Does Inequality Constrain the Power to Tax? Evidence from the OECD

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Abstract:

We investigate the consequences of income inequality on the income tax-to-GDP ratio for 21 OECD countries over a long time period spanning 1870 to 2011. We use several identification strategies, including using unionization as a new IV for inequality. In contrast to predictions from median voter models, we find that rising inequality significantly depresses the income tax ratio. This finding is robust to alternative measures of inequality, treatment for endogeneity, and model specification. The tax ratio increases with the degree of democracy and openness and decreases with urbanization. Inequality also reduces the indirect tax ratio and alters the tax structure.

JEL Classification: H2, E25

Keywords: Tax ratio; inequality; fiscal policy; OECD

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1. Introduction

Since the 1980s, most OECD economies have simultaneously experienced three salient developments: rising inequality, challenging budget conditions, and a reduction in the income tax share. For example, across the OECD, income inequality as measured by market Gini widened from 0.37 in 1980 to 0.47 in 2011, and the income share of the top 10% increased from 28.8% to 35.3% during this same period (Alvaredo et al., 2015; OECD, 2015). At the same time, the budget deficit as a percent of GDP deteriorated from 3.5% to 6.5% (OECD, 2014). During this period they also experienced, *on average*, a decline in the income tax share of total tax revenue, a decline in top income tax rates, and a reduction in income tax progressivity (Piketty and Saez, 2007; OECD, 2012). Are these developments linked? Does inequality make it more difficult to raise income tax revenue? Governments regularly use taxation and expenditure to moderate inequality. However, inequality may in turn affect fiscal policy. The effect of inequality on fiscal policy is theoretically ambiguous; while inequality may generate demand for redistribution that results in higher taxes, the opposite is also possible, with inequality resulting in a lower tax ratio.

There is a considerable literature on the determinants of fiscal policy and taxes (e.g., Hettich and Winer, 1988; Besley and Case, 1995; Milanovic, 2000; Harms and Zink, 2003; Aidt and Jensen, 2009; Corneo and Neher, 2015). However, there is a paucity of evidence on inequality's effect on taxes and the handful of extant studies report mixed findings. For example, Aizenman and Jinjara (2012) study 50 countries for the period 2007-2011, finding that tax revenues fall as a share of GDP as inequality rises. Adam *et al.* (2015) find that inequality reduces labor taxes and increases capital taxes in a sample of 75 countries for the year 2004. Boustan *et al.* (2013) show that inequality increases taxes at the municipality and school district level, for the USA during the period 1970 to 2000. Using a laboratory setting, Agranov and Palfrey (2015) find that inequality increases tax rates.

We make two contributions to this emerging empirical literature. First, we investigate the net effect of income inequality on the income tax ratio (income tax revenues to GDP) among 21 OECD countries, over a relatively long period of nearly one-and-a-half centuries, spanning the years 1870 to 2011. Specifically, we explore the effect of income inequality on income taxes, indirect taxes, and the structure of taxation as reflected in the ratio of income to indirect taxes. Long data are vital for investigation of the inequality-tax nexus, since major changes in these variables occurred over time, particularly during the period 1914-1950; this delivers large

identifying variations in the data. The use of a very long time span enables us to investigate the long-run effect of inequality on taxes.

Given the use of taxation to alleviate the impact of inequality, it is vital that reverse causality is dealt with. Our core identification strategy is to use 5- and 10-year lags in inequality. In addition, we make a second contribution to the literature by introducing unionization as a new, strong and valid instrument for inequality. Following Easterly's (2007) influential paper, the wheat-sugar land suitability ratio has predominantly been used as the instrument for inequality. However, the time invariance of this instrument renders it unsuitable for panel regressions and limits the cross-country variations in the instrumented estimates. We propose unionization as a time varying instrument for inequality. Historically, unionization has been negatively associated with inequality (Freeman and Medoff, 1984; Jaumotte and Buitron, 2015). Unions do this primarily through direct bargaining and political lobbying, which increases the relative pay of lower skilled, constrains the pay of top earners, and also establishes pay norms that permeate beyond unionized firms. In addition to using lags and unionization as an IV, we also adopt two other alternate identification strategies to deal with potential feedback-effects from taxes to inequality: internal instruments in system GMM and adjusted inequality following Brückner's (2013) IV methodology.

Using the longer dataset and the alternate identification strategies, we show in this paper that rising inequality has historically *depressed* the income tax-to-GDP ratio in the OECD over the long-run. This finding is robust to alternative measures of inequality, econometric specification, and treatment for endogeneity. It matters for policy if rising inequality depresses the income tax ratio, as this entails offsetting contributions from other revenue sources, e.g., regressive general consumption taxes and social security contributions. When opportunities for such substitution are limited, and holding debt constant, inequality increases pressure on government budgets and in general restrains a nation's ability to use fiscal policy to redistribute and tackle issues arising from inequality. It also matters for the analysis of the determinants of inequality, as uncorrected, reverse causation can lead to biased estimates of the impact of taxes on inequality.

The plan of the remainder of the paper is as follows. In Section 2 we discuss the theoretical predictions and the econometric specification. Section 3 discusses the identification strategy. The data are discussed in Section 4. The baseline results and robustness checks are presented and discussed in Section 5. Section 6 concludes the paper.

2. Theoretical predictions and model specification

Political and institutional factors play a central role in the determination of fiscal policy. There are sound theoretical arguments that inequality can result in greater redistribution and higher taxes. For example, median voter models predict that mounting inequality will require greater redistribution and rising progressivity in taxation, especially when inequality makes the median voter poorer (Meltzer and Richard, 1981). However, it is also possible that inequality may result in lower taxes because of political pressure and tax resistance. Consequently, taxes may be lower than what is preferred by median voter. Harms and Zink (2003) a survey of various explanations, e.g. with voluntary voting it is the decisive political voter rather than the median voter that determines tax rates.

Progressive taxation and fiscal redistribution create a disincentive to work and invest. Consequently, some sections of society, particularly the rich, lobby against the implementation of redistribution policies (Bénabou, 2002; Acemoglu and Robinson, 2008). Rising inequality may affect political support for redistribution, stimulating political pressure and lobbying against redistribution, which if successful, reduces the need for additional tax. Bénabou (2000) argues that capital and insurance market imperfections can result in multiple equilibria, enabling high inequality and low redistribution or low inequality and high redistribution. One possible outcome is that inequality leads to resistance to redistributive policies and political pressure to reduce income taxes. Indeed, opposition to redistributive policies may even be so great, that some unequal societies may actually redistribute less (Bénabou, 2000; Moene and Wallerstein, 2001; De Mello and Tiongson, 2006).

Inequality might encourage tax resistance, e.g., under-reporting of tax and tax evasion. Inequality increases the gap between taxes paid and government services received, thereby reducing voter and taxpayer satisfaction with the tax system and potentially reducing tax compliance. Inequality might also increase social mistrust (Rothstein and Uslaner, 2005; Gustavsson and Jordahl, 2008); this may alter norms, reduce tax morale, and increase tax evasion. Intrinsic factors matter for tax compliance (Dwenger et al. 2016). Inequality may shape intrinsic motives for tax compliance and alter social preferences for redistribution. Higher redistributive tax rates can similarly encourage tax evasion and avoidance (Clotfelter, 1983; Gorodnichenko *et al.*, 2009). This is particularly the case when inequality places a greater tax burden on the rich, who then become less willing to comply. Progressive income taxes reduce the income share of the top decile (Roine *et al.*, 2009; Piketty *et al.*, 2014). Hence, tax avoidance and evasion is likely to be much larger in the upper tail of the income distribution

(Feldstein, 1995). The source of rising inequality is also a factor. Thus, if inequality is rising because of higher relative earnings in the top decile and if income is extracted from less visible sources, then it becomes easier to avoid tax.

Inequality may also alter reform options. Tax reform occurs when it is politically feasible. Inequality may restrict government's ability to reform tax, particularly in terms of broadening the tax base. Political pressure can erode the tax base by making it more difficult to change the tax code to increase taxes, while simultaneously encouraging greater exemptions. Inequality might also impair government tax collection efforts. Consequently, the tax ratio falls if national income rises faster than tax revenues. This is not merely a mechanical response. Rather, it arises from democratic processes and political pressure to constrain tax.

The prediction that inequality makes it more difficult to raise taxes to fund redistribution is inconsistent with standard predictions of median voter models. Rational taxpayers will wish to constrain government tax power (Brennan and Buchanan, 2000). Inequality affects taxpayers' calculus; when inequality widens, taxpayers tighten constraints on tax power. Consequently, median voter effects can be offset by tax avoidance and tax resistance, *e.g.*, through constitutional and non-constitutional reform on tax rules on specific taxes or on overall tax revenue. Moreover, expressive voting models might be more germane. In most democracies, voters are not individually decisive. Faced with very little instrumental impact on election outcomes, individual voters may choose to vote expressively (Brennan and Lomasky, 1993). In the case of inequality, individual voters can at the ballot express their support for the poor and dislike of the rich, even though if enacted this might result in policies (such as higher taxes) that are against their individual self-interest (Brennan and Lomasky, 1993). Thus, while they may express a willingness to raise higher taxes and redistribute, voters' real preferences may be to reduce taxes and hence they lobby and resist attempts to increase taxes. This channel would be strengthened where inequality erodes social trust.

Hence, the net effect of inequality on taxes is theoretically indeterminate: inequality may increase the tax ratio, as predicted by the median voter model, or reduce it, as predicted by the above arguments. We investigate the net effect of inequality on the tax ratio by estimating the following reduced form model:

$$Tax_{it} = \beta_0 + \beta_1 Tax_{i,t-1} + \beta_2 Ineq_{it} + \gamma X'_{it} + CD_i + TD_t + \varepsilon_{it}, \quad (1)$$

where Tax is the share of income tax in GDP (we also consider alternatively indirect taxes and the tax mix), $Ineq$ is a measure of income inequality, X_{it} is a vector of control variables, i and t index the i th country in time period t , respectively, and CD and TD denote country and time

fixed effects, respectively, included in all regressions including first-stage regressions. The fixed effects are particularly important. The country fixed effects control for any country specific factors that might increase inequality and limit the tax ratio. The time fixed effects control for various cyclical oscillations in economic activity and shocks that affect all OECD nations. Eqn. (1) is specified in levels because all variables are measured as ratios; however, a log-log specification gives similar results to those reported below.

Given the above theoretical considerations, our main variable of interest is measured as the market (or gross) Gini coefficient (*Gini*); this measures inequality *before* tax and redistribution. We also use the top 10 percent pre-tax income shares (*Top10*) as an alternate measure of inequality. Eqn. (1) allows for persistence in fiscal policy through a partial adjustment process as suggested by Acemoglu *et al.* (2015) and Aidt and Jensen (2013). Ordinarily, the inclusion of a lagged dependent variable with fixed effects introduces bias in the coefficient of the lagged dependent variable. However, this bias will be insignificant in our case, as we use a very long time series. The statistical and economic significance of inequality does not change if all the models are estimated without the lagged dependent variable.

We include several control variables in the X_{it} vector, namely openness measured by the ratio of imports to GDP (*Op*), the rate of urbanization (*Urb*), per capita GDP (*lnGDP*), and democracy as measured by the Polity index (*Polity*). The level of income and urbanization are included as proxies for overall development, the Kuznets process, and broadening of the tax base (Aidt and Jensen, 2009; Kenny and Winer, 2006; Sturm and de Haan, 2015). Openness measures the impact of economic integration (Feenstra *et al.*, 1996); openness presents greater opportunities for skilled workers to find alternate opportunities and this can impact income taxes. Significant institutional changes have occurred over time for several of the countries included in our sample. Meltzer and Richard (1981), Aidt *et al.* (2006) and Aidt and Jensen (2009), among others, argue that democracy affects fiscal policy. Indeed, the effect of inequality on government deficits and debt levels may depend on the relative political power of various interest groups; the poor demand redistribution that often results in distortionary taxes whilst the rich demand fewer redistributive taxes (Alesina and Rodrik, 1994).

3. Identification strategy

We deal with possible endogeneity using several econometric strategies. Our core identification strategy is to use 5- and 10-year lags in inequality. In addition, we consider three

other strategies: (1) trade union density as a novel, powerful, and valid instrument for income inequality; (2) the system GMM estimator to generate internal instruments; and (3) Brückner's (2013) method to derive measures of inequality that are free of the effects of taxation.

3.1 *Identification through lags*

Lags can address potential endogeneity biases resulting from simultaneous and reverse causation, as lagged inequality is likely to be exogenous to the current tax ratio. Thus, we re-estimate Eqn. (1) using 5- and 10-year lagged income inequality (*Gini* and *Top10*). As part of robustness, we also consider 15- and 20-year lags in inequality. A possible counter argument is that taxation may be endogenous even to lagged inequality. For example, if it is known that fiscal policy will be used to redress inequality, then the current level of inequality may be a function of future fiscal policy. As an example, employers might in some cases depress earnings knowing that governments will in the future redistribute incomes to compensate. However, to the extent that this occurs, it is the *expected* fiscal policy that is endogenous to inequality rather than fiscal policy that is revealed in the data. Moreover, such effects should wash out by using 10-year lags, or longer.

3.2 *Unionization as an IV*

Most of the instruments used in prior studies are not suitable for our sample of OECD nations over a long time period, because these instruments are time-invariant. For example, Easterly (2007) uses land suitable for growing wheat relative to land suitable for growing sugarcane. Instead, we propose unionization as an IV. The intuition behind unionization as an IV is that historically, unions have played a significant role in shaping inequality; unionization is associated with greater bargaining power for labor, increased labor's income share and reduced inequality. This conclusion is drawn from the empirical findings of the large literature on the importance of labor market institutions on inequality; see for example Blau and Kahn (1996), DiNardo *et al.* (1996), Freeman (2007), and Koeniger *et al.* (2007).

The impact of unionization on inequality is theoretically ambiguous, due to offsetting general equilibrium effects (Johnson and Mieszkowski, 1970). However, while some of the microeconomic and single country evidence is mixed (e.g., DiNardo *et al.* (1996) find that unions reduce inequality whereas Hirsch and Schumacher (1998) find that unions have no effect), the cross-country empirical evidence indicates that unions inhibit inequality. This is confirmed by several studies of OECD economies. For example, Koske *et al.* (2012) find that

unionization reduces inequality across the OECD for the period 1981 and 2007. Similar conclusions are reached by Blau and Kahn (1996), Gustafsson and Johansson (1997), Wallerstein (1999), Rueda and Pontusson (2000), and Koeniger *et al.* (2007), among others.

Unionizations can potentially affect both sides of the distribution of incomes. The main channels through which unions impact the incomes of the lowest deciles and the middle class is by increasing the relative pay (wages and benefits) of the unskilled, their political support for policies that have a redistributive impact (*e.g.*, minimum wages and the welfare state), and their support of left-wing and left-of-center governments which tend to implement policies that reduce inequality (Freeman and Medoff, 1984). These factors compress pay differentials between low- and high-paid employees. They can also potentially compress differentials between males and females and between various socioeconomic groups. For example, union members enjoy a sizeable earnings premium (Jarrell and Stanley, 1990). This premium tends to be relatively larger for lower skilled workers, thereby compressing earnings (Kahn, 2000).

Earnings compression occurs both within unionized plants and also between firms (Freeman and Medoff, 1984). For example, the ‘threat’ of unionization compresses earnings between unionized and non-unionized plants, as non-unionized firms match pay and pay processes of unionized firms. Further, collective bargaining agreements can in some countries extend to non-union workers. Similarly, union influenced political pressure depresses pay relativities between firms. Additionally, unions also influence earnings norms and thereby affect pay setting in non-unionized firms, particularly in many European OECD nations (Western and Rosenfeld, 2011).

Higher wages induced by unions may lower labor’s income share if the elasticity of substitution between capital and labor exceeds one. However, most empirical estimates suggest that the elasticity of substitution is lower than 1. For example, Chirinko’s (2008) review of evidence base puts this elasticity in the range of 0.40 to 0.60. This inelastic substitution between capital and labor suggests a positive relationship between workers’ bargaining power and labor’s income share. Thus, as predicted by right-to-manage and the efficient-bargain models, increasing wages will increase labor’s share (Blanchard and Giavazzi, 2003; Bentolila and Saint-Paul, 2003). Conversely, the decline in unionization in recent decades will reduce labor’s share.

Unionization can also impact the income share of the top decile. For example, union bargaining and union influenced political pressure can curtail managerial and even executive pay. Jaumotte and Buitron (2015) find that declining union density explains a large fraction of

the increase in the share of the top 10 percent, attributing this to a decline in bargaining power of workers relative to top earners.

Our interest is not on the precise channels through which unions impact inequality but rather their overall net impact. Moreover, our contention is not that unions are the only factor shaping inequality; indeed there is a range of supply, demand, and institutional factors at work. However, the extant evidence suggests an inverse association between unions and inequality, at least among the OECD economies. Indeed, we also find that over the historical period and across the average OECD economy, unionization has impacted upon inequality. This makes unionization a strong instrument for inequality.

Exclusion restriction

An argument can be made that the exclusion restriction may not be fully satisfied if unions lobby for higher taxes to finance welfare payments (e.g., as in Alesina and Perotti, 1995) or to provide goods and services that do not affect inequality in the short run or at all. However, the counter argument is that most if not all government activity has at least some redistribution component. Moreover, even if unionization does affect taxes independently of inequality, this will tend to bias the coefficient of inequality in the opposite direction of what we find, i.e., unionization increases taxes whereas we show in this paper that inequality reduces taxes. Hence, if unionization is not a perfect instrument for inequality, then our conclusions will be even stronger. In section 5.2 below we apply Berkowitz *et al.*'s (2012) fractionally resampled Anderson–Rubin (FAR) test to formally investigate violations of the exclusion restriction; the results are robust to such violations.

3.3 Alternate treatment of endogeneity

In addition to using unionization as an IV, we consider two other methods to address endogeneity. First, we use the two-step system GMM estimator to generate internal instruments for current inequality. For these estimates we take 10-year averages of the data. Second, we follow Brückner (2013) to construct an adjusted inequality series where the response of inequality to taxes has been removed; this produces an adjusted inequality series that is free from endogeneity. This offers an alternate IV approach to unionization. For the sake of brevity below we report only the results using lagged inequality, unionization as an IV, and the two-step system GMM.

4. Data

We use pre-tax, pre-transfer market Gini coefficient (*Gini*) and pre-tax top 10 percent income shares (*Top10*), as two complementary measures of income inequality for 21 high income OECD countries over the period 1870-2011. Gini coefficients data are compiled from the Standardized World Income Inequality Database and the top 10% income share data from the World Wealth and Income Database. The *Gini* data are only available after 1960 and the *Top10* data are not available for all countries considered here, commencing later than 1870, mostly after 1910. We backdate and impute the *Gini* and the *Top10* data to 1870 using various historical sources, complemented with capital's income share following the lead of Williamson (1997) and De La Escosura (2008). Islam and Madsen (2015) used a similar dataset and methods. However, we have revised their data for a number of countries. See the online Data Appendix for details on the construction of the data.

The data relate to 21 high income OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Collectively, these 21 countries produced 41% of world GDP in 2011 (Maddison Historical Statistics using Geary Khamis PPP in 1990 prices). We matched this data with data on the ratio of tax revenue to GDP, union membership, and control variables. Our primary focus is on income tax, however we also consider indirect taxes in our analysis. We divide income taxes by GDP to get a measure of the effective tax rate. This method has the advantage over statutory tax rates in that it reports how much is effectively paid in taxes out of income after tax deductions and changes to the tax base, whereas composite income tax rates may not reflect well the effective tax rate.

The unionization rate is measured as the ratio of the number of organized trade union members to total employment. Openness is measured as the ratio of imports to GDP, urbanization is measured as the ratio of population of cities of 100,000 people to total population, real GDP per capita is measured as the ratio of real GDP to population, and democracy is measured by the revised combined Polity 2 score. Summary statistics of the key variables are reported in the Appendix (Table A1).

Figure 1 illustrates the association between inequality (measured by the Gini coefficient) and the income tax ratio, averaged across the OECD economies. An inverse relationship is notable from about 1915 to 1980; particularly during and immediately after the two world wars where inequality was reduced due to strong political forces (Piketty, 2014). Conversely, increasing inequality after 1980 is associated with strong political forces against equality and in favor of lower taxes initiated by, for example, the Thatcher-Reagan governments. Figure 1 also illustrates the well-documented phenomenon of the persistent rise in taxes relative to income over much of the period studied (Meltzer and Richard, 1981).

Figure 1: Market Gini coefficient and the income tax ratio, unweighted average of 21 OECD economies, 1870-2011

Figure 2 compares the evolution of inequality and the unionization rate, our IV. A strong negative correlation is evident, suggesting that unionization may indeed serve as a potentially strong instrument for income inequality, this is confirmed formally below by *F*-tests for the excluded instrument. Growing inequality since the 1980s may be explained, at least in part, by declining power of labor unions, though immigration, globalization, and information technology all contributed (Katz and Murphy, 1992).

Figure 2: Market Gini coefficient and union membership rate, unweighted average of 21 OECD countries, 1870-2011

5. Results

5.1 Baseline specifications

We commence with the unconditional baseline regressions. These are set out in Table 1 and show that inequality has a statistically significant negative coefficient. Pooled OLS results are reported in columns (1) to (4), where we add a lagged dependent variable in columns (3) and (4) to reflect a partial adjustment process in the evolution of fiscal policy.¹ Country and time fixed effects are introduced in columns (5) and (6). The IV-2SLS results are reported in columns (7) and (8); these also include two-way fixed effects. These second-stage estimates confirm that inequality reduces the tax ratio. The first-stage regressions show that unionization reduces inequality and the *F*-tests confirm that unionization is a strong and a potentially valid instrument for inequality. The Hausman-Wu endogeneity tests reject the null hypothesis of the exogeneity of inequality, lending support for the use of an identification strategy.

¹ The adverse effect of inequality on the tax ratio is robust to longer lags, *e.g.*, four- and eight-year annual lags of the dependent variable.

Table 1: Inequality and income taxes, unconditional estimates, 21 OECD countries, 1870-2011

	Pooled OLS, <i>Gini</i> (1)	Pooled OLS, <i>Top10</i> (2)	Pooled OLS, <i>Gini</i> (3)	Pooled OLS, <i>Top10</i> (4)	Two-way fixed effects, <i>Gini</i> (5)	Two-way fixed effects, <i>Top10</i> (6)	IV- 2SLS, <i>Gini</i> (7)	IV- 2SLS, <i>Top10</i> (8)
$Tax_{i,t-1}$	-	-	0.98*** (0.00)	0.98*** (0.01)	0.92*** (0.01)	0.91*** (0.02)	0.87*** (0.02)	0.86*** (0.02)
$Ineq_{it}$	-0.16*** (0.01)	-0.32*** (0.01)	-0.01** (0.00)	-0.01** (0.00)	-0.01** (0.00)	-0.03*** (0.01)	-0.20*** (0.05)	-0.16*** (0.03)
R^2	0.06	0.13	0.96	0.96	0.96	0.96	0.75	0.83
<i>First Stage Regressions</i>								
$Union_{it}$							-0.10*** (0.02)	-0.13*** (0.01)
F -test							40.19	182.74
Endog (p -val)							0.00	0.00
Observations	2601	2601	2580	2580	2580	2580	2580	2580

Notes: Dependent variable is the income tax-GDP ratio (Tax). $Ineq$ denotes inequality. $Gini$ denotes market Gini. $Top10$ is the income share of the top 10%. Columns (1) to (6) estimated with OLS. Columns (7) and (8) use unionization rate ($Union$) as an IV. F -test is for excluded instrument. $Endog$ is a Hausman-Wu test for endogeneity of inequality in the regressions. Results reported in columns (5) to (8) also include country and time fixed effects. Parentheses report robust standard errors. *, **, and *** denote 10%, 5% and 1% significance levels, respectively.

The adverse effect of inequality on the tax ratio is maintained when we add control variables. These conditional estimates (Eqn. 1) are reported in Table 2, for alternate treatments of endogeneity.² Columns (1) and (2) use 5-year lags, while Columns (3) and (4) use 10-year lags of inequality; these four columns are estimated using OLS. Columns (5) and (6) use unionization as an IV. Columns (7) and (8) use System GMM.³ All the results show that income inequality reduces the income tax ratio. Moreover, the effect is also economically significant. Specifically, the elasticity of taxes with respect to inequality is -0.7 and -1.13 for Gini and Top10, when 5-year lags are used, and -0.62 and -1.18 when 10-year lags are used, respectively.

² Inference with regard to inequality is robust to various combinations of the control variables (not reported here), as well as additional sensitivity analysis reported below.

³ The System GMM estimates satisfy a battery of diagnostic checks, including Hansen's overidentifying restrictions tests for instrument validity, and AR(2) tests for second order serial correlations.

Table 2: Inequality and income taxes, baseline conditional estimates, 21 OECD countries, 1870-2011

	5-year lag, OLS, <i>Gini</i>	5-year lag, OLS, <i>Top10</i>	10-year lag, OLS, <i>Gini</i>	10-year lag, OLS, <i>Top10</i>	IV-2SLS Union, <i>Gini</i>	IV-2SLS Union, <i>Top10</i>	10-year System GMM, <i>Gini</i>	10-year System GMM, <i>Top10</i>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Tax_{i,t-1}$	0.77*** (0.02)	0.74*** (0.02)	0.59*** (0.03)	0.55*** (0.03)	0.86*** (0.03)	0.87*** (0.02)	0.52*** (0.15)	0.55*** (0.18)
$Ineq_{it}$	-0.03*** (0.01)	-0.08*** (0.01)	-0.06*** (0.01)	-0.15*** (0.02)	-0.21*** (0.06)	-0.12*** (0.03)	-0.12** (0.05)	-0.28*** (0.09)
Op_{it}	0.02* (0.01)	0.02* (0.01)	0.03** (0.01)	0.03*** (0.01)	0.02* (0.01)	0.01 (0.01)	0.00 (0.06)	0.02 (0.06)
Urb_{it}	-0.01 (0.01)	-0.01 (0.01)	-0.02** (0.01)	-0.02** (0.01)	0.04*** (0.01)	0.01 (0.00)	-0.02 (0.04)	0.03 (0.05)
$lnGdpc_{it}$	1.35*** (0.35)	1.49*** (0.34)	1.97*** (0.43)	2.20*** (0.42)	0.03 (0.20)	0.45** (0.18)	2.35** (1.00)	1.19 (1.36)
$Polity_{it}$	-0.02 (0.02)	-0.02 (0.02)	-0.04* (0.02)	-0.03 (0.02)	-0.04*** (0.02)	-0.01 (0.01)	0.01 (0.12)	-0.01 (0.16)
R^2	0.90	0.90	0.84	0.85	0.76	0.85		
<i>First Stage Regressions</i>								
$Union_{it}$					-0.09*** (0.01)	-0.16*** (0.01)		
$F\text{-test}$					36.28	321.66		
Endog ($p\text{-val}$)					0.00	0.00		
Hansen (p)							0.43	0.37
AR (2) (p)							0.93	0.83
Observations	2367	2367	2277	2277	2439	2439	238	238

Notes: Dependent variable is the income tax-GDP ratio (Tax). *Gini* denotes market Gini. *Top10* is the income share of the top 10%. Columns (1)-(4) estimated using OLS. Inequality is lagged 5 years in columns (1) and (2) and 10 years in columns (3) and (4), respectively. Columns (5) and (6) use unionization as an IV. System GMM model is estimated in 10-year intervals ($N=21$; $T=15$); 2nd lag of explanatory variables is used as internal instruments. All regressions include time and country fixed effects. Parentheses report robust standard errors. *, ** and *** denote 10%, 5% and 1% significance levels, respectively. See the text for variable descriptions. See also notes to Table 1.

The results presented in Table 2 suggest that the degree of democracy ($Polity$) does not increase the income tax ratio; the coefficient is in the majority of cases negative but it is estimated with low precision. A similar result is reported by Mulligan *et al.* (2004) who find that democracy has no effect on various taxes. However, they found that democracy was correlated with *less* redistributive income taxes during the 1973 to 1990 period. In contrast, Aidt and Jensen (2009) find that for 10 OECD economies, democracy increased taxes during the 1860 to 1938 period. To investigate this deeper, we consider lags between democracy and the income tax ratio.

We re-estimated the models using 5- and 10-year lags in the democracy score. The coefficients of inequality remain unaffected (i.e. statistically significant with a negative coefficient). However, we find that lagged polity has a statistically significant positive impact on the tax ratio. This result is maintained when *all* control variables are lagged either 5 or 10 years; see Table 3. Hence, it appears that democracy increases the income tax ratio in the OECD once lags are introduced in the analysis. The evidence is less robust for the other variables.

However, there is some evidence from Tables 2 and 3 that openness increases the income tax ratio, while urbanization decreases it. We find no consistent evidence for the level of development.

Table 3: Inequality and income taxes, conditional estimates, 21 OECD countries, 1870-2011, all explanatory variables lagged

	5-year lag, OLS, <i>Gini</i> (1)	5-year lag, OLS, <i>Top10</i> (2)	10-year lag, OLS, <i>Gini</i> (3)	10-year lag, OLS, <i>Top10</i> (4)
$Tax_{i,t-1}$	0.75*** (0.02)	0.73*** (0.02)	0.60*** (0.03)	0.55*** (0.03)
$Ineq_{it}$	-0.03*** (0.01)	-0.08*** (0.01)	-0.04*** (0.01)	-0.14*** (0.02)
Op_{it}	-0.00 (0.01)	-0.00 (0.01)	0.03** (0.01)	0.04*** (0.01)
Urb_{it}	-0.01** (0.01)	-0.01** (0.01)	-0.02** (0.01)	-0.01 (0.01)
$lnGdpc_{it}$	-0.27 (0.32)	-0.11 (0.31)	-0.79** (0.38)	-0.53 (0.36)
$Polity_{it}$	0.05*** (0.02)	0.05*** (0.02)	0.12*** (0.02)	0.12*** (0.02)
R^2	0.90	0.90	0.84	0.85
Observations	2352	2352	2247	2247

Notes: Dependent variable is the income tax-GDP ratio. *Gini* denotes market Gini. *Top10* is the income share of the top 10%. All explanatory variables are lagged 5 years in columns (1) and (2) and 10 years in columns (3) and (4), respectively. All estimations use OLS. All regressions include time and country fixed effects. Parentheses report robust standard errors. *, ** and *** denote 10%, 5% and 1% significance levels, respectively.

5.2 Robustness

We explored the sensitivity of our results in several ways. The first robustness check involves incorporating foreign taxes and tax competition into the modelling. Specifically, we add the foreign average tax-GDP ratio calculated as the inverse distance (geographic) weighted average value of tax-GDP ratio for all sample countries excluding country i . The motivation behind this is the possibility of strategic interactions between rival jurisdictions, tax policy emulation, or yardstick competition (Besley and Case, 1995). Hence, the tax rate of a given country might be influenced by tax rates in other nations and this is more likely to occur over time as economic integration has increased. We consider both one-year and multiple year lags in the foreign tax rate, so as to remove the possibility of spatial endogeneity. The key results are presented in Table 4. Our results with respect to inequality are upheld.

Table 4: Inequality and income taxes, conditional estimates, 21 OECD countries, 1870-2011, including inverse distance weighted foreign tax ratio

	IV-Union, <i>Gini</i>	IV-Union, <i>Top10</i>	5-year lag, OLS, <i>Gini</i>	5-year lag, OLS, <i>Top10</i>	10-year lag, OLS, <i>Gini</i>	10-year lag, OLS, <i>Top10</i>	10-year System GMM, <i>Gini</i>	10-year System GMM, <i>Top10</i>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Tax_{i,t-1}^f$	0.23*** (0.08)	0.20*** (0.06)	0.62*** (0.10)	0.27** (0.11)	0.65*** (0.09)	0.32*** (0.09)	0.63* (0.36)	0.61** (0.24)
$Ineq_{it}$	-0.76*** (0.07)	-0.71*** (0.04)	-0.11*** (0.01)	-0.28*** (0.02)	-0.11*** (0.01)	-0.28*** (0.02)	-0.25** (0.09)	-0.40** (0.17)

Notes: Tax^f indicates inverse distance weighted foreign tax-GDP ratio. $Ineq$ and Tax^f are lagged 5 years in columns (3) and (4) and 10 years in columns (5) and (6), respectively. The full set of controls and country and time fixed effects are included but not reported. See notes to Table 2.

As a second robustness check, we investigate alternate tax ratio data, using data from Cagé and Gadenne (2015). This data relates to the total tax rate. Cagé and Gadenne's (2015) tax ratio data are available for all of our sample countries over the period 1792 to 2006. However, these data suffer heavily from missing observations. The results using these alternate tax data are presented in Columns (1) and (2) of Table 5, and confirm our results with respect to income tax.

Our third robustness check follows Brückner's (2013) IV approach where the tax ratio is instrumented by urbanization, to construct an adjusted inequality series by removing the response of inequality to tax ratio (see Brückner 2013 for details). Using this endogeneity-free adjusted inequality as an instrument for our income inequality, the IV results reported in columns (3) and (4) of Table 5 demonstrate a significant negative effect of inequality on the tax ratio consistent with our baseline results.⁴

A fourth robustness check involves introducing longer lags between inequality and taxes. Specifically, we use 15- and 20-year lags in inequality. This allows for slower moving processes to take effect. The results remain qualitatively similar; see columns (5) to (8) of Table 5.

⁴ We also consider two alternate instruments: the family farms and literates series developed by Vanhanen (2013). Family farms area is measured as the ratio of family farms area to total cultivated area, and literates is measured as the ratio of literate population to total population. Family farms is a measure of the distribution of land ownership, while literates is a proxy for literacy (Vanhanen, 1997). See also Easterly (2007) on the link between family farms and inequality. Both land inequality and education are highly correlated with income inequality and may thus serve as potential instruments. These results also confirm our baseline results.

Table 5: Inequality and income taxes, conditional estimates, 21 OECD countries, 1870-2011, alternate data and identification strategy

	IV- Union, Cagé & Gadenne (2015) tax ratio, <i>Gini</i> (1)	IV- Union, Cagé & Gadenne (2015) tax ratio, <i>Top10</i> (2)	IV- Brückner, <i>Gini</i> (3)	IV- Brückner, <i>Top10</i> (4)	15-year lag, OLS, <i>Gini</i> (5)	15-year lag, OLS, <i>Top10</i> (6)	20-year lag, OLS, <i>Gini</i> (7)	20-year lag, OLS, <i>Top10</i> (8)
$Tax_{i,t-1}$	0.80*** (0.05)	0.80*** (0.05)	0.92*** (0.01)	0.88*** (0.02)	0.49*** (0.03)	0.46*** (0.03)	0.43*** (0.03)	0.41*** (0.03)
$Ineq_{it}$	-0.38** (0.15)	-0.22*** (0.08)	-0.03*** (0.01)	-0.10*** (0.02)	-0.06*** (0.01)	-0.16*** (0.02)	-0.05*** (0.01)	-0.12*** (0.02)
Op_{it}	0.02 (0.03)	0.04* (0.02)	0.01 (0.01)	0.01 (0.01)	0.03** (0.01)	0.03** (0.01)	0.02 (0.01)	0.02* (0.01)
Urb_{it}	0.01 (0.05)	-0.06*** (0.02)	0.00 (0.00)	0.01 (0.00)	-0.03*** (0.01)	-0.03*** (0.01)	-0.06*** (0.01)	-0.06*** (0.01)
$lnGdpc_{it}$	-0.35 (0.83)	0.47 (0.65)	0.23 (0.17)	0.42** (0.17)	1.94*** (0.47)	2.29*** (0.46)	1.85*** (0.52)	2.12*** (0.51)
$Polity_{it}$	-0.03 (0.03)	-0.01 (0.02)	-0.01 (0.01)	-0.01 (0.01)	-0.03 (0.02)	-0.03 (0.02)	-0.01 (0.03)	-0.01 (0.02)
R^2	0.51	0.60	0.86	0.85	0.81	0.82	0.80	0.80
<i>First Stage Regressions</i>								
$Union_{it}$	-0.11*** (0.01)	-0.19*** (0.01)						
$Ineq_{it}^*$			0.98*** (0.02)	0.93*** (0.01)				
F -test	48.36	520.85	295.25	406.21				
Endg (p -val)	0.00	0.00	0.00	0.00				
Observations	1930	1930	2439	2439	2186	2186	2091	2091

Notes: Columns (1) and (2) use the Cagé and Gadenne (2015) tax revenue data. The endogeneity adjusted inequality ($Ineq^*$) in columns (3) and (4) are derived from IV estimates using urbanization as an instrument for taxes in the inequality regressions. Inequality and taxes are lagged 15 years in columns (5) and (6) and 20 years in columns (7) and (8), respectively. Parentheses report robust standard errors. *, ** and *** denote 10%, 5% and 1% significance levels, respectively.

We also examine the sensitivity of our IV estimates to potential violations from the exclusion restriction by applying Berkowitz *et al.*'s (2012) fractionally resampled Anderson–Rubin (FAR) test. Berkowitz *et al.* (2012) show that valid inferences can be made when an instrumental variable does not perfectly satisfy the orthogonality condition. When there is a mild violation of the orthogonality condition, the Anderson and Rubin (AR) test over-rejects the null hypothesis that income inequality has no significant effect on the economic outcome variables. In order to correct this problem, Berkowitz *et al.* (2012) derive the *fractionally* resampled Anderson–Rubin (FAR) test based on the jackknife histogram estimator in order to obtain valid but conservative inferences. Therefore, the FAR test is a modification of the AR test that accounts for violations of the orthogonality condition.

Table 6 reports the *p-values* of the full sample AR, Row (1), and the resampled FAR, Row (2), tests for the significance of the income inequality coefficients presented in Columns (7) and (8) of Table 1 (unconditional estimates) and Columns (5) and (6) of Table 2 (conditional estimates) using 10,000 repetitions of the resampling procedure. While the *p-values* are slightly larger than for the AR test, the FAR test rejects the hypothesis that the second stage coefficient on income inequality is zero at least at the 5% level of significance. Thus, the FAR tests suggest that valid inferences for the effects of inequality on income tax ratio can be made even if the exogeneity of unionization rate does not strictly hold and the instrument is not perfect. In any case, our primary identification strategy is to use 5- and 10-year lags in inequality and these provide solid evidence that inequality depresses the income tax ratio.

Table 6 – Fractionally resampled Anderson-Rubin (FAR) tests

	<i>Unconditional</i>		<i>Conditional</i>	
	<i>Gini</i>	<i>Top10</i>	<i>Gini</i>	<i>Top10</i>
	(1)	(2)	(3)	(4)
AR (<i>p-value</i>) (1)	0.000	0.000	0.000	0.000
FAR(<i>p-value</i>) (2)	0.001	0.000	0.001	0.000

Notes: The results are based on the IV estimates in Table 1, Columns (7) and (8), and Table 2, Columns (5) and (6). The full sample and resampled Anderson-Rubin (AR) *p-values* are presented in Rows (1) and (2), respectively. The null hypothesis is that income inequality has no significant effect on the income tax ratio.

Finally, we considered other potential control variables. We replaced urbanization with agricultural share (the ratio of agricultural output to GDP) as a measure of industrialization. We considered whether tax revenues were influenced by commodity prices by including the mining-to-GDP ratio as a regressor. We also considered the vote share of left-wing parties.⁵ Finally, we also added the dependency ratio (defined alternatively as the ratio of the population younger than 15 years, *Young*, or older than 64 years, *Old*, to the working-age population aged 15-64 years). We find that these variables are not robust determinants of the income tax ratio. However, our central result regarding inequality is unaffected regardless of these alternate specifications. As an additional test we also considered the impact of wars. Wars impact the size of government (Beetsma et al. 2016). We explored whether our results are driven by the decreasing tax rates in the immediate post-war periods because the military expenses declined substantially and took the pressure of budgets. To explore this we include a variable for the war effort, measured as military expenditure to GDP. We also include a *lagged* interaction

⁵ We have 1949 observations when we include the left-wing vote share, compared to 2439 observations when this variable is excluded.

between tax rates and war effort. Our results remain robust. All these additional results are available from the authors.

5.3 Indirect taxes and the tax mix

If rising inequality makes it difficult for politicians to increase the income tax ratio, they may be tempted to switch to indirect taxes. Hence, our final investigation involves assessing the impact of inequality on indirect taxes and the tax mix. Panel (a) of Table 7 reports that inequality also depresses the indirect tax ratio. At first blush, this result may appear unexpected. If inequality reduces the income tax ratio, governments may expand indirect taxes or alter the tax mix in favor of less ‘visible’ taxes. However, many of the same factors – such as resistance to redistributive policies and tax resistance and tax evasion - that affect income taxes may also operate with regard to other taxes. Our results suggest inequality restricts substitution between alternate taxes. However, the effect on different types of taxes could vary. For example, tax resistance and opportunities for tax evasion might be greater for direct taxes than indirect taxes. To explore this, we focus on the tax mix, calculated as the ratio of direct to indirect taxes. These results are presented in panel (b) of Table 7. Inequality has a negative effect on the tax mix though this is weakly significant in the IV and GMM estimates. These results indicate that even though inequality reduces both the income and indirect tax ratios, it has a relatively larger effect on income taxes. Consequently, the ratio of direct to indirect taxes falls. This could arise, if for example, there is greater resistance to changing direct taxes and politicians find it relatively easier to alter indirect taxes.

Table 7: Inequality and indirect taxes, conditional estimates, 21 OECD countries, 1870-2011

	IV- 2SLS Union, <i>Gini</i> (1)	IV-2SLS Union, <i>Top10</i> (2)	5-year lag, OLS, <i>Gini</i> (3)	5-year lag, OLS, <i>Top10</i> (4)	10-year lag, OLS, <i>Gini</i> (5)	10-year lag, OLS, <i>Top10</i> (6)	10-year System GMM, <i>Gini</i> (7)	10-year System GMM, <i>Top10</i> (8)
<i>(a) Indirect taxes</i>								
$Taxin_{i,t-1}$	0.91*** (0.03)	0.89*** (0.03)	0.69*** (0.05)	0.66*** (0.05)	0.34*** (0.06)	0.30*** (0.06)	0.65*** (0.05)	0.63*** (0.05)
$Ineq_{it}$	-0.16*** (0.06)	-0.09*** (0.03)	-0.03*** (0.01)	-0.16*** (0.03)	-0.04** (0.01)	-0.26*** (0.03)	-0.07* (0.04)	-0.10* (0.06)
<i>(b) Tax mix (direct-to-indirect taxes)</i>								
$Taxm_{i,t-1}$	0.76*** (0.08)	0.77*** (0.08)	0.23*** (0.06)	0.24*** (0.06)	0.08** (0.03)	0.08** (0.03)	0.23** (0.12)	0.34*** (0.12)
$Ineq_{it}$	-0.02* (0.01)	-0.01* (0.01)	-0.02*** (0.00)	-0.02*** (0.00)	-0.02*** (0.00)	-0.03*** (0.00)	-0.01* (0.01)	-0.04* (0.02)

Notes: Table reports second stage regression results. $Taxin$ indicates indirect tax-GDP ratio, $Taxm$ indicates tax mix. Inequality, $Taxin$ and $Taxm$ are lagged 5 years in columns (3) and (4) and 10 years in columns (5) and (6), respectively. The full set of controls and country and time fixed effects are included but not reported; see Appendix Tables A2 and A3. Parentheses report robust standard errors. *, ** and *** denote 10%, 5% and 1% significance levels, respectively. See also notes to Table 1.

6. Summary and Discussion

Using data spanning nearly 150 years, we show that rising income inequality is associated with a declining income tax ratio in OECD economies. The magnitude of the effect is economically significant. For example, taking the results from Table 3, where all control variables are lagged 10 years, the coefficient on inequality translates into a long-run elasticity of the income tax ratio with respect to *Gini* of -0.50. The comparable estimated elasticity with respect to the income share of the *Top10* is -1.06.

The income tax ratio has historically increased throughout the OECD. Various explanations have been advanced for this phenomenon, *e.g.*, widening of electoral franchise, interest group rent seeking, and revenue maximizing bureaucrats. Our results suggest that another reason for the historical growth in the tax rate was the long term decline in market inequality, particularly between 1915 and 1980. Conversely, increasing inequality post-1980 has put downward pressure on the tax ratio, as evidenced also by declining income tax progressivity and reduced importance of income tax relative to total tax revenues (see, for example, Roine *et al.*, 2009).

Several implications follow that suggest avenues for further investigation. Our focus has been purely on taxes and we have thus abstained from scrutiny of expenditure. The tax ratio is one measure of government size and our findings imply that rising inequality may limit the size of governments; at least as far as income tax revenues are concerned. As argued by Brennan and Buchanan (2000), the power to tax does not imply any particular spending. Accordingly, a useful extension would be to compare the long run impact of inequality on total government expenditure and the composition of spending. Another consideration is that when inequality restraints the tax ratio, it adds pressure on budgets. One solution may be to increase debt; thus, inequality may very well lead to a preference to transfer fiscal burden onto future generations. Azzimonti *et al.* (2014) link public debt to growing inequality and financial globalization, but their channel is through uninsurable idiosyncratic risk. Our results suggest another, potentially reinforcing mechanism working through the tax ratio.

Our results also have implications regarding the impact of inequality on growth. One hypothesized channel through which inequality is said to impact growth is through fiscal policy. For example, Alesina and Rodrik (1994) argue that inequality leads to greater demand for redistribution and when redistribution is financed through distortionary taxes, inequality will depress growth. Our finding that inequality reduces distortionary income taxes casts doubts about the importance of this channel, at least for the OECD economies,

Finally, another implication of our findings relates to Piketty's (2014) argument that lower taxes aggravate inequality because higher income earners have stronger incentives to push for higher pre-tax income. Therefore, our finding that pre-tax inequality reduces the income tax ratio, suggests that rising pre-tax income inequality may also aggravate post-tax income inequality. Moreover, if tax affects market inequality through supply decisions, then there is positive feedback effect; rising inequality reduces taxes which then increases inequality further.

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APPENDIX

Table A1: Summary statistics of key variables (21 OECD countries, 1870-2011)

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
Market Gini Coefficient (<i>Gini</i>)	2982	47.21	9.69	22.51	85.28
Top 10 percent income share (<i>Top10</i>)	2982	34.36	7.70	17.52	65.83
Union membership rate (<i>Union</i>)	2982	18.53	17.05	0.00	75.65
Ratio of income tax revenue to GDP (<i>Tax</i>)	2601	7.68	6.39	0.00	31.30
Agricultural share of GDP (<i>Agr</i>)	2982	17.94	16.06	0.56	88.29
Openness (<i>Op</i>)	2982	18.03	10.80	0.03	82.74
Urbanization (<i>Urb</i>)	2764	23.17	15.06	1.52	93.43
Log of real GDP per capita (<i>lnGdpc</i>)	2982	8.58	0.89	6.60	10.36
Democracy (<i>Polity</i>)	2868	6.59	5.58	-9.00	10.00
Family farms area as a % of total area of holdings (<i>Family</i>)	2982	53.65	23.53	0.00	98.00
Literates as a % of adult population (<i>Literacy</i>)	2982	86.04	19.99	10.84	100.00
Young age dependency ratio (<i>Young</i>)	2982	44.14	12.45	20.46	77.70
Old age dependency ratio (<i>Old</i>)	2982	13.88	5.86	2.23	36.23

Table A2: Inequality and indirect taxes, conditional estimates, 21 OECD countries, 1870-2011

	IV- 2SLS Union, <i>Gini</i> (1)	IV-2SLS Union, <i>Top10</i> (2)	5-year lag, OLS, <i>Gini</i> (3)	5-year lag, OLS, <i>Top10</i> (4)	10-year lag, OLS, <i>Gini</i> (5)	10-year lag, OLS, <i>Top10</i> (6)	10-year System GMM, <i>Gini</i> (7)	10-year System GMM, <i>Top10</i> (8)
<i>Taxin_{i,t-1}</i>	0.91*** (0.03)	0.89*** (0.03)	0.69*** (0.05)	0.66*** (0.05)	0.34*** (0.06)	0.30*** (0.06)	0.65*** (0.05)	0.63*** (0.05)
<i>Ineq_{it}</i>	-0.16*** (0.06)	-0.09*** (0.03)	-0.03*** (0.01)	-0.16*** (0.03)	-0.04** (0.01)	-0.26*** (0.03)	-0.07* (0.04)	-0.10* (0.06)
<i>Op_{it}</i>	0.01 (0.01)	0.01 (0.01)	0.02* (0.01)	0.02** (0.01)	0.04*** (0.01)	0.06*** (0.01)	-0.04 (0.05)	-0.03 (0.04)
<i>Urb_{it}</i>	0.01 (0.01)	-0.01 (0.01)	-0.06*** (0.02)	-0.06*** (0.02)	-0.11*** (0.02)	-0.11*** (0.02)	-0.02 (0.05)	-0.03 (0.05)
<i>lnGdpc_{it}</i>	-1.14** (0.52)	-0.80* (0.41)	-0.12 (0.27)	-0.52* (0.27)	1.21*** (0.27)	0.15 (0.28)	0.33 (0.62)	0.11 (0.70)
<i>Polity_{it}</i>	-0.02 (0.01)	0.01 (0.01)	0.01 (0.01)	-0.01 (0.01)	-0.03* (0.02)	-0.03 (0.02)	-0.07 (0.10)	-0.04 (0.09)
<i>R</i> ²	0.81	0.83	0.90	0.90	0.84	0.85		
<i>First Stage Regressions</i>								
<i>Union_{it}</i>	-0.11*** (0.01)	-0.20*** (0.01)						
F-statistic	65.22	645.07						
Endg (<i>p-val</i>)	0.00	0.00						
Hansen (<i>p</i>)							0.58	0.52
AR (2) (<i>p</i>)							0.35	0.34
Observation	2580	2580	2507	2507	2417	2417	253	253

Notes: Dependent variable is the indirect tax-GDP ratio (*Taxin*). *Gini* denotes market Gini. *Top10* is the income share of the top 10%. Columns (1) and (2) use unionization as an IV. Columns (3) to (6) estimated using OLS. Inequality and indirect tax are lagged 5 years in columns (3) and (4) and 10 years in columns (5) and (6), respectively. System GMM model is estimated in 10-year intervals (N=21; T=15); 2nd lag of explanatory variables is used as internal instruments. All regressions include time and country fixed effects. The numbers in parentheses are robust standard errors. *, ** and *** denote 10%, 5% and 1% significance levels, respectively. See also notes to Tables 1 and 2.

Table A3: Inequality and tax mix, conditional estimates, 21 OECD countries, 1870-2011

	IV- 2SLS Union, <i>Gini</i> (1)	IV-2SLS Union, <i>Top10</i> (2)	5-year lag, OLS, <i>Gini</i> (3)	5-year lag, OLS, <i>Top10</i> (4)	10-year lag, OLS, <i>Gini</i> (5)	10-year lag, OLS, <i>Top10</i> (6)	10-year System GMM, <i>Gini</i> (7)	10-year System GMM, <i>Top10</i> (8)
$Taxm_{i,t-1}$	0.76*** (0.08)	0.77*** (0.08)	0.23*** (0.06)	0.24*** (0.06)	0.08** (0.03)	0.08** (0.03)	0.23** (0.12)	0.34*** (0.12)
$Ineq_{it}$	-0.02* (0.01)	-0.01* (0.01)	-0.02*** (0.00)	-0.02*** (0.00)	-0.02*** (0.00)	-0.03*** (0.00)	-0.01* (0.01)	-0.04* (0.02)
Op_{it}	0.01 (0.00)	0.01 (0.00)	0.02** (0.01)	0.02** (0.01)	0.02*** (0.01)	0.02*** (0.01)	0.02* (0.01)	0.02 (0.01)
Urb_{it}	0.01** (0.00)	0.01* (0.00)	0.01*** (0.00)	0.01** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01 (0.01)	0.01 (0.01)
$lnGdpc_{it}$	-0.06 (0.06)	-0.02 (0.07)	-0.15 (0.11)	-0.11 (0.11)	-0.20* (0.12)	-0.14 (0.11)	0.09 (0.14)	-0.07 (0.15)
$Polity_{it}$	-0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.01)	0.01 (0.01)
R^2	0.62	0.62	0.49	0.49	0.47	0.47		
<i>First Stage Regressions</i>								
$Union_{it}$	-0.12*** (0.01)	-0.20*** (0.01)						
F-statistic	73.30	617.18						
Hansen (p)							0.63	0.79
AR (2) (p)							0.39	0.38
Observation	2436	2436	2363	2363	2273	2273	238	238

Notes: Dependent variable is the tax mix measured as the ratio of income tax to indirect tax revenue ($Taxm$). *Gini* denotes market Gini. *Top10* is the income share of the top 10%. Columns (1) and (2) use unionization as an IV. Columns (3) to (6) estimated using OLS. Inequality and indirect tax are lagged 5 years in columns (3) and (4) and 10 years in columns (5) and (6), respectively. System GMM model is estimated in 10-year intervals (N=21; T=15); 2nd lag of explanatory variables is used as internal instruments. All regressions include time and country fixed effects. The numbers in parentheses are robust standard errors. *, ** and *** denote 10%, 5% and 1% significance levels, respectively. See also notes to Tables 1 and 2.

DATA APPENDIX:

This appendix details the construction of the data.

Country List

The 21 high income OECD sample countries consist of Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Definitions

Inequality (<i>Gini</i> and <i>Top10</i>)	Gini coefficient and top 10 percent income share
Unionization (<i>Union</i>)	Trade union membership divided by economy-wide employment
Income tax ratio (<i>Tax</i>)	Income tax revenues divided by GDP
Agricultural share (<i>Agr</i>)	Agricultural GDP divided by total GDP
Openness (<i>Op</i>)	Imports divided by GDP
Urbanization (<i>Urb</i>)	Cities of 100,000 divided by the size of the population.
GDP per capita (<i>Gdpc</i>)	Real GDP divided by population.
Democracy (<i>Polity</i>)	Revised combined Polity 2 score.
Family farms (<i>Family</i>)	Family farms area divided by total cultivated area or total area of holdings.
Literacy (<i>Literacy</i>)	Literate population divided by adult population
Young age dependency ratio (<i>Young</i>)	The ratio of the population younger than 15 years to the working-age population aged 15-64 years.
Old age dependency ratio (<i>Old</i>)	The ratio of the population older than 64 years to the working-age population aged 15-64 years.

Data sources

1 Market Gini Coefficient (Gini)

Australia, 1870-1959 & 2011, spliced with the inverse of the labour share; 1960-2010, Market Gini, Solt, F. (2009), "Standardizing the World Income Inequality Database." *Social Science Quarterly*, 90(2): 231-242. SWIID Version 4.0, September 2013, Accessed on 20/06/2014 (<http://myweb.uiowa.edu/fsolt/swiid/swiid.html>); **Austria**, 1870-1927 & 1965-1969, spliced with the inverse of the labour share; 1928-1964, Flora, P., Kraus, F., and Pfenning, W. (1987), "State, Economy, and Society in Western Europe 1815-1975. A Data Handbook in Two Volumes. Vol. 2: The Growth of Industrial Societies and Capitalist Economies. Frankfurt am Main, Germany: Campus Verlag; Chicago, IL: St. James Press; 1970-1982, Gini, UNU-WIDER World Income Inequality Database, Version 2.0c, May 2008, Accessed on 20/06/2014 (http://www.wider.unu.edu/research/Database/en_GB/wiid/); 1983-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Belgium**, 1870-1978, spliced with the inverse of the labour share; 1979-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Canada**, 1870-1959, spliced with the inverse of the labour share; 1960-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Denmark**, 1870-1919, spliced with the inverse of the labour share; 1920-1960, Flora *et al.* (1987), *op. cit.*; 1961-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Finland**, 1870-1921, spliced with the inverse of the labour share; 1922-1959, Flora *et al.* (1987), *op. cit.*; 1960-2011, Market Gini, Solt, F. (2009), *op. cit.*; **France**, 1870-1959, spliced with the inverse of the labour share; 1960-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Germany**, 1870-1954, spliced with the inverse of the labour share; 1955-1959, Flora *et al.* (1987), *op. cit.*; 1960-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Greece**, 1870-1973, spliced with the inverse of the labour share; 1974-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Ireland**, 1870-1972, spliced with the inverse of the labour share; 1973-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Italy**, 1870-1966, Brandolini, A. and Vecchi, G. (2011), "The Well-Being of Italians: A Comparative Historical Approach", Paper presented at the conference, Italy and the World Economy, 1861-2011, Rome, Banca d'Italia 12-15 October 2011; 1967-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Japan**, 1870-1959 & 2011, spliced with the inverse of the labour share; 1960-2010, Market Gini, Solt, F. (2009), *op. cit.*; **Netherlands**, 1870-1945, spliced with the inverse of the labour share; 1946-1961, Flora *et al.* (1987), *op. cit.*; 1962-2011, Market Gini, Solt, F. (2009), *op. cit.*; **New Zealand**, 1870-1959, spliced with the inverse of the labour share; 1960-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Norway**, 1870-1890, spliced with the inverse of the labour share; 1891-1959, Flora *et al.* (1987), *op. cit.*; 1960-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Portugal**, 1870-1967, spliced with the inverse of the labour share; 1968-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Spain**, 1870-1964, spliced with the inverse of the labour share; 1965-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Sweden**, 1870-1919, spliced with the inverse of the labour share; 1920-1959, Flora *et al.* (1987), *op. cit.*; 1960-2011, Market Gini, Solt, F. (2009), *op. cit.*; **Switzerland**, 1870-1948, spliced with the inverse of the labour share; 1949-1960, Flora *et al.* (1987), *op. cit.*; 1961-2011, Market Gini, Solt, F. (2009), *op. cit.*; **UK**, 1870-1937, spliced with the inverse of the labour share; 1938-1959, Flora *et al.* (1987), *op. cit.*; 1960-2011, Market Gini, Solt, F. (2009), *op. cit.*; **USA**, 1870-1959, spliced with the inverse of the labour share; 1960-2011, Market Gini, Solt, F. (2009), *op. cit.*

2 Income Share of Top 10% (Top 10)

Australia, 1870-1940 & 2011, spliced with the inverse of the labour share; 1941-2010, Top 10% income share, Alvaredo, F., Atkinson, A. B., Piketty, T. and Saez, E. "The World Wealth and Income Database," Accessed on 20/06/2014 (<http://topincomes.g-mond.parisschoolofeconomics.eu/>); **Austria**, 1870-1927, spliced with the inverse of the labour share; 1928-1975, Flora, P., Kraus, F., and Pfenning, W. (1987), "State, Economy, and Society in Western Europe 1815-1975. A Data Handbook in Two Volumes. Vol. 2: The Growth of Industrial Societies and Capitalist Economies. Frankfurt am Main, Germany: Campus Verlag; Chicago, IL: St. James Press; 1976-1982, Gini, UNU-WIDER World Income Inequality Database, Version 2.0c, May 2008, Accessed on 20/06/2014 (http://www.wider.unu.edu/research/Database/en_GB/wiid/); 1983-1994, Top 10% income share, UNU-WIDER World Income Inequality Database, *op. cit.*; 1995-2011, Top 10% income share, Income distribution, Eurostat Database, Accessed on 20/06/2014 (http://epp.eurostat.ec.europa.eu/portal/page/portal/income_social_inclusion_living_conditions/data/database); **Belgium**, 1870-1968, spliced with the inverse of the labour share; 1969-1994, Top 10% income share, UNU-WIDER World Income Inequality Database, *op. cit.*; 1995-2011, Top 10% income share, Eurostat Database, *op. cit.*; **Canada**, 1870-1940 & 2011, spliced with the inverse of the labour share; 1941-2000, Top 10% income share, Alvaredo *et al.*, *op. cit.*; 2001-2010, Top 10% income share (LAD), Alvaredo *et al.*, *op. cit.*; **Denmark**, 1870-2010, Top 10% income share, Atkinson, A. B. and Sogaard, J. E. (2013), "The Long Run History of Income Inequality in Denmark: Top Incomes from 1870 to 2010", EPRU working paper series 2013/1, University of Copenhagen, Denmark; 2011, Top 10% income share, Eurostat Database, *op. cit.*; **Finland**, 1870-1921, spliced

with the inverse of the labour share; 1922-1959, Flora *et al.* (1987), *op. cit.*; 1960-1994, Top 10% income share, UNU-WIDER World Income Inequality Database, *op. cit.*; 1995-2011, Top 10% income share, Eurostat Database, *op. cit.*; **France**, 1870-1904, spliced with the inverse of the labour share; 1905-2009, Top 10% income share, Alvaredo *et al.*, *op. cit.*; 2010-2011, Top 10% income share, Eurostat Database, *op. cit.*; **Germany**, 1870-1873, spliced with the inverse of the labour share; 1874-1890, Flora *et al.* (1987), *op. cit.*; 1891-1998, Top 10% income share, Alvaredo *et al.*, *op. cit.*; 1999-2011, Top 10% income share, Eurostat Database, *op. cit.*; **Greece**, 1870-1959, spliced with the inverse of the labour share; 1960-1994, Top 10% income share, UNU-WIDER World Income Inequality Database, *op. cit.*; 1995-2011, Top 10% income share, Eurostat Database, *op. cit.*; **Ireland**, 1870-1937, spliced with the inverse of the labour share; 1938-2009, Top 10% income share, Alvaredo *et al.*, *op. cit.*; 2010-2011, Top 10% income share, Eurostat Database, *op. cit.*; **Italy**, 1870-1959, spliced with the inverse of the labour share; 1960-1973, Top 10% income share, UNU-WIDER World Income Inequality Database, *op. cit.*; 1974-2009, Top 10% income share, Alvaredo *et al.*, *op. cit.*; 2010-2011, Top 10% income share, Eurostat Database, *op. cit.*; **Japan**, 1870-1946 & 2011, spliced with the inverse of the labour share; 1947-2010, Top 10% income share, Alvaredo *et al.*, *op. cit.*; **Netherlands**, 1870-1913, spliced with the inverse of the labour share; 1914-2011, Top 10% income share, Alvaredo *et al.*, *op. cit.*; **New Zealand**, 1870-1923 & 2011, spliced with the inverse of the labour share; 1924-1952, Top 10% income share-married couples & single adults, Alvaredo *et al.*, *op. cit.*; 1953-2010, Top 10% income share-adults, Alvaredo *et al.*, *op. cit.*; **Norway**, 1870-1890, spliced with the inverse of the labour share; 1891-1947, Flora *et al.* (1987), *op. cit.*; 1948-2011, Top 10% income share, Alvaredo *et al.*, *op. cit.*; **Portugal**, 1870-1975, spliced with the inverse of the labour share; 1976-2005, Top 10% income share, Alvaredo *et al.*, *op. cit.*; 2006-2011, Top 10% income share, Eurostat Database, *op. cit.*; **Spain**, 1870-1964, spliced with the inverse of the labour share; 1965-1980, Top 10% income share, UNU-WIDER World Income Inequality Database, *op. cit.*; 1981-2010, Top 10% income share, Alvaredo *et al.*, *op. cit.*; 2011, Top 10% income share, Eurostat Database, *op. cit.*; **Sweden**, 1870-1902, spliced with the inverse of the labour share; 1903-2011, Top 10% income share, Alvaredo *et al.*, *op. cit.*; **Switzerland**, 1870-1932, spliced with the inverse of the labour share; 1933-2009, Top 10% income share, Alvaredo *et al.*, *op. cit.*; 2010-2011, Top 10% income share, Eurostat Database, *op. cit.*; **UK**, 1870-1917, spliced with the inverse of the labour share; 1918-1989, Top 10% income share-married couples & single adults, Alvaredo *et al.*, *op. cit.*; 1990-2011, Top 10% income share-adults, Alvaredo *et al.*, *op. cit.*; **USA**, 1870-1916, spliced with the inverse of the labour share; 1917-2011, Top 10% income share, Alvaredo *et al.*, *op. cit.*

Labour's income share

Calculated as the economy-wide compensation to employees plus imputed compensation to self-employed divided by nominal GDP. The imputed compensation to employees is computed as the number of self-employed multiplied by economy-wide compensation to employees divided by economy-wide employment. The output elasticities of inputs are computed from the average factor shares using data up to 2002. The following starting dates are used (in parentheses): Canada (1926), USA, (1899), Japan (1906), Australia (1870), Denmark (1900), Finland (1870), France (1920), Germany (1870), Italy (1950), Netherlands (1870), Norway (1930), Sweden (1870), and UK (1870). OECD *National Accounts* are used for the post 1950 data.

Compensation to employees

Canada: F. H. Leacy (ed.), 1983, *Historical Statistics of Canada*, Statistics Canada: Ottawa. **USA.** T. Liesner, *One Hundred Years of Economic Statistics*, The Economist: Oxford. **Japan.** K. Ohkawa, M. Shinchara and L. Meissner, 1979, *Patterns of Japanese Economic Development: A Quantitative Appraisal*, Yale University Press: New Haven. **Australia.** Withers, G., Endres, T. and Perry, L. (1985), 'Australian Historical Statistics: Labour Statistics,' Australian National University, Source Papers in Economic History, No 7. **Denmark.** H C Johansen, 1985, *Dansk Historisk Statistik, 1814-1980*, København: Gyldendal. **Finland.** Table 12A, Hjerpe, R. (1989), *op. cit.* **France.** Table F.4, Liesner, T. (1989), *op. cit.* Include the non-agricultural sector. **Germany.** Table 122, W. G. Hoffmann, F. Grumbach, and H. Hesse, 1965, *Das Wachstum der Deutschen Wirtschaft seit der mitte des 19. Jahrhunderts*, Springer-Verlag: Berlin. **Netherlands.** Central Bureau voor de Statistiek, 2001, *Tweehondred Jaar Statistiek in Tjdsrekenen, 1800-1999*, Centraal Bureau voor de Statistiek, Voorburg. **Norway.** Nasjonalregnskap 1865-1960, Statistisk Sentralbyrå Oslo 1968. **Sweden.** Jungenfelt, K.G. (1966), *Lonandelen och den Ekonomiska Utvecklingen*, Almquist & Wiksell, Stockholm. **UK.** Table 1, Feinstein, C.H. (1976), *Statistical Tables of National Income, Expenditure and Output of the UK 1855-1965*, Cambridge University Press, Cambridge. Include all sectors in the economy.

Total employment

After 1950. *LFS*. Before 1950 the following sources are used. **Canada**. 1921-1959. F.H. Leacy (ed.), 1983, *op. cit.* 1913. A. Maddison, 1991, *Dynamic Forces in Capitalist Development*, Oxford University Press: Oxford. **US**. 1900- 1949. T. Liesner, *Op. Cit.* **Japan**. K. Ohkawa, M. Shinohara, and L. Meissner, 1979, *op. cit.* **Australia**. M. W. Butlin, 1977, *A Preliminary Annual Database 1900/01 to 1973/74*, Research Discussion Paper 7701, Reserve Bank of Australia: Sydney. **Denmark**. 1870-1949. S A Hansen, *Økonomisk Vækst I Danmark*, Akademisk Forlag: København. **France**. ILO, *Yearbook of Labour Statistics* and C. Clark, 1957, *The Conditions of Economic Progress*, Macmillan: London. **Germany**. 1900-1914, 1924-1940, and 1949. Hoffmann *et al.* (1965) *op cit.* **Italy**. Clark, 1957, *op. Cit.* **Netherlands**. 1800-1913: J.-P. Smits, E. Horlings, and J. L. van Zanden, 2000, *Dutch GNP and its Components, 1800-1913*, Groningen, <http://www.eco.rug.nl/ggdc/PUB/dutchgnp.pdf>. The general investment deflator is used for separate items. 1913-60: Central Bureau voor de Statistiek, 2001, *op cit.* **Sweden**. O. Johansson, 1967, *The Gross Domestic Product of Sweden and its Composition 1861-1955*, Almqvist and Wiksell: Stockholm. **UK**. Clark, 1957, *Op. Cit.*

Economy-wide nominal GDP

After 1950. OECD, *National Accounts*, Vol. II, Paris. Before 1960 the following sources are used. Real GDP multiplied by GDP-deflators from the following sources. **Canada**. M C Urquhart, 1988, "Canadian Economic Growth 1870-1980," Queens University Discussion Paper No 734. **USA**. 1870-1929: N. S. Balke and R. J. Gordon, 1986, *The American Business Cycle: Continuity and Change*, Chicago: University of Chicago Press. 1929-1960 Survey of Current Business August 1998: "GDP and Other Major NIPA Series 1927-97". **Japan**. K. Ohkawa *et al.*, 1979, *op cit.* **Australia**. 1863-1939. W. Vamplew, 1987, *Australian Historical Statistics*, Broadway, N.S.W: Fairfax, Syme & Weldon Associates. 1940-1960. Liesner, *op. Cit.* **Denmark**. S. A. Hansen, 1976, *op. cit.* **France**. P Villa, 1993, *Une Analyse Macroéconomique De La France Au XX^e Siècle*, Paris: CNRS Editions, and M Lévy-Leboyer and F Bourguignon, 1985, *The French Economy in the Nineteenth Century*, Cambridge: Cambridge University Press. **Germany**. T Liesner, 1989, *op. cit.* and interpolated using CPI and real GDP over the periods 1914-1924 and 1939-1949. **Italy**. C. Bardini, A. Carreras, and P. Lains, 1995, "The National Accounts for Italy, Spain and Portugal," *Scandinavian Economic History Review* XLII, 115-146. **Netherlands**. Central Bureau voor de Statistiek, 2001, *op cit.* **Sweden**. O Johansson, 1967, *op. cit.* **UK**. C. H. Feinstein, 1976, *Statistical tables of national income, expenditure and output of the U.K. 1855-1965*, Cambridge: Cambridge University Press.

3 Unionization

Trade Union membership

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