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Inequality and Growth in the 21st Century

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Abstract

This paper distinguishes between income inequality induced by differences in labor productivity and induced by differences in capital income. Persson and Tabellini (1994) argue that productivity-induced income inequality leads to lower growth since distortionary taxes increase and harm capital accumulation. However, if income inequality stems from differences in capital income, then labor tax rates fall, leading to higher growth. Using OECD data, increased capital income inequality (proxied by the top 1% income share) has a significant positive relationship with subsequent economic growth. Controlling for capital income inequality yields a negative relationship between labor income inequality and growth, as originally conjectured.

Keywords: capital income, inequality, growth

JEL: D31, E62, O40

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Is inequality necessarily harmful for growth? Political economy models in the early nineties, as articulated by Persson and Tabellini (1994),[1] formalize an attractive prediction: a more unequal distribution of income implies divergence between mean and median income and so, under universal suffrage, raises redistribution. Such redistributive policies are financed by distortionary taxes, in principle affecting investment and growth-promoting activities.

A substantial amount of evidence has attempted to test the impact of inequality on growth, but the literature has not provided a satisfactory conclusion so far. For example, earlier cross-country OLS studies (e.g. see Alesina and Rodrik, 1994; Persson and Tabellini, 1994; Perotti, 1996; and Deininger and Squire, 1998) all find negative consequence of higher inequality for economic performance. However, with the appearance of inequality data set compiled in Deininger and Squire (1996), panel data models start to challenge the negative effect of inequality on growth found in cross-country regressions. Barro (2000) finds little overall link between income inequality and economic growth in a panel of countries, reporting a negative effect in poor countries and a positive effect in rich countries. Perhaps the most surprising result is Forbes (2000). By controlling for country-specific effects and period effects, she finds that in the short and medium-term, an increase in the level of income inequality in a country has a positive and significant relationship with subsequent growth rates.[2]

In response to this puzzle, new theoretical literature has proposed mechanisms through which greater levels of income inequality can promote economic growth. For instance, Galor and Moav (2004) study the effect of inequality on growth along the process of development. In the early stages of development, when physical capital accumulation is the prime engine of

[1] Alesina and Rodrik (1994) and Bertola (1993) also provide similar anecdotes.

[2] Li and Zou (1998) also find the positive link by using an improved data set on income inequality again compiled in Deininger and Squire (1996). More recent empirical work is that of Frank (2009), who, estimating a dynamic panel data model but using regional data from different U.S. states, provides evidence that the long-run relationship between inequality and growth in the United States is positive and in principle driven by the upper end of the income distribution.

growth, inequality stimulates growth as it channels resources towards individuals with more incentive to save. The positive effect of inequality on growth is reversed when human capital accumulation instead of physical capital is the primary engine for growth, where equality alleviates human capital accumulation and therefore stimulates growth.[3]

The mechanism analyzed in this paper instead revisits Persson and Tabellini (1994) more closely. In their model, labor is the only source of income and the rich have higher income by dint of higher individual-specific skills (productivity, in other words). However, labor is not the only source of income for the rich and moreover, the labor share of income has declined in recent years (see Azmat et al., 2012; Karabarbounis and Neiman, 2013). Indeed, Piketty (2014) relates rising inequality to the falling labor share: if the rate of return on capital is greater than the rate of economic growth, then the share of capital rises, and if ownership is concentrated within a small number of groups, then inequality inexorably increases. Further, capital income has recently become more unequal as well as more important. Kaymak and Poschke (2016) document considerable increases in the concentration of wealth in the U.S. over the past 50 years. Luo et al. (2017), building upon Meltzer and Richard (1981), link rising capital income inequality to declining redistribution: if inequality increases such that the share of capital income going to the top capital-income recipients increases, then the preferred tax rate falls because the (capital) rich are supplying less taxable labor income and hence the capacity of the median voter to redistribute is reduced.

Hence this paper instead asks how inequality stemming from capital income affects economic growth. Individuals differ in their capital endowment, with a right skewed capital income

[3]Moreover, Foellmi and Zweimuller (2006) study an innovation-based growth model and identity that an increasing unequal distribution of income affects the incentive to innovate through a price effect, where greater inequality allows innovators to charge higher prices, and a market-size effect, with an opposite direction. It turns out that the price effect always dominates the market-size effect, and thus increased inequality simulates growth.

distribution. The majority of individuals are endowed with limited (or zero) assets or wealth and so are compelled to supply labor for their income, which is taxed. In contrast, if capital income is not taxed then the capital-rich are relatively less exposed to taxation. The stock of aggregate capital is accumulated as average productivity of all individuals increases. In direct contrast to Persson and Tabellini (1994), the key result is that increased inequality in capital income leads higher economic growth. When income differences are driven by capital income, the capacity of the median voter to redistribute through the tax system is reduced because the capital-rich supply less (taxable) labor. Such redistributive policies are financed by distortionary taxes, in principle, affecting capital accumulation and growth-promoting activities. If capital income inequality increases such that the preferred labor income tax rate falls as the (capital-poor) median voter cannot effectuate redistribution, then the subsequent rate of economic growth increases because smaller size of redistributive policies are financed by less distortionary taxes.

The relationship between inequality and growth is investigated empirically using a panel of nineteen OCED countries, augmenting the analysis of Forbes (2000) to include a measure of capital income inequality as an additional explanatory variable. Direct measures of capital income inequality are not widely available. In the empirical work this is proxied by the top 1% total income share, taken from the World Wealth and Income Database (WID).[4] Empirical justification for this proxy is also from the WID, wherein non-wage (i.e. capital) income data for the top 1% and the top 10% for Australia, Canada, France and the United States are available. I posit that the higher the ratio of the share of non-wage income going to the top 1% relative to the top 10% the more unequal the distribution of capital income. Figure 1 plots this measure of capital income inequality with the top 1% income share for

[4]The 0.1% income share could alternatively be used, though the results are very similar since the correlation between the 0.1% and 1% income shares is around 0.98.

these countries, showing a strong correspondence and giving some credence to using the latter to proxy for the former for the wider sample of countries.

The empirical analysis below also separately includes specific measures of productivity-induced labor income inequality as distinct from capital income inequality. As discussed below the two measures are empirically as well as conceptually distinct from one another. Consistent with the theory proposed, an increase in capital income inequality has a positive and significant relationship with subsequent economic growth. A one standard deviation increase in capital income inequality is statistically correlated with a 0.9% increase in average annual growth over the next five years. The positive relationship holds up when different sample sets or omitted variables are considered, and also when difference and system generalized method of moments technique is used to deal with potential endogenous problem. I also find that once capital income inequality is controlled for, then the impact of labor income inequality becomes negative, consistent with Persson and Tabellini (1994) and in contrast to the empirical work using panel technique to test their hypothesis.

The next section theoretically analyzes how the rate of growth changes with capital income inequality. Section 2 contains the empirical work, and section 3 concludes.

1 The Model

This model revisits Persson and Tabellini (1994) to include labor income taxation instead of wealth taxation. I study an overlapping generations model with constant population, where individuals live for two periods. Individuals born in period t, indexed by i, have preferences defined over consumption when young c^i, leisure when young l^i, and consumption when old d^i, represented by a strictly concave, continuous, twice-differentiable utility function

$v_t^i = U(c_t^i, l_t^i, d_{t+1}^i)$. Consumption and leisure are both normal goods. Following the original, I first analyze the equilibrium behavior conditional on a given tax policy and then address the tax policy choice itself.

1.1 Economic Environment

Income may be derived from both labor and capital, and the stock of asset, k, accumulated on average by the previous generation has a positive externality on the income of the newborn generation as in Persson and Tabellini (1994). All individuals possess a unit of time to allocate to labor n^i, or leisure $l^i = 1 - n^i$. Individual labor income $y_t^i = n^i e^i k_t$ depends on productivity, e^i, as well as hours worked, and is taxed at a linear rate τ. Capital income varies exogenously across individuals and is denoted by $R^i k_t$. Following Meltzer and Richard (1981), consumption is also financed by lump-sum redistribution, r, common to all individuals, hence the budget constraints are:

$$c_t^i + k_{t+1}^i = (1 - \tau_t) n^i e^i k_t + r_t + R^i k_t \tag{1}$$

$$d_{t+1}^i = \gamma k_{t+1}^i \tag{2}$$

where k^i is the individual accumulation of asset, and γ is the exogenous rate of return on asset.[5] Individuals make decision between consumption and investment when young, financed by labor and capital income as well as lump-sum transfers, and benefit from the return on that investment when old. Note that the stock of aggregate capital is accumulated as average productivity of all individuals increases. With homothetic preferences, the ratio of consumption in the two periods is independent of wealth and labor income taxation,

[5] Throughout the paper I use superscripts to denote individual-specific variables and no superscripts to denote average variables.

$\frac{d^i_{t+1}}{c^i_t} = D$. Equivalently, every individual has the same "saving rate".

To clarify the argument, capital income is assumed to be untaxed. In practice it is often more difficult to raise taxes on capital than on labor. Capital is often highly mobile internationally, whilst labor is not, and given this Diamond and Mirrlees (1971) show that small open economies should not tax capital income. Indeed, international tax competition limits the democratic control over capital income taxation. Whilst in practice capital income taxation rates are positive, Gordon et al. (2004) observe lower average rates than for labor income in most countries. Moreover, the academic literature documents considerable difficulties with the collection of capital income taxation, primarily due to different types of capital income being taxed differentially (thereby, enabling arbitrage opportunities), and the fact that interest payments are tax-deductible. Indeed Gordon and Slemrod (1988), using US tax return data from 1983, estimated that the tax revenue loss from eliminating capital income taxation completely would be zero, hence that the tax burden on capital was effectively non-existent. It is an open question quite why the median voter would tolerate such a state of affairs, but conceivably the perceived deadweight and/or capital flight losses from increasing capital income taxation to some extent nullifies it as an instrument. Thus I focus on the choice of the labor income tax.

Each individual chooses labor supply so as to maximize:

$$v^i_t = U[\frac{\gamma}{\gamma + D}\big((1-\tau_t)n^i e^i k_t + r_t + R^i k_t\big), 1 - n^i, \frac{\gamma D}{\gamma + D}\big((1-\tau_t)n^i e^i k_t + r_t + R^i k_t\big)]. \quad (3)$$

The first-order condition is:

$$\frac{\gamma}{\gamma + D}(1-\tau_t)e^i k_t U_c - U_l + \frac{\gamma D}{\gamma + D}(1-\tau_t)e^i k_t U_d = 0 \quad (4)$$

which determines the labor supply, $n[(1-\tau_t)e^i, r_t, R^i]$, for those who wish to work.[6] Since leisure is a normal good, I have that

$$\frac{\partial n^i}{\partial R^i} = -\frac{\frac{\partial^2 v_t^i}{\partial n^i \partial R^i}}{\frac{\partial}{\partial n^i}(\frac{\partial v_t^i}{\partial n^i})} < 0 \tag{5}$$

given the assumption that v is strictly concave.[7] Similarly, since consumption is a normal good I have that:

$$\begin{aligned} \frac{\partial c_t^i}{\partial R^i} &= \frac{\gamma k_t}{\gamma + D}[1 + \frac{\partial n^i}{\partial R^i}(1-\tau_t)e^i], \\ &= \frac{\gamma k_t}{\gamma + D}\frac{\frac{\gamma}{\gamma+D}(1-\tau_t)e^i k_t U_{cl} + \frac{\gamma D}{\gamma+D}(1-\tau_t)e^i k_t U_{dl} - U_{ll}}{-\Delta} > 0, \end{aligned} \tag{6}$$

a condition which imposes additional restrictions on U_{cl} and U_{dl}. Hence, all else equal, people who are relatively capital-rich supply less labor and enjoy higher consumption.

There are two sources of heterogeneity that determine differences in before-tax labor income. Firstly productivity, as analyzed by Meltzer and Richard (1981), and secondly capital income endowments. At the individual level increases in productivity will all else equal increase labor

[6]Note again that k_t is given due to accumulation by the previous generation. Further, for simplicity (but without loss of generality) I henceforth assume that the joint distribution of e^i and R^i is such that $n^i > 0$ for all i, so that everyone supplies a strictly positive amount of market work.

[7]In detail, using (4), I have that

$$\begin{aligned} \frac{\partial n^i}{\partial R^i} &= \frac{\frac{\partial^2 v_t^i}{\partial n^i \partial R^i}}{-\frac{\partial}{\partial n^i}(\frac{\partial v_t^i}{\partial n^i})} \\ &= k_t\frac{(\frac{\gamma}{\gamma+D})^2(1-\tau_t)e^i k_t U_{cc} + (\frac{\gamma D}{\gamma+D})^2(1-\tau_t)e^i k_t U_{dd} - \frac{\gamma}{\gamma+D}U_{cl} + 2\frac{\gamma^2 D}{(\gamma+D)^2}(1-\tau_t)e^i k_t U_{cd} - \frac{\gamma D}{\gamma+D}U_{dl}}{-\Delta} < 0, \end{aligned}$$

with $\frac{\partial}{\partial n^i}(\frac{\partial v_t^i}{\partial n^i}) \equiv \Delta = \big(\frac{\gamma}{\gamma+D}(1-\tau_t)e^i k_t\big)^2 U_{cc} + U_{ll} + \big(\frac{\gamma D}{\gamma+D}(1-\tau_t)e^i k_t\big)^2 U_{dd} - 2\frac{\gamma}{\gamma+D}(1-\tau_t)e^i k_t U_{cl} + 2(\frac{\gamma}{\gamma+D}(1-\tau_t)e^i k_t\big)^2 D U_{cd} - 2\frac{\gamma D}{\gamma+D}(1-\tau_t)e^i k_t U_{dl} < 0$.

income.[8] On the other hand increases in capital income will all else equal reduce the labor supply and, therefore, labor income. This underpins their proclivity towards taxation of labor income.

Average labor income can thus be written by integrating:

$$\bar{y}_t = k_t \int_0^\infty \int_0^\infty e^i n[(1-\tau_t)e^i, r_t, R^i] f(e^i, R^i) de^i dR^i \tag{8}$$

where $f(e^i, R^i)$ is joint distribution function of e^i and R^i. Individual productivity and capital endowments conceivably are correlated with each other to some extent: if, for example, high productivity individuals simultaneously enjoy high capital income. Finally, the government's balanced budget requirement (in per capita terms) is given by:

$$\tau_t \bar{y}_t = r_t. \tag{9}$$

For the average individual, by use of (2) and (8) I can thus solve for the growth rate of k

$$g_t = \frac{k_{t+1} - k_t}{k_t} = \frac{D(\int_0^\infty \int_0^\infty e^i n[(1-\tau_t)e^i, r_t, R^i] f(e^i, R^i) de^i dR^i + R)}{\gamma + D} - 1 \tag{10}$$

[8]Note that, as in Meltzer and Richard (1981), the sign of $\frac{\partial n^i}{\partial e^i}$ is indeterminate, but for any individual with positive labor income I have

$$\begin{aligned} \frac{\partial y_t^i}{\partial e^i} &= k_t(n^i + e^i \frac{\partial n^i}{\partial e^i}) \\ &= k_t \frac{e^i\big(\frac{\gamma}{\gamma+D}(1-\tau_t)k_t U_c + \frac{\gamma D}{\gamma+D}(1-\tau_t)k_t U_d\big) + n^i\big(\frac{\gamma}{\gamma+D}(1-\tau_t)e^i k_t U_{cl} + \frac{\gamma D}{\gamma+D}(1-\tau_t)e^i k_t U_{dl} - U_{ll}\big)}{-\Delta} > 0, \end{aligned} \tag{7}$$

must be positive given condition (6).

where R is average capital income. Note that analogous to (5), I have:

$$\frac{\partial n^i}{\partial r_t} = -\frac{\frac{\partial^2 v_t^i}{\partial n^i \partial r_t}}{\frac{\partial}{\partial n^i}(\frac{\partial v_t^i}{\partial n^i})} < 0 \tag{11}$$

again given the assumption that v is strictly concave.[9] Hence for given productivity and capital income endowment, individual labor supply falls with increased redistribution. Therefore:

$$\frac{\partial \bar{y}_t}{\partial r_t} = k_t \int_0^\infty \int_0^\infty e^i \frac{\partial n^i}{\partial r_t} f(e^i, R^i) de^i dR^i < 0. \tag{12}$$

This establishes that the left-hand side of (9) is strictly decreasing with r. Moreover, $\tau\bar{y}$ is non-negative and bounded above by τe, where e is average productivity. In turn, the right-hand side of (9) is strictly increasing with r. Thus, there is a unique value of r to satisfy (9) for any τ.

1.2 The Median Voter's Choice of Tax Policy

I now turn to the policy-setting decision. Crucially, the median voter is still a Condorcet winner even though the electorate is heterogeneous on two dimensions. The logic of this is that the preferred tax rate remains a monotonic function of the labor income alone, regardless of the underlying determinants of that labor income. Hence high labor income (whether

[9] In detail, using (4), I have that

$$\begin{aligned}\frac{\partial n^i}{\partial r_t} &= \frac{\frac{\partial^2 v_t^i}{\partial n^i \partial r_t}}{-\frac{\partial}{\partial n^i}(\frac{\partial v_t^i}{\partial n^i})} \\ &= \frac{(\frac{\gamma}{\gamma+D})^2(1-\tau_t)e^i k_t U_{cc} + (\frac{\gamma D}{\gamma+D})^2(1-\tau_t)e^i k_t U_{dd} - \frac{\gamma}{\gamma+D}U_{cl} + 2\frac{\gamma^2 D}{(\gamma+D)^2}(1-\tau_t)e^i k_t U_{cd} - \frac{\gamma D}{\gamma+D}U_{dl}}{-\Delta} < 0.\end{aligned}$$

induced by either high productivity or low capital income) will engender aversion to taxes, whilst low labor income (whether induced by low productivity or a generous capital income inheritance) will engender support for tax-financed redistribution. Formally, the median labor income-earner, m, is the median voter. She sets taxes to maximize utility subject to the budget constraints (1) and (2), the government budget constraint (9), and a rational anticipation of how taxation will affect the incentives to supply labor in the economy. The first-order condition for the median voter with respect to the tax rate is:

$$\bar{y}_t - y_t^m + \tau_t \frac{d\bar{y}_t}{d\tau_t} = 0 \tag{13}$$

where y^m is the labor income of the median voter. For a given ratio of mean to median labor income, the political equilibrium τ is constant over time, so that the time subscript t is suppressed henceforth. Let $\theta = 1 - \tau$ be the fraction of earned income retained. Condition (13) yields the following solution for the tax rate chosen by the median voter

$$\tau = \frac{m - 1 + \eta_r}{m - 1 + \eta_r + m\eta_\theta}, \tag{14}$$

with $\eta_r < 0$ and $\eta_\theta > 0$ the partial elasticities of average income (assumed constant, as in Meltzer and Richard, 1981), and labor income inequality $m = \bar{y}/y^m$.[10]

The key insight of Meltzer and Richard (1981) is that an increase in labor income inequality raises taxation, since an increase in income inequality raises m and from (14) I have that

$$\frac{d\tau}{dm} > 0. \tag{15}$$

I am interested in the consequences of higher capital income inequality as in Luo et al. (2017).

[10] Details are available in the Appendix A.

To study this issue I consider an increase in the capital income earned by the individuals in the set $\mathcal{K}$ of all individuals with capital income above $\mathcal{Q}_{99\%}$.[11] The effect of the increase in capital income going to the top capital-income recipients is to reduce the gap between *taxable* mean and median labor income. Hence an increase in overall income inequality can coexist with a reduction in labor income inequality. Since $\frac{d\tau}{dm} > 0$, it follows that an increase in capital income inequality unambiguously lowers the tax rate chosen.

Lemma 1 *Suppose the top capital-income recipients are sufficiently productive that they also earn labor income above the median labor income, and consider an increase in capital-income inequality represented by an increase in the capital income earned by the top capital-income recipients. Then the labor income tax rate τ falls as capital income inequality rises.*

The proof of Lemma 1 is in Appendix B. This indicates that government size diminishes with increased capital income inequality, identical to Proposition 1 in Luo et al. (2017). If inequality increases such that the share of capital income going to the top income recipients increases, then the preferred tax rate falls because the (capital) rich are supplying less taxable labor income and hence the capacity of the median voter to redistribute is reduced.

The key issue is the extent to which the median voter can effectively redistribute through the tax system. As discussed above there are good reasons to believe that taxation of relatively mobile capital is considerably more difficult than taxation of labor income. If the rich are rich primarily due to capital income, perhaps because of the rising capital share, and perhaps due to successful reclassification of their income streams, then the capacity of the median voter to redistribute is curtailed. Moreover if rising inequality translates into further reductions in the supply of taxable labor then it follows that the demand for redistribution will fall.

[11] I focus on the 99% percentile because in the empirical section that follows I use the income share of the top 1% as our measure of capital income inequality.

1.3 Capital Income Inequality and Growth

I now turn to the effect of capital income inequality on economic growth via the channel of redistribution. Combining (10) and the total derivative of $\bar{y}$, I have Lemma 2.

Lemma 2 *The growth rate falls as the labor income tax rate τ rises, e.g.,*

$$\frac{dg}{d\tau} = \frac{D}{\gamma + D} \frac{d(\int_0^\infty \int_0^\infty e^i n[(1-\tau)e^i, r, R^i] f(e^i, R^i) de^i dR^i + R)}{d\tau} < 0. \tag{16}$$

Thus all else equal, the higher is the labor income taxation, the lower is the growth rate. The Appendix C contains more mathematical details.

From the properties of the g and τ functions derived above, I can obtain Lemma 3.

Lemma 3 *A more unequal distribution of labor income decreases growth, e.g.,*

$$\frac{dg}{dm} = \frac{dg}{d\tau}\frac{d\tau}{dm} < 0. \tag{17}$$

This indicates that labor income inequality is harmful for growth which is identical in spirit to Persson and Tabellini (1994). Now consider the consequences of higher capital income inequality and the mechanism analyzed above.

Proposition 1 *The growth rate rises as capital income inequality rises.*

In direct contrast to Persson and Tabellini (1994) economic growth increases with increased capital income inequality. When income differences are driven by capital income, the capacity of the median voter to redistribute through taxation is reduced since the capital-rich supply less (taxable) labor. Such redistributive policies, financed by distortionary taxes, in principle, affect capital accumulation and growth-promoting activities which in turn is actually detrimental to growth. If capital income inequality increases such that the preferred labor income tax rate falls as the (capital-poor) median voter cannot effectuate redistribution, then the subsequent rate of economic growth increases because smaller size of redistributive policies are financed by less distortionary taxes. If declining distortionary taxes translate into further less restriction on aggregate capital accumulation then it follows that subsequent economic growth will increase.

2 Evidence

The empirical analysis examines a panel of nineteen OECD countries over the period 1965-2010.[12] Following Perotti (1996) and Forbes (2000), the dependent variable is the average rate of growth of income per capita over five-year period as yearly growth rates incorporate short-run disturbances. For example, this means that growth rate in period 2 is averaged over 1971-1975 and is regressed on explanatory variables measured during period 1 (1966-1970).[13] This reduces yearly serial correlation from business cycles. The change from their model is to include capital income inequality and labor income inequality instead of aggregate inequality as Luo et al. (2017) have employed.

Figure 4 depicts the top income share data for all nineteen countries, showing all countries experienced a downward trend in the earlier years followed by a period of stasis or even slight increase since around 1990. Obviously there are interesting differences across the countries, for example greater recent increases in the English-speaking countries as discussed by Piketty and Saez (2006). The argument proposed in this paper is the following: as the top income

[12]Specifically the countries included are Australia, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Current data availability for the top income share precludes using other countries.

[13]In practice, each explanatory variable is measured in 1970, except capital income inequality and labor income inequality, which are sometimes not available in a specific year and is taken from the year closest to 1970.

share increases, the supply of taxable labor of the rich falls, which is likely to result in policies that allow less labor income taxation and therefore more accumulation and higher growth.

As noted above previous empirical literature including both country dummies and period dummies has generally been unsupportive of the original Persson and Tabellini (1994) hypothesis. If the mechanism put forward in this paper is important, and productivity differences and capital-income inequality are correlated with each other, then arguably previous analyses have suffered from an omitted variable bias. A measure of productivity heterogeneity is therefore employed in the empirical analysis. This measure is taken from the University of Texas Inequality Project's Estimated Household Income Inequality data.[14] These data (denoted by $UTIP$) use Theil's T statistic - measured across sectors within each country - to estimate wage inequality. Assuming competitive labor markets, then wage inequality should be capturing underlying heterogeneity in productivity. Figure 5 depicts these data, which also exhibit increases in recent years, varying across countries. This measure is thus close to Meltzer and Richard (1981) and Persson and Tabellini (1994) original conception of the driver of the demand of redistribution - productivity-based inequality.

A natural objection here is that the top income share will also be picking up productivity-induced inequality as in Luo et al. (2017). Inevitably there is a correlation between productivity inequality as measured by $UTIP$ and the income share of the top 1%, but this is somewhat weaker than might be expected. Figure 6 depicts a scatter plot of the two series, exhibiting a correlation coefficient of around 0.49. Hence there is meaningful separate information in the two series. The argument proposed in this paper is that the top income share is especially informative about capital income inequality rather than productivity-induced labor income inequality. The smaller sample of countries depicted in Figure 1 discussed in Luo et al. (2017) lends some credence to this argument.

[14]See Galbraith and Kum (2005).

The analysis includes control variables following Forbes (2000). Controls include per capita GDP in constant chained PPP US$ (denoted y). Per capita GDP y and the resultant growth rates are taken from the Penn World Tables (e.g. Ram, 1987). Following most empirical studies of income distribution and growth (e.g. Alesina and Rodrik, 1994; Persson and Tabellini, 1994) human capital effects are also included, and are represented by average years of secondary schooling in the male and female population aged over 25 (denoted $MEDU$ and $FEDU$), drawn from the data set compiled in Barro and Lee (1996). These two schooling variables proxy for the stock of human capital at the beginning of each of the estimation periods. The price level of investment (the PPP of investment over exchange rate relative to the United States, denoted $PPPI$) as used in Perotti (1996) are also employed in the regression analysis to capture market distortions that affect the cost of investment, also taken from the Penn World Tables. Finally, the country dummies are employed to control for time-invariant omitted-variable bias, and the period dummies are employed to control for global shocks that may affect aggregate growth in any periods but are not captured by other explanatory variables.

It is clearly possible to include a set of additional variables. However, as in Perotti (1996) this paper mainly focuses on this simple specification for three considerations. First, in order to estimate the impact of inequality on growth it is important to make as few discrepancy as possible relative to typical growth model. Second, as the number of observations is limited by the availability of inequality data, this simplified specification will help maximize the number of degrees of freedom. Third, since some control variables used in standard-growth model (e.g. government expenditure) may be endogenous, focusing on stock variables measured at the start of each periods instead of flow variables measured throughout each periods can reduce the potential endogeneity problem. To summarize, the growth model central to this section is

$$GROWTH_{i,t} = \beta_1 TOPINC_{i,t-1} + \beta_2 UTIP_{i,t-1} + \beta_3 y_{i,t-1} + \beta_4 MEDU_{i,t-1} + \beta_5 FEDU_{i,t-1} + \beta_6 PPPI_{i,t-1} + \alpha_i + \eta_t + u_{i,t} \tag{18}$$

where i represents each country and t represents each time period, $GROWTH$ is average annual growth, α_i are country dummies, η_t are period dummies, and $u_{i,t}$ is the error term.

Table 1 contains estimation results from fixed-effects panel regressions with average annual growth rate as the dependent variable. Column 1 examines the original Persson and Tabellini (1994) hypothesis using five-year periods, 1965-2005, applying the benchmark specification in Forbes (2000) with productivity-induced inequality ($UTIP$), and finding its coefficient to be insignificant but importantly positive. This positive sign coheres with the results in Forbes (2000). Column 2 further augments this specification with capital income inequality. The estimated coefficient for capital income inequality is positive, with a p-value of 2.0% and the estimated relationship is sizable: A one standard deviation increase in capital income inequality is statistically correlated with a 0.9% increase in average annual growth over the next five years,[15] consistent with the theoretical reasoning given here. It is also noteworthy that the coefficient estimate for productivity-induced labor income inequality is now negative, though is still not statistically significant. Following Forbes (2000) results are also presented (in columns 4 and 5) using ten-year panels, and the results essentially duplicate those in columns 1 and 2, establishing that this observed short-term, positive relationship is not dampened over time.

Column 6 of Table 1 contains Arellano-Bond dynamic panel estimation results extending the specification used in columns 4 and 5 to include the lagged dependent variable ($GROWTH$).

[15] Note, however, that it is unlikely that any country's top income share could rise by this magnitude in a short period of time.

Here the positive relationship between capital income inequality and growth holds up, and indeed the coefficient estimate pertaining to labor income inequality is negative and significantly different from zero at the 10% level, consistent with the Persson and Tabellini (1994) hypothesis. This evidence suggests that previous tests of the Persson and Tabellini (1994) hypothesis were hampered by the conflation of capital and labor income inequality. Columns 7-9 again test 1-3 using extended sample of 1965-2010 and duplicate their results.

Most of the coefficient estimates of control variables agree with those traditionally reported in typical literature. As indicated by models considering conditional convergence, the coefficient on initial income level is negative and statistically significant. Note also that the opposite signs on the coefficients of $MEDU$ and $FEDU$ are in line with the findings in Barro and Sala-I-Martin (2003) and Perotti (1996), who obtain the results based on a larger sample. For a given male attainment, an increase in initial female attainment leads to less backwardness and thus slower subsequent growth since the economy converges toward steady state (see Barro and Sala-I-Martin, 2003).

Previous work on the effect of income inequality on economic growth (Forbes, 2000) discusses the necessity to deal with potential endogeneity. Following the specification by Forbes (2000), column 1 of Table 2 applies difference GMM by Arellano and Bond (1991) to a panel covering 18 OECD countries during 1965-2010 in five-year periods. The basic difference GMM regression, eliminating the fixed effects and using lags of the endogenous variables as instruments, produces similar results presented in Table 1, in particular, significant and positive coefficient on lagged capital income inequality. While heightening the concern is the problem of weak instruments in difference GMM, which led to the development of system GMM by Arellano and Bover (1995) and Blundell and Bond (1998), and could reinforce endogeneity bias. The perfect p-value of 1.00 for the Hansen test is a classic sign of instrumental proliferation.

The remaining columns 2-5 of Table 2 examine the sensitivity of the results to reducing the number of instruments. Column 2 firstly collapses the instruments. Columns 3 and 4 use two different lags from the instrument set, and column 5 combines the two modification. It should also be noted that the AR(2) test and the Hansen J test show that there is no further serial correlation, and the overidentifying restrictions are not rejected. As difference GMM can suffer from the problem of weak instrument, the rest columns of Table 2 utilise the benefit of system GMM, which augments the equation estimated by difference GMM, simultaneously estimating an equation in levels with suitable lagged differences of endogenous variables as instruments. Therefore, columns 6-10 mimic columns 1-5 whilst instead using system GMM and produce similar results, which reinforce the proposed theory. Throughout Table 2 the positive coefficients on capital income inequality lose significance as the number of instruments falls.

Table 3 tests the robustness and contains estimation results from fixed-effects panel regressions using five-year periods. Column 1 uses the same specification as column 2 of Table 1 but excluding Asian countries (e.g. Japan and Korea) to examine whether the regional coverage of the sample affects the results. Apart from the regional coverage, not surprisingly, the representative of very poor countries is extremely limited due to the unavailability of the top income share statistics. However, the relationship between capital income inequality and growth may depend on the stage of development of a country. I split the sample into wealthy and poor countries based on initial income level in 1965, and then reestimate equation (18) for two groups (reported in columns 2 and 3). Note that no matter which sample selection is utilized, the relationship between capital income inequality and growth remains positive and statistically significant.

Column 4 of Table 3 includes the percentage of population over the age of 65 (denoted $PROP65$) as an additional control variable for reasons related to the work of fiscal policy approach as with Perotti (1996). This demographic variable may be correlated with income inequality as among retirees both average income and inequality are lower. In turn, if the population in a country is older, then the demand for social security is higher and hence, more taxation distortions and slower subsequent growth. The coefficient on this demographic variable is negative and statistically significant at the 5% level, supporting the mechanism proposed. Further, inequality stemming from capital income is likely to be correlated with the labor share of income (denoted $SHARE$). As in Facchini et al. (2017) a recent declining labor share has played a part in explaining the slowdown in the growth of government size and therefore, less distortions and higher growth. In fact, no matter whether I control for $PROP65$ or the labor share, as in columns 4 and 5, the coefficient on capital income inequality is positive and statistically significant at the 5% level. Note also that throughout columns 1-5 of Table 3 the coefficient estimates for labor income inequality are consistently negative (though not significant). The estimated effect of capital income inequality on growth remains sizable: An increase in $TOPINC$ by one standard deviation is associated with an increase in average rate of growth of GDP per capita by around 0.7%.

3 Conclusion

This paper analyzes how inequality in the capital income distribution affects growth. Capital income is quite distinct from labor income. I define it as rental income, and also model it as untaxed, hence redistribution is financed solely by taxation applied to labor income, and voters have preferences over the tax rate based on their position in the capital income distribution. Despite the fact that there are two underlying sources of heterogeneity in the populations, the median voter is still the unique Condorcet winner because tax preferences are monotonic in labor income.

The result relating growth to capital income inequality is novel. In contrast to Persson and Tabellini (1994) increased capital-income inequality now leads to higher growth. Agents who are endowed with capital income are less averse to labor-income taxation. If the share of capital income of the rich increases such that their taxable labor supply falls and the preferred tax rate falls as the median voter has a reduced capacity to redistribute through taxation, then the subsequent rate of economic growth increases because smaller size of redistributive policies are financed by less distortionary taxes.

The relationship between inequality and growth is tested in a panel of 19 OCED countries, augmenting the work of Forbes (2000) to include capital income inequality as an additional explanatory variable. The measure of capital income inequality in the analysis is the top 1% income share. Consistent with the theory, subsequent growth rate is found to be positively associated with capital income inequality. Moreover controlling for the top income share renders a consistently negative estimate for the impact of labor income inequality on growth, in line with the original Persson and Tabellini (1994) hypothesis. The positive impact of capital income inequality on growth survives in a variety of econometric specification, including when difference and system GMM technique is employed.

Appendix

A Derivation of Equations (13) and (14)

The problem of the median voter m is to choose the tax rate so as to maximize

$$v_t^m = U[\frac{\gamma}{\gamma+D}\big((1-\tau_t)n^m e^m k_t + \tau_t \bar{y}_t + R^m k_t\big), 1-n^m, \frac{\gamma D}{\gamma+D}\big((1-\tau_t)n^m e^m k_t + \tau_t \bar{y}_t + R^m k_t\big)], \tag{A.1}$$

and the first-order condition for the median voter with respect to the tax rate is

$$\begin{aligned}(\bar{y}_t - y_t^m + \tau_t \frac{d\bar{y}_t}{d\tau_t})(\frac{\gamma}{\gamma+D}U_c + \frac{\gamma D}{\gamma+D}U_d)& \\ + \big(\frac{\gamma}{\gamma+D}(1-\tau_t)e^m k_t U_c - U_l + \frac{\gamma D}{\gamma+D}(1-\tau_t)e^m k_t U_d\big)\frac{dn^m}{d\tau_t} &= 0.\end{aligned} \tag{A.2}$$

Thus, making use of equation (4), the tax rate chosen by the median voter must satisfy

$$\bar{y}_t - y_t^m + \tau_t \frac{d\bar{y}_t}{d\tau_t} = 0. \tag{A.3}$$

For a given labor income inequality, the political equilibrium τ is constant over time, so that the time subscript t is suppressed henceforth. Changes in the tax rate τ affect average income via two channels: its effect on the opportunity cost of leisure, and its effect on transfers (from the government's budget constraint $r = \tau\bar{y}$). In particular, I have that

$$\begin{aligned}\frac{d\bar{y}}{d\tau} &= \frac{\partial \bar{y}}{\partial r}\frac{dr}{d\tau} + \frac{\partial \bar{y}}{\partial \theta}\frac{d\theta}{d\tau}, \\ &= \frac{\partial \bar{y}}{\partial r}(\bar{y} + \tau\frac{d\bar{y}}{d\tau}) - \frac{\partial \bar{y}}{\partial \theta}\end{aligned} \tag{A.4}$$

with $\theta = 1 - \tau$. Thus, the total derivative of average labor income with respect to changes in the tax rate is given by

$$\frac{d\bar{y}}{d\tau} = \frac{\bar{y}_r \bar{y} - \bar{y}_\theta}{1 - \tau \bar{y}_r} < 0, \tag{A.5}$$

with $\bar{y}_r = \frac{\partial \bar{y}}{\partial r}$ and $\bar{y}_\theta = \frac{\partial \bar{y}}{\partial \theta}$. Finally, substituting (A.5) into (A.3) I have

$$\begin{aligned} 0 &= \bar{y} - y^m + \tau \frac{\bar{y}_r \bar{y} - \bar{y}_\theta}{1 - \tau \bar{y}_r}, \\ &= (\bar{y} - y^m)(1 - \tau) + \frac{\eta_r \bar{y}(1 - \tau) - \eta_\theta \bar{y} \tau}{1 - \eta_r}, \end{aligned} \tag{A.6}$$

where $\eta_r = \bar{y}_r \frac{r}{\bar{y}}$ and $\eta_\theta = \bar{y}_\theta \frac{\theta}{\bar{y}}$ are the partial elasticities of average income. Solving the above equation for τ, yields

$$\tau = \frac{m - 1 + \eta_r}{m - 1 + \eta_r + m\eta_\theta} \tag{A.7}$$

with $m = \frac{\bar{y}}{y^m}$.

B Proof of Lemma 1

Although I impose almost no restrictions on the joint distribution $f(e^i, R^i)$, as in Luo et al. (2017) I wish to guarantee that: i) the chosen tax rate is positive; and that ii) the individuals that are in the top of the capital income distribution are never the decisive voter. Thus, in the sequel I make the following two assumptions:

Assumption 1 *The joint distribution $f(e^i, R^i)$ is such that the labor income distribution is right-skewed. Thus, $y^m < \bar{y}$ and the chosen tax rate is positive.*

From (13) I see that Assumption 1 guarantees that the chosen tax rate is positive.

Assumption 2 *The joint distribution $f(e^i, R^i)$ is such that the set of individuals $i \in \mathcal{K}$ with* *capital income R^i above the 99% percentile of the capital income distribution has productivity e^i which is sufficiently high so that $y^i = e^i n^i k > y^m$ for all $i \in \mathcal{K}$.*

Figure 2 illustrates the condition imposed by Assumption 2. The locus denoted $y = y^m$ represents productivity and capital income pairs, (e^i, R^i), for which labor income y is equal to the median voter's labor income, y^m. To the right of this locus, $y > y^m$, since $\frac{\partial y^i}{\partial e^i} > 0$ and $\frac{\partial y^i}{\partial R^i} < 0$. The dashed line denoted $\mathcal{Q}_{99\%}$ represents the 99% quantile of the capital income marginal density function. Assumption 2 is a condition requiring that the set $\mathcal{K}$ of all individuals with capital income above $\mathcal{Q}_{99\%}$ is located to the right of the locus $y = y^m$, as shown in Figure 2.

Now consider an increase in the capital income earned by the individuals in the set $\mathcal{K}$ of all individuals with capital income above $\mathcal{Q}_{99\%}$. This is represented in Figure 3: the individuals in the set $\mathcal{K}$ that correspond to the original individuals in the top 1% of the capital income distribution receive an exogenous increase in capital income; thus, the set $\mathcal{K}$ shifts upwards in the space (e^i, R^i), but still satisfying the restriction imposed by Assumption 2, that guarantees that none of the members of the set $\mathcal{K}$ are the median voter (the new set is represented by the triangle above, in Figure 3). Notice that this experiment constitutes an increase in capital income inequality, since I maintain the capital income of all the other individuals unchanged and, hence, the capital income share of the top 1% is increased.[16] Under a right-skewed labor income distribution $y^m < \bar{y}$, and given (14) above then $\tau > 0$. As with Meltzer and Richard (1981) demand for redistribution stems from changes in the labor income distribution. However, the labor income distribution may now change depending on the distribution of capital income as well as the productivity distribution.

[16] It is not, however, a mean preserving spread in capital income. But lowering the capital income of the bottom 99% capital income earners in order to preserve the mean capital income would only reinforce our results.

To see the consequences of higher capital income inequality, notice that all the individuals in the set $\mathcal{K}$ will choose to work less, because they enjoy an increase in their capital income and leisure is a normal good. This will tend to lower the average labor income $\bar{y}$, since I have that

$$\bar{y} = p(\mathcal{K})\,\bar{y}(\mathcal{K}) + (1 - p(\mathcal{K}))\,\bar{y}(\sim \mathcal{K}), \tag{B.1}$$

where $\bar{y}(\mathcal{K})$ is the average income of the individuals in set $\mathcal{K}$ and $\bar{y}(\sim \mathcal{K})$ is the average income of the individuals not in set $\mathcal{K}$. From Assumption 2 I have that $\bar{y}^{\mathcal{K}} > y^m$.

Taking the total derivative of $\bar{y}$ with respect to $R(\mathcal{K})$, the capital income of the individuals in set $\mathcal{K}$ in equation B.1 I obtain

$$\begin{aligned}
\frac{d\bar{y}}{dR(\mathcal{K})} &= p(\mathcal{K})\left(\frac{\partial \bar{y}(\mathcal{K})}{\partial R(\mathcal{K})} + \frac{\partial \bar{y}(\mathcal{K})}{\partial r}\frac{d\bar{y}}{dR(\mathcal{K})}\tau\right) + (1 - p(\mathcal{K}))\left(\frac{\partial \bar{y}(\sim \mathcal{K})}{\partial r}\frac{d\bar{y}}{dR(\mathcal{K})}\tau\right), \\
&= p(\mathcal{K})\frac{\partial \bar{y}(\mathcal{K})}{\partial R(\mathcal{K})} + \frac{\partial \bar{y}}{\partial r}\frac{d\bar{y}}{dR(\mathcal{K})}\tau, \\
&= p(\mathcal{K})\frac{\partial \bar{y}(\mathcal{K})}{\partial R(\mathcal{K})} + \eta_r\frac{d\bar{y}}{dR(\mathcal{K})},
\end{aligned} \tag{B.2}$$

where I used the fact that $\eta_r = \frac{\partial \bar{y}}{\partial r}\frac{r}{\bar{y}} = \frac{\partial \bar{y}}{\partial r}\frac{\tau\bar{y}}{\bar{y}} = \frac{\partial \bar{y}}{\partial r}\tau$. Using (B.2) to solve for $\frac{d\bar{y}}{dR(\mathcal{K})}$, I obtain

$$\frac{d\bar{y}}{dR(\mathcal{K})} = \frac{p(\mathcal{K})}{1 - \eta_r}\frac{\partial \bar{y}(\mathcal{K})}{\partial R(\mathcal{K})} < 0, \tag{B.3}$$

since leisure is a normal good. Thus, average income $\bar{y}$ must fall.

In turn, I have that

$$\frac{dy^m}{dR(\mathcal{K})} = \frac{\partial y^m}{\partial r}\frac{\partial \bar{y}}{\partial R(\mathcal{K})}\tau > 0. \tag{B.4}$$

Thus, I have established that $\bar{y}$ must fall and y^m must increase following an increase in the capital-income going to the top capital-income recipients. Therefore, $m = \bar{y}/y^m$ falls and the increase in capital income inequality lowers labor income inequality. The upshot is that the increase in the capital income going to the top capital-income recipients results in a lower τ, the labor income tax chosen by the median voter.

C Derivation of Equation (16)

For the average individual in (1) and (2), I have

$$\begin{aligned} k_{t+1} &= y_t + Rk_t - c_t, \\ &= y_t + Rk_t - \frac{d_{t+1}}{D}, \\ &= y_t + Rk_t - \frac{\gamma k_{t+1}}{D}. \end{aligned} \tag{C.1}$$

Solving the above equation for k_{t+1}, yields

$$k_{t+1} = \frac{D(y_t + Rk_t)}{\gamma + D}. \tag{C.2}$$

Combining the above equation and (8), the growth rate of k can be obtained

$$\begin{aligned} g_t &= \frac{k_{t+1} - k_t}{k_t}, \\ &= \frac{D\big(\int_0^\infty \int_0^\infty e^i n[(1-\tau_t)e^i, r_t, R^i] f(e^i, R^i) de^i dR^i + R\big)}{\gamma + D} - 1. \end{aligned} \tag{C.3}$$

Again for a given labor income inequality, the political equilibrium τ and g are constant over time, so that the time subscript t is suppressed henceforth. Thus, the effect of taxation on growth, making use of (A.5), yields

$$\begin{aligned}\frac{dg}{d\tau} &= \frac{D}{\gamma + D}\frac{d\Big(\int_0^\infty \int_0^\infty e^i n[(1-\tau)e^i, r, R^i] f(e^i, R^i) de^i dR^i + R\Big)}{d\tau}, \\ &= \frac{D}{\gamma + D}\frac{\frac{1}{k}dy}{d\tau} < 0.\end{aligned} \tag{C.4}$$

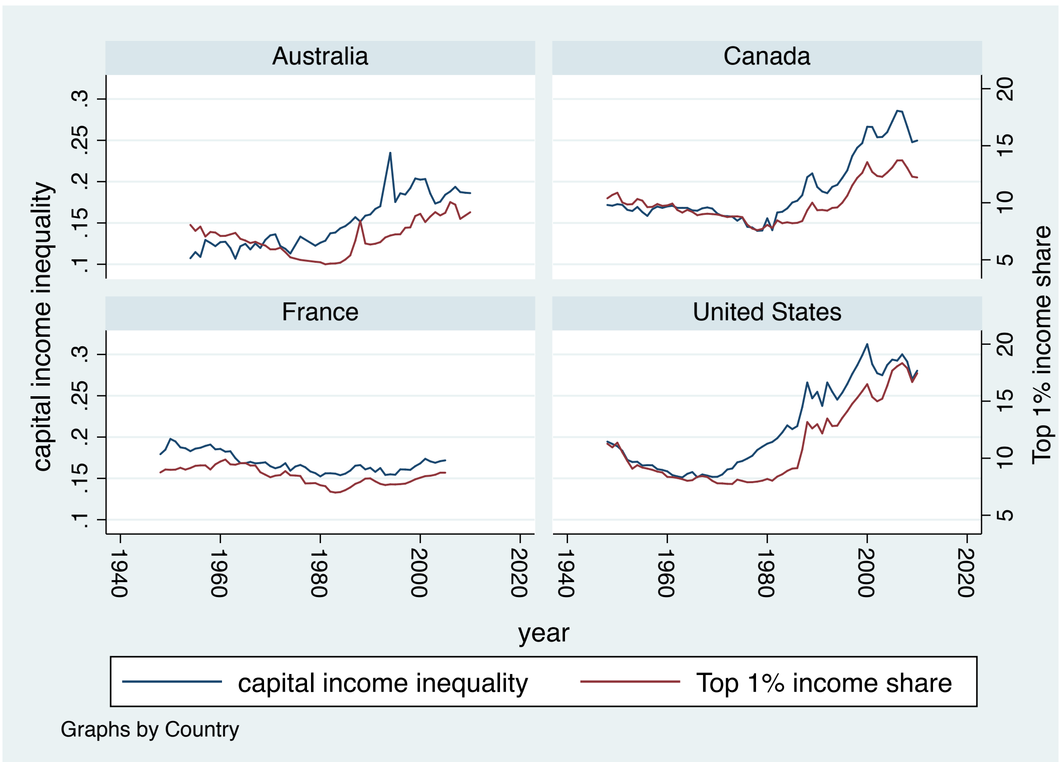

Figure 1: Capital income inequality versus top 1% income share

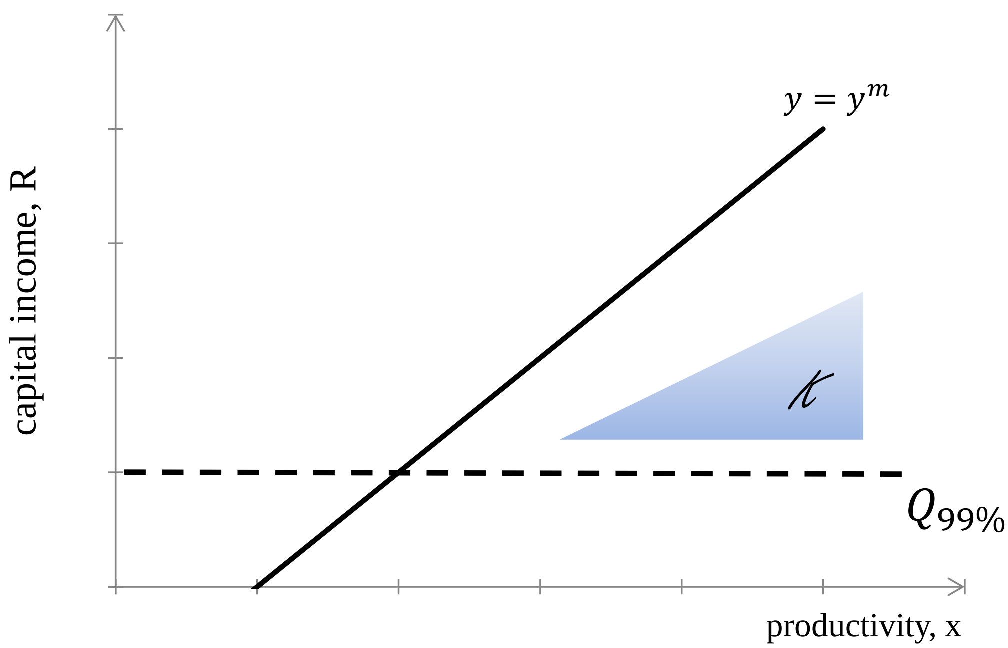

Figure 2: Capital income and productivity joint distribution (Assumption 2)

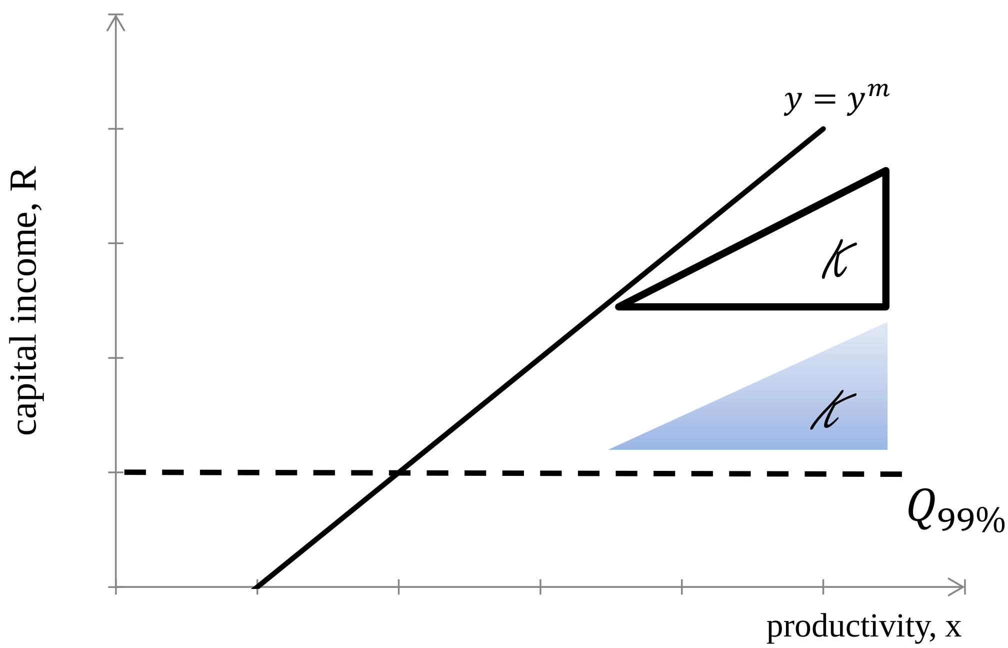

Figure 3: Increase in capital income inequality

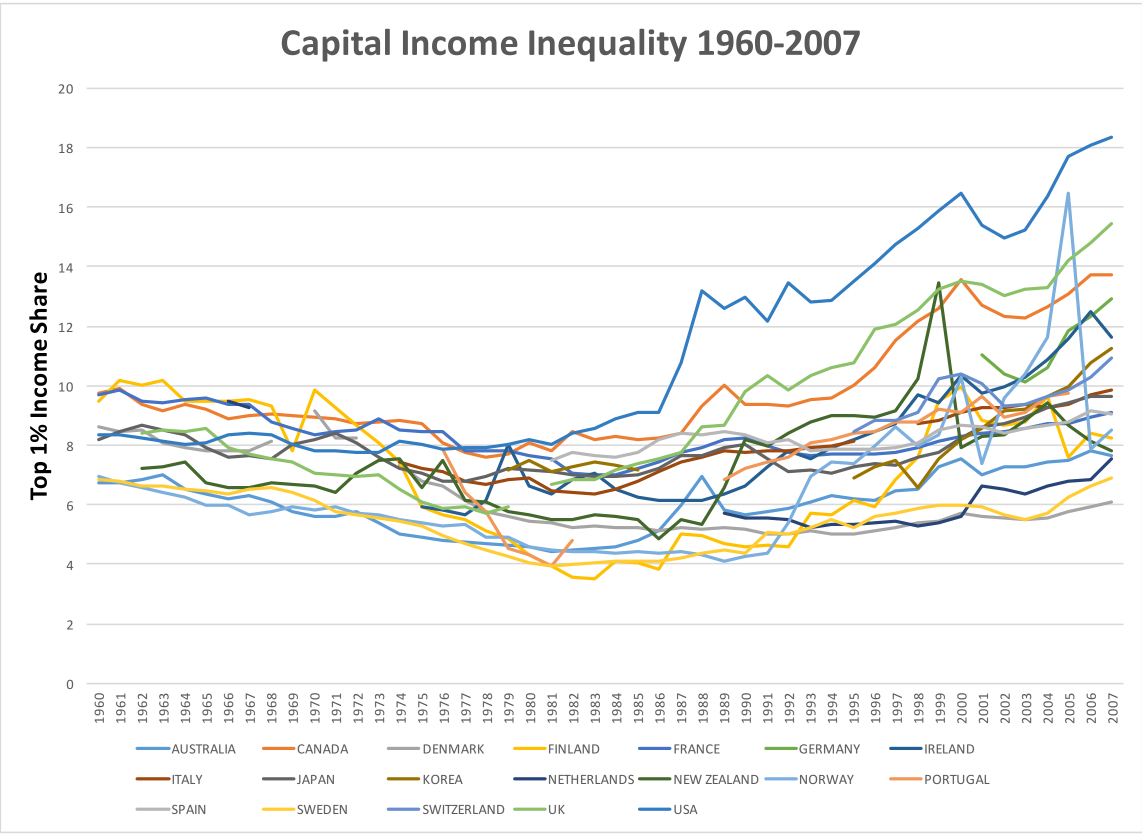

Figure 4: Capital income inequality, 1960-2007

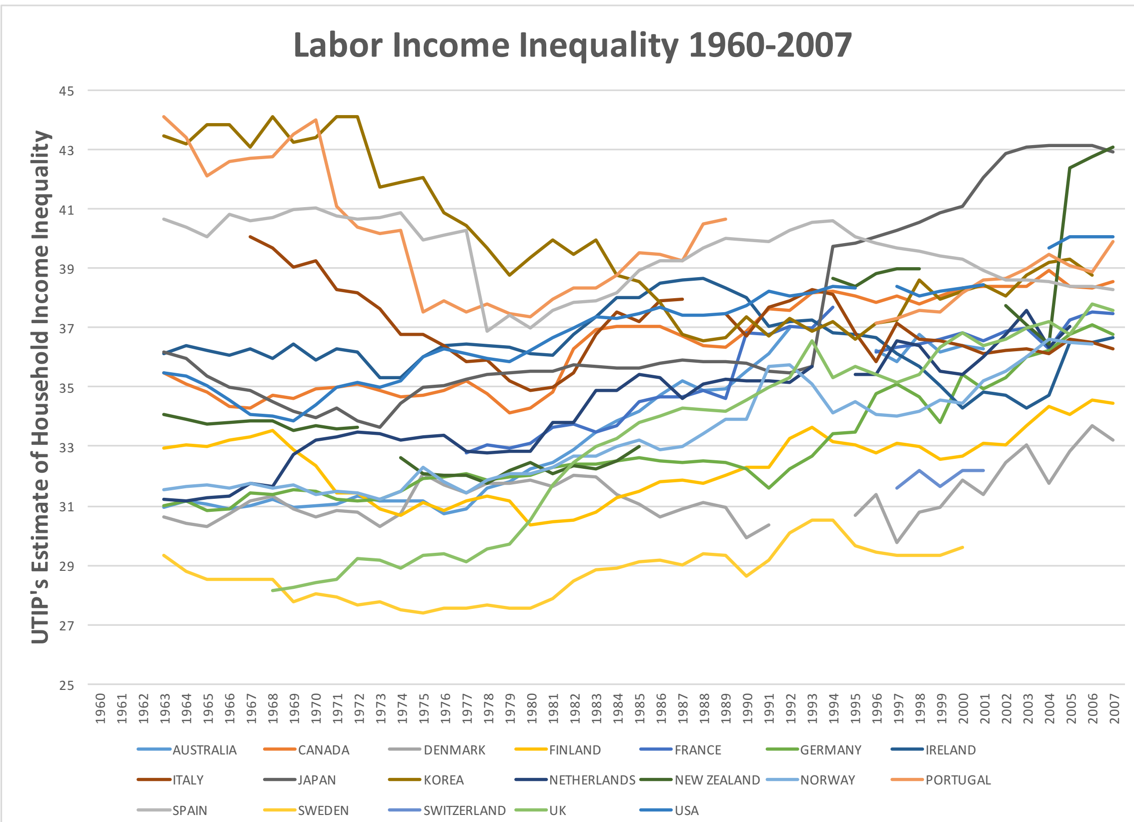

Figure 5: Labor income inequality, 1960-2007

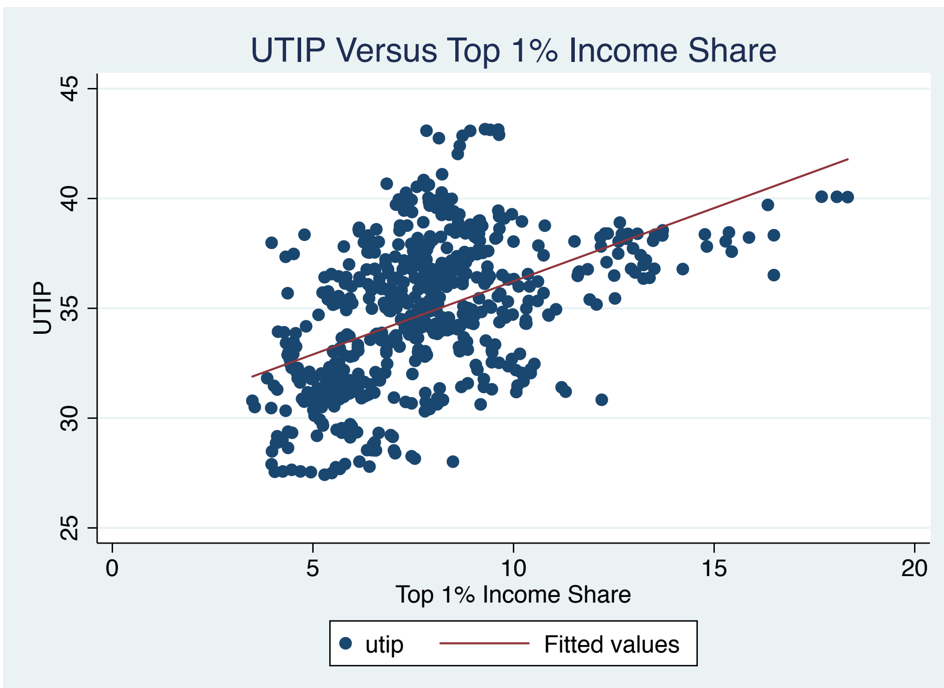

Figure 6: Labor income inequality and capital income inequality, 1960-2007

Table 1: Panel estimation results with fixed effects – average annual per captia growth rate

	1965-2005						1965-2010		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
L.GROWTH			-0.0324			-0.0442			-0.00593
			(0.0911)			(0.203)			(0.0795)
L.TOPINC		0.412	0.491		0.529	0.539		0.424	0.563
		(0.161)	(0.164)		(0.140)	(0.187)		(0.179)	(0.124)
L.UTIP	0.119	-0.108	-0.189	0.198	-0.0668	-0.265	0.116	-0.114	-0.145
	(0.113)	(0.154)	(0.165)	(0.0974)	(0.111)	(0.143)	(0.120)	(0.154)	(0.142)
L.y	-0.459	-0.612	-0.828	-0.557	-0.610	-0.792	-0.336	-0.544	-0.825
	(0.155)	(0.130)	(0.127)	(0.100)	(0.0964)	(0.138)	(0.123)	(0.113)	(0.0961)
L.MEDU	0.141	0.433	0.412	0.0947	0.915	1.038	-0.172	-0.137	-0.137
	(0.612)	(0.504)	(1.029)	(0.546)	(0.532)	(1.012)	(0.696)	(0.514)	(0.843)
L.FEDU	-0.369	-0.201	-0.439	0.0459	-0.462	-1.051	0.277	0.551	0.483
	(0.774)	(0.615)	(1.181)	(0.731)	(0.781)	(1.257)	(0.827)	(0.595)	(0.905)
L.PPPI	-0.00908	-0.00212	-0.00397	0.00215	0.0121	0.0263	-0.00737	0.00171	0.00220
	(0.0127)	(0.00690)	(0.0124)	(0.0109)	(0.00954)	(0.0107)	(0.0124)	(0.00746)	(0.0110)
Obs	138	125	92	70	63	32	154	141	118
Countries	19	19	18	19	19	17	19	19	18
Periods	5-year	5-year	5-year	10-year	10-year	10-year	5-year	5-year	5-year
R^2 (within)	0.523	0.631		0.595	0.736		0.524	0.626	

Notes: Panel regressions of average annual per capita growth rate including fixed effects, $L.TOPINC$, $L.UTIP$, $L.y$, $L.MEDU$, $L.FEDU$, $L.PPPI$, and robust standard errors clustered by country in parentheses. Year dummies are included in all regressions. Columns (3) and (6) contain Arellano-Bond estimation with lagged values of both the predetermined and endogenous variables as instruments. Columns (7)-(9) again test (1)-(3) using extended sample 1965-2010.

Table 2: Difference and system GMM regressions – average annual per captia growth rate

	1965-2010									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
L.TOPINC	0.386	0.441	0.387	0.480	0.359	0.115	0.211	0.0803	0.115	0.459
	(0.160)	(0.167)	(0.188)	(0.203)	(0.341)	(0.0626)	(0.136)	(0.0622)	(0.0626)	(0.292)
L.UTIP	-0.147	-0.285	-0.123	-0.160	-0.0492	-0.0351	-0.204	-0.0210	-0.0351	-0.469
	(0.169)	(0.224)	(0.240)	(0.169)	(0.437)	(0.0449)	(0.110)	(0.0454)	(0.0449)	(0.358)
L.y	-0.507	-0.786	-0.862	-0.651	-0.366	-0.170	-0.211	-0.134	-0.170	-0.330
	(0.0958)	(0.0912)	(0.121)	(0.104)	(0.947)	(0.0788)	(0.110)	(0.0770)	(0.0788)	(0.164)
L.MEDU	-0.457	-0.726	-0.766	-0.608	-3.286	0.390	-0.437	-0.134	0.390	-2.115
	(0.460)	(1.020)	(0.972)	(0.533)	(4.913)	(0.492)	(0.745)	(0.499)	(0.492)	(1.322)
L.FEDU	0.832	0.882	0.727	0.971	3.536	-0.162	0.900	0.195	-0.162	2.475
	(0.490)	(1.295)	(1.121)	(0.662)	(5.658)	(0.452)	(0.827)	(0.387)	(0.452)	(1.258)
L.PPPI	0.000338	0.0166	0.00672	0.000378	-0.000266	-0.0177	-0.0166	-0.0220	-0.0177	-0.0139
	(0.00628)	(0.0129)	(0.0117)	(0.00728)	(0.0242)	(0.00724)	(0.0134)	(0.00750)	(0.00724)	(0.0147)
Obs	118	118	118	118	118	141	141	141	141	141
Countries	18	18	18	18	18	19	19	19	19	19
Periods	5-year	5-year	5-year	5-year	5-year	5-year	5-year	5-year	5-year	5-year
Hansen test	4.44	9.57	7.16	5.55	exactly identified	3.31	4.52	11.93	5.54	2.34
AR(2) p-value	0.366	0.322	0.264	0.300	0.997	0.749	0.710	0.863	0.749	0.720
Estimator	difference GMM	difference GMM	difference GMM	difference GMM	difference GMM	system GMM	system GMM	system GMM	system GMM	system GMM
Method to reduce count		collapse	lags 1-1	lags 1-2	collapse & lags 1-1		collapse	lags 1-1	lags 1-2	collapse & lags 1-1

Notes: In columns (1)-(5) estimations use the difference GMM of Arellano and Bond (1991), with robust standard errors. In columns (6)-(10) estimations use the system GMM of Arellano and Bover (1995) and Blundell and Bond (1998), with robust standard errors. "collapse" stands for collapsed instruments; "lags" stands for restricting the number of lags used in generating instuments from the endogenous variables. Year dummies are included in all regressions. Endogenous variables used as instruments: *L.TOPINC*, *L.UTIP*, *L.y*, *L.MEDU*, *L.FEDU*, *L.PPPI*.

Table 3: Sensitivity analysis – average annual per captia growth rate

	1965-2005					1965-2010				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$L.TOPINC$	0.304	0.350	0.466	0.325	0.440	0.265	0.295	0.474	0.328	0.440
	(0.114)	(0.146)	(0.209)	(0.132)	(0.171)	(0.110)	(0.117)	(0.189)	(0.132)	(0.175)
$L.UTIP$	-0.0493	-0.0460	-0.179	-0.0611	-0.126	0.000345	0.00976	-0.184	-0.0585	-0.110
	(0.121)	(0.129)	(0.195)	(0.108)	(0.134)	(0.113)	(0.143)	(0.200)	(0.0933)	(0.152)
$L.y$	-0.439	-0.455	-0.676	-0.616	-0.738	-0.383	-0.404	-0.611	-0.573	-0.655
	(0.119)	(0.0712)	(0.302)	(0.107)	(0.0999)	(0.0634)	(0.0986)	(0.221)	(0.0763)	(0.101)
$L.MEDU$	-0.131	0.786	0.451	-0.162	0.316	-0.806	0.0346	0.130	-0.716	-0.259
	(0.460)	(0.964)	(1.358)	(0.706)	(0.617)	(0.480)	(0.915)	(0.704)	(0.604)	(0.662)
$L.FEDU$	0.339	0.0446	-0.855	0.327	0.0651	1.186	0.806	-0.0412	1.202	0.783
	(0.509)	(1.018)	(2.694)	(0.711)	(0.661)	(0.505)	(0.785)	(1.126)	(0.606)	(0.701)
$L.PPPI$	-0.000104	0.00300	0.00235	0.00495	0.00433	0.00234	0.00891	0.00305	0.00657	0.00629
	(0.00806)	(0.00851)	(0.0279)	(0.00863)	(0.00769)	(0.00736)	(0.00883)	(0.0234)	(0.00754)	(0.00907)
$L.PROP65$				-0.463					-0.461	
				(0.216)					(0.130)	
$L.SHARE$					-0.0550					-0.0658
					(0.0561)					(0.0579)
Obs	113	63	62	125	108	127	69	72	141	124
Countries	17	9	10	19	18	17	9	10	19	18
Data	Excluding Asia	Higher income	Lower income	Full	Full	Excluding Asia	Higher income	Lower income	Full	Full
Periods	5-year	5-year	5-year	5-year	5-year	5-year	5-year	5-year	5-year	5-year
R^2 (within)	0.634	0.608	0.769	0.659	0.676	0.637	0.582	0.773	0.670	0.667

Notes: Regression specification is the same as column (2) of Table 1, and robust standard errors clustered by country in parentheses. Year dummies are included in all regressions. Column (1) excludes Asian countries. Columns (2) and (3) respectively correspond to higher and lower levels of initial income in 1965. Column (4) includes $L.PROP65$ as a further control, and column (5) includes $L.SHARE$ as a further control. Columns (6)-(10) again test (1)-(5) using extended sample 1965-2010.

References

Alesina, Alberto, and Dani Rodrik (1994) Distributive politics and economic growth. *Quarterly Journal of Economics* 109(2): 465-490.

Arellano, Manuel, and Stephen R. Bond (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies* 58(2): 277-297.

Arellano, Manuel, and Olympia Bover (1995). Another look at the instrumental variable estimation of error-components models. *Journal of econometrics* 68(1): 29-51.

Azmat, Ghazala, Alan Manning, and John Van Reenen (2012). Privatization and the decline of labour's share: International evidence from network industries. *Economica* 79: 470-492.

Barro, Robert J. (2000). Inequality and growth in a panel of countries. *Journal of Economic Growth* 5(1): 5-32.

Barro, Robert J., and Jong Wha Lee (1996). International measures of schooling years and schooling quality. *American Economic Review* (*Papers and Proceedings*) 86(2): 218-223.

Barro, Robert J., and Xavier Sala-I-Martin (2003). *Economic Growth*. New York: McGraw-Hill.

Bertola, Giuseppe (1993). Factor shares and savings in endogenous growth. *The American Economic Review* 83: 1184-1199.

Blundell, Richard, and Stephen Bond (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics* 87(1): 115-143.

Deininger, Klaus, and Lyn Squire (1996). A new data set measuring income inequality. *World Bank Economic Review* 10(3): 565-591.

Deininger, Klaus, and Lyn Squire (1998). New ways of looking at old issues: Inequality and growth. *Journal of Economic Growth* 57(2): 259-287.

Facchini, Francois, Mickael Melki, and Andrew Pickering (2017). Labor costs and the size of government. *Oxford Bulletin of Economics and Statistics* 79(2): 251-275.

Foellmi, Reto, and Josef Zweimuller (2006). Income distribution and demand-induced innovations. *Review of Economic Studies* 73(4): 941-960.

Forbes, Kristin J. (2000). A reassessment of the relationship between inequality and growth. *The American Economic Review* 90(4): 869-887.

Frank, Mark W. (2009). Inequality and growth in the United States: Evidence from a new state-level panel of income inequality measure. *Economic Inquiry* 47(1): 55-68.

Galbraith, James K., and Hyunsub Kum (2005). Estimating the inequality of household incomes: A statistical approach to the creation of a dense and consistent global data set. *Review of Income and Wealth* 51(1): 115-143.

Galor, Oded, and Omer Moav (2004). From physical to human capital accumulation: Inequality and the process of development. *Review of Economic Studies* 71(4): 1001-1026.

Karabarbounis, Loukas, and Brent Neiman (2013). The global decline of the labor share. *Quarterly Journal of Economics* 129(1): 61-103.

Kaymak, Baris, and Markus Poschke (2016). The evolution of wealth inequality over half a century: The role of taxes, transfers and technology. *Journal of Monetary Economics* 77: 1-25.

Li, Hongyi, and Heng-fu Zou (1998). Income inequality is not harmful for growth: Theory and Evidence. *Review of Development Economics* 2(3): 318-334.

Luo, Weijie, Andrew Pickering, and Paulo Santos Monteiro (2017). Inequality and the size of government. Discussion Papers 17/02, Department of Economics, University of York.

Meltzer, Allan H., and Scott F. Richard (1981). A rational theory of the size of government. *Journal of Political Economy* 89(5): 914-927.

Perotti, Roberto (1996). Growth, income distribution and democracy. *Journal of Economic Growth* 1(2): 149-187.

Persson, Torsten, and Guido Tabellini (1994). Is inequality harmful for growth? *The American Economic Review* 84(3): 600-621.

Piketty, Thomas (2014). *Capital in the twenty-first century.* Harvard University Press, Cambridge MA.

Piketty, Thomas, and Emmanuel Saez (2006). The evolution of top incomes: A historical and international perspectives. *American Economic Review Papers and Proceedings* 96(2): 200-205.

Ram, Rati (1987). Wagner's hypothesis in time-series and cross-section perspectives: Evidence from real data for 115 countries. *Review of Economics and Statistics* 69(2): 194-204.