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Do higher public and private debt levels benefit the wealthy? An empirical analysis of top wealth shares in the UK

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Abstract

Purpose – Despite the concomitant rise in recent decades in both debt levels (public as well as private) and wealth inequality, empirical evidence on the relationship is absent in existing literature. This is striking especially since recent theoretical contributions point to a link between debt and wealth inequality. We contribute to the debate by investigating empirically whether higher levels of UK public and household debt increase the UK wealth concentration at the top 1 and 10% of the wealth distribution.

Design/methodology/approach – We employ the Autoregressive Distributed Lag (ARDL) cointegration approach with UK time series data from 1970 to 2019. For robustness, a further analysis using panel data fixed effects estimation on a cross-country sample that also includes France and the USA is undertaken. We also use bootstrapping to conservatively estimate statistical significance.

Findings – Higher levels of public and household debt are found to increase wealth concentration at the top 1 and 10%. The effect is stronger for household debt. Fixed effects estimation on a cross-country dataset supports the results for the UK.

Originality/value – This study is the first to investigate empirically whether rising levels of UK public and household debt benefit the wealthy and thus widen the gap between the "haves" and "have-nots".

Keywords Wealth inequality, Top wealth shares, Public debt, Private debt, ARDL, Panel fixed effects

Paper type Research paper

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1. Introduction

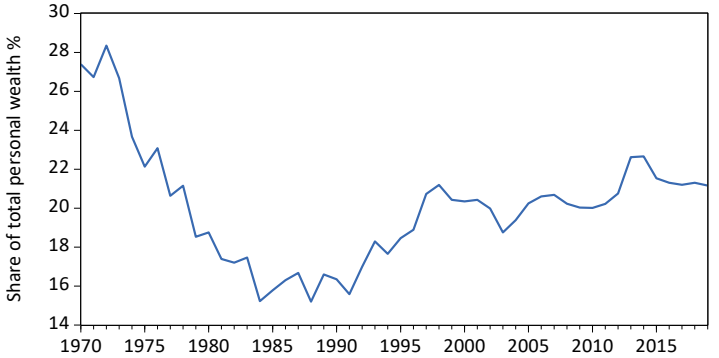
Over the last two decades, two significant phenomena particularly in many high-income, Western economies have drawn special attention: rising levels of debt (public as well as private) and a persistent widening of the uneven distribution of personal wealth. In the UK, these trends have been particularly pronounced, stimulating academic research and attracting much public interest. This article contributes to the literature studying the wealth distribution of the UK by investigating the impact of both public and household debt on the wealth shares of the top 1% and 10% of UK households.

The inequality debate gained momentum with the publication of Piketty's (2014) *Capital in the Twenty-First Century* [1], in which he warned that the tendency of returns on capital (Piketty's "r", which includes returns on bonds, stocks or any form of property) to exceed the rate of economic growth (Piketty's "g") – viewed by Piketty as the main driver of wealth concentration at the top – threatens to generate extreme inequalities [2]. Specifically, Piketty alerts to a state of affairs whereby accumulated wealth becomes more concentrated among those whose earnings come from owning capital and assets rather than from labour. Partly due to difficulties related to the measurement of the uneven distribution of personal wealth, several studies published since then have, therefore, focused on the empirical evidence pertaining to the evolution of the top wealth shares (see, *inter alia*, Kopczuk, 2015; Alvaredo *et al.*, 2018), which has now become the measure of choice to capture wealth inequality (see also Islam and McGillivray, 2020) [3].

Wealth inequality fell throughout much of the 20th century, with the proportion of UK wealth held by the richest 10% falling from more than 90% to around 50% by the 1980s. The concentration of wealth of the top 1% also decreased dramatically, from 70% in 1914 to 16% in 1980 (Alvaredo *et al.*, 2018). However, since 1980, the trend has reversed (Atkinson and Piketty, 2007; Piketty and Saez, 2003).

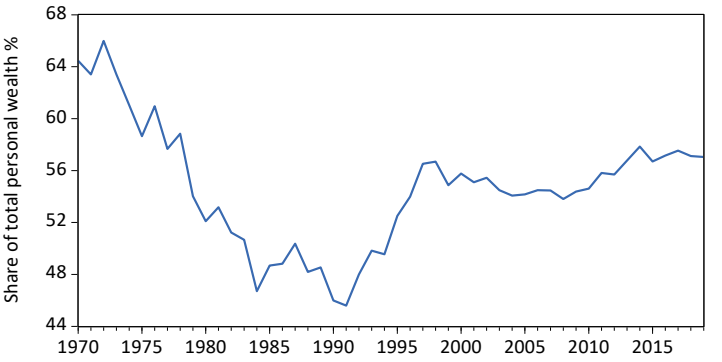
As shown in Figures 1 and 2, from the mid-1980s and early 1990s, the wealth shares of both the top 1% and 10% have risen considerably. In 2019, the richest 1% of the UK population held more than a fifth of total wealth, while the top decile captured nearly 60%.

Since the 2007/2008 financial crisis, the wealth shares of the richest have been said to have been fuelled by rising asset prices such as housing values, land and stocks rather than saving. Alvaredo *et al.* (2018, p. 26), too, highlight an increase in top wealth shares since 1980, but argue that the increase "notably" pertains to "the distribution of wealth excluding housing".



Source(s): World Inequality Database (WID)

Figure 1.
UK top 1% wealth share 1970 to 2019

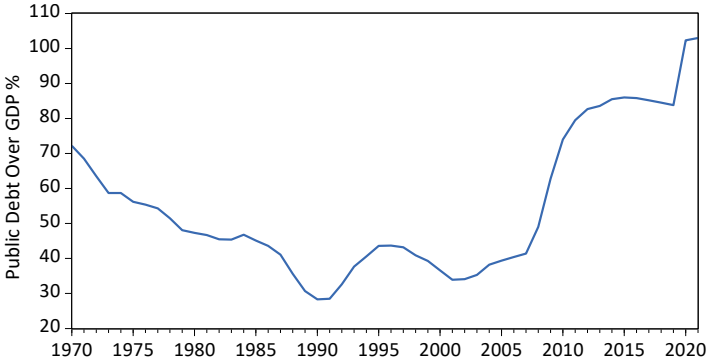


Source(s): World Inequality Database (WID)

Figure 2.
UK top 10% wealth share 1970 to 2019

Several factors have been considered as determinants of wealth concentration in relevant literature such as monetary policy (Mumtaz and Theophilopoulou, 2020), house prices (Fuller *et al.*, 2020) and mortality rates (Berman and Morelli, 2021). In this paper, we add to this literature by testing whether rising levels of UK public debt and private (household) debt may have contributed to the higher concentration of wealth at the top of the wealth distribution.

Starting with public sector debt, in March 2021 UK net debt reached 103% of GDP, the highest level since 1960. Figure 3 plots the UK public debt over GDP ratio from 1970 to 2021. From 1970 to 1990 net debt continued to fall drastically from over 70% of GDP to below 30%. This steady reduction was part of a trend primarily due to a prolonged, peace-time period of economic growth. Public sector debt then rose again but after a few years of government financial restraint, from 1995, it fell to 29% of GDP by 2002. Since then, UK's national debt has recorded a steady rise. Over the period 2002–2007, the rise was mainly due to increased government spending on health and education alongside higher social security spending. The sharp rise from 2008 to 2015 has much to do with the economic recession that followed the financial crisis, including the bailouts of Northern Rock, Royal Bank of Scotland, Lloyds and other banks. After 2015 and up to 2019, the effects of the UK government's efforts to slow down the rise in public debt by reducing the budget deficit and adopting strict spending



Source(s): European Commission's Directorate General for Economic and Financial Affairs

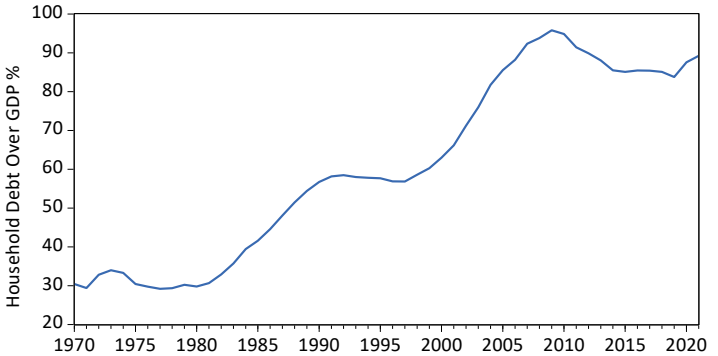
Figure 3.
UK public debt over GDP, 1970 to March 2021

limits were dampened by lower-than-expected economic growth. From 2020, net public debt as a proportion of GDP rose sharply due to the impact of the Coronavirus and associated policy measures.

Undoubtedly, the global financial crisis and, more recently, the policy measures adopted by governments worldwide to counter the coronavirus pandemic (COVID-19) impact on their respective economies have led to a severe deterioration of fiscal positions in many countries (further threatened by attempts by some administrations to tackle the cost-of-living crisis via further public sector borrowing). Hence, although 103% of GDP is a very high level of debt by post-war UK standards, it is worth noting that some other developed countries have an even bigger public debt problem. Italy and Japan are a case in point, with a national debt as a proportion of GDP of 154% and 256%, respectively. However, unlike Italy and Japan, the UK also has worryingly high levels of private (household) debt. As shown in Figure 4, UK household debt over GDP has recorded, in between modest and short-lived reductions, a staggering rise over the past 50 years, from around 30% in 1970 to 90% in 2021. Although household debt has been rising in all advanced economies over the same period, in 2021 the ratio of household debt over GDP in Japan and Italy was just over 67% and 45%, respectively. The sharp rise in UK household debt over the 1980s was in large part fuelled by a boom in consumer credit (credit cards and loans), whereas the steep increase over the decade preceding the global financial crisis can be primarily accounted for by increases in mortgage debt.

The general arguments linking debt to wealth inequality are intuitively plausible. For example, when governments borrow, they must honour interest payments to bondholders, which are usually paid out of taxes. The payment of interest on government debt must, therefore, involve a transfer of wealth from taxpayers to bondholders. Since – pension funds notwithstanding – government bonds are held to a great extent by those at the top of the wealth distribution, this tax-and-interest-payment cycle redistributes wealth in favour of the wealthy. Some recent theoretical studies have offered more sophisticated hypotheses on the mechanisms through which public debt and/or household debt may affect wealth concentration (see Maebayashi and Konishi, 2021; Borissov and Kalk, 2020; Mian *et al.*, 2021). However, this literature is not vast, and even less attention has been paid to uncovering the empirics behind the theory. Indeed, empirical evidence of the relationship is almost nonexistent.

Part of the reason for the paucity of applied work on the debt-wealth inequality nexus is the lack of good quality wealth data, over long time periods and/or for enough countries (Fuller *et al.*, 2020). For cross-countries studies, the common approach adopted to circumvent such data constraint has been to use income inequality as a proxy for wealth inequality (see,



Source(s): Bank for International Settlements (BIS)

Figure 4.
UK debt to GDP ratio for household sector

e.g. Ezrachi *et al.*, 2023). However, wealth is far more concentrated than income (Cagetti and De Nardi, 2008), thus making income inequality a poor proxy. Moreover, because wealth is an accumulated stock rather than an annual flow, its distribution tends to move more slowly than income distribution (Kopczuk, 2015).

Wealth data can be obtained from three sources: administrative data from income and inheritance tax, lists of large wealth holders and household surveys. The distribution of wealth is rarely observed directly in available administrative data. Moreover, the abandonment of wealth and sometimes inheritance taxes in some countries often makes it difficult to track top wealth holders. Rich lists partially address this gap. For example, in the UK, the Sunday Times Rich List (STRL) published by the British newspaper The Sunday Times since 1989. However, the problem with lists such as STRL is that their methodology is often opaque. For instance, STRL measures "identifiable wealth" merely from data available in the public domain, yet it excludes bank accounts and "small" shareholdings in private equity portfolios. It also lacks transparency as to the precise consideration given to liabilities. Additionally, by design, rich lists only concern a tiny fraction of the population, the "super rich". Household surveys, too, are problematic as they may not capture a fully representative sample of all individuals, and suffer from low response rates, especially from high-wealth individuals (Kopczuk, 2015). In the UK, the Office for National Statistics' (ONS) Wealth and Assets Survey (WAS) measures the well-being of households and individuals in terms of their assets, savings, debt and planning for retirement. However, WAS has been in existence only since 2006, which coupled with its biennial interview wave pattern, makes it difficult to exploit the data within a time series framework. Furthermore, WAS contains some very wealthy outliers. Finally, as Advani *et al.* (2021) observe, WAS underestimates total wealth. They find that fitting a Pareto distribution (which, since Klass *et al.*, 2006, is often taken as a good fit for skewed and heavy-tailed distributions such as those of wealth holdings) to UK wealth data, both WAS and STRL "underestimate family wealth at the very top of the distribution" (Advani *et al.*, 2021, p. 399).

In an attempt to overcome the limitations of the wealth data sources discussed above, researchers working on the World Inequality Database (WID) combined different data sources: national accounts, survey data, fiscal data and wealth rankings. The WID database can be regarded as the most reliable in tracking the evolution of wealth levels and, therefore, it is the one we draw from to collect data of the top wealth shares.

We contribute to the wealth inequality literature by examining the impact of both public and household debt on wealth inequality in the context of UK data from 1970 to 2019. Specifically, we investigate the effects of UK public and household debt on the top 1% and 10% wealth shares. We employ the Autoregressive Distributed Lag (ARDL) cointegration approach (Pesaran *et al.*, 2001). Our findings indicate that higher debt levels, both public and private, significantly increase the concentration of wealth in the top 1% and 10%. For both wealth shares, the effect is most pronounced for household debt. A further analysis using panel data fixed effects estimation on a cross-country sample that also includes France and the USA broadly attests to the robustness of our results for the UK.

2. Theoretical channels linking debt to wealth inequality

As noted earlier, the effect of public debt on wealth inequality is relatively straightforward under non-distortionary taxation. Michel and Pestieau (1998, 2005) were the first to suggest that although public borrowing is neutral in aggregate terms, it redistributes income from the poorer non-altruists to the richer altruists who own the entire capital stock and public debt. Within this two-agent framework, the rich altruists increase their equilibrium wealth by exactly the amount of increase in public debt while the poor non-altruists maintain their zero wealth. As a result, wealth inequality increases unambiguously.

Departing from a strictly steady-state perspective in which public debt converges, Maebayashi and Konishi (2021) consider how public debt affects wealth inequality in the presence of distortionary taxation, such as an income tax on the rich altruists' bond holdings. Their results can be summarised as follows. First, when the initial public debt is small, the economy can reach a stable equilibrium in which both public debt and wealth inequality converge to a stable level, but when the initial public debt is very large, the economy with higher wealth inequality can converge to a stable equilibrium whereas the economy with low wealth inequality cannot converge to any stable equilibrium. If the economy is in an unsustainable region, both public debt and wealth inequality continue to increase, and the economy goes bankrupt in the long run. Second, an increase in the public deficit ratio makes the public debt less sustainable, with wealth inequality increasing as public debt grows into an unsustainable region. Third, if the government taxes the bequests of the rich and redistributes them to the poor, the economy is more likely to fall into the region in which the public debt is not sustainable and wealth inequality continues to increase. Finally, in the long run, a rise in the public deficit ratio increases wealth inequality and reduces the growth rate. An increase in the redistributive tax reduces both wealth inequality and the growth rate, and hence, leads to the trade-off between equality and growth. However, it should be noted that in their two-period overlapping generations model, the division of the population into two income classes ("the rich" and "the poor") cannot be affected by the public debt policy. Instead, it operates on the basis of heterogeneity of agents' preferences, particularly in discount factors, and on utility deriving from a "joy of giving" savings motive, with the rich old generation bequeathing larger wealth to children than the poor old generation does.

Borissov and Kalk (2020) investigate the role of public debt in the dynamics of wealth inequality by considering an endogenous growth model with positional concerns (where agents' decisions depend not only on their absolute level of consumption but also on the perception of their social status) and public debt financed by distortionary income taxes. Their framework entails two possible regimes depending on the strength of positional externality: egalitarian and two-class. In the egalitarian regime, the wealth distribution gravitates toward full equality regardless of the initial state. In the two-class regime (the rich and the poor), the entire stock of capital and public debt is eventually owned by the dynasties which were the richest in the beginning and all other dynasties become poor. Borissov and Kalk's (2020) model advances Maebayashi and Konishi (2021) by allowing zero optimal bequests using a less stringent form of altruism and by treating agents as identical except for their initial wealth. They show that if positional concerns are not too strong, there is a threshold level of the debt-to-GDP ratio. Below the tipping point, the economy converges to a unique egalitarian balanced-growth equilibrium, whereas if this ratio is above the threshold level, the economy ends up in a two-class balanced-growth equilibrium with poor dynasties saving nothing in the long run and rich dynasties owning the entire capital stock and public debt. A key result is that the growth rate in the egalitarian equilibrium is higher than that in any possible two-class equilibrium. Hence, a reduction in public debt may cause the economy to switch from the two-class regime to the egalitarian regime and accelerate growth. Crucially, their findings also suggest that government policies aimed at reducing initial inequality using public debt may, in fact, increase wealth inequality in the long run.

Chatzouz (2020) examines the implications of public debt for wealth inequality using a stylized Diamond model where the distinction between dynamically efficient and inefficient economies (i.e. whether real interest rates are greater or lower than real economic growth) is the criterion that defines the burden of taxation. Here too, agents derive utility from bequests, with young agents inheriting income from their parents who are distinguished by their past savings and by their degree of altruism (with richer parents saving a larger fraction of their incomes). His model predicts that public debt distributes wealth unequally. The result is explained by the increase in the after-tax wage inequality driven by the general equilibrium effects of public

debt, namely the crowd-out of physical capital. Furthermore, the redistribution of resources across generations augments the effect by raising the bequest motive of the rich.

A distinct yet related contribution to the debate on the implications of high debt levels for wealth inequality comes from Mian *et al.*'s (2021) theory of indebted demand, according to which high levels of debt lower aggregate demand, and thus the natural rate of interest. Their model introduces non-homothetic consumption-saving behaviour into an otherwise conventional two-agent endowment economy, where the saver saves a larger proportion of lifetime income than the borrower. Since in the model the wealthy lend to the rest of the population, household debt is an important financial asset in the portfolio of the wealthy. This assumption too is plausible, indeed a stylized fact, as shown by Mian *et al.* (2020) who present evidence that a large part of household debt in the US reflects the top 1% of the wealth distribution lending to the bottom 90%. They find that large debt levels weigh negatively on aggregate demand: as borrowers cut consumption to pay off their debts to savers, the latter, having a higher propensity to save, only partially offset the drop in borrowers' spending. Mian *et al.* (2021) label the depressed demand resulting from elevated debt levels as "indebted demand", greater levels of which are associated with reduced natural interest rates. As Mian *et al.* (2021, p. 3) summarise, "From the perspective of savers, reduced interest rates are necessary to balance the greater desire to save in response to greater debt service payments". Their framework predicts a number of patterns found in the data, one of which, given our interest, is that a rise in top-income shares shifts resources from borrowers to savers, pushing down interest rates due to savers' greater desire to save. Lower interest rates, in turn, stimulate more debt, causing indebted demand – as debt is simply a further shift of resources in the form of debt service payments from borrowers to savers.

Although low in number, the above theoretical contributions should suffice in justifying our hypothesis that high levels of both public debt and household debt may benefit those at the top of the wealth distribution, at the expense of the rest.

As mentioned earlier, due to data availability limitations, applied studies investigating the factors that may drive wealth inequality (as opposed to income inequality) are even fewer, and empirical analyses testing the specific effect of public or household debt on the top wealth shares are inexistent, at both country and cross-country level.

Piketty's work also sparked interest in investigating the role that housing plays in the dynamics of wealth inequality and, more specifically, how house prices impact wealth-to-income ratios. This strand of literature (Bonnet *et al.*, 2014; Fuller *et al.*, 2020) has focused particular attention on another of Piketty's observations according to which, a smaller driver of rising wealth-to-income ratios can be attributed to the price effect associated with capital gains. In other words, not only do savers accumulate returns on their ownership of property, but they also benefit from any appreciation of the underlying assets. Some authors, such as Bonnet *et al.* (2014), have challenged this logic. According to Bonnet *et al.* (2014), it is rent, not housing prices, that matters for the dynamics of wealth inequality, because rent represents both the actual income of housing capital for landlords and the dwelling costs saved by owner-occupiers. As such, proper measurement of capital requires correcting the value of housing capital by measuring it on actual rental prices and not housing prices. When Bonnet *et al.* (2014) apply this adjustment, they find that the capital/income ratio is actually stable or only slightly higher in the countries in their sample (France, the US, the UK and Canada) with the sole exception of Germany.

Fuller *et al.* (2020) too, took up issue with Piketty's argument. They argued that, unlike financial assets, which are mostly held by those at the top of the wealth distribution, the wealth held via home ownership tends to be more widely distributed among middle-income earners. This would suggest that greater rates of home ownership redirect (housing) wealth towards a more egalitarian distribution. Using the wealth-to-income ratio as a proxy for overall levels of wealth inequality, Fuller *et al.* (2020) investigate the impact of house prices on wealth inequality in 13 Western European and non-European countries. They find that in

both the short and long run, wealth-to-income ratios are driven mostly by housing prices and, to a lesser extent, by price changes in other financial assets.

The absence of empirical studies investigating the impact of public and/or household debt on wealth inequality speaks volumes as to the difficulties in collecting relevant data not only on the distribution of wealth but also on variables that, going by the driving factors highlighted in theoretical models, may drive the observed wealth concentration at the top. The level of inherited wealth or bequests, which has been said to account for most of capital formation (see Cagetti and De Nardi, 2008), is a case in point, with no UK data on the intergenerational transmission of wealth being available for estimation.

3. Empirical framework and data

3.1 Empirical framework

Despite the difficulties with the availability of data discussed above, our empirical specification is as follows:

$$\begin{aligned} WEALTH_t = {} & \beta_0 + \beta_1 GOV\_DEBT\_GDP_t + \beta_2 HOU\_DEBT\_GDP_t + \beta_3 STOCK_t \\ & + \beta_4 HOUSEPRICE_t + \beta_5 RENTAL_t + \beta_6 INTRATE_t + \beta_7 WELFARE_t \\ & + \beta_8 TAX_t + \beta_9 GINI_t + u_t \end{aligned} \quad \text{Eq. (1)}$$

where *WEALTH* is wealth inequality measured by the 1% and 10% top wealth shares; *GOV_DEBT_GDP* is the ratio of public debt over GDP; *HOU_DEBT_GDP* is the ratio of household sector debt to GDP; *STOCK* is a stock share index; *HOUSEPRICE* is the UK house price index; *RENTAL* is a measure of UK rental price inflation; *INTRATE* denotes long-term (issued at par with 20 years to maturity) bond yields; *WELFARE* is total welfare spending as a percentage of GDP; *TAX* refers to natural logarithm of tax revenue; and *GINI* is a measure of income inequality.

Following Pesaran *et al.* (2001), we rewrite Eq. (1) as a conditional ARDL model:

$$\begin{aligned} \Delta WEALTH_t = {} & C_0 + C_1 t + \Sigma_{k=1}^{p} \beta_1' \Delta WEALTH_{t-k} + \Sigma_{k=0}^{p} \beta_2' \Delta GOV_{DEBT_{GDP}t-k} \\ & + \Sigma_{k=0}^{p} \beta_3' \Delta HOU_{DEBT_{GDP}t-k} + \Sigma_{k=0}^{p} \beta_4' \Delta STOCKCAP_{t-k} \\ & + \Sigma_{k=0}^{p} \beta_5' \Delta HOUSEPRICE_{t-k} \\ & + \Sigma_{k=0}^{p} \beta_6' \Delta RENTAL_{t-k} + \varphi_1 D_{wealth} + \varphi_2 D_{gov} + \varphi_3 D_{hou} \\ & + \lambda_1 \Sigma_{k=0}^{p} \beta_7' \Delta INTRATE_{t-k} + \Sigma_{k=0}^{p} \beta_8' \Delta WELFARE_{t-k} + \Sigma_{k=0}^{p} \beta_9' \Delta TAX_{t-k} \\ & + \Sigma_{k=0}^{p} \beta_{10}' \Delta GINI_{t-k} + \lambda_1 WEALTH_{t-1} + \lambda_2 GOV_{DEBT_{GDP}t-1} \\ & + \lambda_3 HOU_{DEBT_{GDP}t-1} + \lambda_4 STOCKCAP_{t-1} + \lambda_5 HOUSEPRICE_{t-1} \\ & + \lambda_6 RENTAL_{t-1} \lambda_7 INTRATE_{t-1} + \lambda_8 WELFARE_{t-1} \\ & + \lambda_9 TAX_{t-1} + \lambda_{10} GINI_{t-1} + \varphi_t \end{aligned} \quad \text{Eq. (2)}$$

where C_0 and $C_1 t$ are the drift and trend components, and D_{wealth}, D_{gov} and D_{hou} are year dummies to account for structural breaks for *WEALTH*, *GOV_DEBT_GDP* and *HOU_*

DEBT_GDP identified from the Zivot-Andrews' UR test. In Eq. (2), the long-run relationship is determined by the coefficients λs, and the short-run relationship by Σs. Following Pesaran *et al.* (2001), the null hypothesis of no cointegration (H_0: $\lambda_1 = \lambda_2 \ldots = \lambda_{10} = 0$) is tested using the *F*-statistic. We also use Banerjee *et al.* (1998) t-BDM test, with a null hypothesis of no cointegration H_0: $\lambda_1 = 0$ against H_1: $\lambda_1 < 0$. The computed test statistics are then compared with two sets of critical values, upper and lower. If the estimated value of the *F* or t-BDM statistic lies above the upper critical bound, the null is rejected, indicating the existence of a long-run relationship.

One advantage of the ARDL cointegration approach is that it is applicable when it is not known with certainty whether the variables are *I(0)* or *I(1)*. However, since the method requires that no variable be *I(2)* or higher, we still test for the order of integration of all the variables. We employ the Phillips and Perron (1988) unit root (UR) test and, to account for a structural break, the Zivot and Andrews (1992) UR test. Although our interest centres on the long-run equilibrium relationship, as originally noted by Pesaran and Shin (1999), another virtue of the ARDL approach lies in the rich set of dynamics of the underlying ARDL specification, which allows the ARDL-based estimator to satisfactorily address potential endogeneity problems [4].

By way of robustness, we then extend the analysis to a cross-country setting by estimating a fixed effects panel data model for the UK, USA and France for the period 1980–2019. Eq. (1) can, therefore, be rewritten as:

$$\begin{aligned} WEALTH_{it} = {} & \beta_0 + \beta_1 GOV\_DEBT\_GDP_{it-1} + \beta_2 HOU\_DEBT\_GDP_{it-1} + \beta_3 STOCK_{it-1} \\ & + \beta_4 HOUSEPRICE_{it-1} + \beta_5 RENTAL_{it-1} + \beta_6 INTRATE_{it-1} \\ & + \beta_7 WELFARE_{it-1} + \beta_8 TAX_{it-1} + \beta_9 GINI_{it-1} + u_t \end{aligned} \quad \text{Eq. (3)}$$

where the subscript *i* refers to country *i*. We estimate Eq. (3) with a fixed effects regression with Driscoll-Kraay standard errors (Driscoll and Kraay, 1998), which are robust to general forms of cross-sectional dependence and general serial correlation across time when the temporal dimension becomes large. To mitigate the potential endogeneity problem, following De Vita and Luo (2021), we lag all independent variables by one year.

3.2 Data

We estimate Eq. (2) using annual UK data over the period 1970–2019. Although WID wealth data stretch even further back, the start date of our sample is dictated by the availability of UK public debt data, which only goes as far back as 1970. The end date (2019) is dictated by the advent of the COVID-19 pandemic, consideration of which would skew the data. Fifty observations may seem a fairly small sample, however, given that cointegration is concerned with the long run, our low frequency ensures that the dataset covers a long period spanning half a century, thus rendering possible an analysis of long-run convergence in the relationship under scrutiny [5].

In terms of control variables, we begin by including variables reflecting the three types of capital investment highlighted in Piketty's wealth inequality hypothesis, namely stock, government bonds, and real estate. We, therefore, control for the share price index (*STOCK*), the interest rate on long-term government debt (*INTRATE*) and the house price index (*HOUSEPRICE*). The first two variables are expected to increase the concentration of top wealth shares while, given the widespread ownership of property across the wealth distribution, house prices may not necessarily have a positive effect on top holders of

wealth. Based on Bonnet *et al.*'s (2014) arguments, we also include a measure of UK rental price inflation (*RENTAL*) based on *rental price* rather than *housing price*. Furthermore, we control for social welfare spending (*WELFARE*), which by its redistributive nature may be expected to decrease wealth inequality. We also account for taxation (*TAX*), specifically revenues from taxes on income and investment profits. The UK has a form of progressive taxation which limits the amount of after-tax income that individuals/households can direct towards capital investment (Piketty and Saez, 2003). Higher tax revenues are likely to reflect higher taxation for richer groups, thereby reducing the potential for wealth accumulation. Finally, we control for income inequality using the Gini index (*GINI*). Although earnings from labour may not necessarily correlate with the wealth concentrated at the top (on this point, see Benhabib *et al.*, 2017), the Gini index may capture wage effect disparities stemming from the influence of competition policy and enforcement on the competitiveness of labour markets, a variable for which data covering our full sample period is unavailable (e.g. the competition law index by Bradford and Chilton, 2018, ends in 2010).

Table 1 presents descriptive statistics for our time series' estimation variables. All of the values appear to be reasonable and concord with prior studies' reports. Over the sample period, the average wealth shares of the top 1% is 19.88% with a standard deviation of 3.07%, and for the top 10% is 54.11% with a standard deviation of 4.77%. On average, the level of household debt-to-GDP ratio (mean = 59.6915) is higher than the level of government debt-to-GDP ratio (mean = 53.4314). Table 2 presents the correlation coefficients of the variables, and their respective statistical significance, showing fairly reassuring values. The definition of each variable, and their respective sources, are detailed in Appendix 1.

4. Results

Table 3 presents the results of the UR tests using Phillips and Perron (1988) in columns (1) and (2), and Zivot and Andrews (1992) in columns (3) to (5). The two UR tests show some discordance. According to the former, all series are *I(1)* in levels and first-difference stationary while going by the Zivot and Andrews' test, *HOU_DEBT_GDP*, *STOCK*, *RENTAL*, *HOUSEPRICE*, *WELFARE*, *TAX* and *GINI*, are already *I(0)* in levels. We attribute the discrepancy to the fact that the Zivot and Andrews' test accounts for a structural break in the evolution of the series. However, reassuringly, both tests confirm that

	Mean	Median	Max	Min	Std. Dev
TOP1	0.1988	0.1993	0.2835	0.1520	0.0307
TOP10	0.5411	0.5381	0.6599	0.4559	0.0477
GOV_DEBT_GDP	53.4314	46.9911	86.9232	28.8663	18.2725
HOU_DEBT-GDP	59.6915	57.8750	95.8000	29.2000	23.1943
STOCK	51.9162	49.2266	111.8835	3.2205	37.56223
RENTAL	0.0695	0.0489	0.2898	0.0046	0.0593
HOUSEPRICE	0.0892	0.0785	0.3757	−0.0888	0.0939
INTRATE	46.1703	30.4589	120.9515	2.1276	38.5010
WELFARE	7.6189	7.9661	14.7658	0.9358	4.1691
TAX	7.9228	6.0600	16.9700	4.7500	4.1147
GINI	31.3660	33.5000	34.4000	25.6000	3.2801

Source(s): Authors' calculations

Table 1.
Descriptive statistics

	TOP1	TOP10	GOV_DEBT_GDP	HOU_DEBT-GDP	STOCK
TOP1	1				
TOP10	0.9621***	1			
GOV_DEBT_GDP	0.5904***	0.6316***	1		
HOU_DEBT-GDP	−0.0492	−0.1174	0.3044**	1	
STOCK	0.0008	−0.0608	0.3217**	0.9106***	1
RENTAL	−0.0519	0.0038	−0.2334*	−0.7513***	−0.7695***
HOUSEPRICE	0.2115	0.2614*	−0.1655	−0.4515***	−0.3761***
INTRATE	−0.6497***	−0.6718***	−0.3782***	−0.2096	−0.3055**
WELFARE	−0.3145**	−0.3614***	0.1239	0.9294***	0.9199***
TAX	−0.3158**	−0.4266***	−0.0647	0.8565***	0.8583***

	HOUSEPRICE	INTRATE	WELFARE	TAX	GINI
HOUSEPRICE	1				
INTRATE	0.3206**	1			
WELFARE	0.1081	−0.0161	1		
TAX	−0.6781***	−0.4462***	−0.1005	1	
GINI	−0.7436***	−0.4372***	−0.0124	0.9087***	1

Note(s): Variables are defined in Appendix 1. All pairwise correlations are calculated using the maximum number of observations available in the sample. *, ** and *** denote statistical significance at the 10, 5 and 1% level

Source(s): Authors' calculations

Table 2.
Correlation matrix

Variables	Phillips-Perron test statistic		Zivot-Andrews test statistic		
	(1)	(2)	(3)	(4)	(5)
	Level	First-difference	Level	First-difference	T_b
TOP1	−2.533	−7.122***	−4.849 (1)	−8.632 (0)***	1984
TOP10	−2.160	−7.620***	−4.961 (1)	−9.980 (0)**	1984
GOV_DEBT_GDP	−1.522	−2.924***	−3.779 (1)	−5.119 (0)***	2008
HOU_DEBT_GDP	−1.852	−2.189**	−4.125 (2)**		2011
STOCK	−0.345	−4.447***	−5.217 (1)***		1996
RENTAL	−2.712	−3.557***	−7.494 (1)***		1983
HOUSEPRICE	−1.759	−6.492***	−6.006 (1)**		1998
INTRATE	−2.636	−4.978***	−2.071 (5)	−7.349 (4)***	1983
WELFARE	−0.052	−5.303***	−5.507 (1)***		1982
TAX	−0.810	−4.006***	−3.328 (1)***		2008
GINI	1.384	−2.373**	−3.346 (2)***		1985

Note(s): The optimal lag structure of the PP test is chosen based on the Newey–West bandwidth with Bartlett weights and is displayed in parentheses. TB denotes the time of break. The optimal lag structure of the Zivot and Andrews' (1992) test is chosen based on the Schwarz Information Criterion and is displayed in parentheses. For all PP tests, a constant and a time trend are included for the regressions in levels, but the time trend is removed in the first difference equations. ***, **, * denote the rejection of the null of a unit root at 1, 5 and 10%, respectively

Source(s): Authors' calculations

Table 3.
Unit root tests

none of the variables are *I(2)* or higher. Hence, we can safely proceed to apply the ARDL bounds testing approach to cointegration.

Table 4 presents the results of the ARDL regressions on the top 1% and 10% wealth shares. For both regressions, the *F* and t-BDM test statistics exceed the upper critical bounds

Variables	Dependent variable: Coefficients	Top 1% *t*-statistics	Dependent variable: Coefficients	Top 10% *t*-statistics
Long-run coefficients				
GOV_DEBT_GDP	0.0008**	2.4933	0.0011**	2.3661
HOU_DEBT-GDP	0.0018***	4.6466	0.0013***	3.1170
STOCK	0.0006***	2.9721	0.0010***	4.0697
HOUSEPRICE	−0.0161	−0.4825	0.0352	0.9667
RENTAL	0.0697	1.1128	0.0189	0.1868
INTRATE	−0.0049	−1.4172	−0.0011	−0.3663
WELFARE	−0.0027***	−4.3084	−0.0025***	−2.7944
TAX	−0.0169	−1.0026	−0.0655***	−3.0464
GINI	0.0006	0.2396	−0.0017	−0.5705
Error correction terms (ECTs)				
Coint. Eq(−1)*	−0.9689***	−8.1980	−0.9346***	−9.5571
Diagnostics	*F*-statistics	*p*-value	*F*-statistics	*p*-value
SC	2.4774	0.1052	1.1446	0.3345
HETER	0.9648	0.5281	1.2867	0.2671
NORM	2.1702	0.3378	3.9800	0.1366
CUSUM	Yes		Yes	
Bounds testing for cointegration				
F-statistics	4.9925***		6.8935***	
t-BMD	−6.1118***		−6.9350***	
Linearity test	*t*-statistics	*p*-value	*t*-statistics	*p*-value
RESET	1.3281	0.1962	1.4721	0.1530

Note(s): At the 1%, 5% and 10% level of significance, the pair of critical values (bound) for the *F*-statistics and *t*-BMD are 2.97–4.24 and −3.96 to −5.79, 2.43 to 3.56 and −3.41 to −5.15, 2.16 to 3.24 and −3.13 to −4.82. SC denotes the Breusch and Godfrey serial correlation test, HETER denotes the Breusch and Pagan heteroscedasticity test and NORM denotes the Jarque–Bera test for normality. RESET denotes the Ramsey RESET regression specification error test to test for linearity. In our regressions, we include (though not report) three-year dummy variables to account for the structural breaks identified in the UR tests in Table 3: TOP1 and TOP10 in 1984, GOV_DEBT_GDP in 2008 and HOU_DEBT_GDP in 2011

Source(s): Authors' calculations

Table 4. Impact of debt on top 1% and top 10% (time series estimation: UK)

at customary significance levels. We, therefore, conclude that there is a long-run (cointegration) relationship among the selected variables [6].

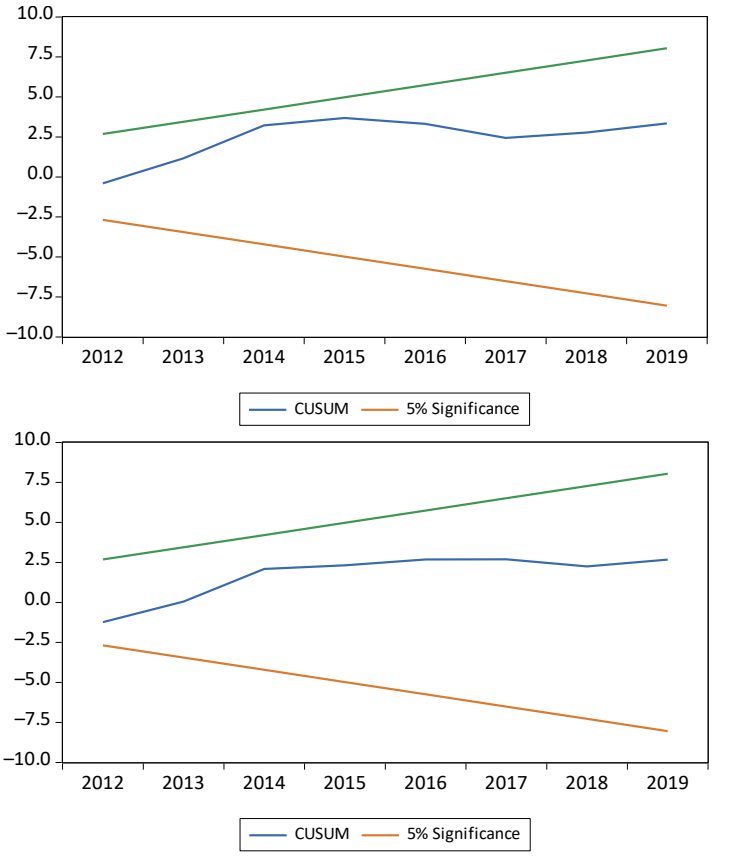
Although Table 4 also reports the error correction terms (ECTs) of the short-run equations [7], our central interest lies in the long-run estimates. The estimated long-run coefficient of *GOV_DEBT_GDP* is positive and statistically significant at the 5% level for both regressions on the top 1% and 10% wealth shares with estimated coefficients of 0.0008 and 0.0011, respectively. Similarly, with estimated coefficients of 0.0018 and 0.0013, *HOU_DEBT_GDP* is positive and statistically significant (at the 1% level) for both regressions. The results are consistent with the predictions of previous theoretical studies that high levels of public and household debt may increase wealth at the top of the distribution (e.g. Borissov and Kalk, 2020; Mian *et al.*, 2021). With respect to our control variables, the investment return on stocks (*STOCK*) shows a positive and statistically significant effect (at 1%) on both top wealth shares, a finding consistent with Piketty's wealth inequality hypothesis. The results also show that more welfare spending (*WELFARE*) reduces the top 1% and 10% wealth

shares, with statistically significant coefficients across the two specifications. On the other hand, higher revenues from taxation (*TAX*) reduce the top 10% wealth share but not the top 1%. The negative estimated coefficients of *TAX* and *WELFARE* might be explained by the fact that: (1) *ceteris paribus*, people in the bottom wealth share stand to benefit more (and lose less) from increased welfare spending than those in the top wealth share; and (2) higher tax revenues are likely to reflect higher taxes for high-income earners (the rich) but not necessary the wealthiest group (the richest 1%). *HOUSEPRICE*, *RENTAL* and *INTRATE* do not show any effect on top wealth shares at any acceptable statistical level of significance.

Diagnostic tests reassure about the validity of the model. There is no evidence of serial correlation and heteroscedasticity, and normality holds. Additionally, the cumulative sum (CUSUM) tests for structural stability (Figure 5) confirm that the parameters are stable.

5. Robustness

As noted earlier, issues related to data availability and degrees of freedom in particular, impose considerable limitations for estimation within a single-country time series framework. The same constraints apply to conducting robustness tests. Given that



Source(s): Authors' computations

Figure 5.
Cumulative sum (CUSUM) test for top 1% and top 10% wealth shares

increasing levels of both debt and wealth inequality are patterns common to many advanced economies, in order to address this challenge, we test the robustness of our results by extending the analysis to a small cross-country, panel data setting that includes in addition to the UK, the US and France [8].

At the cost of losing early time series data for the years from 1970 to 1979 (social spending data are only available from 1980), the panel data setting allows us to gain relevant cross-sectional data for two other countries, up to 2019, thus raising the number of available observations from 50 to 117. Such cross-country approach also warrants us an opportunity to: (1) assess the sensitivity of our main results to a different estimation method, namely, panel fixed effects, and to alternative, international measures of a selection of variables included in our model [9]; and (2) control for, through the use of dummies, country specific and time invariant effects.

The results of this panel data permutation, presented in Table 5, broadly corroborate the time series results for the UK. Our key variables of interest "public debt" and "household debt" are both statistically significant at the 1% level under both the top 1% and 10% wealth shares specifications. The magnitudes of the respective estimated coefficients are also similar to those of Table 4. Specifically, household debt is found to have a stronger impact on the top 1% and 10% wealth shares than public debt (almost double the effect), with estimated coefficients for *HOU_DEBT_GDP* recording magnitudes of 0.0010 and 0.0014, respectively.

In terms of control variables, *STOCK* is confirmed to have a positive and statistically significant effect (at 1%) on both top wealth shares, with estimated coefficients of very similar magnitudes to those of Table 4. Interestingly, under these panel data estimations

	Top 1%	Top 10%
GOV_DEBT_GDP	0.0005**	0.0008***
	(0.0002)	(0.0001)
HOU_DEBT-GDP	0.0010***	0.0014***
	(0.0003)	(0.0002)
STOCK	0.0007***	0.0006***
	(0.0001)	(0.0001)
INTRATE	−0.0020	0.0000
	(0.0013)	(0.0015)
HOUSEPRICE	−0.0011***	−0.0010***
	(0.0003)	(0.0002)
RENTAL	0.2577***	0.0863
	(0.0731)	(0.1443)
SOCIALSPEND	0.0015	−0.0016
	(0.0010)	(0.0010)
TAX	0.0008	−0.0002
	(0.0018)	(0.0015)
GINI	−0.0013	−0.0027
	(0.0010)	(0.0016)
No. of observations	117	117
No. of countries	3	3
R2	0.8552	0.8422

Note(s): The Hausman test is used in all regressions to inform the choice between fixed- and random-effects specifications, p-value = 0.000 rejects the null hypothesis that the coefficients are the same between fixed and random effects. All independent variables have a lag of one year. Constants are not reported. Driscoll-Kraay standard errors are reported in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$ and $^{*}p < 0.1$ denote statistical significance at the 1, 5 and 10% level, respectively

Source(s): Authors' calculations

Table 5. Impact of debt on top 1% and top 10% wealth shares (panel estimation: UK, US and France)

HOUSEPRICE becomes statistically significant (at 1%), but with negatively signed estimated coefficients of 0.0011 and 0.0010 under the top 1% and top 10% specifications. On the other hand, our house *RENTAL* price variable, becomes significantly positive under the top 1% wealth share specification, but stays insignificant under the top 10% specification. We rationalise the negative effect of house prices (*HOUSEPRICE*) on top wealth shares on the basis of the fact that, as noted by Fuller *et al.* (2020), the value of the (housing) wealth held via home ownership is more widely distributed among middle-income earners. It follows that rising house prices may actually reduce the wealth disparity as measured solely by top shares, as analysed here. This also means that there is no inherent conflict between our results and those by Fuller *et al.* (2020), whose estimates show a positive coefficient for house prices on regressions taking the "wealth-to-income ratio" as a proxy for overall levels of wealth inequality, which as discussed earlier, heavily underestimates inequality in the upper tail of the wealth distribution (on this point, see also Islam and McGillivray, 2020).

Our results for *RENTAL* align even more closely to the arguments and evidence put forward by Bonnet *et al.* (2014), according to whom it is rent, not housing prices, that matter for wealth inequality (at least as far as top wealth shares are concerned). Since according to this logic house rent also represents the actual income of housing capital for owners of large property portfolios, *RENTAL* can constitute a substantial form of return on capital investments for the very rich. This is consistent with our result of a positive and significant coefficient of very large magnitude (0.2577) for the top 1% wealth share but not for the top 10% of wealth holders, for whom such returns are evidently of lesser significance.

Finally, tax and social spending become statistically insignificant in these panel estimations. These results suggest that existing taxes on income and profits as well as welfare spending targeting the needy via family and children, unemployment and housing benefits as well as social protection measures adopted to combat poverty, do not significantly reduce wealth inequality measured against wealth holders at the top of the wealth distribution.

6. Conclusions

Although at the theoretical level several recent studies have hypothesised a relationship between debt and wealth inequality, empirical evidence on whether public and household debt impact on top wealth shares is lacking. Using UK time series data on the top 1% and 10% wealth shares, we filled this gap by letting the available data speak.

Using an ARDL approach to cointegration on UK data from 1970 to 2019, our results show that higher debt levels, both public and private, increase concentration in the top 1% and 10% wealth shares. For both top wealth shares, the effect is most pronounced in the case of private, household debt. Higher stock value is also found to increase wealth inequality while welfare spending and general taxation have a negative effect.

Fixed effects panel estimation on a small cross-country dataset provides broad support to the time series results for the UK. These robustness estimations confirm that the wealthiest 1% and 10% benefit from increases in both public and household debt levels as well as rises in the value of stock. The panel estimates also suggest that while rising house prices have a mitigating effect on wealth inequality, thereby reducing disparity across the wealth distribution, rising rental housing values substantially increase the wealth captured by the richest 1%. Under these cross-country specifications, the top 1% and 10% wealth shares are not significantly moved by social spending, taxation, and interest rates.

Policy towards inequality in the form of progressive taxes aimed at achieving vertical equity is often criticised for generating both a disincentive effect to greater earnings from labour and moral hazard resulting from redistribution in favour of the welfare state. These

criticisms, which apply to taxing income from labour mostly to address poverty, appear to lose relevance in the context of taxing wealth, particularly wealth concentrated at the top of the distribution. These considerations make it all the more striking that wealth, whether acquired through capital gains, inheritance or ownership of land and property, remains relatively under-taxed compared to income from labour or even consumption.

Our findings, by demonstrating the significant role high debt levels play in fuelling the increase in top wealth shares, highlight the importance that policy should play in preventing the accumulation of large public deficits and high levels of household debt as a way to reduce rising wealth inequity. This is consistent with Borissov and Kalk (2020) who suggested that government policies aimed at reducing initial inequality using public debt may, in fact, increase wealth inequality in the long run. Our findings also suggest a potential virtuous cycle in taxing high wealth more effectively (rather than relying solely on general taxation and welfare spending in the fight against inequality) as government revenue raised in this way would reduce the need for higher government borrowing which, in turn, would avoid further debt-induced rises in the wealth concentrated at the top.

Notes

1. The reason why inequality has recently made its way to the centre of attention in political debate and academic research has obviously much to do with the new "gilded age" of growing inequality where top wealthholders accumulate wealth at an almost unprecedented scale. But, of course, the debate has been around for centuries among social scientists and historians, concerning itself not only with poverty but with the ethics of an uneven distribution of wealth, a dichotomy eloquently captured in Shakespeare's *King Lear* where the nobleman Gloucester, enunciates: "So distribution should undo excess, And each man have enough" (King Lear, Act 4, Scene 1).

2. For West European nations, the socio-political consequences of further unequal allocation between the "haves" and "have nots" cannot be overstated. To the extent that such inequity is perceived as unfair and illegitimate, extreme wealth inequality could foment social division and civil conflict. It should come as no surprise, therefore, that "reducing inequality" also features as a UN Sustainable Development Goal (UNSDG 10).

3. The wealth-to-income ratio is a highly imperfect measure of wealth inequality. As Fuller *et al.* (2020) note, it may alert us to general trends in wealth inequality, but it could only do so contingent upon certain conditions. Moreover, the ratio reflects, at best, the overall level of wealth distribution while contemporaneously underestimating inequality in the upper tail. As Islam and McGillivray (2020, p. 3) highlight, "the top wealth holders may experience faster growth of their wealth, whereas the bottom wealth holders may experience slower or even decrease their wealth growth".

4. We, therefore, account for the possibility that there may be feedback or reverse causality effects running from wealth inequality to public debt levels via government policies aimed at reducing initial inequality using public debt (see Borissov and Kalk, 2020).

5. As Hakkio and Rush (1991, p. 579) note, because "cointegration is a long-run property, [. . .] we often need long spans of data to properly test it". Similarly, Shiller and Perron (1985) argue that when testing for URs, the length of the time series is far more important than the frequency of observation. Finally, Taylor (1995, p. 112) states that the deficiency of using less than 50 annual observations "should be compensated by the fact that the data set spans nearly half a century".

6. Asymptotic critical values for the t and F cointegration tests are in Pesaran *et al.* (2001). However, it is well known that for these tests p-values using the tabulated values are likely to be oversized (Cushman *et al.*, 2023). Thus, we also used the bootstrapping procedure of McNown *et al.* (2018) which yields more conservative results than does use of tabulated critical values. We find that even when using bootstrapped critical values a cointegrating relationship is confirmed among the variables at the 1% significance level for the t-BMD test under both the top 1% and 10% wealth share specifications (with bootstrapped critical values of −3.06 and −4.43, respectively) and at the

5% significance level for the *F*-test (with values of 4.64 and 4.41 for the respective wealth share model specifications).

7. The ECTs, −0.9689 and −0.9346 for the top 1% and 10% models respectively, are statistically significant, suggesting that it takes just over one year for full adjustment from short-run disequilibrium to long-run equilibrium to be completed.
8. We were unable to add additional countries since social spending data from 1980 are only available for the UK, France and the US.
9. In the panel data analysis, due to data availability limitations, we use the ratio of social spending over GDP as a proxy for welfare spending. The long-term interest rate used in the panel analysis is the 10 years long-term bond yields. Additionally, we use the house price index in the panel estimation while the change in the house price index is used in the time series estimations. The definition of each variable and their respective sources are detailed in Appendix 2.

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Appendix 1

Variables	Variable definition	Sources
TOP1	Share of Top 1% in net personal wealth	World Inequality Database (WID)
TOP10	Share of Top 10% in net personal wealth	WID
GOV_DEBT_GDP	General government debt over GDP ratio	European Commission's Directorate General for Economic and Financial Affairs (AMECO)
HOU_DEBT-GDP	Debt-to-GDP ratio for household sector	Bank for International Settlements (BIS)
STOCK	A share price index measures how the value of the stocks in the index is changing	OECD Macroeconomic Indicators database
RENTAL	Change for consumer price indices (CPIs) for actual rentals for housing	OECD Main Economic Indicators Database
HOUSEPRICE	Change of house price index. House price index captures changes in the value of residential properties and uses sales data collected on residential housing transactions, whether for cash or with a mortgage	Office for National Statistics (ONS)
INTRATE	Long-term bond yields are issued at par with 20 years to maturity	International Monetary Fund, retrieved from FRED, Federal Reserve Bank of St. Louis
WELFARE	Ratio of welfare spending over GDP; welfare spending includes family and children benefits, unemployment, housing, social exclusion, R&D social protection and social protection	HM Treasury PESA, retrieved from ukpublicspendng.ac.uk
TAX	Natural logarithm of tax revenue. Tax revenue is defined as the revenues collected from taxes on income and profits, social security contributions, taxes levied on goods and services, payroll taxes, taxes on the ownership and transfer of property, and other taxes	OECD Macroeconomic Indicators database
GINI	Measure of inequality derived from the Lorenz curve	SWIID Version 6.9 (Solt, 2019)

Source(s): Authors' own creation

Table A1. Variables and sources for time series estimation

Appendix 2

Variables	Variable definition	Sources
TOP1	Share of Top 1% in net personal wealth	World Inequality Database (WID)
TOP10	Share of Top 10% in net personal wealth	WID
GOV_DEBT_GDP	General government debt over GDP ratio	European Commission's Directorate General for Economic and Financial Affairs (AMECO) and FRED, Federal Reserve Bank of St. Louis
HOU_DEBT-GDP	Debt-to-GDP ratio for household sector	Bank for International Settlements (BIS)
STOCK	A share price index measures how the value of the stocks in the index is changing and refers to how much money investors would make as a result of investing in that basket of shares	OECD Main Economic Indicators database
RENTAL	Consumer price indices (CPIs) for actual rentals for housing	OECD Main Economic Indicators database
HOUSEPRICE	The real house price index is given by the ratio of the nominal house price index to the consumers' expenditure deflator in each country from the OECD national accounts database. It covers the sales of newly built and existing dwellings, following the recommendations from the Residential Property Prices Indices (RPPI) manual	OECD Main Economic Indicators database
INTRATE	Long-Term bond yields are issued at par with 10 years to maturity	OECD Main Economic Indicators database
SOCIALSPEND	Ratio of social spending over GDP. Social expenditure comprises cash benefits, direct in-kind provision of goods and services, and tax breaks with social purposes. Benefits may be targeted at low-income households, the elderly, disabled, sick, unemployed, or young persons	OECD Main Economic Indicators database
TAX	Ratio of tax revenue over GDP. Tax revenue is defined as the revenues collected from taxes on income and profits, social security contributions, taxes levied on goods and services, payroll taxes, taxes on the ownership and transfer of property, and other taxes	OECD Macroeconomic Indicators database
GINI	Measure of inequality derived from the Lorenz curve	SWIID Version 6.9 (Solt, 2019)

Source(s): Authors' own creation

Table A2. Variables and sources for panel data estimation

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