For excise taxes paid, we proceed analogously and account for differences in excise taxes ap-

[25]Regarding the shares of low income households, it should be emphasized that, in the CE, spending is much larger than pre-tax income for low income households (accordingly, the spending shares add up to more than 100%). For example, in 2005, the group with pre-tax incomes of $5,000 to $10,000 had average pre-tax incomes of $7,818 but spent $16,111 on average. The difference is made up by transfers and net asset changes. (Note that our focus is on working age households with a minimum degree of labor force attachment. Hence, our sample does not include observations in the lowest CE income group. See section 2 for details.)

plied to the relevant expenditure categories (see figure 17) by constructing corresponding linearized excise tax rates. For the application to CE after-tax expenditures, we transform these rates using

$$\tilde{t}^{Excise}_{s,t} = t^{Excise}_{s,t} \times \frac{\text{Pre-tax price}}{\text{Pre-tax price + Excise tax}} \tag{5}$$

and use them to impute excise taxes paid according to

$$\text{Excise Taxes Paid}_{s,t,k} = Y_{t,k} \times f^{Excise}_{t,k} \times \tilde{t}^{Excise}_{s,t} \tag{6}$$

where $f^{Excise}_{t,k}$ are the year and income group specific excise taxable spending shares of utilities, alcohol, gasoline and tobacco. $\tilde{t}^{Excise}_{s,t}$ are state and year specific corresponding linearized excise tax rates (relative to after-tax expenditures). The following sections explain how we construct the linearized excise tax rates and report our findings.

For 2006, figure 19 shows how our constructed linear excise tax rates correlate with the sum of the state and average local sales tax rates. States which have higher sales taxes also tend to have higher excise taxes. The only exception to this pattern are tobacco taxes; some states with low or nor sales taxes apply sizable excises on tobacco while some with high sales taxes have low tobacco excises.

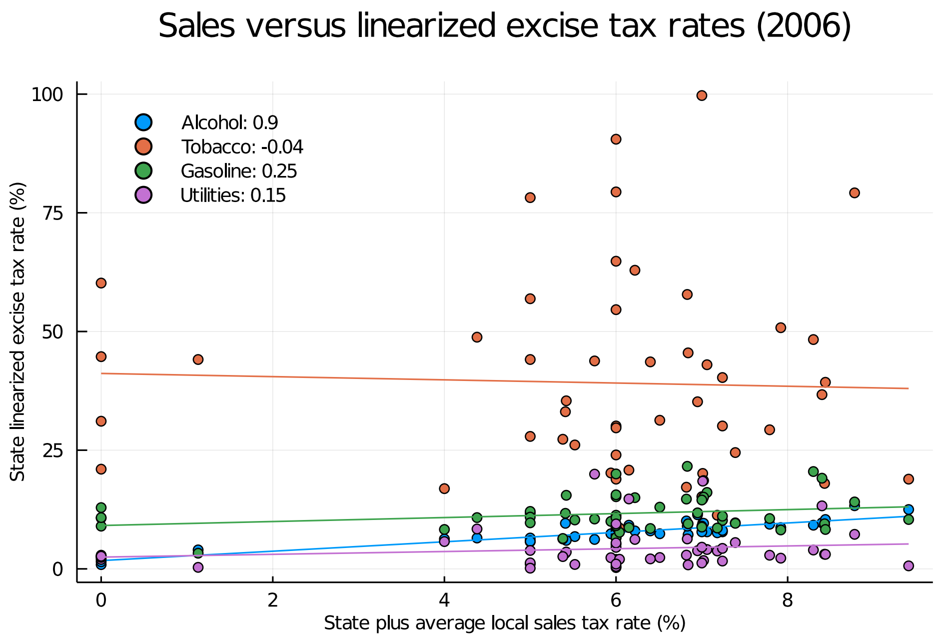


Figure 19: Correlation of state sales and excise tax rates

Sales tax rates Census Bureau accounting standards label them as "*General* Sales and Gross Receipts Taxes". They are applied as an ad valorem tax to a pre-tax price. Hence, sales taxes paid are a linear function of the price per unit times the number of units purchased. Regarding the geographic distribution of state sales tax rates, Duncan (2005) notes that "There is a fairly strong regional pattern to the breadth of state sales tax bases (and reliance on the tax). States in the Northeast and Mid-Atlantic states rely relatively less on the tax, while those in the Plains, Mountain and Western states rely relatively more heavily on the tax." (page 4). Many local governments (counties and cities) also collect sales taxes. According to Duncan (2005) this is the case in 34 states. Among these (except in four) "local taxes are imposed as an add-on to the state tax and are collected and administered by the state tax administration agency". Moreover, the overall norm is that the state and local sales tax base are identical.

We collect the state and year specific sales tax rates $t_{s,t}^{Sales}$ from the Book of States for 2005 and 2006 and the average local rates from Padgitt (2009).[26] Figure 20 shows the combined state and local rates we are using as measures for $t_{s,t}^{Sales}$.

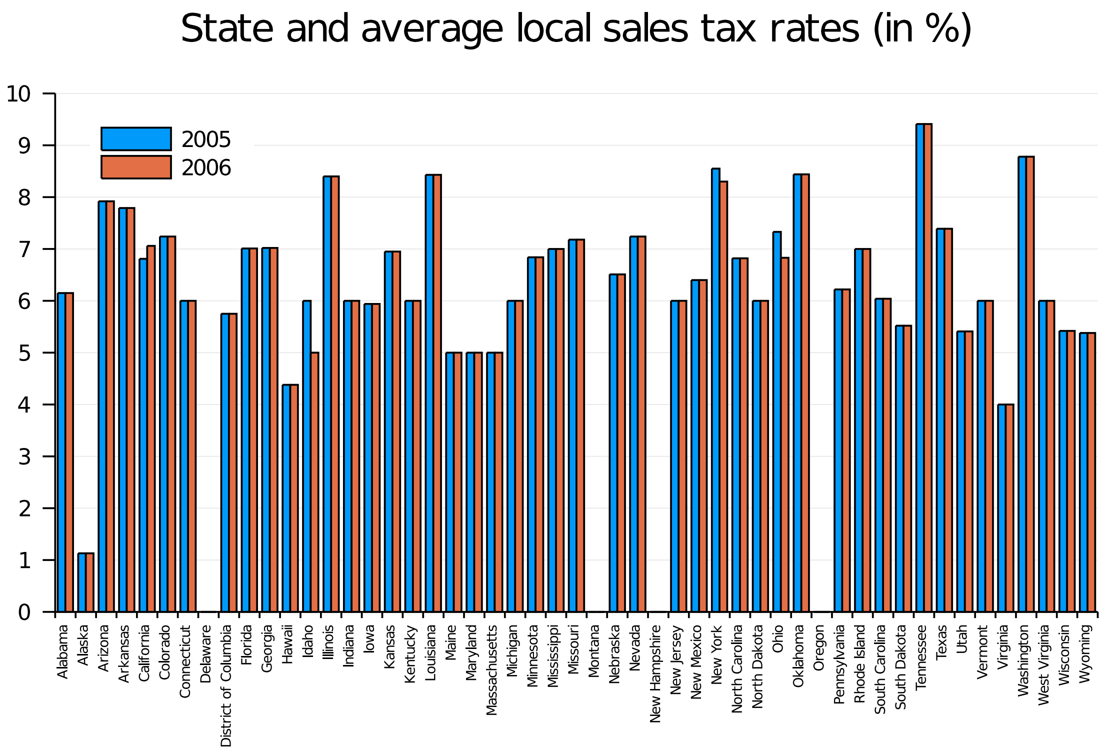


Figure 20: Combined state and average local sales tax rates

To illustrate the relative magnitudes of state and local sales tax rates, figure 21 plots the 2006

[26]Note that the state rates reported in the Book of States do generally not include the local rates. The only exceptions are California and Virgina which include a 1.25% and 1.0% statewide local tax rate (1.0% for both states in 2006.) We account for this when combining average local sales tax rates and state rates. Moreover, to the best of our knowledge, local sales tax rates are not publicly available prior to 2009, which are in Padgitt (2009). Hence we combine the local rates of 2009 and the state rates of 2005 and 2006. However, inspecting local average sales tax rates of later years, as reported in, for example, Drenkard (2012), Drenkard (2013), Walczak and Drenkard (2017), Cammenga (2019), shows they are very persistent over time.

state rate versus the average local rate of 2009. Except in very few states, the state rate is (much) higher than the local rate; the state mean (median) rate is 5.1% (6%) and local rate is 1.1% (0.81%).

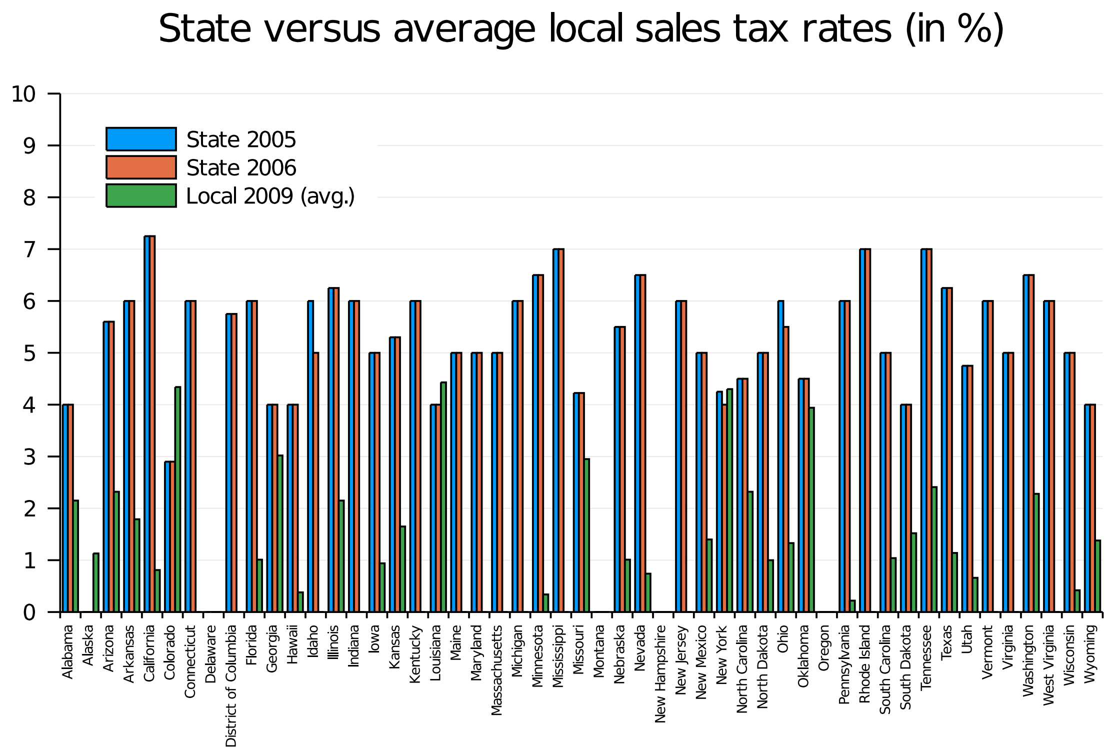


Figure 21: State versus average local sales tax rates

Excise tax rates Census Bureau accounting standards label them ”*Selective* Sales and Gross Receipts Taxes”. They are applied to a small number goods and services, most importantly utilities, gasoline, tobacco and alcohol, and are levied as a fixed extra Dollar amount per unit purchased (e.g. pack of cigarettes or gallon of gasoline).[27] We construct a state and year specific linearized tax rate $t^{Excise}_{s,t}$ for each category of excise taxable goods and services as follows:

- *Utilities*: From the State and Local Government Finances dataset of the Census Bureau, we obtain state data on tax revenues from the sale of public utilities for 2005 and 2006.[28] As these data also include utility taxes collected from corporations, we compute the share collected from households as follows: In the KLEMS Production Account Tables, we find that gross output of utility companies in the US was 416 and 421 billion Dollars in 2005

[27] As their tax base includes cigarettes and alcohol, they are frequently called ”sin taxes”.

[28] According to the Census Bureau Classification Manual, they ”include passenger and freight transportation companies; telephone (land based and mobile), telegraph, cable television providers, and internet service providers, in addition to the electric power, gas, mass transit, and water supply utilities”. Moreover, they also comprise any utility taxes raised as ad valorem taxes. Note that Massachusetts only started collecting utility taxes in 2006.

and 2006.[29] In the OECD NIPA tables, we find that final household utility consumption expenditures in 2005 and 2006 were 273 and 290 billion Dollars.[30] Hence, we compute the share of utilities purchased by households as $h_{2005}^{utilities} = 66\%$ and $h_{2006}^{utilities} = 69\%$.

Next, we use the regional data of the Bureau of Economic Analysis (BEA) to measure (after-tax) personal expenditures on housing and utilities in all states for the same years. In order to isolate the utilities component, we compute the share of expenditures on "Utilities, fuels, public services" relative to expenditures on "Shelter" using CE data.[31]

Armed we these measures, we construct the linearized utilities tax rate for different states (s) and years 2005 and 2006 (t) as

$$t_{s,t}^{Utilities} = \frac{\text{Total utilities tax revenue} \times h_t^{utilities}}{\text{Personal utilities expenditures} - \text{Total utilities tax revenue} \times h_t^{utilities}} \tag{7}$$

and display our results in figure 22.[32]

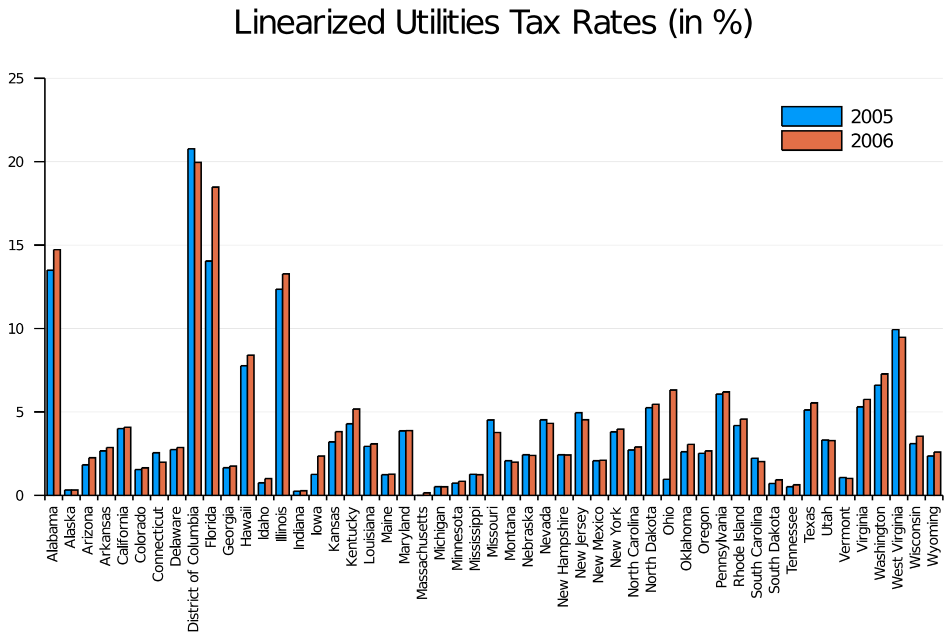


Figure 22: State linearized utilities tax rates

[29] https://www.bea.gov/data/special-topics/integrated-industry-level-production-account-klems KLEMS industry category: "Utilities"

[30] Categories: "Water supply and miscellaneous services relating to the dwelling" and "Electricity, gas and other fuels"

[31] To keep the expenditures comparable to the NIPA categories, we exclude telephone services. Computed as a mean across all consumer units, this share is 19.5% for 2005 and 19.3% for 2006. There is little variation across different pre-tax income groups.

[32] For utilities, we compute $\tilde{t}_{s,t}^{Utilities}$, i.e. the rate applied to after-tax expenditures reported in the CE for the excise tax imputation, as

$$\tilde{t}_{s,t}^{Utilities} = \frac{\text{Total utilities tax revenue} \times h_t^{utilities}}{\text{Personal utilities expenditures}}$$

- *Gasoline*: We obtain average annual pre-tax retail prices (dollars per gallon excluding taxes) for each state from the US Energy Information Administration for the years 2005 and 2006.[33] From the Book of States (table 7.2 for 2005 and 7.14 for 2006), we obtain gasoline excise taxes (cents per gallon) for each state so we can compute linearized gasoline excise tax rate as

$$t_{s,t}^{Gasoline} = \frac{\text{Excise tax}}{\text{Pre-tax price}} \tag{8}$$

In addition, we use the Book of States tables to identify states in which gasoline is also sales taxable.[34] For those states, we obtain the linearized gasoline tax rate according to

$$\text{Final price} = \left(1 + t_{s,t}^{Sales}\right) \times \left(\text{Pre-tax price + Excise tax}\right) \tag{9}$$

where $t_{s,t}^{Sales}$ is the sales tax rate of state s in year t. Hence, the linearized rate is

$$t_{s,t}^{Gasoline} = \frac{\text{Sales tax} + \text{Excise tax}}{\text{Pre-tax price}} \tag{10}$$

$$= \frac{t_{s,t}^{Sales} \times \text{Pre-tax Price} + (1 + t_{s,t}^{Sales}) \times \text{Excise tax}}{\text{Pre-tax price}} \tag{11}$$

$$= t_{s,t}^{Sales} + (1 + t_{s,t}^{Sales}) \times \frac{\text{Excise tax}}{\text{Pre-tax price}} \tag{12}$$

The linearized gasoline tax rates (including the sales tax adjustment) are shown in figure 23.

[33] Available until 2010 here: https://www.eia.gov/dnav/pet/pet_sum_mkt_a_EPM0_PTC_dpgal_a.htm Values for DC are missing for 2005 and 2006. For those years, we use averages of Maryland and Virginia.

[34] In 2005 and 2006, these states were California, Florida, Georgia, Hawaii, Illinois, Indiana, Michigan, New York, Ohio and West Virginia.

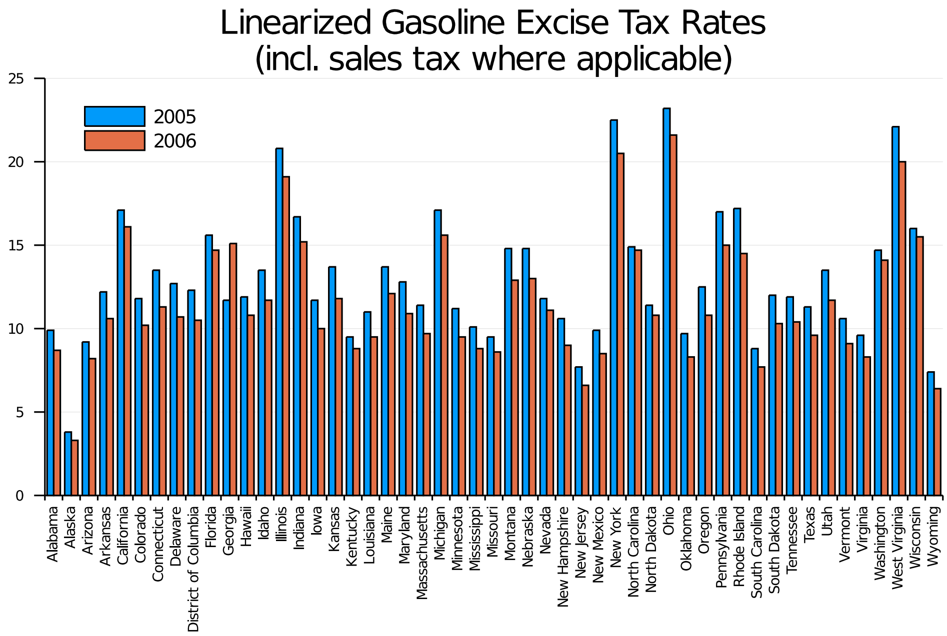


Figure 23: State linearized excise gasoline tax rates

- *Tobacco*: As Orzechowski and Walker (2014) illustrate, more than 90% of tobacco tax revenues come from taxes on cigarettes. Hence, we linearize cigarette excise taxes and apply this rate to all CE tobacco products. We obtain state pre-tax per package prices for 2005 and 2006 from table 13B of Orzechowski and Walker (2014) by subtracting federal and state excise taxes.[35] and state per package excise taxes from the Book of States (table 7.2 for 2005 and 7.14 for 2006). Using these data, we compute the linearized excise tax as for the gasoline excise tax, i.e. using equation (8).

  Moreover, as Orzechowski and Walker (2014) point out, many states also apply sales taxes to cigarette purchases while others do not, exclude the excise tax from sales taxes or apply a per package sales tax at the wholesale level. To account for the quantitative relevance of the sales taxation on our linearized measure, we use data on "Estimated State General Sales Tax Collections on the Sale of Cigarettes" (table 16) and "State Tax-Paid Cigarette Sales" (table 10) from Orzechowski and Walker (2014) to construct a measure for sales taxes paid per package according to

$$\text{Sales tax} = \frac{\text{Sales tax collections from sale of cigarettes}}{\text{State tax-paid cigarette package sales}} \tag{13}$$

  so we can then linearize the cigarette tax rate according to

$$t_{s,t}^{Cigarettes} = \frac{\text{Excise tax} + \text{Sales tax}}{\text{Pre-tax price}} \tag{14}$$

[35] As indicated below table 13B, the price estimates do not include sales taxes.

The results are presented in figure 24.

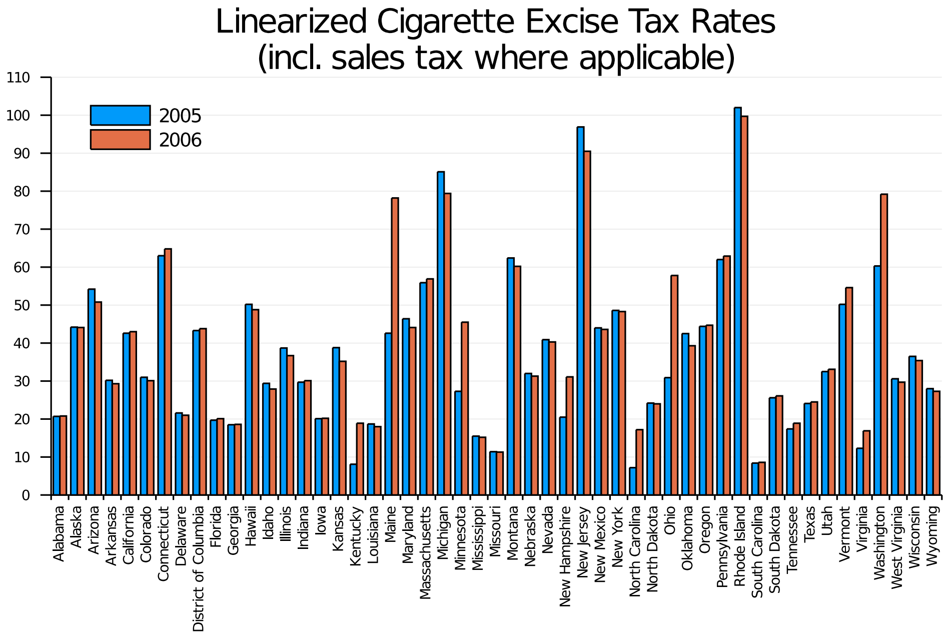


Figure 24: State linearized excise cigarette tax rates (including sales taxes)

- *Alcohol*: In the US, there are distinct beer, wine and spirits excise taxes. Moreover, in 2005 and 2006, the governments of 18 states directly controlled the sale of spirits (or all alcoholic beverages) via public monopoly stores and, accordingly, generated revenue not through excise taxation but through various taxes, fees and net liquor profits.[36] (See Book of States 2005 and 2006 footnote (g) of tables 7.2 and 7.12.)

  We construct a measure for state average linearized alcohol excise tax rates because the CE reports expenditures on all types of alcoholic beverages only and because state and local alcohol tax revenues are not broken down by beverage type. We proceed as follows: From the National Institute on Alcohol Abuse and Alcoholism's surveillance report, we collect volumes of sold beer, wine and spirits by state for 2005 and 2006.[37]

  Next, to compute excise tax revenues for control states, we obtain from the Census of State Governments state and year specific total alcohol related tax revenues, i.e. taxes on the sale of alcoholic beverages plus liquor store net profits (revenues minus expenditures) and compute the implied tax per gallon as

$$\text{Excise tax} = \frac{\text{Alcohol tax and liquor store profits}}{\text{Sold gallons of alcohol}} \tag{15}$$

[36] Those states are also called "control states". In 2005 and 2006, they were: Alabama, Idaho, Iowa, Maine, Michigan, Mississippi, Montana, New Hampshire, North Carolina, Ohio, Oregon, Pennsylvania, Utah, Vermont, Virginia, Washington, West Virginia and Wyoming.

[37] Available here: https://pubs.niaaa.nih.gov/publications/surveillance115/pcyr1970-2018.txt.

For non-control states, we use the nominal excise amounts for each type of alcohol reported in the National Institute on Alcohol Abuse and Alcoholism's Alcohol Policy Information System (APIS).

In addition, as for gasoline and cigarettes, most non-control states also apply general or alcohol specific sales tax rates on purchases of alcohol. (For control states, the sales tax rate is already captured by considering the liquor store profits, i.e. can be considered zero.) We obtain state and year specific data on these rates $t_{s,t}^{Alcohol\ sales}$ from APIS and compute averages for the rates for beer, wine and spirits (if they are distinct).[38]

Finally, we collect beer, wine and spirits prices by state and convert them to prices per gallon.[39]

Using these data, we construct the linearized tax rate on alcoholic beverages as

$$t_{s,t}^{Alcohol} = \frac{\text{Excise tax + Sales tax}}{\text{Pre-tax price}} = \frac{\text{Excise tax + Sales tax}}{\text{Final price - Excise tax - Sales tax}} \tag{16}$$

$$= \frac{\text{Excise Tax} + \text{Final price} \times \frac{t_{s,t}^{Alcohol\ sales}}{1+t_{s,t}^{Alcohol\ sales}}}{\text{Final price - Excise tax - Final price} \times \frac{t_{s,t}^{Alcohol\ sales}}{1+t_{s,t}^{Alcohol\ sales}}} \tag{17}$$

$$= \frac{\text{Excise Tax} + \text{Final price} \times \frac{t_{s,t}^{Alcohol\ sales}}{1+t_{s,t}^{Alcohol\ sales}}}{-\text{Excise tax} + \text{Final price} \times \frac{1}{1+t_{s,t}^{Alcohol\ sales}}} \tag{18}$$

and report our results in figure 25.[40]

[38]We take the mean of on- and off-premise taxes. If APIS reports that sales taxes apply, we use the sum of state and average local tax rates. If sales taxes do not apply, we use the average of the posted wholesale and retail tax rates (on and off premise).

[39]We use the alcoholic beverage CPI of the Bureau of Labor Statistics to discount recent prices to 2005 and 2006.

[40]Since we do not have pre-tax prices, we compute $\tilde{t}_{s,t}^{Alcohol}$, i.e. the rate applied to after-tax expenditures reported in the CE for the excise tax imputation, as

$$\tilde{t}_{s,t}^{Alcohol} = \frac{\text{Excise taxes}}{\text{Final price}} + \frac{t_{s,t}^{Alcohol\ sales}}{1 + t_{s,t}^{Alcohol\ sales}} \tag{19}$$

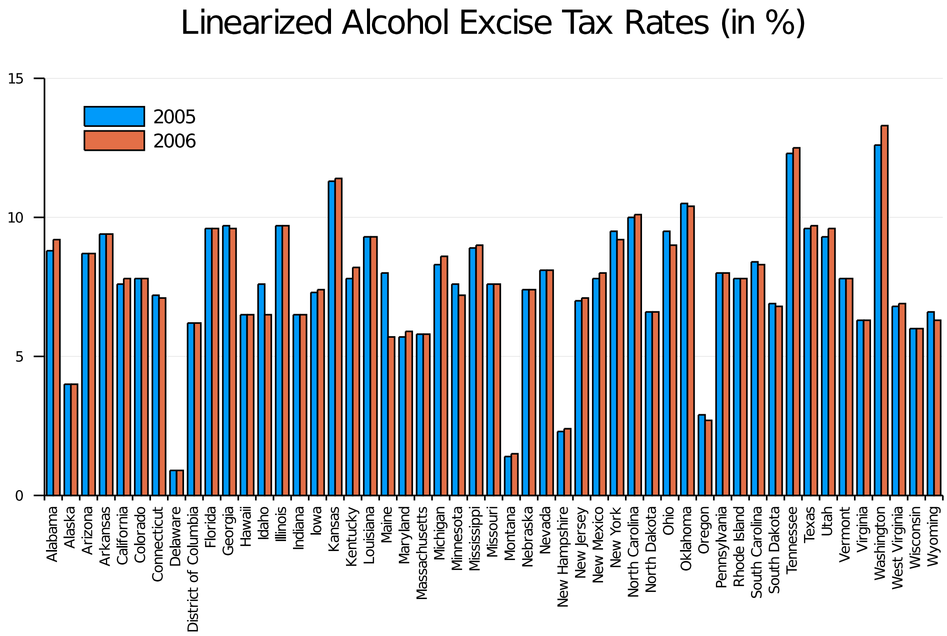


Figure 25: Linearized excise alcohol tax rates (includes sales tax and liquor store revenues)

A.6 Imputing property taxes paid by renters

Our imputation rests on two assumptions which make the procedure tractable:

1. Property taxes are passed from home owners to renters one-for-one
2. In each state s and year t, a linear user cost condition determines rent (gross) payments:

$$\text{Gross Rent}_{s,t} = P \times \beta_{s,t} \tag{20}$$

   where

   - P is the value of the rented residential property
   - $\beta_{s,t}$ is the sum of a non state-specific component x (interest rate, maintenance, depreciation, etc.) and a linear state- and year-specific (linear) property tax rate $t^P_{s,t}$ so $\beta_s = x + t^P_{s,t}$

Rewriting equation (20) as

$$\left(\frac{\text{Gross Rent}}{P}\right)_{s,t} = \beta_{s,t} \tag{21}$$

illustrates that we can obtain estimates $\hat{\beta}_{s,t}$ using state- and year-specific data on rent-price (value) ratios. We obtain these ratios from Zillow's database[41] and present them for the years 2005 and 2006 in figure 26.

[41] Here: https://www.zillow.com/research/data/

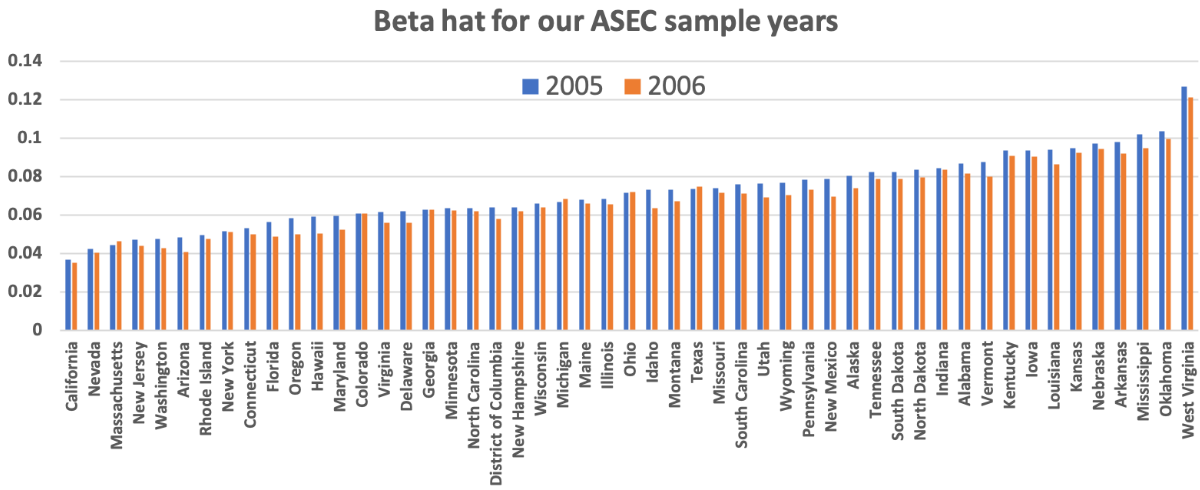


Figure 26: Estimates for $\hat{\beta}_{s,t}$ using Zillow Data

From equation (20) it also follows that we can use $\hat{\beta}_{s,t}$ and data on average gross rent payments of households in different income groups d to compute the average value of houses rented by each income group in each state and year as

$$\widehat{P}_{s,t,d} = \frac{\text{Gross Rent}_{d,t}}{\hat{\beta}_{s,t}} \tag{22}$$

As a measure for Gross $\text{Rent}_{d,t}$ we use data from the CE tables[42] on rent expenditures of different income before taxes groups. We then use the average value of houses rented to compute mean property taxes paid by renters in each income groups d in each state j and year t as

$$\text{Mean Property Taxes Renters}_{s,t,d} = \widehat{P}_{s,t,d} \times t^P_{s,t} \tag{23}$$

where $t^P_{s,t}$ is a linear measure of each state j's property tax rate in year t. Figure 27 illustrates the property taxes for renters imputed according to this procedure in select states in 2006.

[42] Available here: https://www.bls.gov/cex/csxcombined.htm

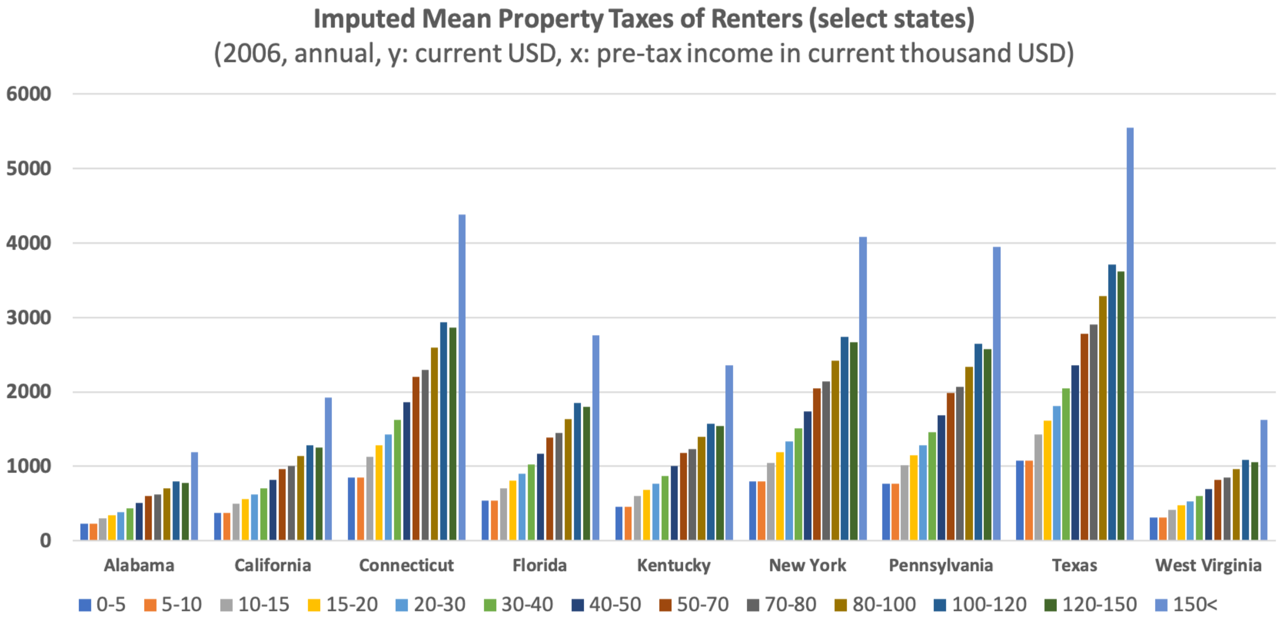


Figure 27: Imputed Property Taxes of Renters

Details on the implementation of our imputation procedure:

1. Computing $\hat{\beta}_{j,t}$ from equation (21)

    - Gross Rent: The only time series available for the Zillow Rent Index (ZRI) are either ”All homes plus multi family residences” or ”Multi family residences”. To align the measure as close as possible to the household level, we use the former index.[43]
    NOTE: This file i) contains monthly data for most states only from September 2010 ii) has missing monthly observations for some states. To address these issues, we first compute annual averages for years starting from 2010 for all states using the data available within each year. Second, using these annual figures, we linearly ’back-polate’ the values until 2005.

    - P: To align this measure closely to the Gross Rent measure, we use from the Zillow Home Value Index (ZHVI) the index for ”All Homes.”[44]

2. Computing $\widehat{P}_{j,t,d}$ from equation (22)

    - Gross Rent$_{d,t}$: We obtain the nominal averages of rent expenditures corresponding to increments of the before tax income distribution from the CE tables. The increments are as shown in figure 28. This gives a mapping between pre-tax income levels and rent expenditures.

[43] The csv file we work with is `State_Zri_AllHomesPlusMultifamily.csv`
[44] The csv file we work with is `State_Zhvi_AllHomes.csv`

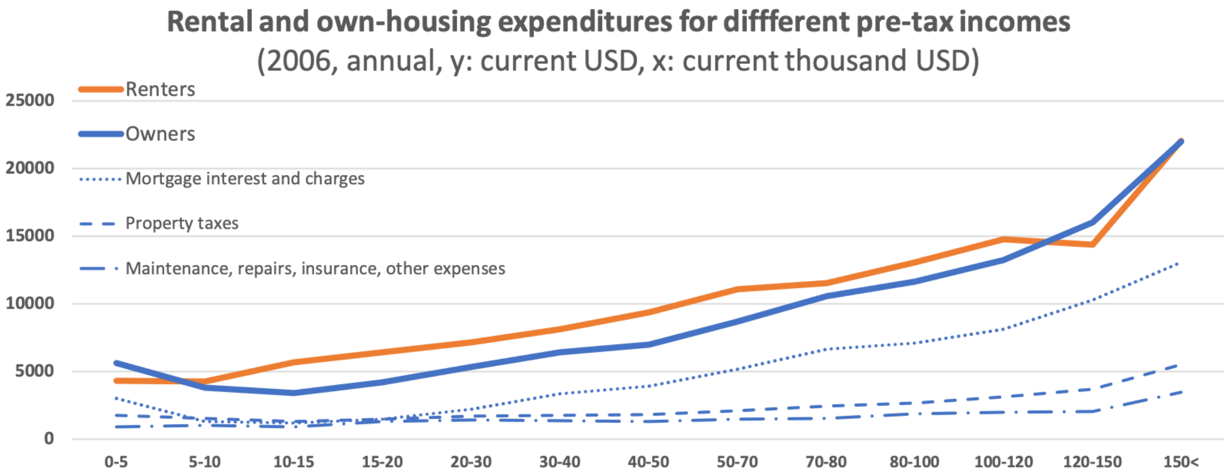


Figure 28: Housing Expenditures from CE Data

3. Computing Mean Property Taxes Renters$_{j,t,d}$ from equation (23)

   - $t^P_{s,t}$: We collected the linear property tax rates from Harris and Moore (2013) and Scarboro (2018) and illustrate them in figure 29. Property taxes are quite constant across years except for a small number of states. Hence, we use the tax rates of 2007 for 2005 and 2006.

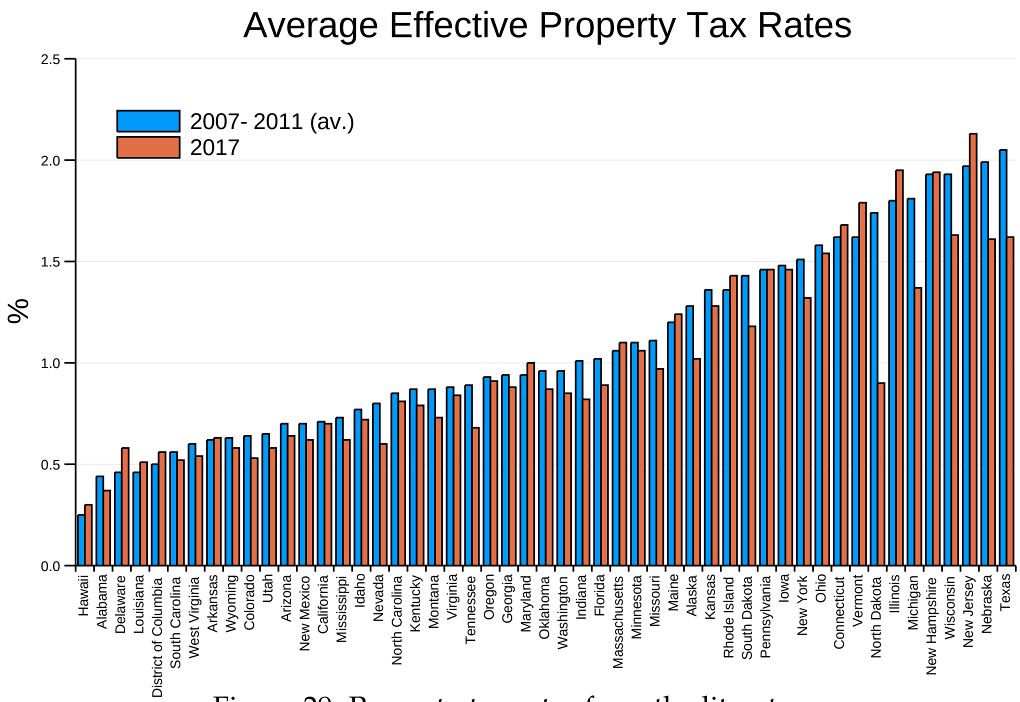


Figure 29: Property tax rates from the literature

B Estimation

B.1 Affine versus log-linear tax function

Fitting the relationship between disposable and pre-government earnings without deductions and exemptions in levels and in logs:

$$y = \beta_0 + \beta_1 x \tag{24}$$

$$\log(y) = \beta_0 + \beta_1 \log(x) \tag{25}$$

- x: gross income + fica employer portion
- y: x - federal income taxes and transfers - state income taxes and transfers - fica + transfers + SS benefits

To compare the fit, we plot both functional forms into the same (log) space as follows:

Let y be income before taxes and transfers and let $\tilde{y}$ be income after taxes and transfers You estimated HSV and affine tax schemes as

$$\log \tilde{y} = \log \lambda + (1 - \tau) \log y \tag{26}$$

and $\tilde{y} = T + (1 - t)y$

I proposed plotting the second on the same log scale as the first. In particular, you have estimates for (T, t). We know that

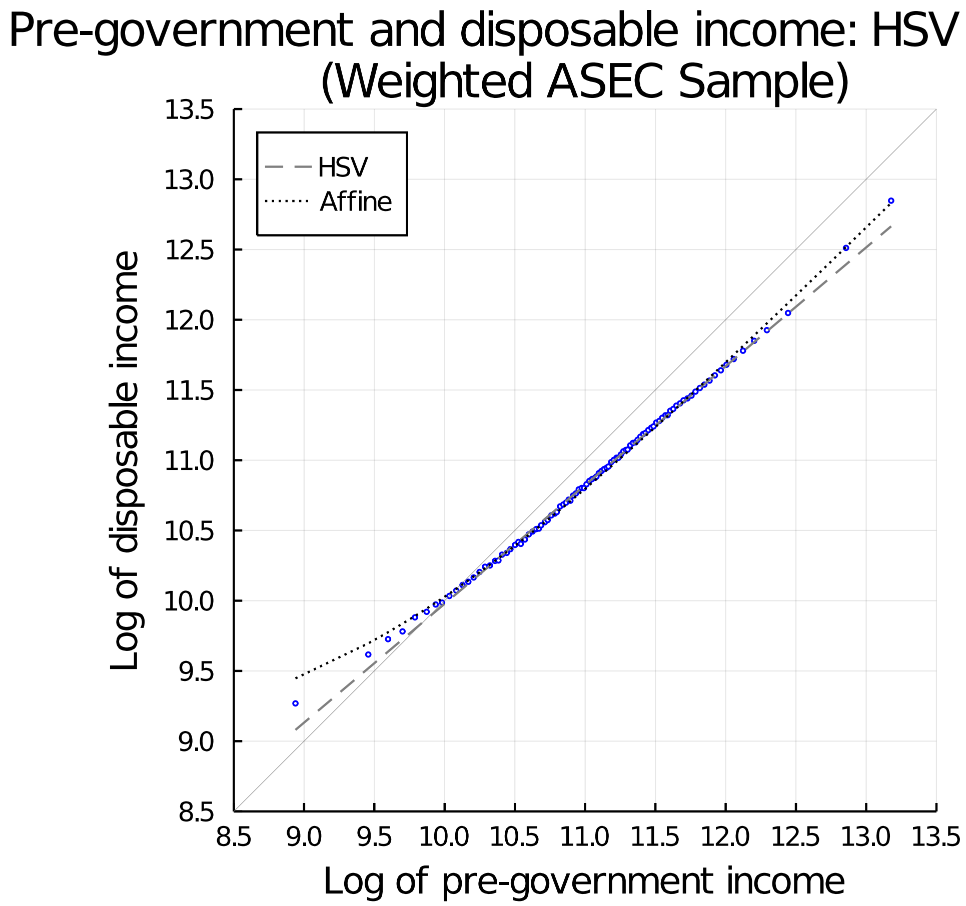
$$\exp(\log \tilde{y}) = T + (1 - t) \exp(\log y) \tag{27}$$

$$\log \tilde{y} = \log(T + (1 - t) \exp(\log y)) \tag{28}$$

So could you make a plot with two lines showing both

$$\begin{aligned} z &= \log \lambda + (1 - \tau)x \\ z &= \log(T + (1 - t) \exp x) \end{aligned}$$

and also include the 100 blue dots for $x = \log y$ and $z = \log \tilde{y}$. This plot will help us gauge whether the affine or HSV function is a better fit.



B.2 Adjusting state income distributions

We adjust state income distributions using weights Let the original ASEC household weights be denoted by κ_i. For the entire US sample, we rank households by (weighted) gross income and record the income values at each percentile in this distribution: $y(P1), y(P2), \ldots, y(P100)$. Next, for each state s, we record the fractions of households with gross income in each of the 100 bins. In particular, using the ASEC weights, we compute the fraction (using weights) of households in state s with gross income between $y_{\min}$ and $y(P1)$, between $y(P1)$ and $y(P2)$ etc. We denote these fractions $\pi_1, \pi_2, \ldots, \pi_{100}$. So, for example

$$\pi_1 = \sum_i \kappa_i \mathbb{I}_{\{y_i \leq y(P1)\}} \tag{29}$$

Suppose household i in state s is in bin j. Suppose we now adjust the households weight according to $\tilde{\kappa}_i = \frac{\kappa_i}{100\pi_j}$.

So now

$$\sum_i \tilde{\kappa}_i \mathbb{I}_{\{y_i \leq y(P1)\}} = \frac{1}{100\pi_1} \sum_i \kappa_i \mathbb{I}_{\{y_i \leq y(P1)\}}$$
$$= \frac{1}{100}$$

Once households are re-weighted appropriately, we estimate τ as for the pooled sample of all states using the new weights.

Figure 30 shows the median of the national income distribution compared to the medians of the state income distributions where we use no weights, ASEC household weights and the weights adjusted as shown above.

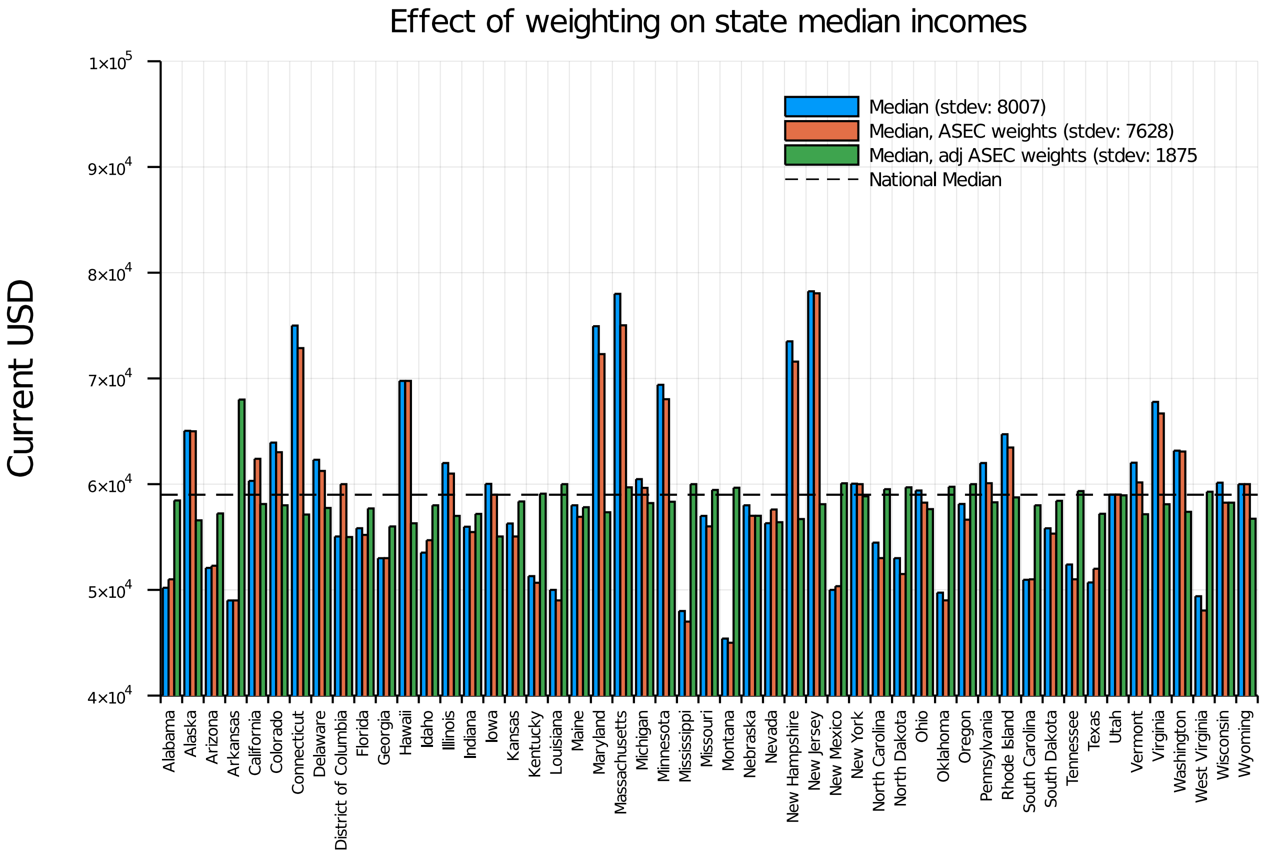


Figure 30: State versus national median incomes

C Local taxes

To fix ideas: In the US, "local" usually refers to all of County, Municipality, Township, Special District and School District. Howe and Reeb (1997) provides an excellent historical account on the emergence and evolution of state and local taxes.

Figure 31 shows the share of local tax revenues in total tax collections in each state (for 2005).

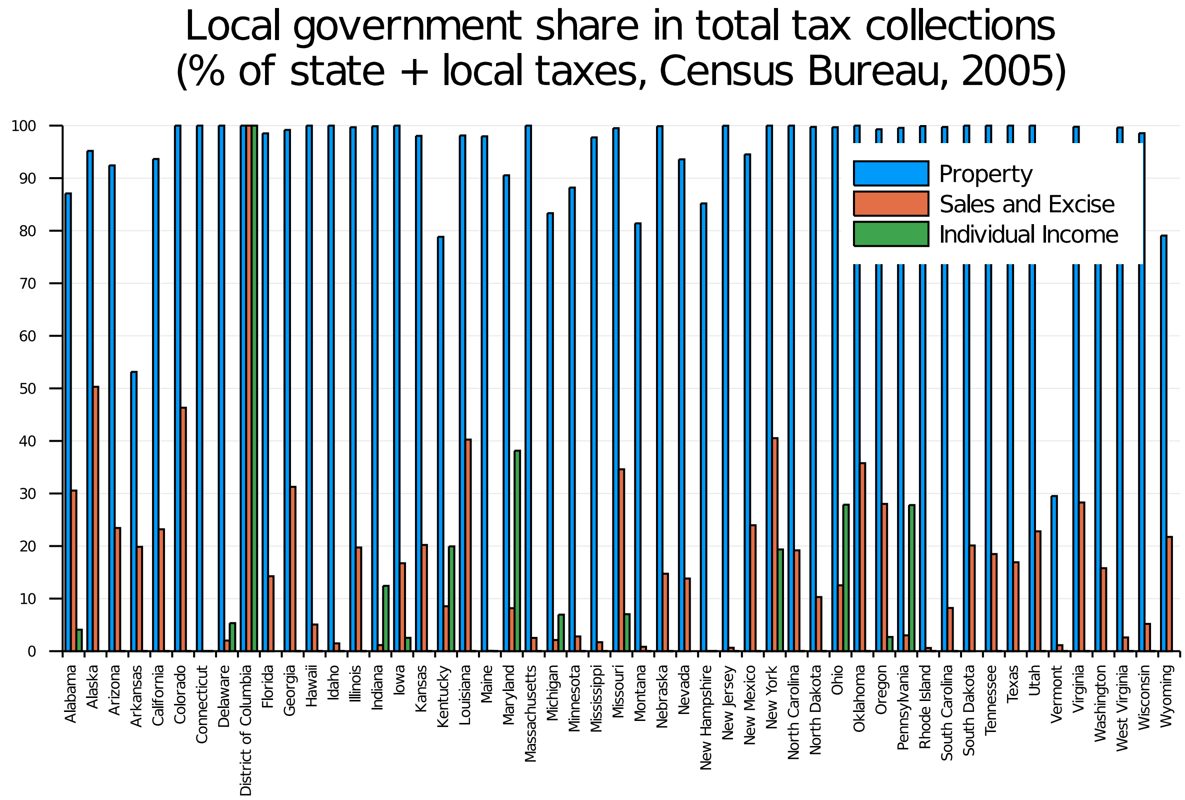


Figure 31: Breakdown of in-state tax collections into state and local

Some takeaways:

- **Property taxes** are almost exclusively levied by local governments. The mean (median) share across states is 94% (99%).
- **Sales and excise taxes** have a small, albeit larger share: mean: 17%; median: 15%.
- **Individual income taxes** have a minuscule share: mean 6%; median 0%

To assess the relative importance of each tax from the perspective of local governments, figure 32 shows a breakdown of total local government revenues by different taxes. Consistent with the evidence presented in figure 31, this figure illustrates that property taxes are the most important source of revenue with a mean (median) share of 74% (75%). Next are sales taxes with 16% (13%) and individual income taxes with 3% (0%).

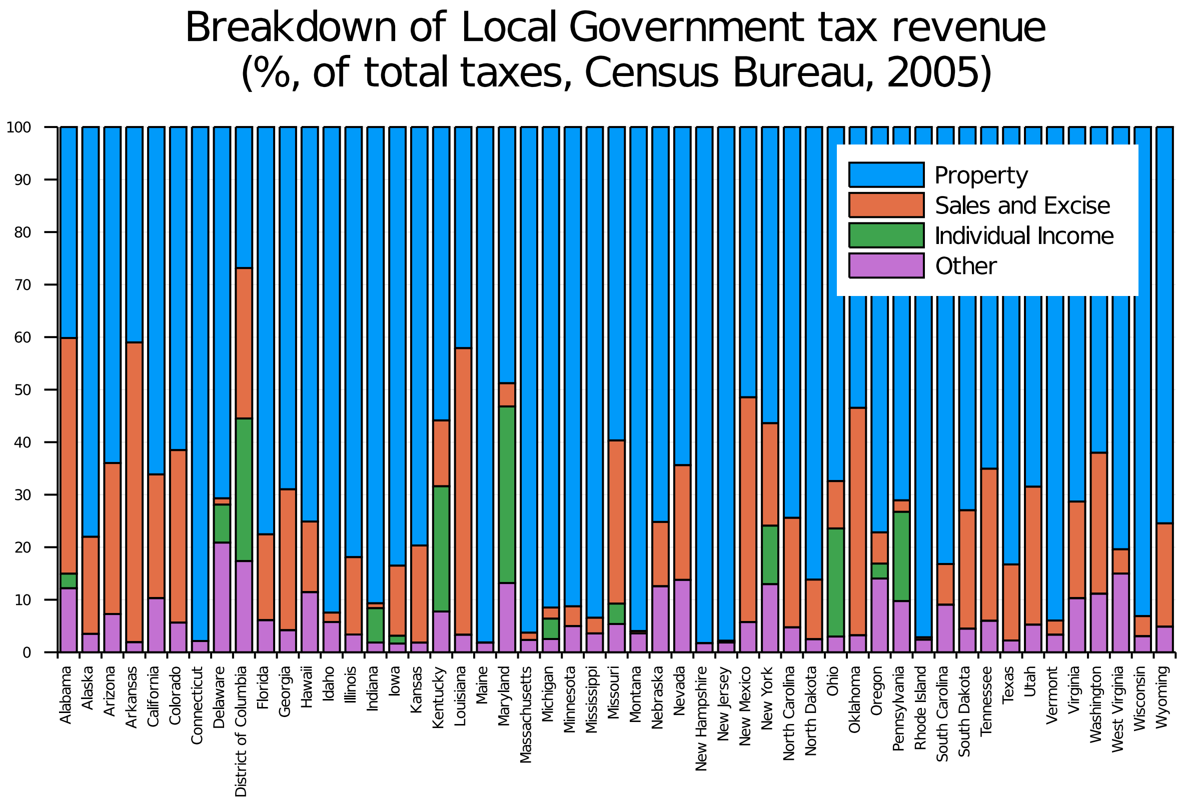


Figure 32: Revenue shares of different local taxes

Local Sales Taxes Given the prominence of local sales taxes, we add state averages of local sales tax rates to our measure of state sales tax rates. As figure 21 in section A.5 shows, the combined rates can be almost twice as large as the state rate alone in some states.

Local Income Taxes Walczak (2019) documents that the first state to introduce income taxes at the local level was Wisconsin (in 1911). In the 1960s, a small number of local governments in a few states (mostly rust belt) followed. Since then, local income taxes have not substantially expanded into other states. From this source, we also obtain information on the local governments which collect income taxes in each state and also obtain linear income tax rates (some local governments levy small fixed lump sum amounts).[45]

For each state, figure 33 plots the fraction of local governments which levy income taxes.[46] Pennsylvania has the largest share (60% of all local governments raise income taxes) and, across all states, the mean (median) share is 3% (0%).

[45]For PA, we abstract from the municipal service tax (LST) which ranges from 0$ to 52$ per year.

[46]The number of local governments in each state comes from the 2017 Census of Governments: https://www.census.gov/data/tables/2017/econ/gus/2017-governments.html

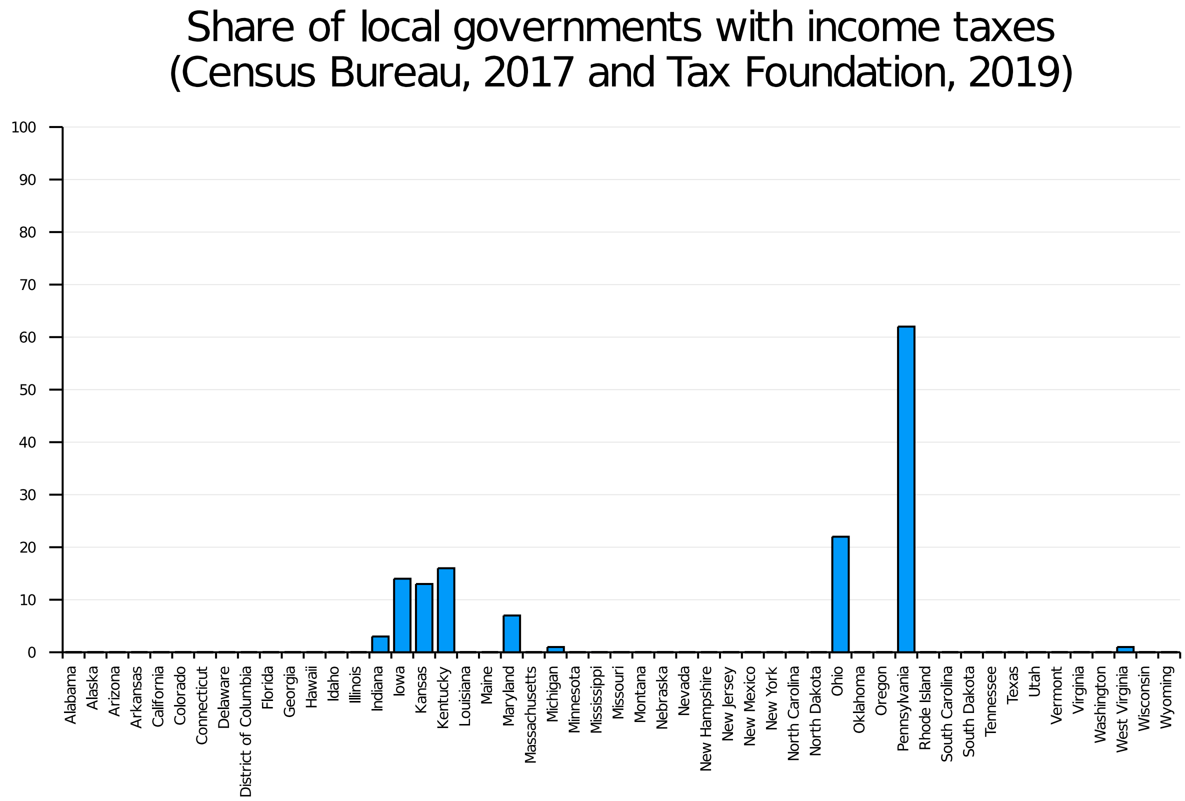


Figure 33: Share of local governments in each state which levy income taxes

For the 15 states in which local governments collect income taxes, figure 34 computes the average income tax rate for residents. The maximum rate is about 3%, while the mean and median rates are 1.2% and 1.17%. (Note that Colorado and West Virginia levy fixed lump sum amounts with annual means of 67$ and 150$.)

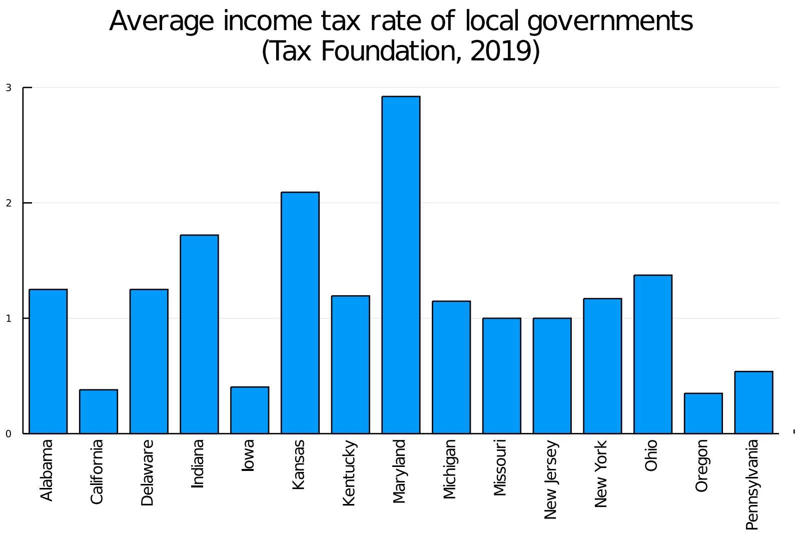


Figure 34: Average local government income tax rate

Given the minor role of local income taxes, we only include state income taxes. According to the documentation of the Census Bureau Tax Model, which imputes federal and state income tax variables in ASEC, the only exception is Maryland[47] where the local tax is assumed to be 0.029% of income.[48] This feature reflects that Maryland is the state with the (by far) highest share of income taxes collected by local governments (more below).

D The regressivity of property taxes

D.1 Progressivity of alternative property tax measures - TBC

In ASEC, property taxes are imputed by the Census Bureau tax model. To check the robustness of our findings when using self-reported property taxes, we match ASEC households on a number of relevant characteristics to ACS households using a hotdeck imputation approach (where the ACS is the donor dataset). We proceed analogously for renters.

D.2 Property Tax Regressivity in ASEC, ACS and AHS

Do the ASEC property tax data feature excess regressivity relative to other publicly available datasets? This question is especially relevant as property taxes in ASEC are not self-reported but imputed by the Census Bureau's tax model.

We compare ASEC, ACS and American Housing Survey (AHS) property tax and income data reported by households residing in different states. For all three datasets, we use the same sample selection as Heathcote, Storesletten, and Violante (2017). For ASEC and ACS, we pool observations from 2005 and 2006. For AHS, we pool years 2003, 2005 and 2007 (to obtain a larger sample size).[49] From each dataset, we compute for each state and different income groups i) medians of property taxes ii) median property taxes as a percentage share of income.

i) medians of property taxes Figures 35 to 37 show nominal amounts of median property taxes paid by different income group in different states according to the ASEC, ACS and AHS. Table 13 presents corresponding ratios of ACS/ASEC and AHS/ASEC median property taxes (i.e. entries larger than 1 imply smaller ASEC reported values) to allow comparing reported

[47] See table 1 here: https://www.census.gov/content/dam/Census/library/working-papers/2005/demo/cpsasec2005taxmodeldoc.pdf

[48] According to its documentation, the NBER's Taxsim model also doesn't include local income taxes.

[49] Prior to 2015, the only available geographic indicator in the AHS Public Use File is the Metropolitan Statistical Area (MSA). However, for the overall majority of records, this variable is suppressed or non-reported. Further, MSA locations imply that our AHS sample mostly captures property taxes of households residing in urban areas. The AHS Internal Use File (IUF) "includes fields identifying detailed geography (down to the 1980 census tract level) for each unit". However, access to the IUF requires Special Sworn Status from the Census Bureau. Details: https://www.census.gov/programs-surveys/ahs/tech-documentation/help-guides/ahs_IUF.html

levels. Tables 14 and 15 provide a direct comparison of nominal amounts and the number of observations in each dataset.

FINDINGS:

- ACS has (many) more observations than ASEC and AHS in all income groups and states (see table 15; AHS does not allow to identify observations in West Virgina).
- In all datasets, property taxes are (weakly) increasing in income. Exceptions are lowest incomes in California and New York who report higher taxes than middle incomes.
- For the overall majority of states and income groups, ASEC property taxes are lower than in ACS and AHS. In terms of percentage deviations, these differences are larger between the ASEC and the ACS than the ASEC and the AHS (see table 13).
- The percentage discrepancies ASEC versus ACS and AHS are larger i) for higher income groups who report (much) larger property taxes in ACS and AHS than in ASEC ii) in California, Kentucky and Texas.

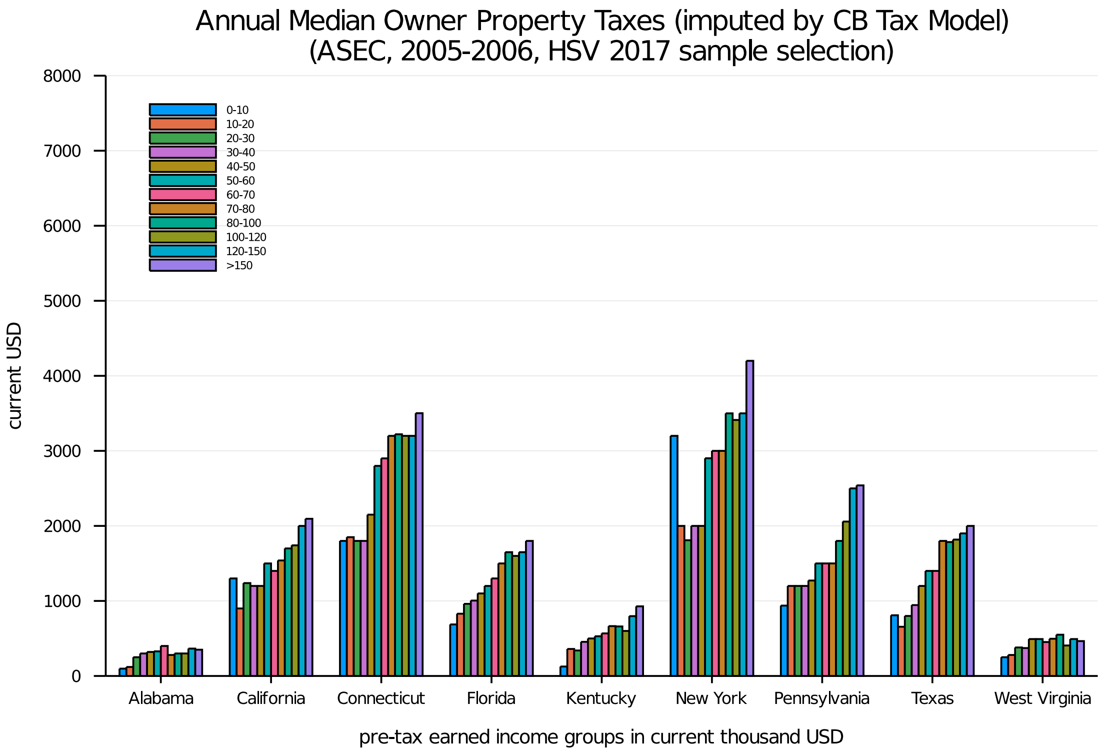


Figure 35: ASEC Property Taxes (imputed by Census Bureau tax model)

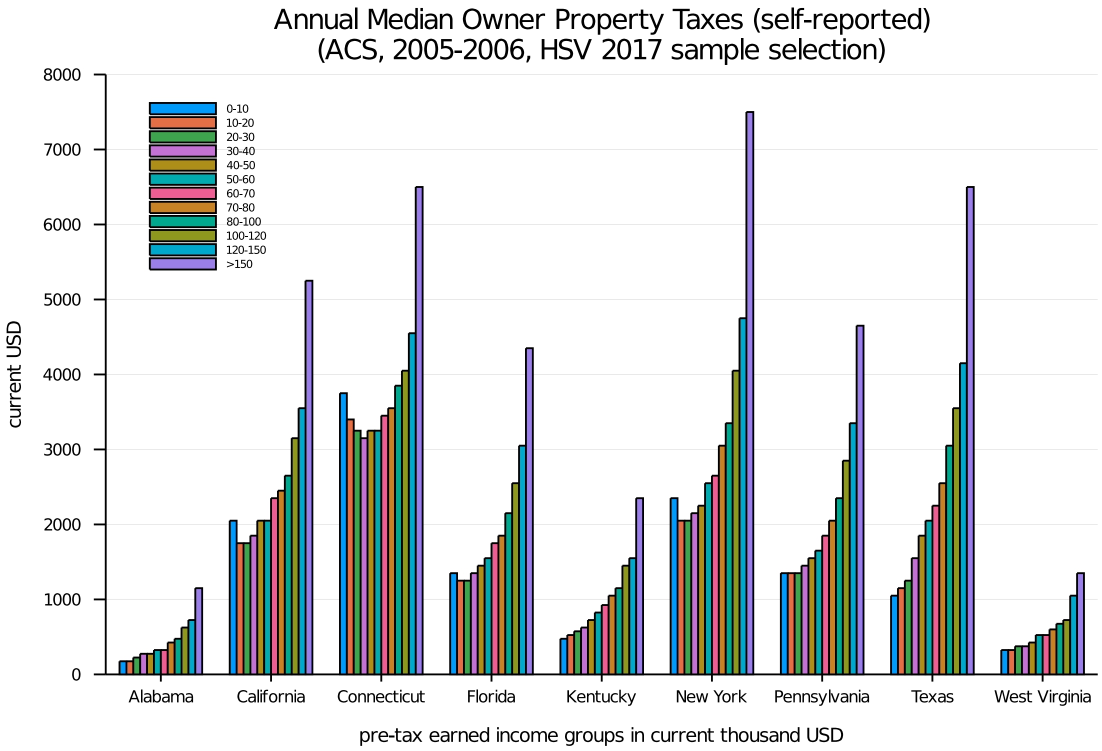


Figure 36: ACS Property Taxes (self-reported)

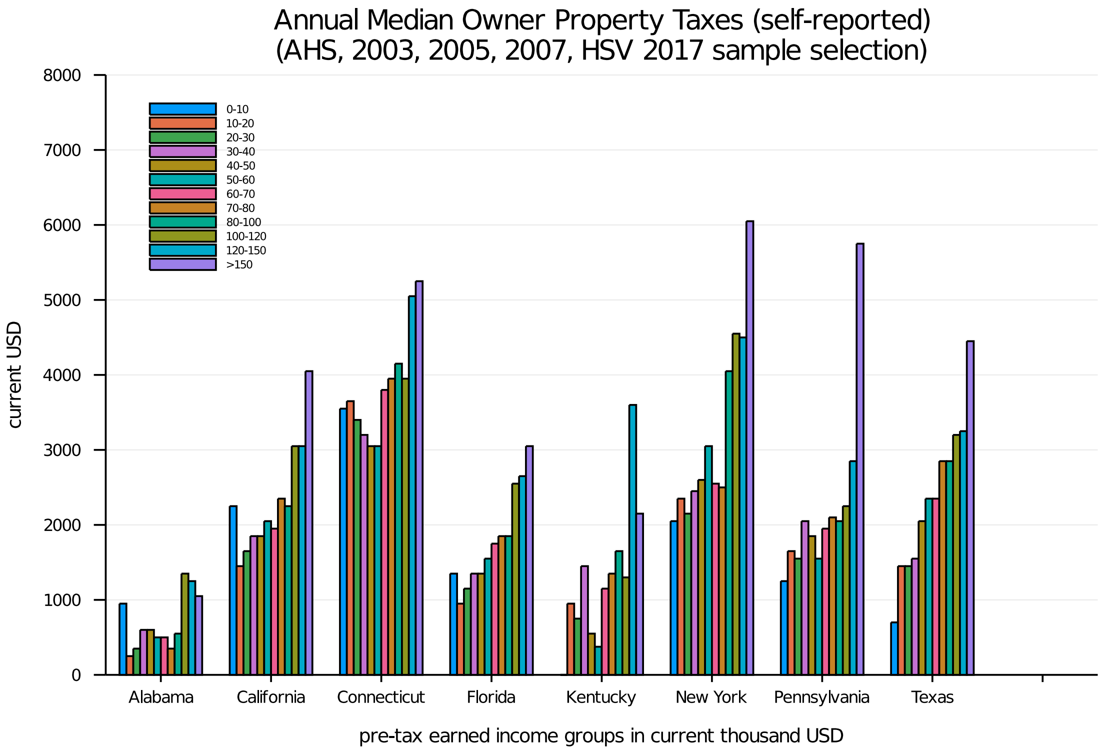


Figure 37: AHS Property Taxes (self-reported)

State	Data	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-100	100-120	120-150	¿150
Alabama	ACS/ASEC	1.8	1.5	0.9	0.9	0.9	1.0	0.8	1.5	1.6	2.1	2.0	3.3
	AHS/ASEC	9.7	2.1	1.4	2.0	1.9	1.5	1.2	1.2	1.8	4.5	3.4	3.0
California	ACS/ASEC	1.6	1.9	1.4	1.5	1.7	1.4	1.7	1.6	1.6	1.8	1.8	2.5
	AHS/ASEC	1.7	1.6	1.3	1.5	1.5	1.4	1.4	1.5	1.3	1.8	1.5	1.9
Connecticut	ACS/ASEC	2.1	1.8	1.8	1.8	1.5	1.2	1.2	1.1	1.2	1.3	1.4	1.9
	AHS/ASEC	2.0	2.0	1.9	1.8	1.4	1.1	1.3	1.2	1.3	1.2	1.6	1.5
Florida	ACS/ASEC	2.0	1.5	1.3	1.3	1.3	1.3	1.3	1.2	1.3	1.6	1.8	2.4
	AHS/ASEC	2.0	1.1	1.2	1.3	1.2	1.3	1.3	1.2	1.1	1.6	1.6	1.7
Kentucky	ACS/ASEC	3.8	1.5	1.7	1.4	1.4	1.6	1.6	1.6	1.7	2.4	1.9	2.5
	AHS/ASEC	0.0	2.6	2.2	3.2	1.1	0.7	2.0	2.0	2.5	2.2	4.5	2.3
New York	ACS/ASEC	0.7	1.0	1.1	1.1	1.1	0.9	0.9	1.0	1.0	1.2	1.4	1.8
	AHS/ASEC	0.6	1.2	1.2	1.2	1.3	1.1	0.8	0.8	1.2	1.3	1.3	1.4
Pennsylvania	ACS/ASEC	1.4	1.1	1.1	1.2	1.2	1.1	1.2	1.4	1.3	1.4	1.3	1.8
	AHS/ASEC	1.3	1.4	1.3	1.7	1.5	1.0	1.3	1.4	1.1	1.1	1.1	2.3
Texas	ACS/ASEC	1.3	1.8	1.6	1.6	1.5	1.5	1.6	1.4	1.7	2.0	2.2	3.2
	AHS/ASEC	0.9	2.2	1.8	1.6	1.7	1.7	1.7	1.6	1.6	1.8	1.7	2.2
West Virgina	ACS/ASEC	1.3	1.2	1.0	1.0	0.9	1.1	1.2	1.2	1.2	1.8	2.1	2.9
	AHS/ASEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 13: Annual median property taxes of different income groups: ACS and AHS vs. ASEC; >1: ASEC smaller; <1: ASEC larger; 0: AHS data missing

State	Data	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-100	100-120	120-150	¿150
Alabama	ASEC	98	120	250	300	320	328	400	280	300	300	365	350
	ACS	175	175	225	275	275	325	325	425	475	625	725	1150
	AHS	950	250	350	600	600	500	500	350	550	1350	1250	1050
California	ASEC	1300	900	1238	1200	1200	1500	1400	1540	1700	1741	2000	2095
	ACS	2050	1750	1750	1850	2050	2050	2350	2450	2650	3150	3550	5250
	AHS	2250	1450	1650	1850	1850	2050	1950	2350	2250	3050	3050	4050
Connecticut	ASEC	1800	1850	1800	1800	2150	2800	2900	3200	3221	3200	3200	3502
	ACS	3750	3400	3250	3150	3250	3250	3450	3550	3850	4050	4550	6500
	AHS	3550	3650	3400	3200	3050	3050	3800	3950	4150	3950	5050	5250
Florida	ASEC	687	830	962	1005	1100	1200	1300	1500	1650	1600	1650	1800
	ACS	1350	1250	1250	1350	1450	1550	1750	1850	2150	2550	3050	4350
	AHS	1350	950	1150	1350	1350	1550	1750	1850	1850	2550	2650	3050
Kentucky	ASEC	126	360	340	455	500	530	568	664	660	600	798	928
	ACS	475	525	575	625	725	825	925	1050	1150	1450	1550	2350
	AHS	0	950	750	1450	550	375	1150	1350	1650	1300	3600	2150
New York	ASEC	3200	2000	1809	2000	2000	2902	3000	3000	3500	3412	3500	4200
	ACS	2350	2050	2050	2150	2250	2550	2650	3050	3350	4050	4750	7500
	AHS	2050	2350	2150	2450	2600	3050	2550	2500	4050	4550	4500	6050
Pennsylvania	ASEC	938	1200	1200	1200	1272	1500	1500	1500	1800	2058	2500	2540
	ACS	1350	1350	1350	1450	1550	1650	1850	2050	2350	2850	3350	4650
	AHS	1250	1650	1550	2050	1850	1550	1950	2100	2050	2250	2850	5750
Texas	ASEC	809	656	800	945	1200	1400	1400	1800	1785	1818	1900	2000
	ACS	1050	1150	1250	1550	1850	2050	2250	2550	3050	3550	4150	6500
	AHS	700	1450	1450	1550	2050	2350	2350	2850	2850	3200	3250	4450
West Virgina	ASEC	250	280	380	372	492	492	452	496	550	406	492	465
	ACS	325	325	375	375	425	525	525	600	675	725	1050	1350
	AHS	0	0	0	0	0	0	0	0	0	0	0	0

Table 14: Annual median property taxes of different income groups

State	Data	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-100	100-120	120-150	¿150
Alabama	ASEC	13	59	71	78	89	94	75	67	111	51	44	44
	ACS	202	1023	1437	1745	1733	1603	1399	1247	1868	1131	777	820
	AHS	3	9	11	20	14	24	10	18	26	11	5	15
California	ASEC	41	141	263	350	396	413	393	368	495	482	383	551
	ACS	814	2791	4191	5804	6972	7304	7808	7297	12585	9985	9728	14595
	AHS	29	87	180	265	304	277	369	366	563	377	376	639
Connecticut	ASEC	17	36	65	75	112	142	115	121	198	168	164	211
	ACS	86	274	402	719	867	1012	1044	1068	1849	1469	1349	2121
	AHS	3	7	4	20	20	19	16	13	20	19	24	21
Florida	ASEC	22	135	226	323	292	275	244	207	329	222	198	261
	ACS	710	2857	4704	5826	6058	6133	5517	4807	7399	4979	3770	4984
	AHS	13	66	137	168	189	141	132	101	172	78	74	111
Kentucky	ASEC	21	68	63	107	97	110	104	80	116	55	46	45
	ACS	214	829	1303	1516	1716	1584	1454	1211	1805	1017	703	708
	AHS	0	1	1	2	11	2	9	4	12	8	6	6
New York	ASEC	19	81	140	171	184	242	232	204	290	216	184	286
	ACS	525	1884	2961	3947	4713	4883	4857	4430	7123	5321	4545	6929
	AHS	4	32	93	113	92	129	154	108	241	208	164	274
Pennsylvania	ASEC	24	69	164	183	201	227	218	192	294	167	143	185
	ACS	560	1990	3388	4240	4797	4870	4556	3811	5654	3454	2663	3019
	AHS	3	21	46	37	41	42	43	24	42	31	13	29
Texas	ASEC	49	203	281	327	304	325	299	258	343	247	187	254
	ACS	1018	3919	5541	6770	7169	6656	6411	5671	9028	6061	4989	6421
	AHS	12	83	121	156	159	141	140	117	189	124	101	160
West Virgina	ASEC	17	63	79	83	91	92	72	68	80	40	32	22
	ACS	110	420	644	681	686	639	564	476	636	308	200	201
	AHS	0	0	0	0	0	0	0	0	0	0	0	0

Table 15: Annual median property taxes - number of observations

ii) median property taxes as a percentage share of income For each income and state group, we compute median property taxes paid as a percentage of median income. Figures 38 to 40 illustrate these shares computed from ASEC, ACS and AHS data. Table 16 in the appendix provides a direct comparison of the shares.

FINDINGS:

- In all three datasets, property taxes as a share of income are decreasing in income (except for Kentucky in the AHS which has very few observations).
- In all three datasets, property taxes as a share of income are much larger for the lowest (two) income groups than for higher income groups, in some states by almost one order of magnitude.
- For all income groups except the lowest two, the ASEC shares are slightly smaller than

those of ACS and AHS. This applies especially to lowest and highest income groups.

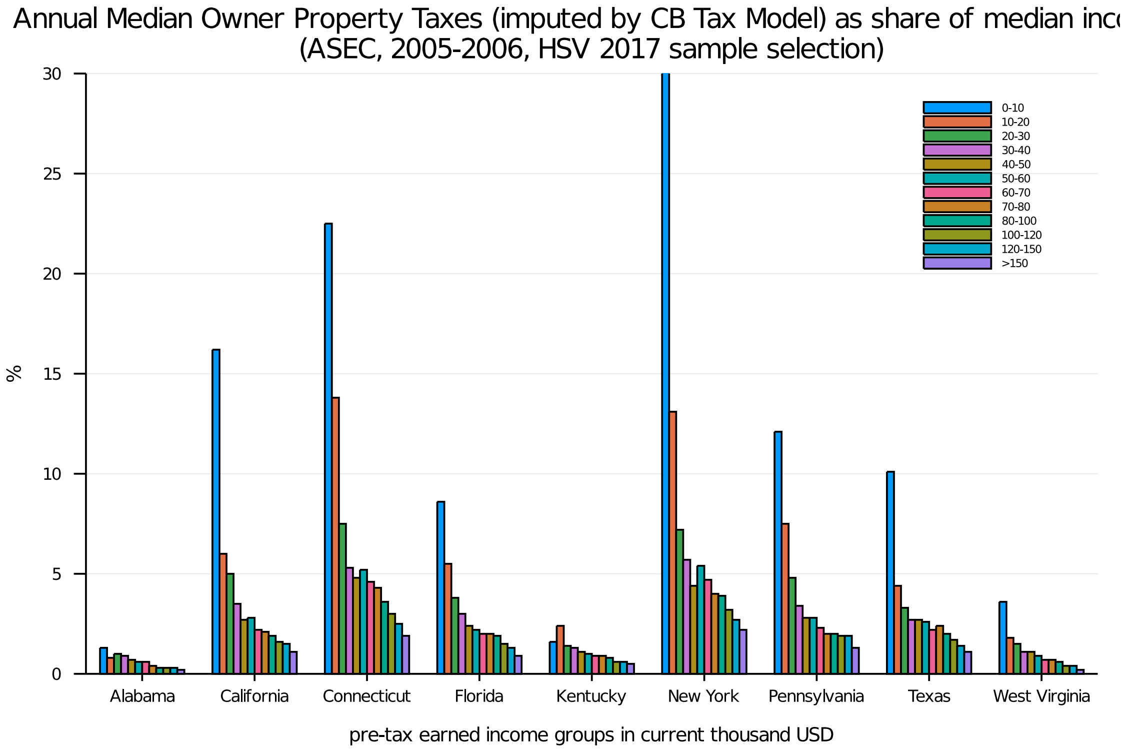


Figure 38: ASEC median property taxes as a percentage of median income (imputed by Census Bureau tax model)

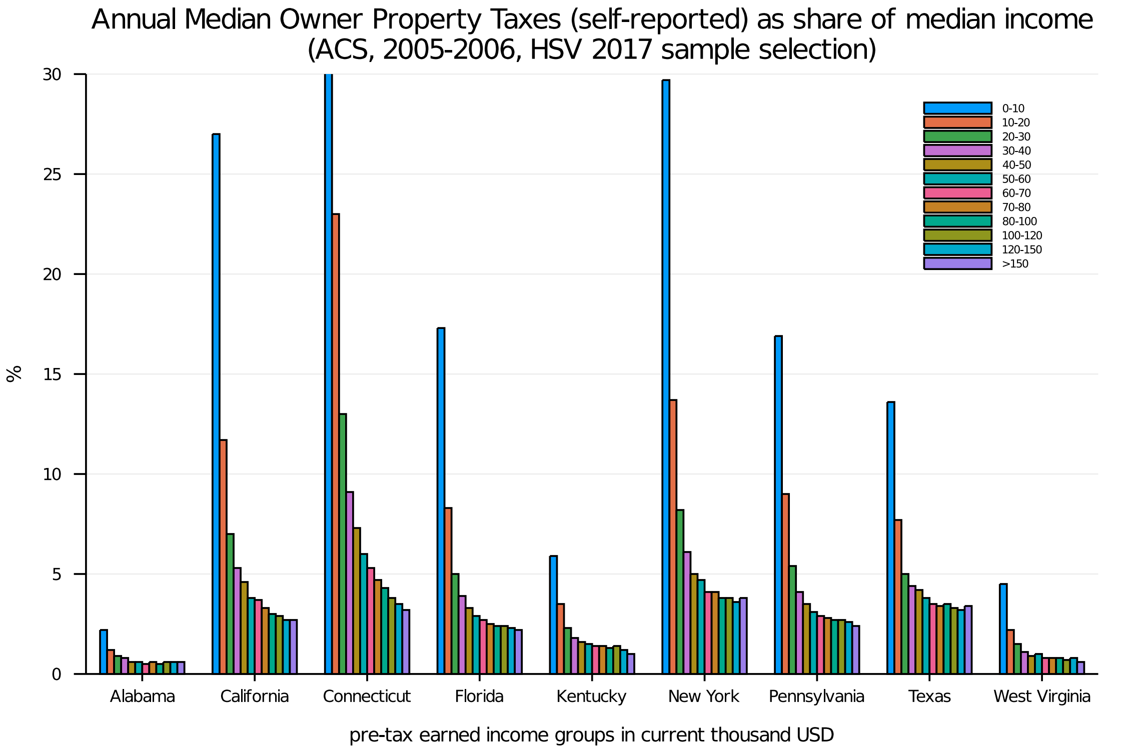


Figure 39: ACS median property taxes as a percentage of median income (self-reported)

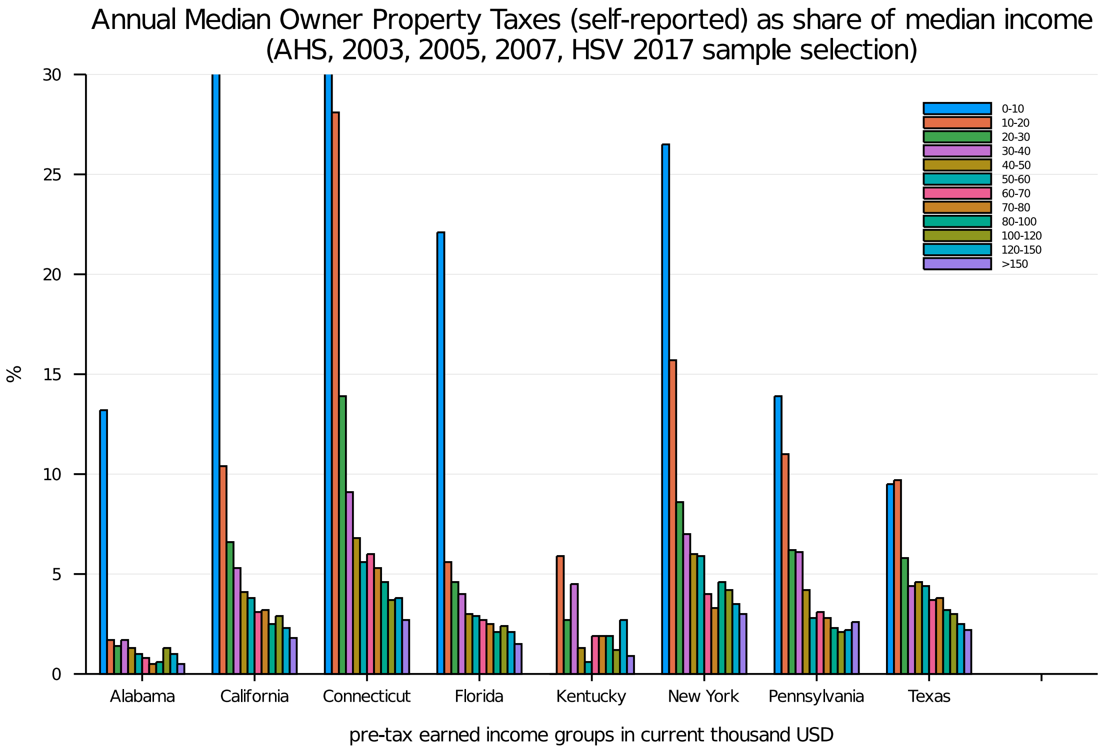


Figure 40: AHS median property taxes as a percentage of median income (self-reported)

State	Data	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-100	100-120	120-150	>150
Alabama	ASEC	1.3	0.8	1.0	0.9	0.7	0.6	0.6	0.4	0.3	0.3	0.3	0.2
	ACS	2.2	1.2	0.9	0.8	0.6	0.6	0.5	0.6	0.5	0.6	0.6	0.6
	AHS	13.2	1.7	1.4	1.7	1.3	1.0	0.8	0.5	0.6	1.3	1.0	0.5
California	ASEC	16.2	6.0	5.0	3.5	2.7	2.8	2.2	2.1	1.9	1.6	1.5	1.1
	ACS	27.0	11.7	7.0	5.3	4.6	3.8	3.7	3.3	3.0	2.9	2.7	2.7
	AHS	32.1	10.4	6.6	5.3	4.1	3.8	3.1	3.2	2.5	2.9	2.3	1.8
Connecticut	ASEC	22.5	13.8	7.5	5.3	4.8	5.2	4.6	4.3	3.6	3.0	2.5	1.9
	ACS	53.6	23.0	13.0	9.1	7.3	6.0	5.3	4.7	4.3	3.8	3.5	3.2
	AHS	50.7	28.1	13.9	9.1	6.8	5.6	6.0	5.3	4.6	3.7	3.8	2.7
Florida	ASEC	8.6	5.5	3.8	3.0	2.4	2.2	2.0	2.0	1.9	1.5	1.3	0.9
	ACS	17.3	8.3	5.0	3.9	3.3	2.9	2.7	2.5	2.4	2.4	2.3	2.2
	AHS	22.1	5.6	4.6	4.0	3.0	2.9	2.7	2.5	2.1	2.4	2.1	1.5
Kentucky	ASEC	1.6	2.4	1.4	1.3	1.1	1.0	0.9	0.9	0.8	0.6	0.6	0.5
	ACS	5.9	3.5	2.3	1.8	1.6	1.5	1.4	1.4	1.3	1.4	1.2	1.0
	AHS	0.0	5.9	2.7	4.5	1.3	0.6	1.9	1.9	1.9	1.2	2.7	0.9
New York	ASEC	40.0	13.1	7.2	5.7	4.4	5.4	4.7	4.0	3.9	3.2	2.7	2.2
	ACS	29.7	13.7	8.2	6.1	5.0	4.7	4.1	4.1	3.8	3.8	3.6	3.8
	AHS	26.5	15.7	8.6	7.0	6.0	5.9	4.0	3.3	4.6	4.2	3.5	3.0
Pennsylvania	ASEC	12.1	7.5	4.8	3.4	2.8	2.8	2.3	2.0	2.0	1.9	1.9	1.3
	ACS	16.9	9.0	5.4	4.1	3.5	3.1	2.9	2.8	2.7	2.7	2.6	2.4
	AHS	13.9	11.0	6.2	6.1	4.2	2.8	3.1	2.8	2.3	2.1	2.2	2.6
Texas	ASEC	10.1	4.4	3.3	2.7	2.7	2.6	2.2	2.4	2.0	1.7	1.4	1.1
	ACS	13.6	7.7	5.0	4.4	4.2	3.8	3.5	3.4	3.5	3.3	3.2	3.4
	AHS	9.5	9.7	5.8	4.4	4.6	4.4	3.7	3.8	3.2	3.0	2.5	2.2
West Virgina	ASEC	3.6	1.8	1.5	1.1	1.1	0.9	0.7	0.7	0.6	0.4	0.4	0.2
	ACS	4.5	2.2	1.5	1.1	0.9	1.0	0.8	0.8	0.8	0.7	0.8	0.6
	AHS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 16: Annual median property taxes as a percentage of median income

D.3 Why property taxes are regressive

What is the source of property tax regressivity? This is an old and unresolved question to which conflicting answers keep being proposed.[50] While ASEC is not as suitable to study this question as the proprietary datasets used by recent papers, we still want to have some idea on the drivers of the cross-state regressivity differences we find. This might also help in deciding whether we should focus on state or local governments as the relevant geographic units in our model.

A common measure of tax progressivity is the ratio of taxes over income. To investigate property tax progressivity implied by this measure, we provide a detailed exposition of the factors

[50]Examples: Musgrave (1974), ..., Oates and Fischel (2016), Levinson (2020), Avenancio-León and Howard (2020), Amornsiripanitch (2020), McMillen and Singh (2020).

which determine property taxes paid, T^P:

$$T^P_{t,s,i} = t^P_{t,s} \times ASV_{t,s,i} \tag{30}$$
$$= t^P_{t,s} \times asr_{t,s,i} \times APV_{t,s,i} \tag{31}$$
$$= t^P_{t,s} \times asr_{t,s,i} \times apr_{t,s,i} \times V_{t,s,i} \tag{32}$$

where t^P is the statutory property tax rate,[51] ASV is the house's assessed value, APV its appraised value and V its true market value. asr is the assessment ratio, apr the appraisal ratio and t indexes year, s locality and i individual (household). Hence, property taxes paid per dollar of income (y) is determined by several variables

$$\left.\frac{T^P}{y}\right|_{t,s,i} = t^P_{t,s} \times asr_{t,s,i} \times apr_{t,s,i} \times V_{t,s,i} \times \frac{1}{y_{t,s,i}} \tag{33}$$

Two comments on $\frac{T^P}{y}$ as a measure of property tax progressivity:

1. **Public datasets (e.g. ASEC, ACS, AHS) lack relevant variables to identify sources of property tax progressivity:**
   - Geography (s): All right hand side variables which are exogenous to the individual (t^P, asr, apr) are set at the level of the "Tax Code Area" (TCA) which provides a common set of public goods and services paid for with property taxes (schools, policing, fire protection, roads, cemeteries, etc). Hence, only within each TCA the same statutory property tax rate t^P applies. Therefore, this is the ideal geographic unit s at which to investigate sources of property tax regressivity. However, TCAs do not correspond to geographic units available in public datasets and they are smaller than a county (counties can actually contain hundreds of TCAs).[52]
   - Policy Parameters (t^P, asr, apr): They are not available in a consolidated database and need to be hand collected.
2. **Additional elements of the property tax code determine progressivity but are omitted from equation (33):**[53]
   - The statutory property tax rate $t^P_{t,s}$ applying in TCA s is the sum of statutory rates

[51] The literature usually reports effective property tax rates computed from $\frac{T^P}{V} = t^P_{eff}$, not statutory rates t^P.

[52] Parcels and overlaps are also relevant. Some info: https://www.co.cowlitz.wa.us/1168/Taxing-Districts-and-Tax-Code-Areas

[53] Most of the information presented in this paragraph is from: https://itep.org/how-property-taxes-work/

$t^P_{t,s,j}$ set by K taxing entities (school districts, fire departments, etc.) located within s

$$t^P_{t,s} = \sum_{j=1}^{K} t^P_{t,s,j} \tag{34}$$

- (Homestead) Exemptions reduce the property's assessed value before the tax rate t^P is applied

$$\text{Taxable Value} = ASV - \text{(Homestead) Exemption} \tag{35}$$

  These exemptions differ across states and can be large. (For example, Alabama's standard property exemption for homeowners is 15,000$.)

- State specific Property Tax Credits reduce the property tax payment

$$\text{Property Tax Bill} = T^P - \text{Property Tax Credit} \tag{36}$$

  As for exemptions, these credits differ across states and can be large.

- States have "Circuit Breaker" programs, i.e. targeted property tax breaks; for specific groups, for example low-income earners or retirees, these programs cap property taxes at a certain share of income.[54]

$$\text{Actual Property Tax Bill} = \min\left\{cb \times y, \text{Property Tax Bill}\right\} \tag{37}$$

  where cb is the percentage of income which the circuit breaker program fixes maximum property taxes to.

Including these additional elements results in equation (32) yields

$$\widetilde{T}^P_{t,s,i} = \min\left\{cb_{t,s,i} \times y_{t,s,i}\,,\left(\sum_{j=1}^{K} t^P_{t,s,j} \times \left(ASV_{t,s,i} - E^P_{t,s,i}\right)\right) - TC^P_{t,s,i}\right\} \tag{38}$$

$$= \min\left\{cb_{t,s,i} \times y_{t,s,i}\,,\left(\sum_{j=1}^{K} t^P_{t,s,j} \times \left(asr_{t,s,i} \times apr_{t,s,i} \times V_{t,s,i} - E^P_{t,s,i}\right)\right) - TC^P_{t,s,i}\right\} \tag{39}$$

where $\widetilde{T}^P_{t,s,i}$ is actual property taxes paid, $TC^P_{t,s,i}$ denotes the property tax credit and $E^P_{t,s,i}$ is a (homestead) exemption. Unfortunately, this representation no longer allows a tractable expression of $\frac{\widetilde{T}^P}{y}$. Also, in order to identify the progressivity contribution of each variable, we need to find additional year and locality (state) specific variables

[54] More info on circuit breakers and states which have them: https://itep.org/property-tax-circuit-breakers-in-2018/ and https://www.thebalance.com/what-is-a-property-tax-circuit-breaker-3193326

as well as eligibility parameters ($cb_{t,s,i}$, $E^P_{t,s,i}$ and $TC^P_{t,s,i}$).

Sources of property tax regressivity

- Two recent literature explanations of property tax regressivity differences:
  1. Avenancio-León and Howard (2020): *asr* is function of i's race with
  $$\mathbb{E}[asr|white] < \mathbb{E}[asr|black]$$
  so – conditional on all other rhs variables of equation (33) – ASV differs by race.
  2. Amornsiripanitch (2020): apr is a function of i's neighborhood
  $$\mathbb{E}[apr|bad\ neighborhood] = \mathbb{E}[apr|good\ neighborhood]$$
  so the appraisal algorithm underestimates the discount of poor neighborhoods on home market values and therefore – conditional on all other rhs variables of equation (33) – APV differs by income (as poorer households tend to own homes in worse neighborhoods).
- Some more possibilities:
  3. poor people live in neighborhoods with high (statutory) local property tax rates
  $$\mathbb{E}[t^P|y\ low] > \mathbb{E}[t^P|y\ high]$$
  4. poor people face high appraised value / true home value ratios
  $$\mathbb{E}[apr|y\ low] > \mathbb{E}[apr|y\ high]$$
  – this is closely related to the explanation of Amornsiripanitch (2020)
  5. poor people have expensive homes relative to their income
  $$\mathbb{E}\left[\frac{V}{y}\middle|y\ low\right] > \mathbb{E}\left[\frac{V}{y}\middle|y\ high\right]$$
  – this would mechanically affect our measure of property tax progressivity (T^P/y)

Inspecting causes of property tax regressivity in the ASEC data We use household level ACS variables on state of residence, earned income y_i, self-reported value of the property V_i and property taxes paid T^P_i to investigate two relevant issues:

1. Do poor people have expensive homes relative to their incomes?
2. How much variation in property taxes is accounted for by variation in income, property value and state of residence? (And does this share differ across incomes and states?)

1. Do poor people have expensive homes relative to their incomes?

- For the same state and income groups as shown earlier, we compute

$$\left.\frac{V}{y}\right|_{t,s,i} \tag{40}$$

The result is shown in figure 41

Figure 41: ACS median home values (self-reported) divided by median income

- We log median incomes and house values of each income group and inspect their relationship in different states. Results are presented as a scatter plot showing Engel curves in figure 42

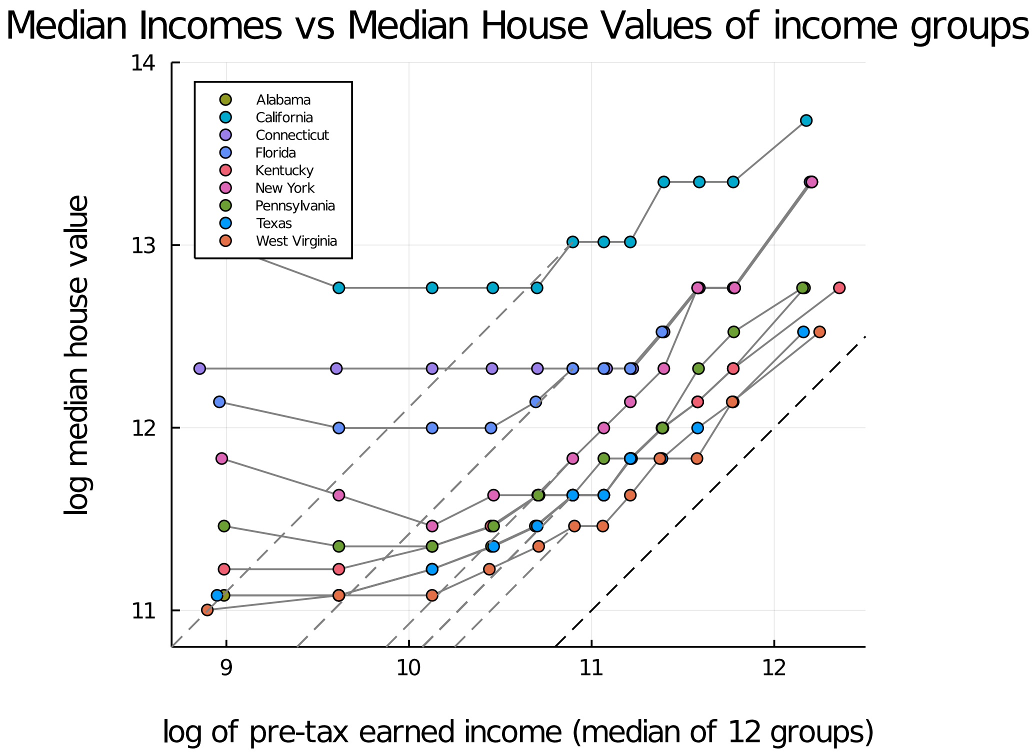


Figure 42: ACS log median home values and log median incomes

2. Variation in property taxes - TBC

E Measuring State Characteristics

E.1 Political color

We use the same approach as Altig, Auerbach, Higgins, Koehler, Kotlikoff, Terry, and Ye (2020) to classify states into Red (Republican), Blue (Democratic) and Purple (Swing): "To explore red-blue TCJA differences, we designate states, including the District of Columbia, as blue, red or purple based on the average voter margin over the past five presidential elections. States where the Republican share of total votes was, on average, five percentage points higher than the Democratic share of total votes over the past five presidential elections are classified as red. States where the Democratic share of total votes was, on average, five percentage points higher than the Republican share of total votes over the past five presidential elections are classified as blue. The remaining states are classified as purple."

E.2 Income: mean, median and inequality

We use American Community Survey (ACS) data to compute several measures of state pre-tax income inequality for 2005. Specifically, for each state's income distribution, we compute means, medians, Gini coefficients and the ratios of the 90/50, 50/10 and 90/10 percentiles. We do so using the same sample selection criteria.[55] Table 17 shows the complete results while figures 43 and 44 show the Gini coefficients and the income ratios.

[55]Note that ACS income variables have year-state specific topcodes. Available here: https://usa.ipums.org/usa/volii/top_bottom_codes.shtml. For example, for 2005, values above this topcode are set to the mean of all values above the 99.5th percentile in the state.

State	Mean	Median	Gini	90/10	90/50	50/10	Ranking Gini	Ranking 90/10
Alabama	72649	60000	0.37	5.51	2.07	2.67	7	9
Alaska	81445	70000	0.36	5.34	1.96	2.72	12	17
Arizona	82065	68000	0.37	5.8	2.13	2.72	8	6
Arkansas	62594	53000	0.35	5.2	2.04	2.55	21	24
California	94638	76800	0.39	6.8	2.24	3.04	4	2
Colorado	85638	73800	0.35	5.26	2.03	2.59	22	21
Connecticut	118936	90000	0.4	5.45	2.3	2.37	2	13
Delaware	90057	76200	0.35	5.05	1.99	2.54	23	31
District of Columbia	140802	106000	0.43	7.14	2.36	3.03	1	1
Florida	81490	66000	0.38	5.72	2.17	2.64	6	8
Georgia	83507	68700	0.37	5.77	2.18	2.64	9	7
Hawaii	83261	72800	0.34	5.48	1.99	2.76	34	11
Idaho	62840	54400	0.34	4.79	1.97	2.44	35	41
Illinois	88958	73800	0.36	5.1	2.05	2.49	13	30
Indiana	73878	64200	0.33	4.59	1.93	2.38	41	44
Iowa	67347	60000	0.31	4.32	1.83	2.36	49	49
Kansas	71349	61000	0.34	4.98	1.98	2.51	36	36
Kentucky	69935	60000	0.36	5.5	2.02	2.73	14	10
Louisiana	72493	62000	0.35	5.13	1.99	2.58	24	29
Maine	66007	57000	0.34	5.18	2.0	2.59	37	27
Maryland	106102	90000	0.34	4.8	2.0	2.4	38	40
Massachusetts	103312	86600	0.35	5.0	2.02	2.47	25	34
Michigan	79002	68000	0.34	5.19	1.99	2.62	39	25
Minnesota	80242	67125	0.35	5.19	2.01	2.58	26	26
Mississippi	65713	55700	0.35	5.18	2.05	2.53	27	28
Missouri	72834	61000	0.36	5.32	2.05	2.59	15	18
Montana	60607	52000	0.35	5.0	1.92	2.6	28	35
Nebraska	67068	59000	0.32	4.62	1.88	2.46	47	43
Nevada	79956	67000	0.35	5.04	2.03	2.48	29	32
New Hampshire	84921	75000	0.31	4.22	1.91	2.21	50	51
New Jersey	114541	94000	0.37	5.32	2.13	2.5	10	19
New Mexico	68108	58800	0.36	6.08	2.07	2.94	16	5
New York	95423	75000	0.4	6.22	2.24	2.78	3	4
North Carolina	76132	62750	0.37	5.47	2.14	2.56	11	12
North Dakota	63297	55900	0.33	4.57	1.88	2.43	42	46
Ohio	76897	66000	0.33	4.81	1.97	2.44	43	39
Oklahoma	65872	55000	0.36	5.43	2.07	2.62	17	14
Oregon	74337	62000	0.36	5.25	2.03	2.58	18	22
Pennsylvania	77958	65500	0.35	5.02	2.03	2.47	30	33
Rhode Island	91765	77000	0.33	4.66	2.02	2.31	44	42
South Carolina	72139	60050	0.35	5.21	2.08	2.5	31	23
South Dakota	62117	55000	0.33	4.59	1.78	2.57	45	45
Tennessee	71480	60000	0.36	5.37	2.07	2.6	19	16
Texas	79309	64600	0.39	6.37	2.23	2.86	5	3
Utah	72701	62000	0.33	4.5	1.96	2.3	46	47
Vermont	73498	61600	0.35	4.88	2.03	2.4	32	38
Virginia	94307	79700	0.36	5.32	2.07	2.57	20	20
Washington	84107	71600	0.35	4.97	1.98	2.5	33	37
West Virginia	62388	55000	0.34	5.4	1.96	2.75	40	15
Wisconsin	74783	65800	0.32	4.32	1.84	2.35	48	50
Wyoming	67642	60140	0.31	4.34	1.77	2.45	51	48

Table 17: Household Labor Income (ACS 2005, household selection criteria see section 2)

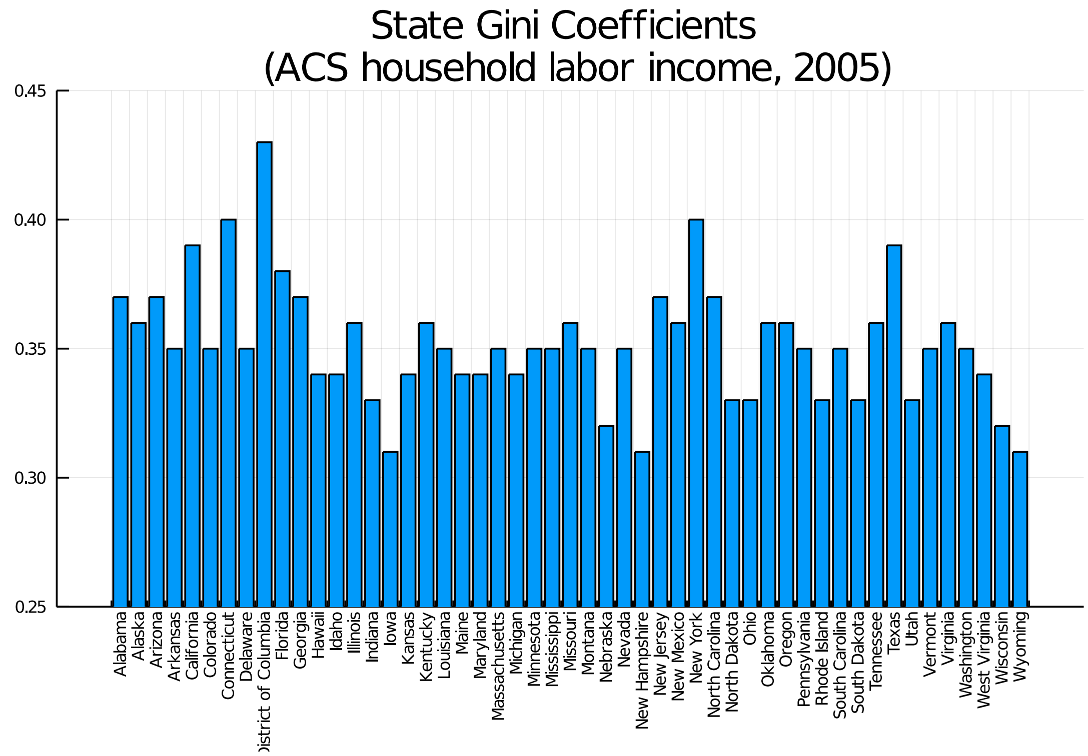


Figure 43: Gini Coefficients of Household Labor Income

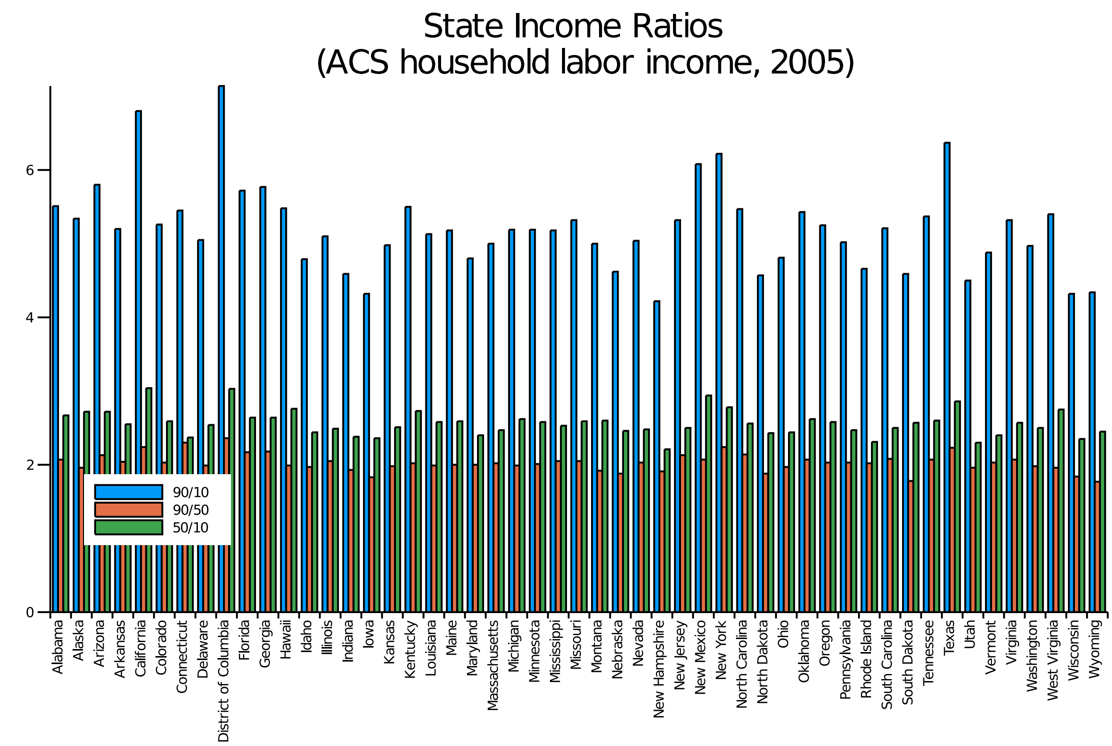


Figure 44: 90/10 Ratios of Household Labor Income

E.3 Spending on Public Goods and Services

We obtain data on state and local spending from the "Census of Governments" dataset of the Census Bureau. For 2006, figure 45 shows total state and local spending as a share of state GDP.

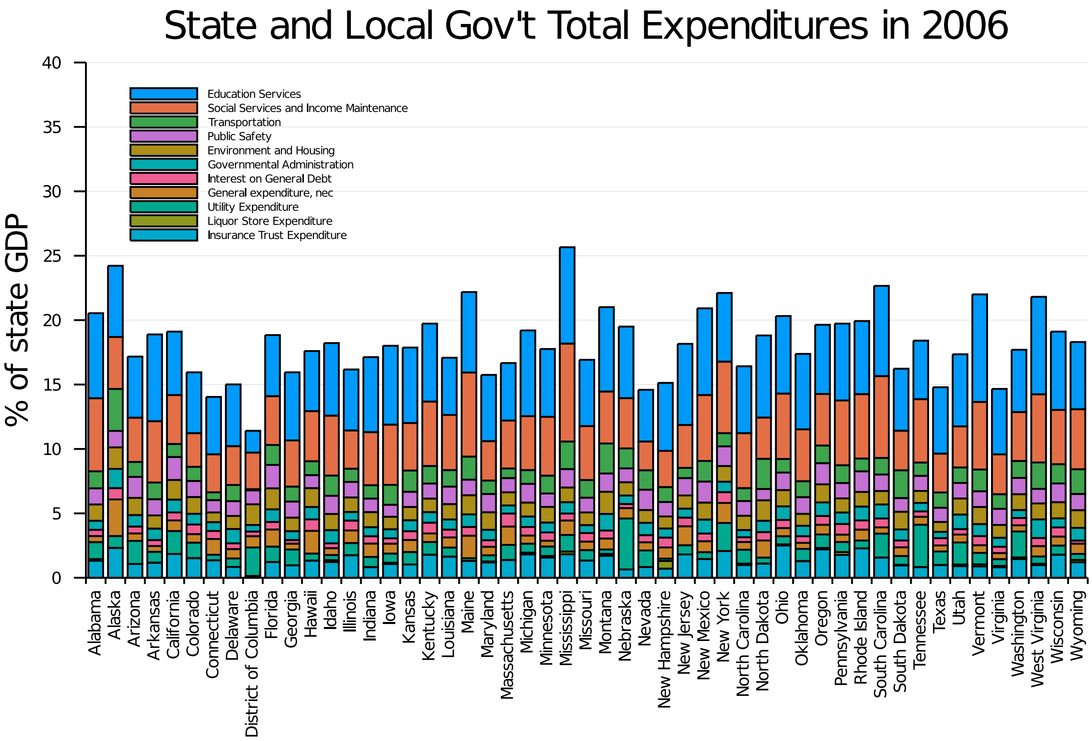


Figure 45: State and local total spending scaled by GDP

To create a more narrow measure of state and local spending on public goods and services, we focus on a subset of "Direct General Expenditures". Specifically, we include state and local spending on i) "Education Services", ii) "Transportation", iii) "Public Safety" and iv) "Environment and Housing".[56]

We do not include spending on "Social Services and Income Maintenance" because this category includes spending not financed from own resources but financed by intergovernmental (federal) grants and transfers. Moreover, several of its subcategories, e.g. spending on public welfare, include direct transfers such as TANF which we included in our progressivity estimation.

Figures 46 and 47 show this narrow measure of state and local spending on public goods and

[56]Subcategories of these aggregates are: i) Higher Education, Elementary and Secondary Education, Other Education, Libraries ii) Highways, Air Transportation (Airpots), Parking Facilities, Sea and Inland Port Facilities iii) Police Protection, Fire Protection, Correction, Protective Inspection and Regulation iv) Natural Resources, Parks and Recreation, Housing and Community Development, Sewerage, Solid Waste Management. All spending includes capital outlays.

services scaled by state GDP and population respectively for 2005.[57]

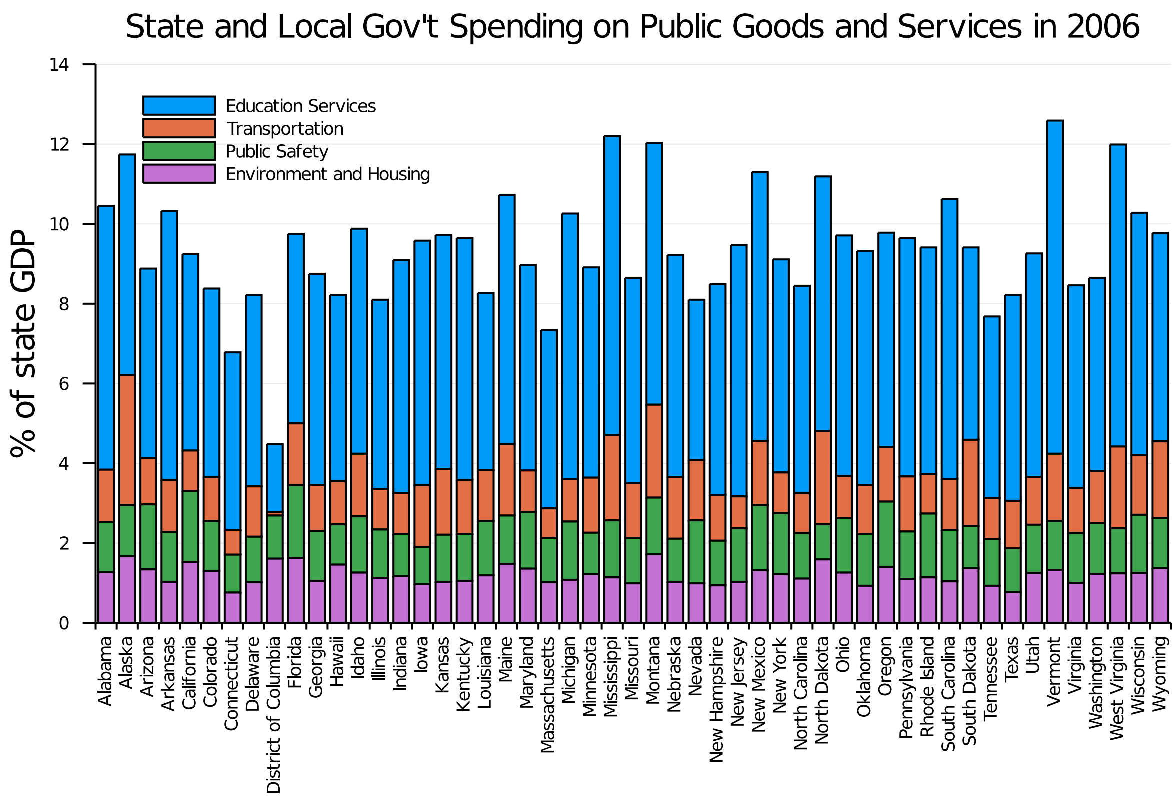


Figure 46: State and local spending on public goods and services scaled by GDP

[57]Data on state GDP are obtained from the Bureau of Economic Analysis and population data from the Census Bureau.

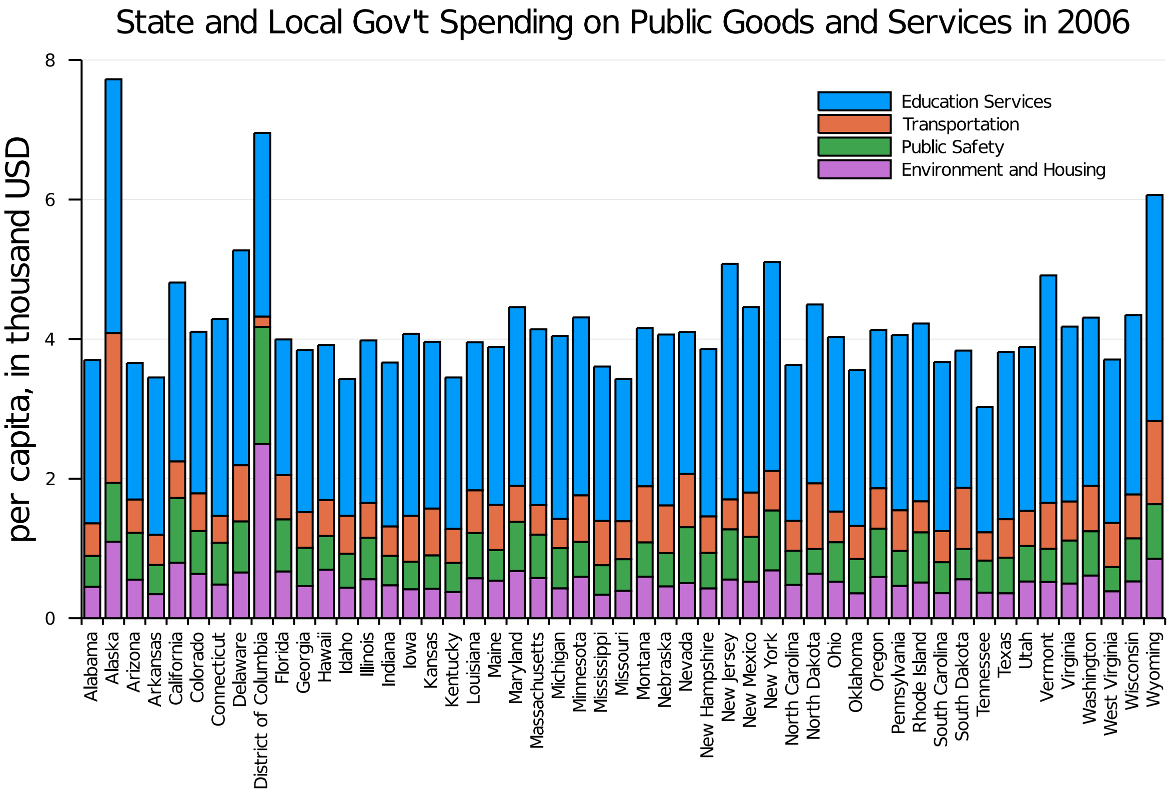


Figure 47: State and local spending on public goods and services scaled by population

E.4 Total Revenues

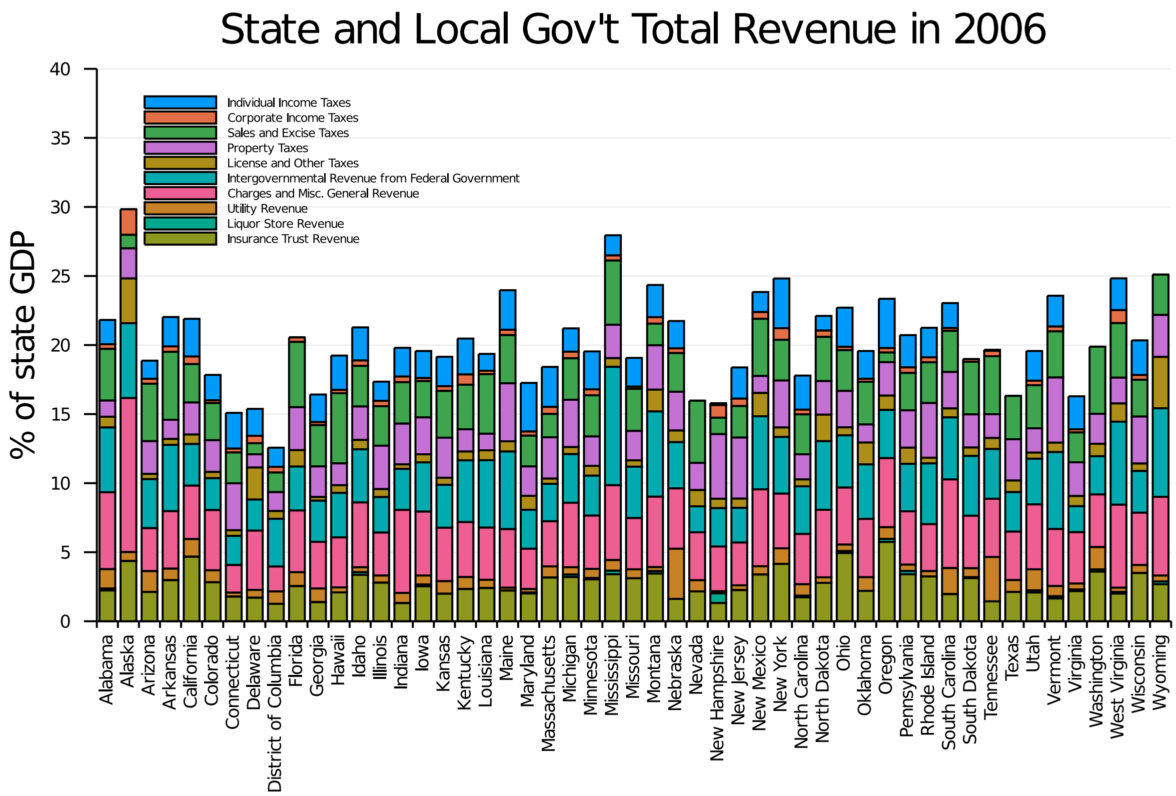


Figure 48: State and local total revenues scaled by GDP

Figure 48 shows total revenues for each state government as well as local governments which each state for 2006.

Comparing these revenues to state spending values presented in earlier figures reveals discrepancies. One might conclude that some states run (large) deficits or surpluses. However, as mentioned by the Census Bureau in its 2006 edition of the "US Government Finance and Employment Classification Manual", its data on state and local revenues and spending are statistical in nature which implies certain limitations. For example, "the difference between a government's total revenue and total expenditure cannot be construed to be a "surplus" or "deficit."

However, as shown in figure 49, the correlation between state and local revenues and spending is very high. Moreover, the figure also indicates that all states had larger revenues than expenditures. This impression is in accordance with the fact that 2006 was a year in which the aggregate US economy was in a state of expansion.

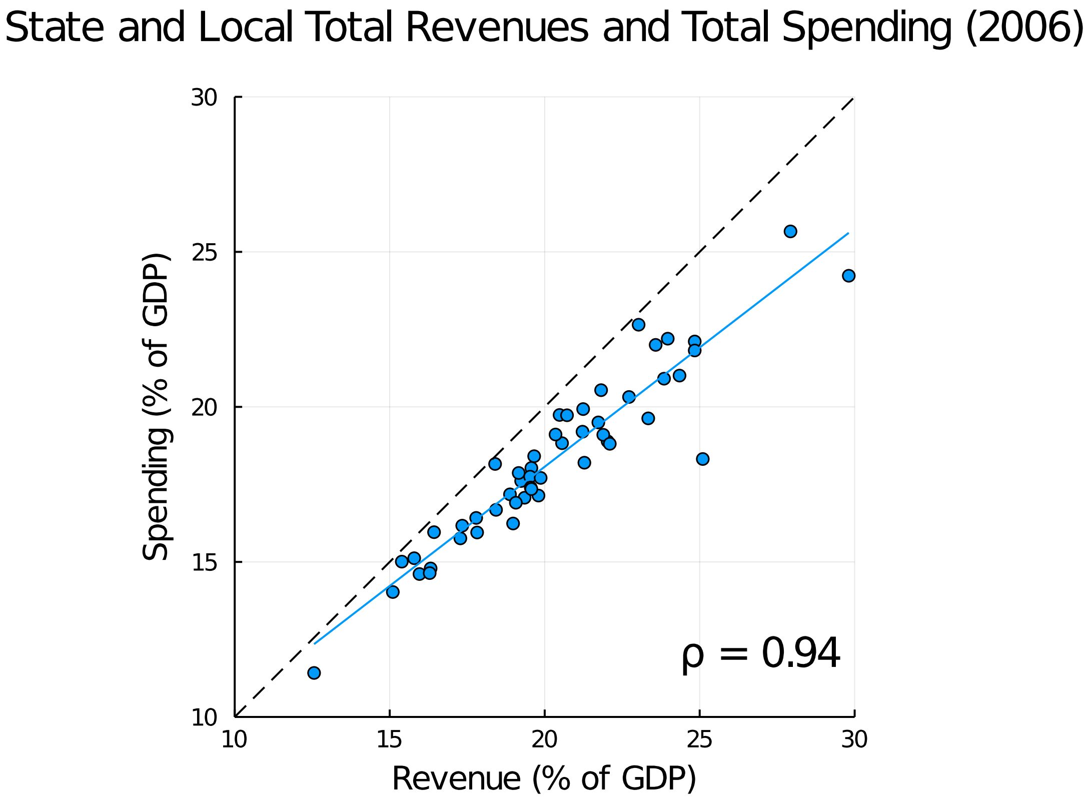


Figure 49: State and local total revenues and expenditures scaled by GDP

E.5 Balanced Budget Rules

We obtain two different measures on the stringency of state's balanced budget rules:

1. From Yarbrough (2016) we obtain a coarse measure classifying state balanced budget rules as "strict", "weak" or "none" (table 1.1). (The only state with "none" is Vermont.) This measure is missing for Alaska, Washington DC and Hawaii.
2. From Poterba and Rueben (2001) we obtain a more granular measure which is based on the Advisory Council on Intergovernmental Relations (ACIR) "Significant Features of Fiscal Federalism" report. This ACIR index ranges from 0 (lax) to 10 (stringent).[58] This measure is missing for Washington DC. Figure 50 illustrates this index.

[58] Poterba and Rueben (2001) use a threshold of 6 to generate a more coarse measure during their analysis.

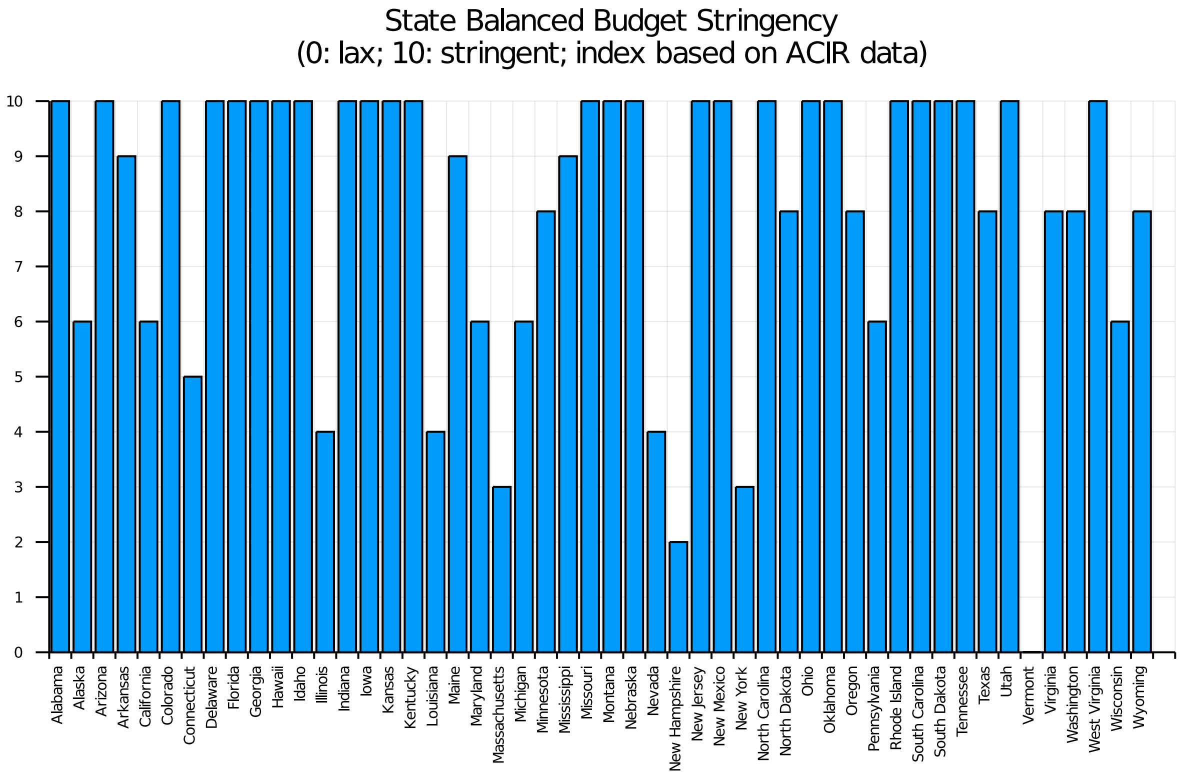


Figure 50: Stringency of state balanced budget rules

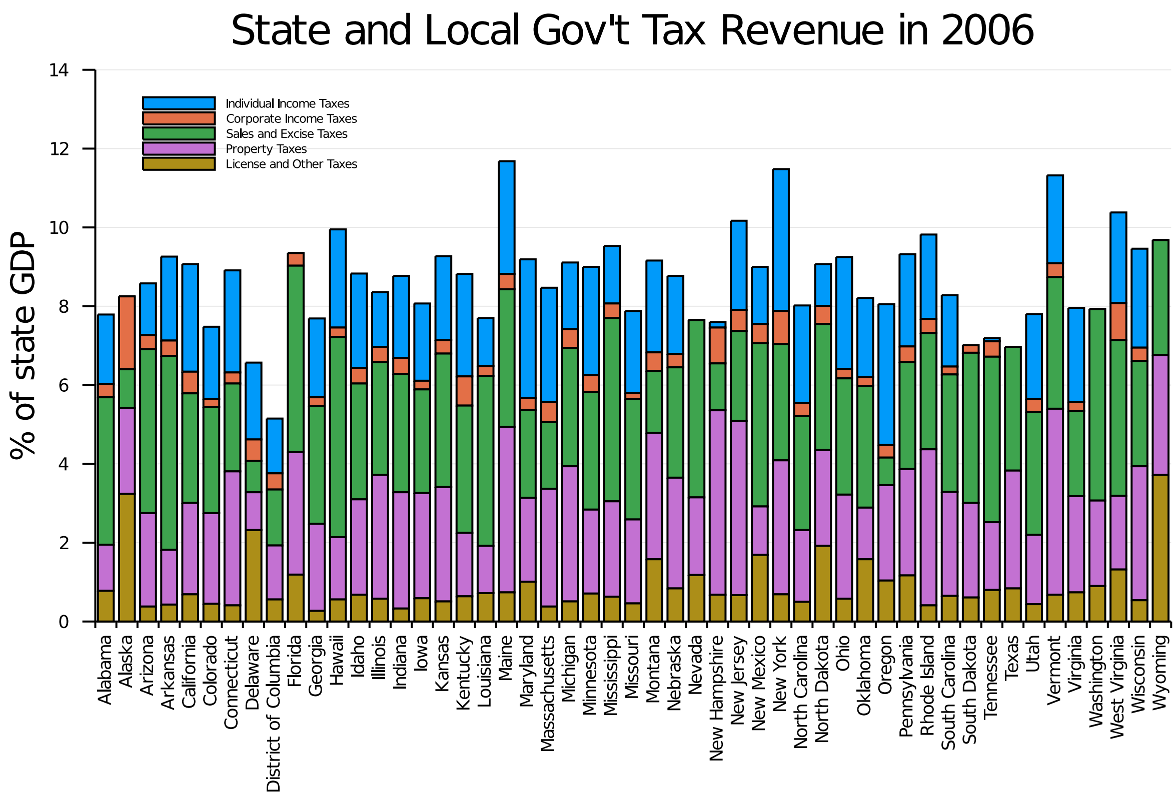


Figure 51: State Tax Revenues