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INCOME INEQUALITY, TAX POLICY, AND ECONOMIC GROWTH*

Siddhartha Biswas, Indraneel Chakraborty and Rong Hai

We investigate how the reduction of income inequality through tax policy affects economic growth. Taxation at different points of the income distribution has heterogeneous impacts on households' incentives to work, invest, and consume. Using US state-level data and micro-level household tax returns over the last three decades, we find that reducing income inequality between low and median income households improves economic growth. However, reducing income inequality through taxation between median and high-income households reduces economic growth. These asymmetric economic growth effects are attributable both to supply-side factors (i.e. changes in small business activity and labour supply) and to consumption demand.

Modern governments have utilised tax policy not only to raise capital for government operations but also to reduce income inequality among citizens. Progressive taxation with negative net tax rates for the lowest income households aims to achieve two distinct objectives:

(*i*) to provide a minimum level of consumption for the low-income population; and
(*ii*) to reduce income inequality between different groups of the population.[1]

The underlying economic justification for this tax policy is that income inequality creates lower economic growth. Researchers find mixed evidence regarding the relationship between income inequality and economic growth.[2]

Our work makes three contributions. First, while there are various possible ways to reduce income inequality, our article investigates how tax policies that reduce income inequality have affected economic growth in US states in the last three decades. We

* Corresponding author: Indraneel Chakraborty, Department of Finance, School of Business Administration, University of Miami, Coral Gables, FL 33124, USA. Email: i.chakraborty@miami.edu.

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[1] See Figure 1, which shows how income inequality is reduced in the US through tax policy which effectively compresses the income distribution around the median household.

[2] Alesina and Rodrik (1994) and Perotti (1996) among others find that there is a negative correlation between average growth and inequality since the 1960s. Persson and Tabellini (1994) document that a similar negative relationship existed in nine developed economies since the 1830s. However, Forbes (2000) finds a positive relationship between income inequality and economic growth and Barro (2000) finds a positive relationship between income inequality and growth in rich countries and a negative relationship in poor countries. See Bénabou (1996), Ostry *et al.* (2014) and Cingano (2014) for detailed surveys of the literature. Seminal work that uses data from US states to study the impact of inequality on economic growth includes Partridge (1997) and Panizza (2002).

find that the growth effect of redistribution through taxation is asymmetric depending on whether the reduction of inequality occurs in the below median part of income distribution or the above median part of income distribution. Our question is different from the literature that has investigated the impact of income inequality levels on economic outcomes and, separately, the literature on the impact of tax rates on economic outcomes. Second, we investigate both supply-side and demand-side mechanisms through which tax policies that reduce income inequality affect economic growth. We find taxation at different points of the income distribution has asymmetric impacts on households' incentives to supply labour, engage in small business activity and consume. Third, our article identifies the impact of tax policies that reduce income inequality from variation between relatively homogenous US states. This compares to seminal work on economic growth that has (perhaps due to data unavailability in the past) focused on cross-country analysis, where heterogeneity across countries is arguably larger over many dimensions.[3]

We allow for asymmetric effects by distinguishing between the impact of tax policy on households below the median income level and on those above the median income level. We find that poverty alleviation, i.e. reduction of income inequality, between low-income and median-income households improves economic growth. The reduction of the income gap between the above median households and the median household, however, has a negative effect on GDP growth. As discussed later, these results are obtained using an instrumental variables approach with controls for marginal tax rates, state fixed effects, year fixed effects and other important economic characteristics.

We explore three major components of economic growth as well. We find that reducing income inequality between below median and median households, in most instances, encourages female labour supply and small businesses growth, as well as consumption expenditure growth. However, reducing income inequality through taxation between above median-income households and median-income households reduces female labour supply, small business growth and job creation. As far as we know, this asymmetric effect of tax policy across the income distribution has not been shown empirically before this article.

Our empirical strategy relies on within-state variation in tax policies that reduce income inequality to explain within-state variation in growth rates of US states over time. We utilise a simple measure that calculates the changes in income distribution induced by income tax policy for each state, using actual tax return data. Specifically, the measure calculates the additional average income tax paid for each additional dollar earned by a person at the higher/lower income level, compared to the reference

[3] Literature on endogenous growth of countries includes seminal work by Romer (1986), Lucas (1988), Barro (1990) and Barro (1991), among others. While we use eight major data sets for the project, the main dataset is a large sample of US income tax returns, TAXSIM microdata, provided by the Internal Revenue Service (IRS) and made available to researchers by the National Bureau of Economic Research (NBER). Thus, our analysis is less prone to measurement error issues that can exist in cross-country data comparisons. Measurement error can cause estimation bias. For example, if a more unequal society underreports its inequality statistics and also grows slower, cross-country estimates of the impact of inequality on growth may suffer from a negative bias. Furthermore, compared to cross-country differences, economic development indicators and institutions are relatively more homogenous across US states. This allows us to assume that the same underlying economic relationship between GDP growth, tax policy and inequality exists across states, which is more defensible than a similar assumption regarding countries.

point of the median income level household. Since this is analogous to a contraction function on income distribution, we refer to it as the contraction factor. As we show this cross-sectional differential tax rate measure is able to explain economic growth even after controlling for the average marginal tax rate for each state over time. This is because an individual considers the impact of tax policy on his income in two dimensions. He considers the tax-induced change in his income with respect to the reference point of median income household. This is in addition to the impact of tax policy on his marginal dollar, where his reference point is himself. We calculate contraction factor between the median income and bottom income group, and the median income and top income group for each US state and year from 1979 to 2008.

Our contraction factors are potentially endogenous to the GDP growth due to the concern that tax policies may respond to economic conditions. To address such concerns, we use two separate sets of exogenous instrumental variables (IV). We estimate our model using a generalised method of moments approach developed by Blundell and Bond (1998) (system GMM), which refines the approach of Arellano and Bond (1991) for panel data that is persistent. The first set of exogenous instrumental variables are the exogenous tax shocks identified by Romer and Romer (2009, 2010), later refined by Mertens and Ravn (2013) at the national level, and their interactions with state-specific initial income inequality and initial propensity towards charity. We also conduct our analysis based on an alternative set of exogenous instrumental variables that are political and demographic measures in each state.

Our results contribute to the literature on tax policy and economic growth. Theoretical predictions regarding the impact of taxes on economic growth are mixed.[4] Thus, the question is primarily an empirical one. The empirical literature has investigated the effects of taxation on economic growth within the US, across US states, and across countries. Using US post-WWII data, recent studies find that a positive change in taxes has a negative impact on GDP growth.[5] Helms (1985) and Reed (2008) focus on state-level taxes and economic growth. There are also a large number of studies using cross-country data, which generally find negative effects of tax increase on output (Koester and Kormendi, 1989; Easterly and Rebelo, 1993; Mendoza *et al.*, 1997; Miller and Russek, 1997; Kneller *et al.*, 1999; Padovano and Galli, 2001; Lee and Gordon, 2005; Alesina and Ardagna, 2010; Arnold *et al.*, 2011; Gemmell *et al.*, 2011; Ferede and Dahlby, 2012 among others). Building upon this literature, we show that redistributive taxation has heterogeneous effects on economic growth.

[4] Mirrlees (1971), Okun (1975) and Becker (2011) argue that taxes reduce economic growth by dampening incentives to work and invest. Barro (1990) shows that taxes can be beneficial for economic growth in the presence of public goods but, as government size increases, the benefits are outweighed by the costs of taxation. Bénabou (2000) shows that taxation can help growth if it finances public investment. Saint-Paul and Verdier (1993, 1997) shows that higher health and education spending benefits the poor, helping to offset labour and capital market imperfections.

[5] Blanchard and Perotti (2002) finds positive tax shocks have negative effects on output in the US from 1947 to 1997. Romer and Romer (2010) find that a tax increase of 1% of GDP implies a 3% fall in output in the US economy from 1947 to 2007. Mertens and Ravn (2013) find that short-run output effects of tax shocks are large in post-WWII US data. They also find that it is important to distinguish between different types of taxes when considering their impact on the labour market and on expenditure components. Barro and Redlick (2011) find a large and significantly negative impact of an increase in average marginal tax rates on US annual economic growth over the time period 1950 to 2006.

The literature that studies the relationship between inequality and economic growth has provided mixed predictions.[6] On one hand, inequality may reduce economic growth. First, political economy theory suggests that greater inequality is conducive to the adoption of distortionary redistributive tools and growth-retarding policies, which hurt economic growth (Alesina and Rodrik, 1994; Persson and Tabellini, 1994; Benhabib and Rustichini, 1996). Second, in the presence of financial market imperfections, higher inequality exaggerates the adverse effects of credit constraints on human capital accumulation and small business growth, reducing growth (Galor and Zeira, 1993; Galor and Moav, 2004). Third, Murphy *et al.* (1989) show that an equal society with homogenous tastes helps to create a large market for domestic manufacturers. On the other hand, greater inequality might increase growth. Higher inequality provides the incentives to work harder, invest more and undertake risks to take advantage of high rates of return (Mirrlees, 1971; Lazear and Rosen, 1981; Rebelo, 1991; Heckman *et al.*, 1998; Guvenen *et al.*, 2014). Higher inequality can also foster aggregate savings and therefore capital accumulation because the rich have a lower propensity to consume.[7] Our results show that tax policy that reduces income inequality can have asymmetric effects on economic growth.

Kuznets (1955) conjectured that inequality increases in the early stages of economic development for a country (due to industrialisation and urbanisation). As industries attract a larger fraction of the labour force, inequality starts decreasing. Aghion and Williamson (1999) note that up to the 1970s, the prediction of Kuznets (1955) was corroborated by data. However, in recent times, wage inequality between and within groups of workers has been increasing (Katz and Murphy, 1992; Juhn *et al.*, 1993; Piketty and Saez, 2003). This evidence provides support for action by policy makers to reduce income inequality.[8] Our results demonstrate that reduction of income inequality between all income groups may not have similar effects. When income inequality is reduced between above median households and median households economic growth may decrease. Our results do not suggest what the optimal tax rate at various levels should be.[9] We document the asymmetric nature of redistributive tax policies on economic growth and argue that policy makers should not assume that reducing income inequality would necessarily translate into economic growth, as the opposite occurs in some cases.

1. Taxes, Incentives and Contraction Factor

This Section discusses relevant US tax policy, our main variable of interest and the source of variation in our empirical analysis.

[6] Voitchovsky (2005) shows that inequality at the top end of the distribution is positively associated with growth, while inequality lower down the distribution is negatively related to subsequent growth.

[7] See Kaldor (1956) and Bourguignon (1981). Forbes (2000) shows that an increase in a country's level of income inequality has a significant positive relationship with subsequent economic growth.

[8] Blundell *et al.* (2008) show that such redistributive tax policies in the US have helped reduce consumption inequality, even in the presence of income inequality.

[9] See Diamond and Saez (2011) for a survey of the literature on optimal taxation. Recent papers include Conesa *et al.* (2009), Holter *et al.* (2014) and Piketty *et al.* (2014) among others.

1.1. *Progressive Taxation and Tax Credits*

Income inequality reduction through tax policy is obtained through two main mechanisms: progressive taxation, which leads to higher marginal taxes for higher income households, and tax credits which provide negative tax rates for the lower income households. Our data on tax returns is the TAXSIM microdata from NBER, prepared by the Statistics of Income Division of the Internal Revenue Service (IRS) for public use. The tax data, discussed in online Appendix B.1, help show that progressive taxation and tax credits 'compress' the income distribution. To illustrate the 'compression' effect, we compare the national before-tax income distribution and after-tax income distribution in Figure 1. The Figure utilises the full sample of TAXSIM tax return data for all US states for the years 1979–2008, in 2009 US dollars.[10] The mean pre-tax income (AGI) in 2009 US dollars is $49,548, with inequality measured by the standard deviation of log income of 1.188. The darker region shows that the after-tax distribution is shifted to the left and contracted – it has a lower mean ($42,508) and smaller standard deviation of log income (1.139). Measured in terms of reduction of

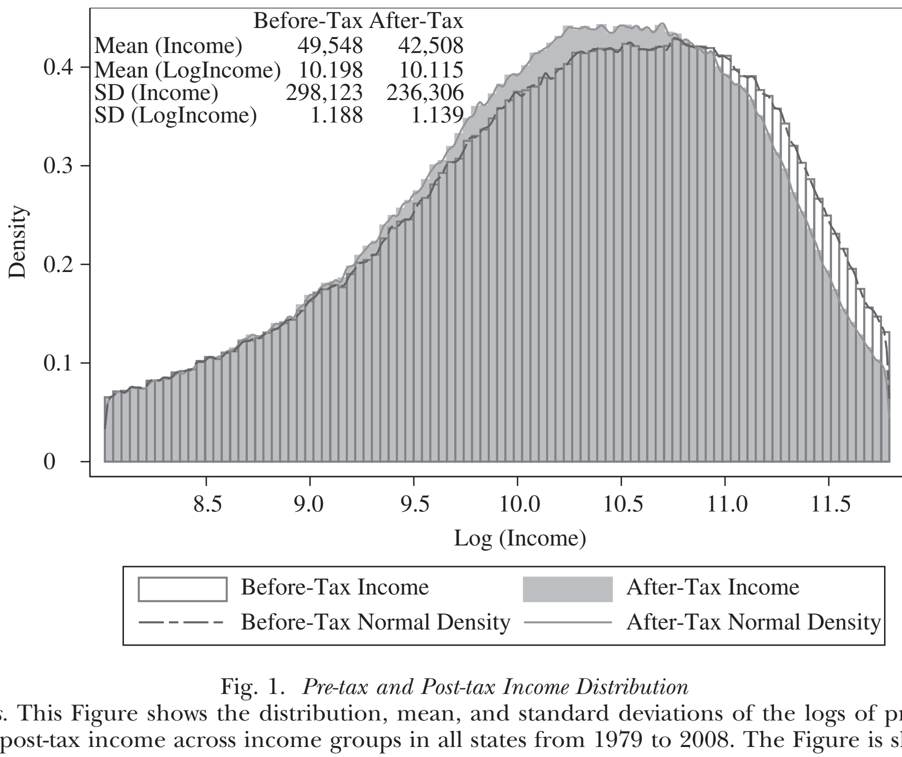


Fig. 1. *Pre-tax and Post-tax Income Distribution*

Notes. This Figure shows the distribution, mean, and standard deviations of the logs of pre-tax and post-tax income across income groups in all states from 1979 to 2008. The Figure is shown from the 5th to 95th percentile of the pre-tax log income distribution to better see the compression in the distribution caused by progressive taxation. The means and standard deviations shown are for the entire national income distribution.

[10] Throughout this article, all monetary figures are deflated to 2009 US$, using the GDP deflator from BEA.

variance of log income, the income inequality on average is reduced by about 8% through taxation.

The progressive taxation and tax-credit policies, in effect, are moving the after-tax income of both the lower and upper-income households towards the median to reduce inequality. Thus, the median income household is a natural reference point to measure the impact on inequality reduction through tax policy. In subsection 1.2, we measure the extra tax liability for each additional dollar earned by the lower income and upper-income households compared to the reference household (the median income household) respectively.

1.2. *Contraction Factor*

In this subsection, we propose a simple measure that evaluates the changes in income inequality induced by the progressive tax policy. Let $Income_{s,t}(i)$ denote the average pre-tax income for households in the ith percentile in the income distribution of state s in year t, and $Tax_{s,t}(i)$ denote the associated total income tax liability in year t and state s. The before-tax income inequality is then measured by the difference between pre-tax income percentile i and j in a given year t, $Income_{s,t}(i) - Income_{s,t}(j)$. Similarly, the after-tax income inequality in year t and state s is given by $[Income_{s,t}(i) - Tax_{s,t}(i)] - [Income_{s,t}(j) - Tax_{s,t}(j)]$. Using the median income household as the reference point, we define the reduction in the after-tax income inequality as a fraction of the before-tax income inequality, referred to as the 'contraction factor' $C_{s,t}(i)$, as follows:

$$C_{s,t}(i) \equiv 1 - \frac{[Income_{s,t}(i) - Tax_{s,t}(i)] - [Income_{s,t}(50) - Tax_{s,t}(50)]}{Income_{s,t}(i) - Income_{s,t}(50)}$$
$$= \frac{Tax_{s,t}(i) - Tax_{s,t}(50)}{Income_{s,t}(i) - Income_{s,t}(50)}. \tag{1}$$

In a progressive tax system, $Tax_{s,t}(i) - Tax_{s,t}(50)$ and $Income_{s,t}(i) - Income_{s,t}(50)$ share the same sign. Further, as long as taxes are used to reduce income inequality, $C_{s,t} \in [0, 1)$. We suppress the subscript s,t of $C_{s,t}(i)$ for simplicity. The contraction factor measures the taxation induced reduction in the income gap between the income percentile of interest and the median income households. The contraction factor can be interpreted as the additional average income tax paid for each additional dollar earned by a person at the ith income percentile, compared to the median income.[11]

Our main analysis will rely on two contraction factors: $C(90)$, that measures the effects of taxation on after-tax income gap reduction between 90th percentile household (high income household) and the median household; and $C(10)$ which evaluates the reduction of the after-tax income gap through taxation between the

[11] Our variable is different from the average marginal tax rate (Barro and Redlick, 2011) that affects an individual's decision to earn an additional dollar given his present income and income tax rate. Barro (1990) and Barro and Redlick (2011) among others, have discussed the importance of marginal tax rates for economic growth. In contrast, the contraction factor aims to capture the impact of tax policy-induced reduction in income inequality, with respect to the median household as the reference household, on economic growth. Our framework for analysis considers the impact of the contraction factors for above-median households and below-median households separately, and also controls for changes in average marginal tax rate over time.

median household and the 10th percentile household (low income household). The top and bottom panels of Figure E1 in online Appendix E graphically demonstrate an increase in contraction factors $C(90)$ and $C(10)$ respectively.[12]

1.3. *Source of Variation*

The source of variation in contraction factors comes from changes in state or federal tax schedules and changes in the underlying income distribution. Figure 2 shows the distribution of contraction factors in our analysis across states for the sample period. The figure suggests that there are variations in both contraction factors between and within states. Figure 3 plots the standard deviations of contraction factors for each state showing that there is within-state variation.[13] Table D2 in online Appendix D summarises the average one period lagged contraction factors as well as average *per capita* annual GDP *per capita* growth rates for the 49 states in our analysis for the sample period of 1980–2009. The Figures and Table suggest significant variation in contraction factors over time and across states.

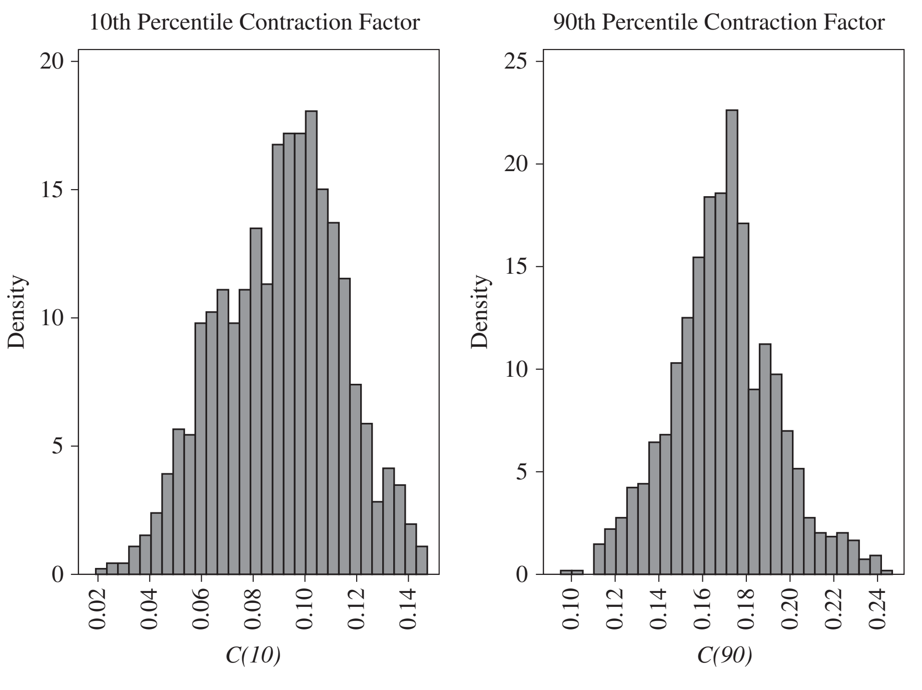
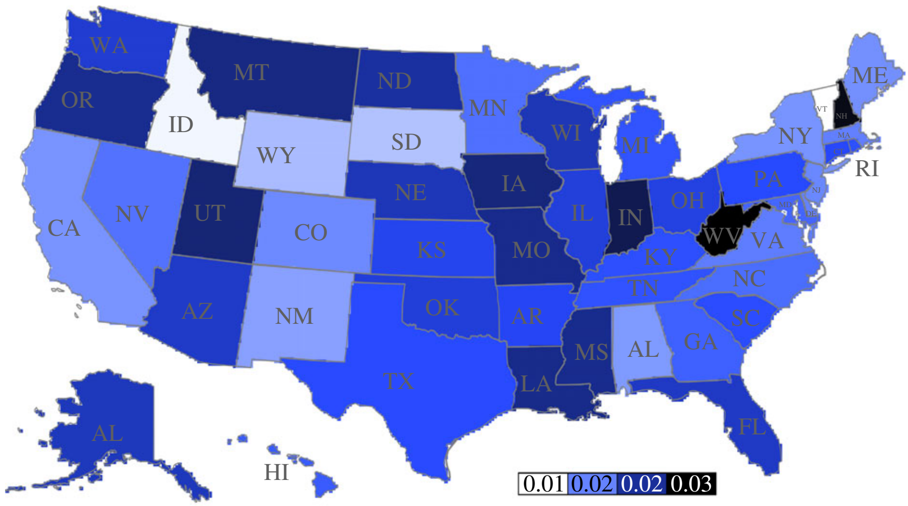
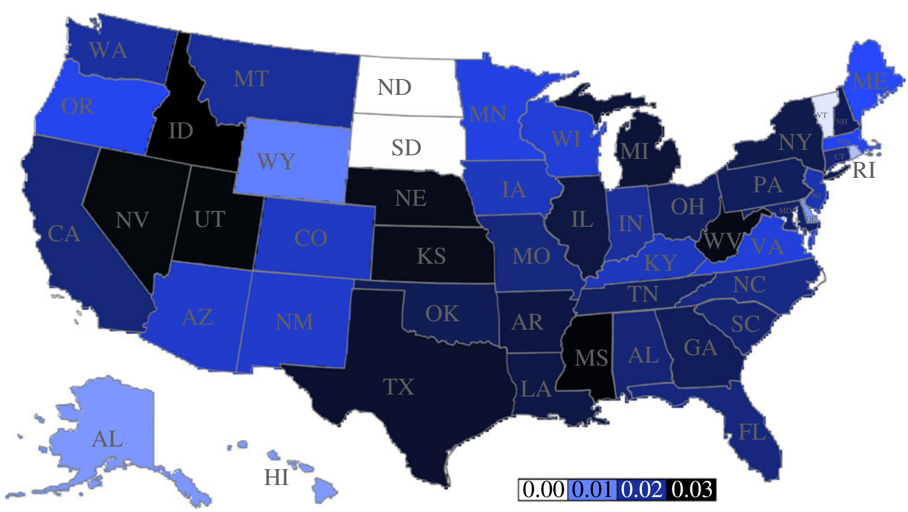


Fig. 2. *Contraction Factor Distribution*
Note. This Figure shows the distribution of contraction factors that cover all states from 1979 to 2008.

[12] In our robustness check section (Section 5), we also show that our analysis yields similar results if we use different thresholds for above median and below median contraction factors such as $C(80)$ and $C(20)$.
[13] Figure E2 in online Appendix E plots the levels of contraction factors for each state averaged over the same time period.



(*a*) Contraction Factor $C(90)$



(*b*) Contraction Factor $C(10)$

Fig. 3. *Contraction Factors Across States: Standard Deviation*
Notes. This Figure illustrates the state standard deviations for both contraction factors, $C(90)$ and $C(10)$. The darker states represent a higher variation in contraction factor. Colour figure can be viewed at wileyonlinelibrary.com

Furthermore, as seen in the left panel of Figure 4, there is a lot of variation in average marginal tax rates across states and over time. Once we demean the average marginal tax rates for each state, the demeaned average marginal tax rates range between −0.05 and 0.07 and follow a bimodal distribution. The left panel of Figure 5 plots the average state income tax rates across all states and years. The right panel of Figure 5 shows the demeaned average state income tax rates distribution.

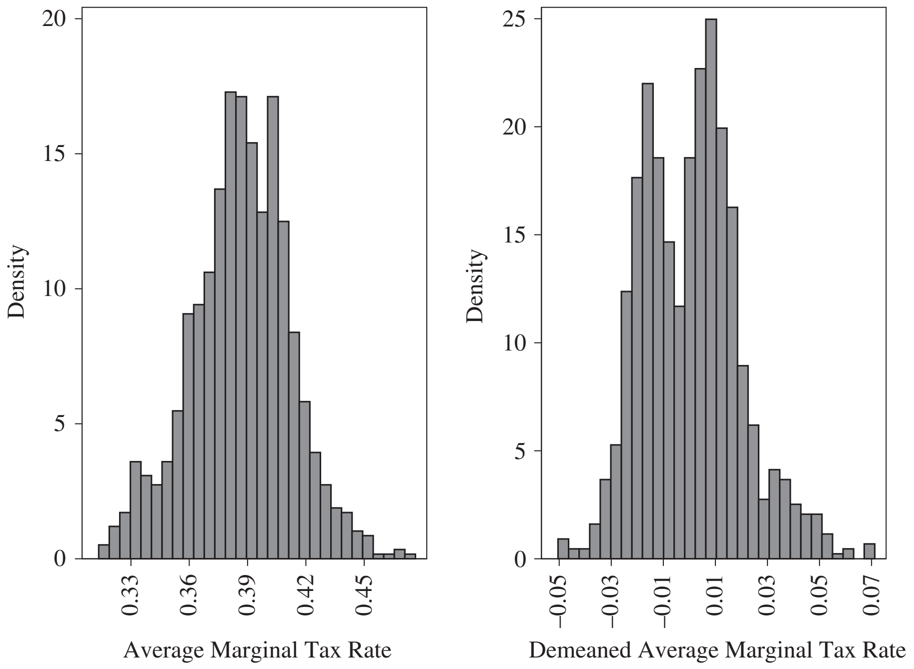


Fig. 4. *Average Marginal Tax Rate Distribution*
Note. This Figure shows the distribution of average marginal tax rates based on the state income distributions from 1979 to 2008.

Lastly, the Earned Income Tax Credits (EITCs) also provide additional variation in the net tax liability across states and over time. The federal EITC, established in the tax code in 1975, is a refundable tax credit for low and moderate-income working people, particularly those with children. The amount of EITC benefit depends on a recipient's income and number of children. Over time, many states have also established their own EITCs to supplement the federal credit. Figure 6 plots the number of states that have refundable state EITCs over time.[14] State EITCs are typically set as a percentage of the federal credit and these match ratios generally differ by states and change over time. Figure 7 plots the distribution of state refundable EITC match as a percentage of federal EITC over our sample period.[15]

[14] As of 2012, 25 states have enacted state EITCs: Colorado, Connecticut, Delaware, District of Columbia, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, Vermont, Virginia and Wisconsin. Some of these state EITCs are refundable, and some are not. In addition, a few local EITCs have been enacted in San Francisco, New York City, and Montgomery County, Maryland.

[15] Table D3 in online Appendix D reports correlation between the state-level Gini coefficient in a given year with the contraction factors $C(10)$ and $C(90)$ in the state in that year. A higher level of income inequality measured by Gini correlates with less contraction. We also note that the Gini coefficient correlates more strongly with the ratio of income of 90th and 50th percentile households than with the ratio of 50th and 10th percentile households. This is due to the positively skewed income distribution. This observation provides additional motivation for using contraction factors which allow for distinguishing between the impact of above and below median households on the economy.

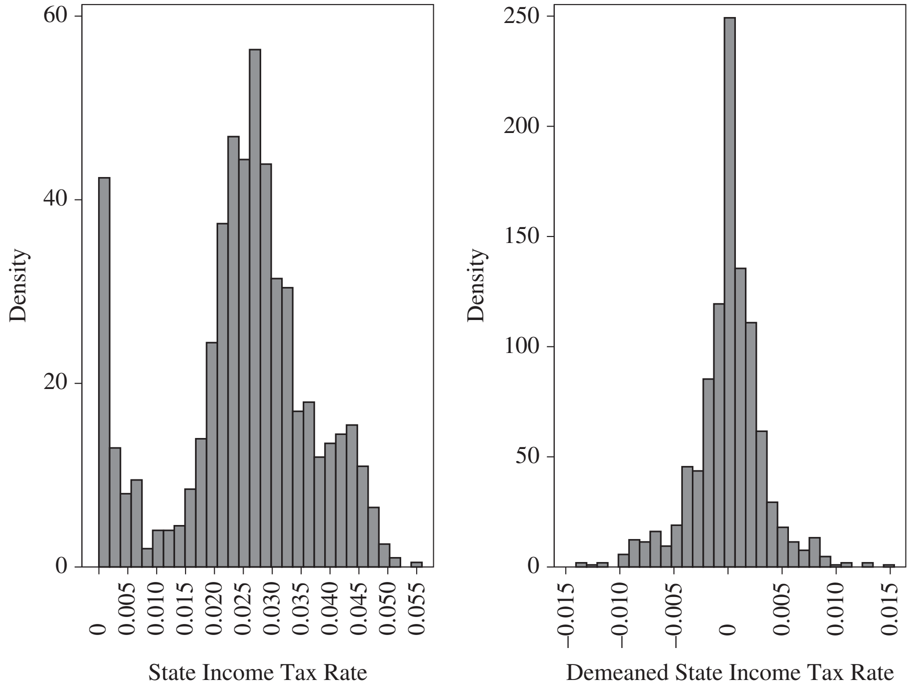


Fig. 5. *State Tax Rate Distribution*
Note. This Figure shows the distribution of state average personal income tax rate factors that cover all states from 1979 to 2008.

2. Framework of Analysis

This Section discusses our empirical specification and estimation strategy.

2.1. *Empirical Specification*

We estimate the effects of below median and above median contraction factors on state-level annual *per capita* economic growth, using the following specification:

$$\begin{aligned}\log GDP_{s,t} - \log GDP_{s,t-1} = {} & \kappa_1 \times \log C_{s,t-1}(10) + \kappa_2 \times \log C_{s,t-1}(90) \\ & + \gamma_1 \times (AMTR_{s,t-1} - AMTR_{s,t-2}) \\ & + h_1 \times \log \frac{Income_{s,t-1}(50)}{Income_{s,t-1}(10)} + h_2 \times \log \frac{Income_{s,t-1}(90)}{Income_{s,t-1}(50)} \\ & + \alpha \times \log GDP_{s,t-1} + \boldsymbol{X}_{s,t-1}\boldsymbol{\beta} + \delta_s + \eta_t + \varepsilon_{s,t}, \end{aligned} \tag{2}$$

where $GDP_{s,t}$ is the *per capita* real GDP for state s and year t, $C_{s,t-1}(90)$ is previous years' contraction factor between the 90th percentile household and the median household; we use it as a measure of income inequality reduction between high income households and median income households. $C_{s,t-1}(10)$ is previous year's contraction factor between the 10th income percentile household and the median household; it represents the income inequality reduction between median income households and

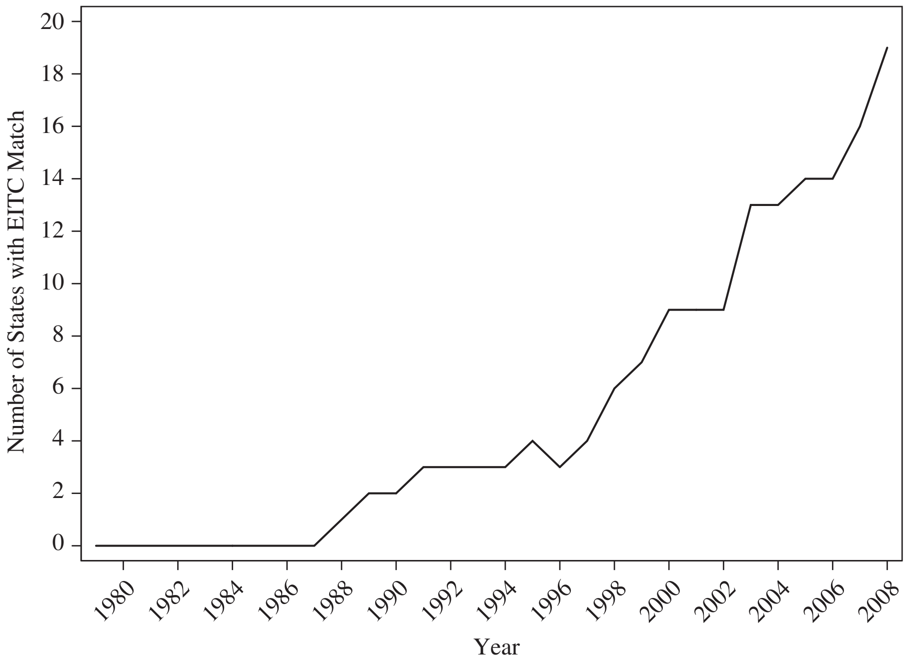


Fig. 6. *Number of States with State EITC Programme*
Note. This Figure shows the number of states in a given year that have a refundable state EITC program over our sample period from 1979 to 2008.

low income households. Lagged contraction factors address the possible concern of contemporaneous effects.[16] $AMTR_{s,t-1}$ is the average marginal income tax rate, i.e. the additional tax paid on the next dollar earned, in state s and year $t-1$. $Income_{s,t-1}(10)$, $Income_{s,t-1}(50)$, and $Income_{s,t-1}(90)$ are income levels at 10th, 50th and 90th respectively. $\boldsymbol{X}_{s,t-1}$ is a vector of additional controls, δ_s denotes state fixed effects, and η_t denotes time fixed effects.

The coefficient κ_1 measures the effect on year t's GDP growth rate from a 1% increase in below median contraction factor $C(10)$ and the coefficient κ_2 measures the effect on year t's growth rate from 1% increase in above median contraction factor $C(90)$. The contraction factors $C_{s,t-1}(10)$ and $C_{s,t-1}(90)$ depend on the predetermined income distribution of state s in year $t-1$ and on the income tax legislation (both federal level and state level). We are interested in both the sign and the magnitude of κ_1 and κ_2 to establish that tax policies that reduce income inequality have asymmetric effects. As noted, the contraction factors are based on the income distribution and tax legislation at year $t-1$, which are predetermined with respect to the GDP growth rate in year t. This alleviates simultaneity concerns. However, there is still an endogeneity concern regarding the contraction factors since they are driven by potential

[16] For example, an unobserved shock $\epsilon_{s,t}$ that affects the growth of economy at time t, could also affect households' choices and thus income, which ultimately affects the contemporaneous contraction factor C_t at time t.

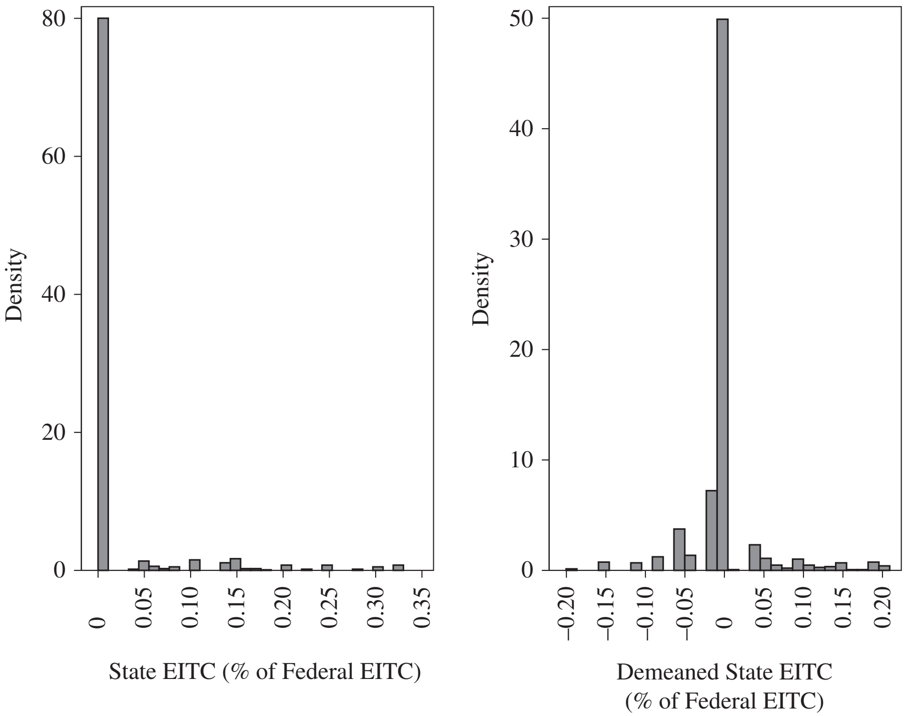


Fig. 7. *State EITC Match Distribution*
Notes. This Figure shows the distribution of state refundable EITC match (as % of federal EITC) for our sample period from 1979 to 2008. The state EITC match rates differ by family structure. Here we only plot the matching rate for a two-child household.

endogenous tax legislation changes. We address this endogeneity concern by using instrumental variables, which are discussed in detail in subsection 2.2.

As discussed before, previous literature has also shown that changes in marginal tax rates have important implications on economic growth because they affect households' current choices on employment and consumption compared to the previous period.[17] As marginal tax rates increase, incentives to work decline for the same household irrespective of the tax rate of other households. Therefore, following Barro and Redlick (2011), we control for changes in average marginal tax rate between year $t-1$ and $t-2$ ($AMTR_{s,t-1} - AMTR_{s,t-2}$).[18] Furthermore, Forbes (2000) show that levels of income inequality affect economic growth. Hence, we include $\log[Income_{s,t-1}(90)/Income_{s,t-1}(50)]$ and $\log[Income_{s,t-1}(50)/Income_{s,t-1}(10)]$ to capture the level of income inequality between the 90th percentile income household and median household, and median household and 10th percentile household respectively.

[17] Literature includes but is not limited to Mirrlees (1971), Barro (1990, 1991), Alesina and Rodrik (1994) and Barro and Redlick (2011).

[18] Following Barro and Redlick (2011), when computing $AMTR_{s,t-1} - AMTR_{s,t-2}$, we calculate both $AMTR_{s,t-1}$ and $AMTR_{s,t-2}$ based on year $t-1$ income in state s to eliminate the channel, whereby higher income shifts people into higher tax rate brackets for a given tax law.

Lastly, Mankiw *et al.* (1992) show that a neoclassical growth model (Solow, 1956) augmented with accumulation of human capital as well as physical capital yields an empirical specification where GDP growth rate $\log GDP_{s,t} - \log GDP_{s,t-1}$ depends on level of GDP in the previous period (i.e. $\log GDP_{s,t-1}$) and accumulated human capital level. Within the framework of the neoclassical growth model, $(1 + \alpha)$ in (2) measures the rate of convergence in economic growth. We measure human capital level using average years of higher education in the working age population ($Education_{s,t-1}$). Finally, we control for the state government *per capita* real direct general expenditure divided by the *per capita* real GDP (*Government Expenditure*), because Helms (1985) and Barro and Redlick (2011) find that government expenditure affects GDP growth (see Table 1, panel (*b*) for details).

2.2. *Estimation Strategy*

Our key parameters of interest are the coefficients of contraction factors, κ_1 and κ_2, in (2). As already discussed in the previous subsection, a potential concern with OLS is that tax policy may be an endogenous response to the economic conditions. To address this potential endogeneity concern, we use two mutually exclusive sets of exogenous instrumental variables and estimate our model, using a generalised method of moments approach developed by Blundell and Bond (1998). The reason we use two sets of instrumental variables is because despite our attempts at convincing the reader that either of these is an appropriate set of instruments, each set could still have its own concerns. Corroboration of the results with mutually exclusive instruments provides additional confidence.

2.2.1. *Main instruments*

We use the exogenous tax liability shocks narratively identified by Romer and Romer (2009, 2010) and later refined by Mertens and Ravn (2013) to form exogenous instruments for changes in our contraction factors and marginal tax rates (see the appendix in Mertens and Ravn (2013) for more details). Romer and Romer (2009) identified a series of tax liability changes that are exogenous to economic growth in the US from 1945 to 2007. Using a narrative approach based on congressional reports and other government administrative data, Romer and Romer (2009) classify tax liability changes as exogenous if the motivation for the legislative action is either arising from inherited deficit or from ideological concerns.[19] Mertens and Ravn (2013) further extend the analysis by distinguishing between changes in personal and corporate income tax liability, and by distinguishing between unanticipated and anticipated tax changes on the basis of the implementation lag.

These tax shocks, identified by Romer and Romer (2009) and refined by Mertens and Ravn (2013), are exogenous to the current conditions of the economy in the state,

[19] Romer and Romer (2009) classify every significant tax bill into one of the four categories based on the underlying motivation for the tax change: responding to a current or planned change in government spending, offsetting other influences on economic activity, reducing an inherited budget deficit and attempting to increase long-run growth. Romer and Romer (2009) classify the last two types of tax changes as exogenous to the current state of the economy in the sense that they are not a response to the growth prospects of the economy.

Table 1
Variables List

Variable	Description	Source
Panel (*a*): dependent variables		
Economic growth		
Δ logGDP	Changes in log real GDP *per capita*	BEA
Labour supply		
ΔE_M	Changes in male employment rate (18–64 year olds, employed in previous week during March CPS)	CPS
ΔE_F	Changes in female employment rate (18–64 year olds, employed in previous week during March CPS)	CPS
Small business activity		
Δ logEstabs	Changes in log of number of establishments (size 20–49)	BDS
Job creation	Net jobs created as a fraction of total employment (2 year moving average) amongst continuing establishments (size 20–49)	BDS
Consumption*		
Δ logPCE	Changes in log of total personal consumption expenditures *per capita*	BEA
$\Delta \log \text{PCE}_{DG}$	Changes in log of durable goods personal consumption expenditures *per capita*	BEA
$\Delta \log \text{PCE}_{NDGS}$	Changes in log of non-durable goods and services personal consumption expenditures *per capita*	BEA
Panel (*b*): independent and instrumental variables		
Independent variables		
$C(i)$	Contraction factor, i.e. reduction of income inequality, between *i*th percentile household and median household	NBER TAXSIM
$\log C(i)$	Log of the contraction factor	NBER TAXSIM
ΔAMTR	Changes in average marginal tax rate	NBER TAXSIM
log GDP	Log real GDP *per capita*	BEA
$\frac{\text{Income}(i)}{\text{Income}(j)}$	Income ratio of the *i*th percentile to the *j*th percentile, where $i > j$	NBER TAXSIM
$\log \frac{\text{Income}(i)}{\text{Income}(j)}$	Log of the income ratio of the *i*th percentile to the *j*th percentile, where $i > j$	NBER TAXSIM
Education	Average years of schooling beyond grade 12 for population of age 25–64	CPS
Government expenditure[†]	Log of state government direct general expenditure as a fraction of state GDP	US Census State Finances, BEA
Income growth	Changes in log average state personal income	BEA
Tax shock instruments (Z)		
z_{pi}	Narratively identified personal income tax shock	Mertens and Ravn (2013)
z_{ci}	Narratively identified corporate income tax shock	Mertens and Ravn (2013)
$z_{pi} \times \log \frac{\text{Income}_{1979}(i)}{\text{Income}_{1979}(j)}$	Narratively identified personal income tax shock interacted with state inequality ratio in 1979	NBER TAXSIM, Mertens and Ravn (2013)
$z_{ci} \times \log \frac{\text{Income}_{1979}(i)}{\text{Income}_{1979}(j)}$	Narratively identified corporate income tax shock interacted with state inequality ratio in 1979	NBER TAXSIM, Mertens and Ravn (2013)

Table 1

(*Continued*)

Variable	Description	Source
z_{pi} × Charity$_{1979}$	Narratively identified personal income tax shock interacted with state share of total income contributed to charity in 1979	NBER TAXSIM, Mertens and Ravn (2013)
z_{ci} × Charity$_{1979}$	Narratively identified corporate income tax shock interacted with state share of total income contributed to charity in 1979	NBER TAXSIM, Mertens and Ravn (2013)
Political and demographic instruments (Z')		
State senate	Democratic share of seats in upper house	SLER‡
State house	Democratic share of seats in lower house	SLER‡
Governor	Dummy for Democratic governor	CQ Press
Elderly	Fraction of population aged 65 and older	CPS
Age 5–17 population	Fraction of population aged 5–17	CPS
Single mother	Fraction of state households that are single mother households	CPS
Fixed effects		
δ_s	State fixed effects	
η_t	Time fixed effects	

Notes. Panel (*a*) provides descriptions and sources of the dependent variables in our ordinary least squares and instrumental variables approaches. Panel (*b*) provides descriptions and sources of all of the independent variables and instruments. All the variables are at the state-level with annual frequency. All changes in monetary figures are deflated to 2009 US Dollars using GDP deflator. *Consumption change variables are available from 1998 to 2008. †State government direct general expenditure includes state government expenditures for education services, social services and income maintenance, transportation, public safety, environment and housing, governmental administration, interest on general debt, and other general expenditures. It excludes all spending classified as intergovernmental, utility, liquor stores, and employee-retirement or other insurance trusts. $\text{Government Expenditure} = \log\frac{\text{Total Amount of Government Direct General Expenditure}}{\text{GDP}}$
‡See Klarner *et al.* (2013.)

because they relate to unanticipated tax liability changes that are not a response to the growth prospects of the economy in the state.[20] Figure E3 in online Appendix E reports personal income tax shocks from Mertens and Ravn (2013) and reports average contraction factors for each year from 1979 to 2007.[21] During this time period, the largest exogenous change in personal income taxes relates to the Jobs and Growth Tax Relief Reconciliation Act of 2003, which includes across-the-board reductions in marginal tax rates as well as increases in child credit. The largest exogenous increase in personal income taxes relates to Omnibus Budget Reconciliation Act of 1993, which increased income taxes, mostly for high earners.

[20] Furthermore, in practice, these tax liabilities changes are often related to the changes in progressivity of the tax schedule and thus correlate with changes in contraction factors as well as marginal tax rates. In particular, Barro and Redlick (2011) use the changes in exogenous tax liabilities identified by Romer and Romer (2009) to form an instrument for changes in the marginal tax rate in the GDP growth regression analysis.

[21] In particular, Mertens and Ravn (2013) create the personal income tax shock as the narratively identified exogenous personal income liability change divided by previous personal taxable income, z_{pi}; the corporate income tax shock is defined as narratively identified exogenous corporate income tax liability changes scaled by previous period corporate profits, z_{ci}. Mertens and Ravn (2013) provide both quarterly and annual data; we choose the annual level data for our analysis.

The impact of the exogenous tax shocks at the national level varies based on conditions present at the state level. We focus on two initial conditions which are relevant to contraction factors: initial state level inequality measures (as measured by 90th/50th percentile and 50th/10th percentile log income ratio in 1979) and initial attitude towards charity (measured by the share of charity to income ratio in 1979).[22] In the presence of state and year fixed effects, these tax shocks and their interactions with state-specific initial conditions satisfy the exclusion restriction because the within-state variations of these variables come from unanticipated tax liability changes and are exogenous to the growth prospects of the state's economy. Furthermore, these tax shocks have a high positive correlation with shifts in marginal income tax rates; and the interactions of these tax shocks with state-specific initial conditions strongly correlate with contraction factors (relevance condition). Other researchers, such as Barro and Redlick (2011), have also used these tax shocks as instruments for changes in the marginal tax rate in the GDP growth regression analysis. A detailed discussion regarding the relevance of these exogenous instruments to our contraction factors is in subsection 4.1 where we discuss empirical results. Table D5 in online Appendix D reports the results.

Potential concerns regarding main instruments A concern with this set of instruments may be that of reverse causality: actual or expected shocks to GDP might induce changes in tax policies and revenues. To this end, we rely on the work by Romer and Romer (2009) and Mertens and Ravn (2013), which carefully identify and argue that the tax shocks used in this article are not an endogenous response to current economic conditions or expected economic growth perspectives. We also would like to point out that all our specifications utilise lagged controls, and thus the tax changes are of the previous period.

Another concern may be that of simultaneity (skill or task biased technical change might induce relevant changes in tax revenues and affect the growth rate). Since such changes are at the aggregate level, the inclusion of year fixed effects will capture these effects. To the extent state economic conditions are persistent, we include lagged real GDP *per capita* as a control, along with state fixed effect for time-invariant state specific conditions. Further, state-specific inequality levels and education are also included as controls in our specification. However, one may still have concerns regarding whether our main instruments are appropriate. The next subsection introduces an alternative set of instruments that depends on a different identification strategy. In all of our estimation results, we compare the results from both these two sets of mutually exclusive instruments, in order to alleviate the potential concerns regarding each set of individual instruments.

2.2.2. *Alternative instruments*

Our alternative set of instruments utilises political and demographic measures in each state. For political measures, we use election results for sitting legislators in the state

[22] To develop a measure of attitude towards redistribution, we collect total charitable contributions, cash and assets, as recorded in tax returns from the TAXSIM data. We scale the total charitable contributions by the total income in the state.

house and senate, and for state governor.[23] The election data contain the length of term for each elected official, so we are able to construct a time series database of the party in each legislative and gubernatorial seat for each year.[24] We then create three political climate variables that measure the strength of the Democratic Party in the legislative and executive branches of each state's government. The first is an indicator variable that indicates whether there is a Democratic governor ($\text{Governor}_{s,t}$). Our other two instruments measure the strength of the Democratic party's legislative control using the share of legislative seats occupied by Democrats in the state senate, i.e. the upper house ($\text{State Senate}_{s,t}$) and the state house ($\text{State House}_{s,t}$). Panel (*b*) of Table 2 summarises our political instruments.

We also use three demographic measures that can affect state policies on tax credit as instrumental variables: the fraction of population aged 65 and older ($\text{Elderly}_{s,t}$), the fraction of population aged 5 to 17 ($\text{Age 5 to 17 population}_{s,t}$), and the fraction of households headed by single mothers ($\text{Single Mother}_{s,t}$) (two of the demographic instruments, fraction of old and young persons in population, were previously suggested by Helms, 1985). We consider a household to be a single mother household if the head of the household is an unmarried female with at least one dependent child under the age of 18.[25] Panel (*b*) of Table 2 summarises our demographic instruments for each state.

Potential concerns regarding alternative instruments A concern with this alternative set of instruments may be that the election of political parties are endogenous to the economic conditions, or that political parties may affect other state-level policies which in turn affect the economy. Note that state-level economic controls include variables for state-specific economic conditions (income inequality, education), spending differences by political parties (government expenditure), marginal tax rate, persistence in output (last period's real GDP *per capita*) along with controls for state-specific heterogeneity (state fixed effects) and aggregate effects (year fixed effects). However, it is possible that political parties affect the economy beyond expenditure and taxes in a time-variant manner which is not very persistent. The two mutually exclusive set of instruments provide confidence that the instruments are not driving our results.

2.2.3. *System GMM approach*

In addition to the endogeneity of tax policy to state-level economic growth, one may be concerned about the possibility of Nickell bias in (2) given a small $T = 29$ years and large $N = 49$ states.[26] Hence, we implement our estimation using the system GMM method developed by Blundell and Bond (1998). The system GMM approach is an improvement upon the difference GMM proposed by Arellano and Bond (1991). Such

[23] We use the State Legislative Election Returns (Klarner *et al.*, 2013) database, and the Congressional Quarterly Press Voting and Elections Collection data on gubernatorial elections (CQ Press, 2014). See online Appendix B for more details.

[24] Nebraska's state legislature is unicameral and does not specify party affiliations for candidates during elections. As a result, the Nebraska state legislative data are missing.

[25] See online Appendix B for more details.

[26] Nickell (1981) provided analytical expressions for the bias in estimates in dynamic models with individual fixed effects when the time period is short and the number of individuals is large.

Table 2

Summary Statistics

Variable	Observations	Mean	SD	Min	Max	Median
Panel (*a*): summary statistics for dependent variables in model						
Economic growth						
GDP	1,076	37,703.91	9,019.302	18,624.96	69,946.16	37,450.88
Δ logGDP	1,076	0.0146	0.0282	−0.109	0.1323	0.0167
Labour supply						
E_M	1,076	0.7933	0.0407	0.6297	0.8983	0.7954
ΔE_M	1,076	−0.0034	0.025	−0.1077	0.1033	−0.0035
E_F	1,076	0.6573	0.0646	0.409	0.8122	0.6595
ΔE_F	1,076	0.0032	0.0232	−0.0771	0.1007	0.0035
Small business activity						
Estabs	1,076	13,354.43	12,080.97	860	78,489	9,534
Δ logEstabs	1,076	0.0184	0.0268	−0.1064	0.1331	0.0206
Job creation	1,076	0.0075	0.0252	−0.1206	0.0999	0.0108
Consumption*						
PCE	484	30,216.51	4,378.859	19,320.49	43,628.41	29,433.85
Δ logPCE	448	0.015	0.0243	−0.0769	0.077	0.0161
PCE_{DG}	484	3,870.947	448.656	2,674.854	5,081.664	3,855.947
$\Delta \log PCE_{DG}$	448	−0.0031	0.0535	−0.1721	0.1663	0.0045
PCE_{NDGS}	484	26,345.57	4,121.359	15,981.81	39,472.44	25,641.63
$\Delta \log PCE_{NDGS}$	448	0.0174	0.0222	−0.0649	0.0915	0.0186
Panel (*b*): summary statistics for key explanatory variables, controls, and instruments in model						
Key explanatory variables						
$C(10)$	1,076	0.0904	0.0235	0.0192	0.1473	0.0924
$C(90)$	1,076	0.1696	0.0238	0.0951	0.2467	0.1696
$C(15)$	1,076	0.0975	0.0253	0.02	0.1599	0.0996
$C(85)$	1,076	0.1531	0.0234	0.0827	0.231	0.1525
$C(20)$	1,076	0.1043	0.0267	0.0201	0.1749	0.1063
$C(80)$	1,076	0.1449	0.0228	0.0683	0.2353	0.1442
$\log C(10)$	1,076	−2.4429	0.2917	−3.9545	−1.9153	−2.3817
$\log C(90)$	1,076	−1.7841	0.1425	−2.3525	−1.3995	−1.7743
$\log C(15)$	1,076	−2.3664	0.2902	−3.9107	−1.8332	−2.3069
$\log C(85)$	1,076	−1.8887	0.1548	−2.493	−1.4654	−1.8803
$\log C(20)$	1,076	−2.2977	0.2877	−3.9066	−1.7437	−2.2415

Table 2
(*Continued*)

Variable	Observations	Mean	SD	Min	Max	Median
$\log C(80)$	1,076	−1.9442	0.161	−2.6839	−1.4468	−1.9365
ΔAMTR	1,076	0.0053	0.014	−0.0468	0.069	0.0061
Control variables						
log GDP	1,076	10.4938	0.2448	9.843	11.1555	10.5112
$\frac{\text{Income}(50)}{\text{Income}(10)}$	1,076	5.9233	0.9033	3.2776	10.2265	5.861
$\frac{\text{Income}(90)}{\text{Income}(50)}$	1,076	3.1711	0.4402	2.3927	8.8194	3.1239
$\log\frac{\text{Income}(50)}{\text{Income}(10)}$	1,076	1.7674	0.1519	1.1871	2.325	1.7683
$\log\frac{\text{Income}(90)}{\text{Income}(50)}$	1,076	1.1459	0.1236	0.8724	2.177	1.1391
Education	1,076	1.4049	0.3019	0.5246	2.4159	1.4023
Amount of government direct general expenditure *per capita*	1,076	2,383.971	799.5327	920.9448	5,854.39	2,266.16
Government expenditure†	1,076	−2.773	0.2389	−3.3725	−2.0217	−2.7674
Income growth	1,076	0.0213	0.0206	−0.1332	0.1727	0.0215
$\frac{\text{Income}_{1979}(50)}{\text{Income}_{1979}(10)}$	1,076	5.4836	0.5057	4.1431	7.7806	5.4630
$\frac{\text{Income}_{1979}(90)}{\text{Income}_{1979}(50)}$	1,076	2.7051	0.1349	2.4368	3.1011	2.7096
$\log\frac{\text{Income}_{1979}(50)}{\text{Income}_{1979}(10)}$	1,076	1.6974	0.0936	1.4214	2.0516	1.6980
$\log\frac{\text{Income}_{1979}(90)}{\text{Income}_{1979}(50)}$	1,076	0.9939	0.0502	0.8907	1.1318	0.9968
Charity_{1979}	1,076	0.0154	0.0039	0.0076	0.0397	0.0150
Exogenous instruments						
z_{pi}	1,038	−0.0619	0.2868	−1.0796	0.435	0
z_{ci}	1,038	−0.0374	1.6454	−3.2839	7.3821	0
$pi \times \log\frac{\text{Income}_{1979}(50)}{\text{Income}_{1979}(10)}$	1,038	−0.1059	0.489	−1.9774	0.7888	0
$pi \times \log\frac{\text{Income}_{1979}(90)}{\text{Income}_{1979}(50)}$	1,038	−0.0613	0.2849	−1.1534	0.4621	0

Table 2

(*Continued*)

Variable	Observations	Mean	SD	Min	Max	Median
$z_{pi} \times \text{Charity}_{1979}$	1,038	−0.0009	0.0046	−0.0428	0.01	0
$_{ci} \times \log\frac{\text{Income}_{1979}(50)}{\text{Income}_{1979}(10)}$	1,038	−0.0675	2.8037	−6.0146	14.0119	0
$z_{ci} \times \log\frac{\text{Income}_{1979}(90)}{\text{Income}_{1979}(50)}$	1,038	−0.0352	1.6421	−3.5081	8.0508	0
$z_{ci} \times \text{Charity}_{1979}$	1,038	−0.0005	0.0259	−0.1302	0.1693	0
State senate	1,059	0.5701	0.1813	0.1429	1	0.5517
State house	1,059	0.5715	0.162	0.1571	1	0.5667
Governor	1,076	0.5297	0.4993	0	1	1
Elderly	1,076	0.1232	0.0177	0.0742	0.1821	0.1242
Age 5–17 population	1,076	0.1914	0.0172	0.1352	0.2753	0.1896
Single mother	1,076	0.0659	0.0172	0.0313	0.1502	0.0642

Panel (*c*): mean income and tax by income percentile

	i = 10th pct.	i = 15th pct.	i = 20th pct.	i = 50th pct.	i = 80th pct.	i = 85th pct.	i = 90th pct.	Mean
Income(i)	5,247.15	7,992.87	10,872.94	30,619.98	68,167.50	79,555.99	97,287.65	48,089.65
Tax(i)	79.32	167.26	314.13	2,383.17	7,758.68	9,799.30	13,649.92	6,873.15
Income(i) − Tax(i)	5,167.83	7,825.61	10,558.80	28,236.81	60,408.82	69,756.70	83,637.72	41,216.50
$\frac{\text{Tax}(i)}{\text{Income}(i)}$	0.0148	0.0204	0.0284	0.0773	0.1145	0.1238	0.1403	0.1408

Notes. Panel (*a*) shows summary statistics (number of observations, mean, standard deviation, minimum, maximum and median) for all the dependent variables that enter our specification, as well as the corresponding levels of each growth and change variable. Panel (*b*) shows the summary statistics for the main explanatory variables, controls and instruments that enter our model, and the corresponding levels of each growth and change variable. All characteristics are at the state level, and summary statistics shown are pooled across states from 1980 to 2009 for dependent variables and 1979–2008 for independent variables. Panel (*c*) shows average adjusted gross income and tax rates for select income percentiles, pooled across states from 1979 to 2008. All monetary figures are deflated to 2009 US dollars using the GDP deflator. *The consumption series is available from BEA for 1997 to 2009; the growth variables are from 1998 to 2009. The unit of observation is state year. For more information on sample selection, see Section 1. †

$$\text{Government Expenditure} = \log\frac{\text{Total Amount of Government Direct General Expenditure}}{\text{GDP}}.$$

IV GMM methods have become increasingly popular in the empirical literature on inequality and economic growth (Forbes, 2000; Cingano, 2014; Ostry *et al.*, 2014).

Besides exogenous instrument variables, system GMM also utilises lagged values of control variables as internal instrumental variables in the estimation. Specifically, for our internal instruments, we use two period lagged log GDP *per capita* and one period lagged predetermined control variables.[27] Our estimation results are robust to using more lags as internal instruments. In our estimation table, we also report the Arellano-Bond test for autocorrelation, as well as the test for over-identification and validity of instrument variables, all of which provide confidence in our results.

3. Data

We utilise eight major data sources to construct our state-year level panel data set. Data include information on GDP growth, income distribution, taxes and other economic control variables. The state-level GDP *per capita* growth rate is constructed from the US Department of Commerce Bureau of Economic Analysis (BEA). We use TAXSIM data to obtain information on contraction factors, income percentiles, and the corresponding tax liability and average marginal tax rates in each state and each year. We also utilise the TAXSIM data to gather data on initial income inequality and charitable contributions in 1979 to create our instruments related to attitudes towards inequality and redistribution.

Additional data sets include:

(*i*) US Census Bureau for state government finances;
(*ii*) Mertens and Ravn (2013) for narratively identified personal and corporate income tax shocks exogenous to economic growth;
(*iii*) Congressional Quarterly Press and
(*iv*) State Legislative Election Returns (SLER) for election results;
(*v*) Current Population Survey (CPS) data for state-level schooling and labour market variables;
(*vi*) the Business Dynamics Statistics (BDS) database for information on small businesses; and
(*vii*) the BEA for personal consumption expenditures by state and state income growth.

Table 1 panel (*a*), summarises all the dependent variables in our analysis and their data sources. Panel (*b*) of Table 1 lists our explanatory variables and their sources. The exogenous instruments have already been discussed in Section 2 along with the estimation strategy, online Appendix B discusses dependent and explanatory variables.

Table 2 provides summary statistics for all of the variables used in this article. All statistics shown are pooled across all states and years from 1980 to 2009 for dependent variables and 1979 to 2008 for independent variables, as we measure the effect of our lagged regressors on our variables of interest. All the nominal figures are deflated to

[27] As shown in our specification, the controls for our primary estimation are lagged one period: inequality levels relating the 50th and 10th percentile incomes and 90th and 50th percentile incomes, average years of higher education, state government expenditure.

2009 dollars, using the GDP deflator. Panel (*a*) reports summary statistics for all the dependent variables in our analysis. The equal weighted average real GDP *per capita* growth from 1980 to 2009 in US states is 1.46% with a median growth rate of 1.67%. The equal weighted pooled standard deviation of growth rate is significant at 2.8%. Regarding small business activity variables, the number of establishments of size 20 to 49 grows at a 1.84% rate. The net job creation rate by continuing establishments is 0.8%. Our calculations on labour supply show that on average 79.3% of the working age male population are employed, while 65.7% of working age females are employed. On average, male employment decreases by 0.3 pp per year, while female employment increases by 0.3 pp per year. Lastly, BEA data show that the average real total personal consumption expenditure (PCE) *per capita* is $30,217 in 2009 US Dollars and has an annual growth rate of 1.5% from 1998 to 2009. The average real PCE *per capita* on durable goods is $3,871 and the annual growth rate is −0.31%. On average, real PCE on non-durable goods and services *per capita* is $26,346 in 2009 US dollars and the average annual growth rate is 1.7%.

Panel (*b*) reports summary statistics pooled across all states and years from 1979 to 2008 for explanatory variables, controls and instruments, as these variables enter our estimation as lagged measures. The contraction factor between the median and 10th percentile household is 9% and that between the 90th and median household is almost double of that at 17%. Thus, the marginal tax rate almost doubles on the additional income between the two groups. The other key explanatory variable we utilise is the annual change in the average marginal tax rate, which has an average increase of 0.53 pp and ranges from a minimum of −4.6 pp to a maximum of 6.9 pp across states.

We also include several controls identified in the literature as possible determinants of GDP growth rate. This is in addition to state and time fixed effects, which are included in our instrumental variables specification. We control for the level of inequality in each state by considering income ratios between different percentiles. On average, the 90th percentile income is 3.2 times the median income and the median income is on average 5.9 times the 10th percentile income. Higher education provides a measure of human capital and the average years of schooling beyond the 12th grade is 1.4 years. We note that states on average spend $2,384 *per capita* on direct general expenditures, which includes all state spending that is not classified as intergovernmental, utility, liquor stores and employee-retirement or other insurance trusts, while the average state spending as a portion of GDP is approximately 6.25%. Lastly, we can see that state personal income *per capita* grows at an average rate of 2.1%.

Our system GMM analysis with the main set of instruments employs exogenous tax shocks to personal and corporate income as identified by Mertens and Ravn (2013), as well as interaction terms with inequality levels and charitable contributions in 1979. The average personal income tax liability shock is −0.06% of the previous period personal taxable income, with a minimum of −1.1% and a maximum of 0.44%. The average corporate income tax liability shock is −0.04% of the previous period corporate profits, with a minimum of −3.28% and a maximum of 7.38%. We interact tax shocks with the inequality levels of 1979, where the 90th percentile income was 2.7 times the median income, and the median income was 5.5 times the 10th percentile income. Furthermore, we interact these tax shocks with the charitable donations in 1979, which were on average 1.54% of income.

We also use political and demographic measures as an alternate set of instruments within our system GMM analysis. Regarding political climate, Democrats hold on average 57% of the seats in the state senate and also hold 57% of the seats in the state house. Democrats hold governorships in 53% of the observations. Demographically, we note that 12.3% of the population is older than 65 years of age, while 19.1% of the population is between ages 5 and 17. Lastly, 6.6% of the households are headed by a single mother.

4. Empirical Results

This Section first conducts an estimation of the relationship between the reduction of income inequality through tax policy and economic growth. For this, we use system GMM with two sets of mutually exclusive instrumental variables to gain confidence in our results. Then, we explore three important channels through which reducing income inequality through tax policy affects economic growth:

(*i*) employment;
(*ii*) business activity; and
(*iii*) consumption.

Finally, we explore the sources of asymmetric effects of the contraction factors on economic activity.

4.1. *Income Inequality, Tax Policy and Economic Growth*

Table 3 reports the results of the impact of the contraction factor on economic growth. Column (1) does not include any controls other than the below median contraction factor and column (2) adds the above median contraction factor. The raw correlations suggest that these two contraction factors have asymmetric effects. We do not discuss additional OLS results because an important concern is that an unobservable or omitted variable which is correlated with the contraction factor and GDP growth rate may drive OLS correlations. Specifically, an important issue maybe that tax policy driving the contraction factors could be itself endogenously chosen by policy makers in response to economic conditions that also affect GDP growth rate in the state.

Hence, our main specification in column (3) utilises an IV approach with system GMM with an exhaustive set of controls. In Section 2, we have already discussed the estimation strategy and the instruments. The coefficients on the contraction factors in column (3) of Table 3 show that contraction factors have a significant impact on *per capita* economic growth.

The IV estimates in column (3) show that a 1% increase in the contraction factor between the 10th percentile household and the median household increases the GDP *per capita* growth rate by 0.11 pp. At the same time, a 1% increase in the contraction factor between the 90th percentile household and the median household, by increasing taxes by 1% on the 90th percentile household reduces the GDP growth rate by 0.24 pp. Column (4) reports the results for our alternative set of instruments and finds similar qualitative and quantitative results. Column (4) shows that a 1% increase in $C(10)$ increases economic growth by 0.083 pp. Regarding reduction of

Table 3

The Effects of Contraction Factors on State Level GDP Growth

	OLS		IV GMM	
Model			Z + time FE	Z' + time FE
Regressors	(1)	(2)	(3)	(4)
$\log C(10)$	0.008***	0.013***	0.110**	0.083*
	(0.003)	(0.004)	(0.054)	(0.048)
$\log C(90)$		−0.017**	−0.242***	−0.219**
		(0.008)	(0.074)	(0.095)
ΔAMTR			−0.618	−0.405
			(1.637)	(1.726)
logGDP			0.063	−0.016
			(0.069)	(0.053)
$\log \frac{\text{Income}(50)}{\text{Income}(10)}$			0.027	0.024
			(0.019)	(0.027)
$\log \frac{\text{Income}(90)}{\text{Income}(50)}$			0.179*	0.151
			(0.105)	(0.144)
Education			-0.052*	−0.041
			(0.027)	(0.030)
Government expenditure			−0.014	−0.033
			(0.026)	(0.026)
State FE	N	N	Y	Y
Time FE	N	N	Y	Y
M2 (p-value)			0.125	0.212
Hansen J			7.531	7.857
Hansen (p-value)			0.675	0.448
No. observations	1,076	1,076	1,038	1,059
No. instruments			46	45
Means				
Dependent variable	0.0146	0.0146	0.0165	0.0145
$\log C(10)$	−2.4429	−2.4429	−2.4280	−2.4404
$\log C(90)$		−1.7841	−1.7776	−1.7830
$C(10)$	0.0904	0.0904	0.0915	0.0906
$C(90)$		0.1696	0.1706	0.1698

Notes. Significance levels: *10%, **5%, ***1%. OLS standard errors are clustered at the state level. IV GMM model uses robust, two step system GMM estimator with Windmeijer-corrected standard errors. This Table shows our regression results for our main specification with state-level real GDP *per capita* growth as our dependent variable. We look at the log change in GDP *per capita*, $\Delta \log \text{GDP}_{s,t} = \log \text{GDP}_{s,t} - \log \text{GDP}_{s,t-1}$. Column (1) shows OLS estimates with log $C(10)$ as the only regressor, while column (2) adds log $C(90)$ as a regressor. Columns (3) and (4) show our full IV GMM specification results with state and time fixed effects. These columns have coefficients for both log contraction factors, while controlling for lagged GDP *per capita*, changes in average marginal tax rates, income ratios, education, and state government direct general expenditures. Column (3) uses our tax shock instruments, Z, and column (4) uses political and demographic instruments, Z'. The lower panel of the Table shows regressions statistics: the use of fixed effects, number of observations, the mean of the dependent variable and log contraction factors, and IV GMM statistics such as autocorrelation tests, Hansen statistic and number of instruments.

Specification:

$$\begin{aligned}\Delta \log \text{GDP}_{s,t} &= \kappa_1 \log C_{s,t-1}(10) + \kappa_2 \log C_{s,t-1}(90) + \gamma \Delta AMTR_{s,t-1} \\ &\quad + h_1 \log \frac{Income_{s,t-1}(50)}{Income_{s,t-1}(10)} + h_2 \log \frac{Income_{s,t-1}(90)}{Income_{s,t-1}(50)} \\ &\quad + \alpha \log \text{GDP}_{s,t-1} + \boldsymbol{X}_{s,t-1}\boldsymbol{\beta} + \delta_s + \eta_t + \varepsilon_{s,t},\end{aligned}$$

Z: tax shock instruments (personal and corporate tax shocks interacted with charity and state income inequality in 1979). Z': political affiliation and demographic instruments (share of state legislative bodies and governorship, elderly population, age 5–17 population, single mother households).

inequality between above median households and median households through taxation, Column (4) shows that 1% increase in $C(90)$ reduces economic growth by 0.22 pp.

In all Tables including Table 3, we conduct two important diagnostic tests for the system GMM estimator. First, to test for over-identifying restrictions, we report the Hansen J statistic and the corresponding p-value. The p-value fails to reject the null (the p-value is 0.675 in column (3) for the main set of instruments), providing confidence in our choice of instruments. To address the instrument proliferation concern (Roodman, 2009*a, b*), we collapse the instrument matrix and the new tables make sure that the number of instruments is always less than the number of states, which is 49. Another important diagnostic is the test for autocorrelation of the residuals. If there is serial correlation in the first-differenced residuals at an order higher than one, then the moment conditions used by system GMM are not valid.[28] The results of the test are reported as M2 where two represents the second lag. The p-values of M2 are always above 0.10, suggesting that we cannot reject the null hypothesis of zero autocorrelation at the second order. This provides us confidence that internal instruments provide valid moment conditions.

We run the first stage, first difference regression and level regression that mimic those implied by the system GMM procedure (Bazzi and Clemens, 2013). We report test statistics for these first-stage regressions for our main set of instruments and the alternative set of instruments in online Appendix D in Tables D5 and D6, respectively. The first stage R^2 ranges between 0.15 and 0.33 for difference regressions and ranges between 0.69 and 0.71 for level regressions for the main set of instruments. The R^2 for the second set of instruments is similar. In all the first-stage regressions, the overall F-stat p-value is <0.001.

To test potential weak identification concerns directly, we report the Angrist–Pischke test statistics by mimicking two-stage IV regressions for difference regressions and level regressions as implied by system GMM, though separately. The first-stage first difference regressions, using tax shocks as external instruments satisfy the weak identification test (Angrist–Pischke F test p-value <0.001 for difference regression). The level regressions also satisfy the weak identification test (Angrist–Pischke F test p-values of <0.05 for $C(10)$ level regression and <0.01 for $C(90)$ level regression). By noting the Angrist–Pischke χ^2 p-values, we can also conclude that the difference and level equations reject the null that the equations are under-identified. For the second set of instruments (political and demographic instruments), we note that the level equations pass the under-identification and weak identification tests at p-values of < 0.05.

The F-statistic shown in Table D5 for external instruments only shows that the first set of external IV, i.e. tax shocks, have additional identification power for difference equations in the system GMM ($p < 0.001$). Furthermore, as seen in the columns of Table D5, the coefficients in front of tax shock variables are statistically significant after controllingfor other control variables and internal instruments. Similarly, the F-statistic shown in Table D6 for external instruments only shows that the second set of external IV, i.e. political and demographic instruments, have additional identification power for

[28] See Arellano and Bond (1991), Blundell and Bond (1998) and http://www.stata.com/manuals13/xtxtabond.pdf for discussions.

level equations in the system GMM ($p < 0.001$). This evidence suggests that these tax shock instruments have additional identification power. Additional discussion regarding the first stage is in online Appendix C.

4.2. *Components of GDP*

Next, we focus on three main components through which reduction of income inequality through tax policy affect economic growth:

(*i*) labour supply;
(*ii*) activities of small businesses; and
(*iii*) consumption.

Subsection 4.3 discusses the sources of asymmetry in the results regarding the impact of above and below median contraction factors on economic activity.

4.2.1. *Labour supply*

Table 4 reports the impact of above and below median contraction factors on our first component: labour supply. Columns (1) and (2) investigate the impact of contraction factors on the labour supply of males and columns (3) and (4) investigate labour supply of females using the two sets of instruments respectively. All columns show the most exhaustive IV GMM specification with year and state fixed effects. The columns look at the change in the annual employment rate among the working age population in a state (See panel (*a*) of Table 1 and online Appendix B for more details regarding variable construction). The reason that we consider males and females separately is due to recent work that shows taxes have a heterogeneous effect on labour supply based on gender as labour supply decisions are made at the household level.[29]

Column (1) shows that male labour supply does not seem to respond to contraction factors. Column (2), with an alternative set of instruments, corroborates these findings. However, columns (3) and (4) show that female labour supply is statistically and economically significantly dependent on contraction factors. Column (3), where we conduct an instrumental variables approach with system GMM estimator as in subsection 4.1, using our main set of instruments, shows that a 1% increase in the contraction factor between 10th percentile household and median income household achieved through taxes increases female labour supply by 0.10 pp. If the male of the household is already working, then it is intuitive that the effects should be observed on the dimension of female labour supply. The column also shows that reducing above median income inequality by increasing $C(90)$ by 1% reduces female labour supply by 0.19 pp. Subsection 4.3 explores the asymmetry in the results for all three components of GDP together. Column (4), with an alternative set of instruments, reports similar qualitative results. Labour supply of females increases with $C(10)$, although the results are not statistically significant, and falls with higher $C(90)$. The results regarding the impact of above median contraction factor are statistically significant and the

[29] Seminal work on household labour supply decisions include Chiappori (1988) and Blundell and Macurdy (1999). Recent work on taxes and decisions regarding labour supply include, but are not limited to, Kaygusuz (2010); Chakraborty *et al.* (2015).

Table 4

The Effects of Contraction Factors on Changes in Employment Rate

	Males		Females	
Model	Z + time FE	Z' + time FE	Z + time FE	Z' + time FE
Regressors	(1)	(2)	(3)	(4)
$\log C(10)$	0.017	0.048	0.101**	0.052
	(0.056)	(0.041)	(0.043)	(0.048)
$\log C(90)$	−0.083	−0.105	−0.186*	−0.190**
	(0.090)	(0.078)	(0.101)	(0.093)
ΔAMTR	−1.247	−2.008	1.031	−0.411
	(0.862)	(1.445)	(1.174)	(1.842)
logGDP	0.012	0.045	−0.057	0.015
	(0.061)	(0.053)	(0.063)	(0.051)
$\log \frac{\text{Income}(50)}{\text{Income}(10)}$	0.004	0.018	−0.004	0.004
	(0.017)	(0.022)	(0.013)	(0.037)
$\log \frac{\text{Income}(90)}{\text{Income}(50)}$	0.109*	0.193*	0.014	0.095
	(0.062)	(0.107)	(0.063)	(0.137)
Education	−0.025	−0.038	−0.005	−0.031
	(0.027)	(0.024)	(0.026)	(0.023)
Government expenditure	−0.016	−0.018	−0.022	−0.016
	(0.033)	(0.022)	(0.034)	(0.034)
State FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y
M2 (p-value)	0.286	0.571	0.575	0.689
Hansen J	10.009	2.871	7.278	11.118
Hansen (p-value)	0.440	0.942	0.699	0.195
No. observations	1,038	1,059	1,038	1,059
No. instruments	46	45	46	45
Means				
Dependent variable	−0.0018	−0.0034	0.0041	0.0033
$\log C(10)$	−2.4280	−2.4404	−2.4280	−2.4404
$\log C(90)$	−1.7776	−1.7830	−1.7776	−1.7830
$C(10)$	0.0915	0.0906	0.0915	0.0906
$C(90)$	0.1706	0.1698	0.1706	0.1698

Notes. Significance levels: *10%, **5%, ***1%. IV GMM model uses robust, two step system GMM estimator with Windmeijer-corrected standard errors. This Table shows our regression results for our labour supply mechanism with changes in employment rate as our dependent variable. Using the March Current Population Survey, we look at the change in employment rate, $\Delta E_{s,t} = E_{s,t} - E_{s,t-1}$, separately for males and females among 18–64 year olds. All four columns use full IV GMM specification results with state and time fixed effects, showing coefficients for both log contraction factors, while controlling for lagged GDP *per capita*, changes in average marginal tax rates, income ratios, education, and state government direct general expenditures. Columns (1) and (2) have male employment as the dependent variable, whereas columns (3) and (4) have female employment as the dependent variable. Columns (1) and (3) use tax shock instruments, Z, and columns (2) and (4) use political and demographic instruments, Z'.

Specification:

$$\begin{aligned}\Delta E_{s,t} = {} & \kappa_1 \log C_{s,t-1}(10) + \kappa_2 \log C_{s,t-1}(90) + \gamma \Delta AMTR_{s,t-1} \\ & + h_1 \log \frac{Income_{s,t-1}(50)}{Income_{s,t-1}(10)} + h_2 \log \frac{Income_{s,t-1}(90)}{Income_{s,t-1}(50)} \\ & + \alpha \log \mathrm{GDP}_{s,t-1} + \boldsymbol{X}_{s,t-1}\boldsymbol{\beta} + \delta_s + \eta_t + \varepsilon_{s,t},\end{aligned}$$

Z: tax shock instruments (personal and corporate tax shocks interacted with charity and state income inequality in 1979). Z': political affiliation and demographic instruments (share of state legislative bodies and governorship, elderly population, age 5–17 population, single mother households).

magnitude is similar to those in column (3) which are results with our main set of instruments.

4.2.2. *Small business activity*

Table 5 reports the impact of above and below median contraction factors on our second mechanism – small business growth and job creation in continuing small business establishments. We discuss characteristics of small businesses and reasons why we expect personal income tax rates to have an impact on small businesses later in the subsection.

We note that, in column (1), regarding the growth rate in the number of small business establishments, a 1% increase in below median contraction factor leads to 0.07 pp more small business establishments. At the same time, a 1% increase in the above median contraction factor reduces small business growth by 0.23 pp. Column (2) reports similar results, however this time, the positive impact of the below median contraction factor is not significant. When we consider job creation rates in columns (3) and (4), we note that while both columns report numbers with similar signs, only column (4) with the alternative set of instruments is statistically significant. Column (4) reports that a 1% increase in the contraction factor between below-median households and median households through taxation leads to 0.095% increase in job creation. The impact of taxation to reduce income inequality between above median households and median households is negative and significant: a 1% increase in $C(90)$ causes 0.13 pp lower job creation.

To understand our findings on small business growth and job creation, we need to consider both the demand and incentive effects of the redistributive effects of tax policy. Demand effects due to lower income households having a high marginal propensity to consume may lead to an increase in aggregate demand which may fuel some business growth. At the same time, entrepreneurs and small business owners face incentive effects from $C(10)$ and $C(90)$ since in many instances they face personal income tax rates.[30] A higher above median contraction factor $C(90)$ discourages relatively more profitable businesses to grow for the same reason as in the case of labour supply: running a business requires significant effort on the part of

[30] The distribution of small business income in the US largely overlaps with the distribution of household income in general. Approximately 22 million businesses (that include unincorporated businesses, S-corporations and partnerships) face personal income taxes. Median income of small businesses is approximately $71,583 with 10th and 90th percentile at approximately $30,000 and $180,000 respectively. These numbers are quite similar to the income of households in the US which are employed and in similar percentile position of the distribution. See http://www.payscale.com/research/US/Job=Small_Business_Owner/Salary for additional information obtained through a private survey regarding the distribution of income of small business owners in US in recent years. This suggests that personal income taxes also affect small businesses that file as S-corporations and partnerships, both of which are pass-through entities regarding taxation, i.e. the income is passed through these entities and taxed as ordinary income of the owner in question. Data show that there are approximately 4.2 million S-corporations in the US in 2011 and 3.3 million partnerships. Through the Technical Amendments Act of 1958, small businesses were allowed to file as Subchapter S corporations. The benefit of such a tax structure is that firms can operate as limited liability corporations, without suffering double taxation on business earnings. See http://taxfoundation.org/article/america-s-shrinking-corporate- sector for additional information regarding trends in the number of corporations in the US. In addition, please note that comparing the above number of incorporated firms with Census data on total number of establishments suggests that many businesses do not even incorporate (approximate 14.7 million).

Table 5

The Effects of Contraction Factors on Small Business

	Small business growth		Job creation	
Model	Z + time FE	Z' + time FE	Z + time FE	Z' + time FE
Regressors	(1)	(2)	(3)	(4)
$\log C(10)$	0.073*	0.086	0.069	0.095**
	(0.043)	(0.078)	(0.073)	(0.041)
$\log C(90)$	−0.227***	−0.194***	−0.051	−0.132**
	(0.042)	(0.051)	(0.065)	(0.066)
ΔAMTR	−0.753	−2.535	−0.830	−3.015**
	(1.272)	(3.838)	(1.095)	(1.335)
logGDP	0.056	0.040	−0.049	−0.024
	(0.048)	(0.040)	(0.048)	(0.047)
$\log \frac{\text{Income}(50)}{\text{Income}(10)}$	0.010	0.026	−0.015	0.018
	(0.015)	(0.048)	(0.024)	(0.022)
$\log \frac{\text{Income}(90)}{\text{Income}(50)}$	0.166**	0.292	0.094	0.306***
	(0.083)	(0.247)	(0.088)	(0.105)
Education	−0.014	−0.037	−0.008	−0.031
	(0.021)	(0.033)	(0.025)	(0.024)
Government expenditure	−0.029	−0.058**	−0.072***	−0.081***
	(0.029)	(0.023)	(0.025)	(0.019)
State FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y
M2 (p-value)	0.123	0.236	0.423	0.353
Hansen J	9.324	5.351	17.460	4.921
Hansen (p-value)	0.502	0.719	0.065	0.766
No. observations	1,038	1,059	1,038	1,059
No. instruments	46	45	46	45
Means				
Dependent variable	0.0199	0.0186	0.0096	0.0075
$\log C(10)$	−2.4280	−2.4404	−2.4280	−2.4404
$\log C(90)$	−1.7776	−1.7830	−1.7776	−1.7830
$C(10)$	0.0915	0.0906	0.0915	0.0906
$C(90)$	0.1706	0.1698	0.1706	0.1698

Notes. Significance levels: *10%, **5%, ***1%. IV GMM model uses robust, two step system GMM estimator with Windmeijer-corrected standard errors. This Table shows our regression results for our business activity mechanism with small business growth rate as our dependent variable. We look at the growth rate in the establishments of size 20–49, $\Delta \log \text{Estabs}_{s,t} = \log \text{Estabs}_{s,t} - \log \text{Estabs}_{s,t-1}$, as well as net job creation for continuing establishments, which is defined as jobs created less jobs lost scaled by a two year moving average of employment. All four columns use full IV GMM specification results with state and time fixed effects, showing coefficients for both log contraction factors, while controlling for lagged GDP *per capita*, changes in average marginal tax rates, income ratios, education and state government direct general expenditures. Columns (1) and (2) have establishment growth rate as the dependent variable, whereas columns (3) and (4) have net job creation rate as the dependent variable. Columns (1) and (3) use tax shock instruments, Z, and columns (2) and (4) use political and demographic instruments, Z'.
Specification:

$$\begin{aligned}\Delta \log \text{Estabs}_{s,t} &= \kappa_1 \log C_{s,t-1}(10) + \kappa_2 \log C_{s,t-1}(90) + \gamma \Delta AMTR_{s,t} \\ &+ h_1 \log \frac{Income_{s,t-1}(50)}{Income_{s,t-1}(10)} + h_2 \log \frac{Income_{s,t-1}(90)}{Income_{s,t-1}(50)} \\ &+ \alpha \log \text{GDP}_{s,t-1} + \boldsymbol{X}_{s,t-1}\boldsymbol{\beta} + \delta_s + \eta_t + \varepsilon_{s,t},\end{aligned}$$

Z: tax shock instruments (personal and corporate tax shocks interacted with charity and state income inequality in 1979). Z': political affiliation and demographic instruments (share of state legislative bodies and governorship, elderly population, age 5–17 population, single mother households).

entrepreneurs and they may choose to remain employed elsewhere if the after-tax profits in relation to cost of effort are smaller.

Credit constraints among the low-income households may also bind strongly, leading to less entrepreneurship. Census data show that many of these businesses are quite small in terms of sales and thus presumably require little capital.[31] Data show that there are in total 23.8 million establishments in 2014, with 65% of establishments having revenue (not income) of less than $25,000 per year. Hence, many such businesses could start without a large amount of capital. Thus, while small businesses started by lower income households may be credit constrained, which is potentially depressing the incentive effects through tax policy, we still find some positive effect of $C(10)$ on small business starts.

4.2.3. *Consumption*

Table 6 reports the impact of above and below median contraction factors on our final mechanism: personal consumption growth rates in states. The first two columns consider the impact of inequality reduction through tax policy on total personal consumption using the two sets of instruments. The next two columns focus on durable goods and the final two columns focus on personal consumption growth rates of non-durable goods and services. It is important to note that the consumption growth rate data series is shorter, with data available only from 1998 to 2008.

The system GMM IV estimates in column (1) show a significant positive relationship between the above median contraction factor and consumption growth. We see that decreasing inequality between 10th percentile and median household by increasing $C(10)$ 1% results in the consumption growth rate increasing by 0.039 pp. We do not find that consumption growth is decreased statistically by reducing inequality between above median households and median households. This may be because budget constraints bind more often on households below median income, and the marginal propensity to consume is higher among low income households. Column (2), using an alternative set of demographic and political instruments, corroborates the findings of column (1). Columns (3) and (4) focus on durable goods, and find similar sensitivity to changes in contraction factor compared to overall consumption discussed earlier. However, these results are not statistically significant. Column (5) highlights that the consumption growth rate of non-durable goods and services increases by 0.039 pp for each percentage point increase in the contraction factor for below median income households. Again, we do not see a statistically significant impact of reducing above median inequality.

In sum, this subsection shows that inequality reduction through tax policy for below-median households encourages female labour supply, small business activity and consumption, and ultimately economic growth. At the same time, inequality reduction between above median and median households through tax policy deters female labour supply and small business activity, hampering economic growth. Additional mechanisms may also be at work but, in this subsection, we only focus on labour supply, business activity and personal consumption.

[31] See http://censtats.census.gov/cgi-bin/nonemployer/nonsect.pl for census data.

Table 6

The Effects of Log Contraction Factors on Personal Consumption Growth

	Personal consumption		Durable goods		Non-durable goods & services	
Model	Z + time FE	Z' + time FE	Z + time FE	Z' + time FE	Z + time FE	Z' + time FE
Regressors	(1)	(2)	(3)	(4)	(5)	(6)
$\log C(10)$	0.039**	0.029*	0.032	0.029	0.039**	0.028**
	(0.017)	(0.016)	(0.027)	(0.019)	(0.015)	(0.014)
$\log C(90)$	0.129	−0.021	0.198	−0.009	0.107	−0.029
	(0.085)	(0.042)	(0.134)	(0.076)	(0.084)	(0.030)
ΔAMTR	−0.976**	−0.408	−0.985	−0.672	−0.841*	−0.479
	(0.472)	(0.580)	(0.616)	(0.706)	(0.448)	(0.452)
$\log \frac{\text{Income}(50)}{\text{Income}(10)}$	0.005	0.006	0.014	0.014	0.001	0.006
	(0.017)	(0.016)	(0.021)	(0.028)	(0.016)	(0.011)
$\log \frac{\text{Income}(90)}{\text{Income}(50)}$	0.004	0.042	−0.026	0.070	0.004	0.051
	(0.057)	(0.046)	(0.098)	(0.071)	(0.058)	(0.036)
logGDP	−0.090**	0.013	−0.125**	−0.016	−0.085**	0.015
	(0.041)	(0.043)	(0.053)	(0.055)	(0.039)	(0.031)
Education	0.023	0.002	0.045	0.021	0.024	−0.004
	(0.022)	(0.017)	(0.037)	(0.025)	(0.020)	(0.016)
Government	0.009	0.016	0.014	0.007	0.006	0.011
expenditure	(0.021)	(0.014)	(0.023)	(0.016)	(0.025)	(0.013)
Income growth	0.618***	0.677***	0.764***	0.890***	0.595***	0.711***
	(0.140)	(0.146)	(0.219)	(0.209)	(0.157)	(0.128)
State FE	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y
M2 (p-value)	0.164	0.165	0.673	0.384	0.298	0.148
Hansen J	23.085	25.640	26.895	29.578	23.689	28.479
Hansen (p-value)	0.456	0.539	0.260	0.333	0.421	0.387
No. observations	410	437	410	437	410	437
No. instruments	43	48	43	48	43	48
Means						
Dependent variable	0.0195	0.0149	0.0047	−0.0031	0.0215	0.0173
$\log C(10)$	−2.6226	−2.6390	−2.6226	−2.6390	−2.6226	−2.6390
$\log C(90)$	−1.8491	−1.8570	−1.8491	−1.8570	−1.8491	−1.8570
$C(10)$	0.0754	0.0742	0.0754	0.0742	0.0754	0.0742
$C(90)$	0.1590	0.1579	0.1590	0.1579	0.1590	0.1579

Notes. Significance levels: *10%, **5%, ***1%. IV GMM model uses robust, two step system GMM estimator with Windmeijer-corrected standard errors. This Table shows our regression results for our consumption mechanism with personal consumption growth rate as our dependent variable. We look at consumption growth rate for various categories, $\Delta \log \text{PCE}_{s,t} = \log \text{PCE}_{s,t} - \log \text{PCE}_{s,t-1}$. All six columns use full IV GMM specification results with state and time fixed effects, showing coefficients for both log contraction factors, while controlling for lagged GDP *per capita*, changes in average marginal tax rates, income ratios, education, state government direct general expenditures and state personal income growth. Columns (1) and (2) have growth rates for total personal consumption as the dependent variable, columns (3) and (4) have durable goods consumption growth as the dependent variable and columns (5) and (6) have non-durable goods and services consumption growth as the dependent variable. Columns (1), (3), and (5) use tax shock instruments, Z, and columns (2), (4) and (6) use political and demographic instruments, Z'.
Specification:

$$\begin{aligned}\Delta \log \text{PCE}_{s,t} = {} & \kappa_1 \log C_{s,t-1}(10) + \kappa_2 \log C_{s,t-1}(90) + \gamma \Delta AMTR_{s,t-1} \\ & + h_1 \log \frac{Income_{s,t-1}(50)}{Income_{s,t-1}(10)} + h_2 \log \frac{Income_{s,t-1}(90)}{Income_{s,t-1}(50)} \\ & + \alpha \log \text{GDP}_{s,t-1} + \boldsymbol{X}_{s,t-1}\boldsymbol{\beta} + \delta_s + \eta_t + \varepsilon_{s,t},\end{aligned}$$

Z: tax shock instruments (personal and corporate tax shocks interacted with charity and state income inequality in 1979). Z': political affiliation and demographic instruments (share of state legislative bodies and governorship, elderly population, age 5–17 population, single mother households).

4.3. *Source of Asymmetry in Results*

The three components of economic growth considered in this article are driven by disparate mechanisms: incentive effects and demand effects. First, regarding the labour supply component, the obtained results may be driven by incentives to supply labour. This is because, as Table 4 shows, the male employment rate does not respond to changes in contraction factors. Female labour supply, which is more elastic empirically, responds significantly to contraction factors. Since a higher $C(10)$ encourages while a higher $C(90)$ discourages labour, they produce asymmetric effects.

Similar incentive effects are at play in the business creation component because entrepreneurs may also respond to $C(10)$ and $C(90)$. In addition, demand effects may also influence business creation in equilibrium. This is because a higher $C(10)$ leads to additional consumption by lower income households which have a higher marginal propensity to consume (MPC). Finally, $C(10)$ has a direct and positive effect on consumption growth which is our third component. This is because the transfer from low-MPC households to high-MPC households leads to higher aggregate consumption.

5. Robustness

Our results are robust to many alternative specifications. We report our main results (as shown in Table 3) with two alternative specifications next. The first set of alternative specifications utilise contraction factors calculated for the 15th and 85th percentile households (i.e. $C(15)$ and $C(85)$) in place of $C(10)$ and $C(90)$. Similarly, the second set of specifications reports results with contraction factors $C(20)$ and $C(80)$. These alternative specifications help address possible concerns that our results are extremely sensitive to the chosen points on the income distribution.

Table 7 reports the consolidated results from these robustness checks. Columns (1) and (2) report the first robustness check, while columns (3) and (4) report the second test. All columns report IV results with system GMM estimator under the most exhaustive specification. The reported findings are similar to those reported in the main results. However, the coefficient of the below median contraction factor loses significance in column (1). In general, we find that the results below the median contraction factor are somewhat less robust in terms of statistical significance. However, these results continue to underscore the asymmetric impact of the two factors on economic growth.

To further test the robustness of our results, we control for state-level unemployment rate in columns (1) and (2) of Table 8. We find similar results as before. Columns (3) and (4) utilise the state-level market income distribution to calculate contraction factors. Market income is our original income measure (AGI), less the taxable portions of social security and unemployment insurance. We find, in column (3), that a 1% increase in above median income contraction factor results in a 0.141 pp decrease in economic growth, while a similar reduction in below median income contraction factor results in positive economic growth. Obtaining similar results using different income distributions gives us further confidence in our main findings. Column (4) provides similar results, and both factors have statistically significant coefficient in this case as well.

Table 7

Robustness 1 – The Effects of Log Contraction Factors on State Level GDP Growth

	Using log $C(15)$ & log $C(85)$		Using log $C(20)$ & log $C(80)$	
Model Regressors	Z + time FE (1)	Z' + time FE (2)	Z + time FE (3)	Z' + time FE (4)
$\log C(15)$	0.089*	0.086		
	(0.048)	(0.056)		
$\log C(85)$	−0.223***	−0.279***		
	(0.057)	(0.083)		
$\log C(20)$			0.064	0.036
			(0.040)	(0.041)
$\log C(80)$			−0.192***	−0.142***
			(0.054)	(0.048)
ΔAMTR	−1.271	−1.873	−1.913	−1.223
	(1.516)	(2.187)	(1.328)	(2.028)
log GDP	0.055	0.033	0.087	0.004
	(0.065)	(0.059)	(0.069)	(0.047)
$\log \frac{\text{Income}(50)}{\text{Income}(10)}$	0.019	0.022	0.015	0.008
	(0.021)	(0.029)	(0.017)	(0.023)
$\log \frac{\text{Income}(90)}{\text{Income}(50)}$	0.177	0.211	0.159	0.086
	(0.114)	(0.152)	(0.105)	(0.127)
Education	−0.045	−0.054	−0.044	−0.031
	(0.028)	(0.036)	(0.027)	(0.027)
Government expenditure	−0.023	−0.018	−0.003	−0.010
	(0.027)	(0.030)	(0.033)	(0.030)
State FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y
M2 (p-value)	0.233	0.397	0.267	0.340
Hansen J	4.511	4.235	7.592	7.105
Hansen (p-value)	0.921	0.835	0.669	0.525
No. observations	1,038	1,059	1,038	1,059
No. instruments	46	45	46	45
Means				
Dependent variable	0.0165	0.0145	0.0165	0.0145
log $C(15)$, log $C(20)$	−2.3514	−2.3639	−2.2835	−2.2952
log $C(85)$, log $C(80)$	−1.8816	−1.8876	−1.9366	−1.9435
$C(15), C(20)$	0.0987	0.0977	0.1056	0.1046
$C(85), C(80)$	0.1541	0.1532	0.1459	0.1450

Notes. Significance levels: *10%, **5%, ***1%. IV GMM model uses robust, two step system GMM estimator with Windmeijer-corrected standard errors. This Table provides a robustness test to our main regression and has state GDP growth as the dependent variable. Overall the specification is the same but we use different percentiles of the contraction factor. All four columns use full IV GMM specification results with state and time fixed effects, showing coefficients for both log contraction factors, while controlling for lagged GDP *per capita*, changes in average marginal tax rates, income ratios, education and state government direct general expenditures. Columns (1) and (2) use contraction factors with the 15th percentile representing below median and the 85th percentile representing above median, whereas Columns (3) and (4) use contraction factors with the 20th percentile representing below median and the 80th percentile representing above median. Columns (1) and (3) use tax shock instruments, Z, and Columns (2) and (4) use political and demographic instruments, Z'. Specification:

$$\begin{aligned}\Delta \log \text{GDP}_{s,t} &= \kappa_1 \log C_{s,t-1}(i) + \kappa_2 \log C_{s,t-1}(j) + \gamma \Delta AMTR_{s,t-1} \\ &+ h_1 \log \frac{Income_{s,t-1}(50)}{Income_{s,t-1}(10)} + h_2 \log \frac{Income_{s,t-1}(90)}{Income_{s,t-1}(50)} \\ &+ \alpha \log \text{GDP}_{s,t-1} + \boldsymbol{X}_{s,t-1}\boldsymbol{\beta} + \delta_s + \eta_t + \varepsilon_{s,t},\end{aligned}$$

Z: tax shock instruments (personal and corporate tax shocks interacted with charity and state income inequality in 1979). Z': political affiliation and demographic instruments (share of state legislative bodies and governorship, elderly population, age 5–17 population, single mother households).

Table 8

Robustness 2 – The Effects of Log Contraction Factors on State Level GDP Growth

	Unemployment rate		Market income distribution	
Model	Z + time FE	Z' + time FE	Z + time FE	Z' + time FE
Regressors	(1)	(2)	(3)	(4)
$\log C(10)$	0.082	0.060**		
	(0.077)	(0.028)		
$\log C(90)$	−0.244***	−0.149**		
	(0.069)	(0.066)		
$\log C(10)$			0.142***	0.092*
			(0.042)	(0.053)
$\log C(90)$			−0.141**	−0.210**
			(0.067)	(0.085)
ΔAMTR	0.242	0.306	−1.832	−0.814
	(1.911)	(1.051)	(1.513)	(1.753)
log GDP	0.018	−0.044	0.008	−0.017
	(0.139)	(0.036)	(0.054)	(0.050)
$\log \frac{\text{Income}(50)}{\text{Income}(10)}$	0.014	0.016		
	(0.024)	(0.019)		
$\log \frac{\text{Income}(90)}{\text{Income}(50)}$	0.121	0.076		
	(0.149)	(0.079)		
$\log \frac{\text{Income}(50)}{\text{Income}(10)}$			0.036**	0.021
			(0.017)	(0.022)
$\log \frac{\text{Income}(90)}{\text{Income}(50)}$			0.213**	0.171
			(0.092)	(0.146)
Education	−0.035	−0.039***	−0.048**	−0.044
	(0.069)	(0.014)	(0.020)	(0.031)
Government expenditure	−0.010	−0.030	−0.016	−0.023
	(0.079)	(0.022)	(0.025)	(0.027)
Unemployment rate	−0.419	−0.412***		
	(0.338)	(0.098)		
State FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y
M2 (p-value)	0.140	0.156	0.120	0.118
Hansen J	5.256	6.378	5.314	7.112
Hansen (p-value)	0.918	0.702	0.947	0.525
No. observations	1,038	1,059	1,038	1,059
No. instruments	48	47	48	45
Means				
Dependent variable	0.0165	0.0145	0.0165	0.0145
$\log C(10)$	−2.4280	−2.4404	−2.4133	−2.4245
$\log C(90)$	−1.7776	−1.7830	−1.7707	−1.7760
$C(10)$	0.0915	0.0906	0.0927	0.0918
$C(90)$	0.1706	0.1698	0.1718	0.1710

Notes. Significance levels: *10%, **5%, ***1%. IV GMM model uses robust, two step system GMM estimator with Windmeijer-corrected standard errors. This Table provides another robustness test to our main regression and has state GDP growth as the dependent variable. Overall the specification is the same but for one alteration we use an additional control and for the other alteration we use a different income distributions to calculate our original contraction factors, $C(10), C(90)$. All four columns use full IV GMM specification results with state and time fixed effects, showing coefficients for both log contraction factors, while controlling for lagged GDP *per capita*, changes in average marginal tax rates, income ratios, education, and state government direct general expenditures. Columns (1) and (2) introduce the lagged unemployment rate in addition to our existing controls. Columns (3) and (4) use our original specification but use the market income distribution instead to calculate contraction factors and income ratios. Columns (1) and (3) use tax shock instruments, Z, and columns (2) and (4) use political and demographic instruments, Z'. Specification:

$$\begin{aligned}\Delta \log \text{GDP}_{s,t} &= \kappa_1 \log C_{s,t-1}(10) + \kappa_2 \log C_{s,t-1}(90) + \gamma \Delta AMTR_{s,t-1} \\ &+ h_1 \log \frac{Income_{s,t-1}(50)}{Income_{s,t-1}(10)} + h_2 \log \frac{Income_{s,t-1}(90)}{Income_{s,t-1}(50)} \\ &+ \alpha \log \text{GDP}_{s,t-1} + \boldsymbol{X}_{s,t-1}\boldsymbol{\beta} + \delta_s + \eta_t + \varepsilon_{s,t},\end{aligned}$$

Z: tax shock instruments (personal and corporate tax shocks interacted with charity and state income inequality in 1979). Z': political affiliation and demographic instruments (share of state legislative bodies and governorship, elderly population, age 5–17 population, single mother households).

Table 9

Robustness 3 – The Effects of Log Contraction Factors on State Level GDP Growth

Additional controls	Personal income growth		Public welfare expenditure	
Model	Z + time FE	Z' + time FE	Z + time FE	Z' + time FE
Regressors	(1)	(2)	(3)	(4)
$\log C(10)$	0.089*	0.074*	0.103*	0.067**
	(0.048)	(0.045)	(0.062)	(0.028)
$\log C(90)$	−0.277***	−0.181*	−0.232***	−0.139**
	(0.082)	(0.109)	(0.088)	(0.067)
ΔAMTR	0.704	−0.034	0.256	−0.243
	(1.363)	(1.403)	(1.646)	(1.231)
logGDP	0.048	−0.024	0.024	−0.026
	(0.068)	(0.044)	(0.051)	(0.034)
$\log\frac{\text{Income}(50)}{\text{Income}(10)}$	0.015	0.021	0.018	0.018
	(0.016)	(0.024)	(0.022)	(0.017)
$\log\frac{\text{Income}(90)}{\text{Income}(50)}$	0.104	0.103	0.110	0.099
	(0.096)	(0.136)	(0.105)	(0.086)
Education	−0.043	−0.033	−0.039	-0.039**
	(0.027)	(0.028)	(0.027)	(0.018)
Government expenditure	−0.016	−0.023	−0.030	-0.048*
	(0.023)	(0.022)	(0.028)	(0.027)
Income growth	0.120	0.113		
	(0.151)	(0.123)		
Government welfare exp. share			−0.034	−0.077
			(0.081)	(0.058)
State FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y
M2 (p-value)	0.243	0.313	0.146	0.226
Hansen J	8.458	7.760	9.056	7.544
Hansen (p-value)	0.672	0.559	0.617	0.581
No. observations	1,038	1,059	1,038	1,059
No. instruments	48	47	48	47
Means				
Dependent variable	0.0165	0.0145	0.0165	0.0145
$\log C(10)$	−2.4280	−2.4404	−2.4280	−2.4404
$\log C(90)$	−1.7776	−1.7830	−1.7776	−1.7830
$C(10)$	0.0915	0.0906	0.0915	0.0906
$C(90)$	0.1706	0.1698	0.1706	0.1698

Notes. Significance levels: *10%, **5%, ***1%. IV GMM model uses robust, two step system GMM estimator with Windmeijer-corrected standard errors. This Table provides another robustness test to our main regression and has state GDP growth as the dependent variable. Overall the specification is the same but we add different controls for each set. All six columns use full IV GMM specification results with state and time fixed effects, showing coefficients for both log contraction factors, while controlling for lagged GDP *per capita*, changes in average marginal tax rates, income ratios, education and state government direct general expenditures. Columns (1) and (2) add lagged state personal income growth as a control, while columns (3) and (4) use state government public welfare expenditure as an additional control. Columns (1) and (3) use tax shock instruments, Z, and columns (2) and (4) use political and demographic instruments, Z'.
Specification:

$$\begin{aligned}\Delta \log\text{GDP}_{s,t} &= \kappa_1 \log C_{s,t-1}(10) + \kappa_2 \log C_{s,t-1}(90) + \gamma \Delta AMTR_{s,t-1} \\ &\quad + h_1 \log \frac{Income_{s,t-1}(50)}{Income_{s,t-1}(10)} + h_2 \log \frac{Income_{s,t-1}(90)}{Income_{s,t-1}(50)} \\ &\quad + \alpha \log\text{GDP}_{s,t-1} + \boldsymbol{X}_{s,t-1}\boldsymbol{\beta} + \delta_s + \eta_t + \varepsilon_{s,t},\end{aligned}$$

Z: tax shock instruments (personal and corporate tax shocks interacted with charity and state income inequality in 1979) Z': political affiliation and demographic instruments (share of state legislative bodies and governorship, elderly population, age 5–17 population, single mother households).

Table 10

Robustness 4 – The Effects of Alternative Contraction Factors on State Level GDP Growth

Model Regressors	Contraction factors based on national income distribution: Z + time FE (1)	Contraction factors based on national income distribution: Z' + time FE (2)	Alternative measure of inequality reduction (IR): Z + time FE (3)	Alternative measure of inequality reduction (IR): Z' + time FE (4)
$\log C(10)$	0.144*	0.141		
	(0.083)	(0.108)		
$\log C(90)$	−0.308**	−0.288**		
	(0.122)	(0.128)		
Inequality Reduction (10)			0.014	0.005
			(0.013)	(0.015)
Inequality Reduction (90)			−0.017**	−0.022**
			(0.009)	(0.009)
ΔAMTR	0.146	−0.481	−0.825	−1.676
	(1.084)	(2.102)	(1.360)	(2.786)
logGDP	−0.030	−0.032	−0.003	0.014
	(0.078)	(0.048)	(0.059)	(0.051)
$\log\frac{\text{Income}(50)}{\text{Income}(10)}$	0.007	0.014	0.031	0.032
	(0.014)	(0.032)	(0.030)	(0.049)
$\log\frac{\text{Income}(90)}{\text{Income}(50)}$	0.010	0.057	0.117	0.191
	(0.079)	(0.144)	(0.075)	(0.166)
Education	−0.043	−0.061*	−0.047**	−0.059*
	(0.031)	(0.032)	(0.023)	(0.031)
Government expenditure	−0.022	−0.033	−0.032*	−0.039
	(0.032)	(0.029)	(0.019)	(0.024)
State FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y
M2 (p-value)	0.417	0.311	0.158	0.330
Hansen J	8.248	8.017	4.083	10.837
Hansen (p-value)	0.605	0.432	0.944	0.211
No. observations	1,038	1,059	1,038	1,059
No. instruments	46	45	46	45
Means				
Dependent variable	0.0165	0.0145	0.0165	0.0145
$\log C(10)$	−2.4032	−2.4181		
$\log C(90)$	−1.7618	−1.7679		
Inequality Reduction (10)			3.7931	3.7507
Inequality Reduction (90)			6.1913	6.1736

Notes. Significance levels: *10%, **5%, ***1%. IV GMM model uses robust, two step system GMM estimator with Windmeijer-corrected standard errors. This Table provides a robustness test to our main regression by using alternate definitions of inequality reduction and has state GDP growth as the dependent variable. For columns (1) and (2), we use the national income distribution to calculate contraction factors, rather than the state income distributions. For columns (3) and (4), we use an alternative inequality reduction measure detailed below. All four columns use full IV GMM specification results with state and time fixed effects, showing coefficients for inequality reduction, while controlling for lagged GDP *per capita*, changes in average marginal tax rates, income ratios, education and state government direct general expenditures. Columns (1) and (3) use tax shock instruments, Z, and columns (2) and (4) use political and demographic instruments, Z'. Specification:

$$\begin{aligned}\Delta \log\text{GDP}_{s,t} &= \kappa_1 \log C_{s,t-1}(10) + \kappa_2 \log C_{s,t-1}(90) + \gamma \Delta AMTR_{s,t-1}\\ &+ h_1 \log\frac{Income_{s,t-1}(50)}{Income_{s,t-1}(10)} + h_2 \log\frac{Income_{s,t-1}(90)}{Income_{s,t-1}(50)}\\ &+ \alpha \log\text{GDP}_{s,t-1} + \boldsymbol{X}_{s,t-1}\boldsymbol{\beta} + \delta_s + \eta_t + \varepsilon_{s,t},\end{aligned}$$

$$\text{Inequality Reduction}(90) = \left[\log\frac{\text{Income}(90)}{\text{Income}(50)} - \log\frac{\text{Income}(90)-\text{Tax}(90)}{\text{Income}(50)-\text{Tax}(50)}\right] \Big/ \left[\log\frac{\text{Income}(90)}{\text{Income}(50)}\right] \times 100.$$

$$\text{Inequality Reduction}(10) = \left[\log\frac{\text{Income}(50)}{\text{Income}(10)} - \log\frac{\text{Income}(50)-\text{Tax}(50)}{\text{Income}(10)-\text{Tax}(10)}\right] \Big/ \left[\log\frac{\text{Income}(50)}{\text{Income}(10)}\right] \times 100,$$

Z: tax shock instruments (personal and corporate tax shocks interacted with charity and state income inequality in 1979). Z': political affiliation and demographic instruments (majority of state legislative bodies and governorship, elderly population, age 5–17 population, single mother households).

Table 9 checks for robustness of our results with additional controls. While we include the lagged level of GDP in our main specification, columns (1) and (2) include the lagged income growth rate as well. The results remain economically and statistically similar to those in our main specification. Columns (3) and (4) investigate whether controlling for welfare expenditure changes our main findings, especially in the case of the alternative set of instruments that includes demographic instruments. The motivation is Helms (1985), for example, who finds that state expenditure on public services and investment (such as highways and education) is good for economic growth and state expenditure on public welfare is bad for economic growth. Column (3) and (4) report similar results as our main specification suggesting that our results are robust to this test.

Table 10 utilises alternative measures of reduction of income inequality through tax policy. For columns (1) and (2), we use the national income distribution to calculate contraction factors, rather than the state income distributions. This ensures that income of the percentiles is constant across states but also means that we are not comparing the same percentiles across states. The results remain similar. For columns (3) and (4), we use an alternative inequality reduction measure that is the difference between before and after tax income inequality:

$$\text{Inequality Reduction}(i) = \left[\log\frac{\text{Income}(50)}{\text{Income}(i)} - \log\frac{\text{Income}(50)-\text{Tax}(50)}{\text{Income}(i)-\text{Tax}(i)}\right] \Big/ \log\frac{\text{Income}(50)}{\text{Income}(i)},$$

where income i corresponds to 10th or 90th percentile for the below and above median households, respectively. Again, we find that the asymmetry of impact of inequality reduction for above and below median household on economic growth persists. The negative results for inequality reduction for above median households remains statistically significant.

6. Conclusion

Modern democracies have accepted the role of income taxation in addressing income inequality. This article distinguishes the economic growth effect of income taxation in reducing inequality between below median and median income households, from the economic growth effect of taxation in reducing inequality between median households and above median households.

We find that taxation at different points of the income distribution has asymmetric impacts on households' incentives to invest, work and consume. Tax policy that alleviates poverty improves economic growth in most instances. At the same time, we find that the reduction of incentives that is caused by a lower after-tax income gap between median and rich households reduces economic growth. This article does not address optimal taxation and general equilibrium effects of tax policy. We also do not investigate the impact of specific tax policies and welfare programmes on economic growth.

Hopefully, our findings will help policy makers make more informed decisions regarding tax policy by carefully balancing social insurance with incentive preservation.

University of North Carolina
University of Miami
University of Miami

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Additional Supporting Information may be found in the online version of this article:

Appendix A. Tax Definitions.
Appendix B. Additional Data Description.
Appendix C. First Stage.
Appendix D. Additional Tables.
Appendix E. Additional Figures.
Data S1.

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