Long-run trends in top income shares: The role of income and population growth

Carla Krolage[1] · Andreas Peichl[2] · Daniel Waldenström[3]

Abstract

This paper studies the sensitivity of long-run trends in top income shares to differences in top-share measures. While the standard measure fixes a share of the population, we define alternatives that allow variation in both incomes and size of the top group based on defining absolute income thresholds. In an application to United States data, we find that top income share trends over the past century vary somewhat depending on the measure used. Allowing top groups to increase in size after 1980 along with overall economic growth results in a larger increase of top income shares. The historical drops before WWII are sensitive to the choice of income deflator: using GDP inflates interwar top income shares but using CPI deflates them. Altogether, these results recommend using complementary approaches to defining top income groups when measuring long-term top income share trends.

Keywords Income distribution · Inequality · Top incomes · Growth · Measurement

1 Introduction

Measuring long-term trends in income inequality using top income shares is challenging, since inequality is a multi-faceted outcome and no single measure can capture all relevant aspects. The standard top income measure uses a fixed population share and measures its share of total personal income. This top income share meets many of the desired distributional criteria of a relative inequality measure, but there are some aspects that it does not

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fully account for. One is the role of overall income growth, which may lift the incomes of entire groups such that the number of top income earners increases in the economy. Another aspect is population growth, which mechanically increases the size of top groups and, if population growth disproportionately increases the bottom of the distribution, of their income shares even when their incomes do not change at all.

In this study, we examine how the long-run evolution of top income shares in the United States over the twentieth century is influenced by using different top share measures that incorporate the role of income and population growth in different ways.[1] We use three alternative measures of top income shares that are based on absolute and hybrid inequality approaches, aimed to complement the standard (relative) measure in the literature. Two of the measures are based on a fixed income threshold that corresponds to a certain top fractile – say, the top 1 percent – in a given year, which is deflated over time using either consumer prices (our first alternative measure) or GDP (our second measure). The third measure instead defines a fixed top group in terms of number of units, for example the top 1 million earners, and then tracks their income shares over time.

The idea behind using these alternative top income shares is that they capture different relevant aspects of income inequality than the standard top share measure does. Atkinson (2007) highlights that not only the income share of the top group matters, but also whether the rich have become more numerous. A growing population implies that the size of the top group grows regardless of whether the incomes of its top earners change in real or even relative terms. Productivity growth that lifts the population to income levels previously only enjoyed by the rich would not change income shares of a top group defined as a fixed fractile of the population. Whether these properties are desirable for a top income inequality measure in times of population and economic growth or not depends on the research question. As over the past century, the US population has tripled and real per capita GDP has increased more than fivefold (see Figs. A.1 and A.2 in the Supplementary Material), it may be of first-order relevance to analyze how these factors influence inequality trends. By fixing the number of top earners, as in our final alternative measure, we remove the impact of population growth on the top income share. In the standard measure, top shares may increase as the population grows simply because the size of the top group has increased as it is a fixed share of the total. Of course, the population growth effect on top income shares can be either positive or negative. A positive effect arises if population growth mainly implies adding low-income earners, perhaps due to immigration of low-skilled people. This would make the top group expand mechanically as it is a fixed share of the total, and lead to an inclusion of more relatively well-paid individuals. The standard top share measure would then increase even though the real incomes of the top earners had not changed at all. Therefore, the new top income measures account for such changes and therefore complement the standard approach.

Our analysis extends the literature on absolute versus relative inequality measurement to top income shares. The baseline top income share measure is a relative one, while our three alternative measures are either hybrids (those fixing a relative income threshold and

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then deflating to capture absolute income changes) or a purely absolute measure (fixed top group). Relative inequality measures have been by far the most widely used, and for good reason.[2] Relative income measures are scale-invariant, allowing for comparisons over time despite changes in overall population size or incomes earned. However, the inability of relative income measures to reflect changes in the structure of incomes or income groups has spurred discussions among inequality researchers about whether one should always favor relative over absolute notions of inequality (see, e.g., Atkinson and Brandolini (2010) and Bosmans et al. (2014), in the context of global inequality measurement).[3]

In addition to this academic debate, survey evidence suggests that many people perceive absolute (rather than relative) differences in incomes as being an important aspect of inequality (see, e.g., Amiel and Cowell 1992, 1999). Therefore, in addition to the well-known relative measures, other inequality measures that reflect either absolute (see, e.g., Kolm 1976a, 1976b, Blackorby and Donaldson 1980) or intermediate (see, e.g., Bossert and Pfingsten 1990) notions of inequality have been proposed in the literature. While absolute (or intermediate) versions of various inequality measures (such as the Gini coefficient) have been proposed, this has not been the case for top income shares. We therefore contribute to this literature by providing alternative top income shares that allow for other notions of inequality compared to the standard relative approach.

Our findings show that the long-run inequality trends are indeed sensitive to the choice of top income-share measure. Compared to the standard one, we find that the secular decrease up to the 1980s is larger when using GDP-deflated top incomes and a fixed top group but smaller when using CPI-deflated top incomes. This variation reflects several things, but among them the fact that economic hardship during the wars and the economic crises caused the top groups to shrink in size. In the post-1980 era, the standard top shares have increased by an order of magnitude, e.g., the top percentile share has almost doubled between 1980 and 2010. However, both the CPI- and GDP-deflated top income shares have increased at an even faster pace. In addition to experiencing a higher income growth, these measures reflect that the top groups have also grown in size; more people today qualify as top income earners than they did 30 years ago when required to earn the same absolute income as in that era. The steeper top income share trend when using GDP-deflated incomes suggests that productivity growth in society has been disproportionately reaped by top earners.[4] Looking at the measure using a fixed number of top earners, the share is actually lower than the standard measure, reflecting a relative shrinkage of this group.

We also find interesting patterns for the top groups just below the highest percentile, suggesting heterogeneous influences from population and economic growth on top incomes. In contrast to the expanding group size observed in the top percentile, we observe rather stable population shares in lower top brackets using the two fixed-income threshold measures (the fixed number of earners measure is, of course, unchanged). Their average incomes are also relatively similar to the standard top measures, which jointly results in limited growth, or even a slight decrease, in the income share of these groups. In other words, the proportion of individuals with above-average productivity gains are found almost exclusively in the highest-earning percentile, not in top groups lower down the distribution.

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[2]Note, however, that there is also some criticism of relative measures which can lead to paradoxical results in certain situations (Chakravarty and Sarkar 2021).

[3]See, e.g., Foster (1998) and Decerf (2017) for the literature on absolute vs. relative poverty measurement and Peichl et al. (2010) for a comprehensive discussion and analysis of relative and absolute inequality measures when analyzing affluence.

[4]See Dew-Becker and Gordon (2005) for an early discussion of the distribution of US productivity growth.

We decompose the different top percentile measures' post-1980 growth into their underlying factors. This allows us to more precisely identify to which extent the development of top income share measures is driven by changes in average top incomes, changes in the number of taxpayers and changes in the lower part of the earnings distribution.

Finally, when running the analysis across income sources, we investigate the extent to which the increasing importance of wage income is attributable to increasing numbers of taxpayers belonging to the top percentile. While the baseline results show an increasing importance of wage incomes at the top, our results point to a more nuanced development. We find that for the very top, the relative importance of wages vis-à-vis capital and entrepreneurial income has been slightly declining over the past three decades.

The contributions of our study are directed primarily at the income inequality literature. While we are not the first to examine how different measurement approaches influence top income share trends, previous studies have focused on the concept of income, for example the effect of subtracting taxes and adding unrealized capital gains (Armour et al. 2013), on changing the computation of business income (Alstadsaeter et al. 2016) or on using national accounts-equivalent income measures (Piketty et al. 2018). The recent literature on distributional national accounts (DINA) is of particular relevance for our analysis because it explicitly examines the distributional effect of including the entire national income instead of only the fiscal income concepts used so far in the top income literature. For this reason, we conduct a further analysis of how our measures perform when using DINA incomes rather than fiscal incomes.[5] In addition, Auten and Splinter (2019) re-estimate top shares accounting for tax base changes, income sources absent from tax records and changing marriage rates. With their methodology, income shares are shown to increase at a much lower rate. By contrast, our analysis keeps the income concept unchanged throughout and instead focuses on different statistical measures of top shares and their composition.

Our findings also add to the research literature assessing long-run trends in top income shares in the Western world, specifically in the US. Most of these studies use the baseline definition of top income shares (Piketty and Saez 2003, 2006) Atkinson and Piketty (2007, 2010), Leigh (2009), Atkinson et al. (2011) and Roine and Waldenström (2015)), but in some cases, they use other data sources to compute the top share (Burkhauser et al. 2012). Our analysis complements these studies by asking how the picture would change if one considers further aspects, such as the variation in the size of top groups as in the fixed threshold measures. Using different top share measures and a richer compositional analysis that comes with it could also provide insights for cross-country comparisons of the historical evolution of inequality.

2 Empirical approach

In order to investigate the impact of population and real income growth on top income shares, different measures are necessary to complement the standard approach. We construct three alternative top income share measures, which draw on the headcount measures

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[5]There is a current debate about how to compute DINA incomes, for example, in the US case (Auten and Splinter 2019). While our analysis is about the relative performance of different top share measures rather than which underlying income one wishes to use, we nevertheless apply our methodology to both standard and DINA top income shares.

in the poverty literature[6] as well as the growing literature on combining relative and absolute notions of inequality. In our empirical analysis, we then compare the baseline measure (denoted A) to the three alternative top share measures, denoted B to D.

Measure A is the standard top income share, showing the share of total income earned by a fixed share of the population, for example, the top percentile. This measure shows top groups that are fixed in population shares but may vary in group size.

Measure B defines top earners in relation to a CPI-deflated income threshold. An absolute income level is chosen to define a top earner and then this level is kept over time, with incomes adjusted by CPI inflation. This measure may result in the top group changing not only in group size but also in population share, which happens if real incomes among top earners grows faster or slower than in the rest of the population. In the analysis, we choose 1980 as base year from which the income threshold is computed.[7]

Measure C is defined in the same way as measure B, but deflates incomes by GDP per capita instead of CPI. GDP captures the overall productivity growth in the economy, which is informative about the extent to which top incomes grow faster than the overall economy.[8] If increases in top real incomes were attributable solely to economic growth and not to changes in the income distribution, income and population shares above the GDP-deflated thresholds should remain roughly constant over time. In a robustness check, where we use the DINA data, we apply the same national income price index as Piketty et al. (2018).

Measure D shows income shares of a constant number of top earners, such as the top one million earners in the distribution. We include this measure since rising income shares of measures B and C may reflect two effects: a rising number of taxpayers above the fixed income thresholds and rising incomes of these earners. By fixing a number of high-earning taxpayers, we isolate the latter effect. If population growth was distributionally neutral, the income share of a given number of top earners should decline proportionally with population growth. The extent to which the observed pattern deviates from this pattern is informative about inequality trends within the top group.[9]

To sum up, measure A is a relative top income share measure, measure D is an absolute one, while measures B and C are hybrid measures providing an intermediate view. Which one to use in an empirical analysis depends on the context and research question at hand. We suggest to use all of them to investigate the full picture of inequality trends.

Data Our estimates are based on the standard source of international top income data: The World Inequality Database (WID). These estimates encompass income shares and percentile thresholds for the US over the years 1917–2014, using incomes from all sources before tax and deductions and most transfers. These data come from tax returns statistics compiled by the IRS and have been adjusted to consider changes in the tax law (Piketty and Saez 2003). Thresholds and annual incomes are computed in real terms to ensure their comparability across years. Realized capital gains are not included in the baseline calculations, but we

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[6]See Peichl et al. (2010) for a comprehensive discussion of alternative measures to analyze income inequality focusing on the top of the distribution drawing on the poverty measurement literature.

[7]To be precise, we use the same inflation measure as Piketty and Saez (2003) which is the so-called CPI-U-RS series. The CPI-U-RS series is especially designed to provide researchers with a historical CPI series in which prices are measured consistently over time in order to facilitate long-run comparisons.

[8]Per capita growth is chosen instead of overall growth to net out the growth effect of the changing population size.

[9]Theoretically, this measure could be further decomposed into population growth due to migration vs. population growth from natives. However, due to data limitations, this is not possible in our empirical analysis, but this might offer an interesting opportunity for future research.

show in the Supplementary Material that our findings are not sensitive to the treatment of capital gains.

As is common in this literature, the units of analysis are the income tax units (single or married households) and they are related to the total number of potential tax units in the population calculated from census data. Income thresholds and shares are calculated assuming a Pareto distribution to approximate income shares of top fractiles.

Due to the large income growth over the past century and the fact that WID provides data only on the top income decile, we sometimes need additional data for those cases when more than 10 percent of tax units surpass a given threshold. If needed, we supplement the data with IRS SOI[10] tax statistics on larger income brackets than given in the WID Database. The corresponding data sets are available from 1986 onward and capture the income shares and thresholds of rather broad income brackets.[11]

In addition to the WID data, we contrast our findings with recent DINA measures. These are based on different concepts for calculating top income shares and strive to capture the full scope of national accounts (Piketty et al. 2018).

3 Top income share trends across measures

We start our empirical analysis with a broad comparison of the four different top share measures by analyzing both income and population shares of the top group and their long-run developments. In the next subsections, we analyze our new measures in more detail by looking at subgroups of the top 5 and the top 1 percent. In Section 4, we dig deeper by decomposing the various measures into their components as well as investigating differential trends by income source.

3.1 The top 1 percent share

Figure 1 presents the evolution of the top 1 percent pre-tax income share in the US between 1917 and 2014 according to the four top income share measures presented above.[12] Since it commonly serves as a focal point in the literature, we use the year 1980 as a reference year (see Figs. A.7 and A.8 in the Supplementary Material for reference years 1917 and 2014). Measure A, the standard measure as used by Piketty and Saez, exhibits the marked U-shaped pattern that has been described numerous times in the past literature, showing a share beginning high at 15-20 percent, decreasing to under ten percent and finally rising to prewar levels in recent years. Measure B, which shows the income share of earners with an income above the CPI-deflated 1980 income threshold (that is, the 99th percentile) looks different. It is much lower in the prewar era, hovering around ten percent, where it stays until the mid-1980s, when it rises rapidly, reaching over 30 percent in the 2000s. Measure C, the GDP-deflated 1980 income threshold is also different. This share drops drastically from over 30 percent in the interwar era to ten percent in the 1960s, a fall that is twice as large as in the baseline series. Moreover, while the share remains rather similar to the baseline until the mid-1980s, it displays a substantially higher growth rate afterwards and again reaches

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[10]Source: https://www.irs.gov/uac/SOI-Tax-Stats-Historical-Table-3

[11]As Piketty and Saez's computation procedure results in a slight divergence between World Wealth and Income data and IRS data, adjustments were made to ensure that the 10-percent threshold of the IRS data matched the 10-percent level of our base dataset.

[12]Figure A.5 in the Supplementary Material shows graphs for different top income groups.
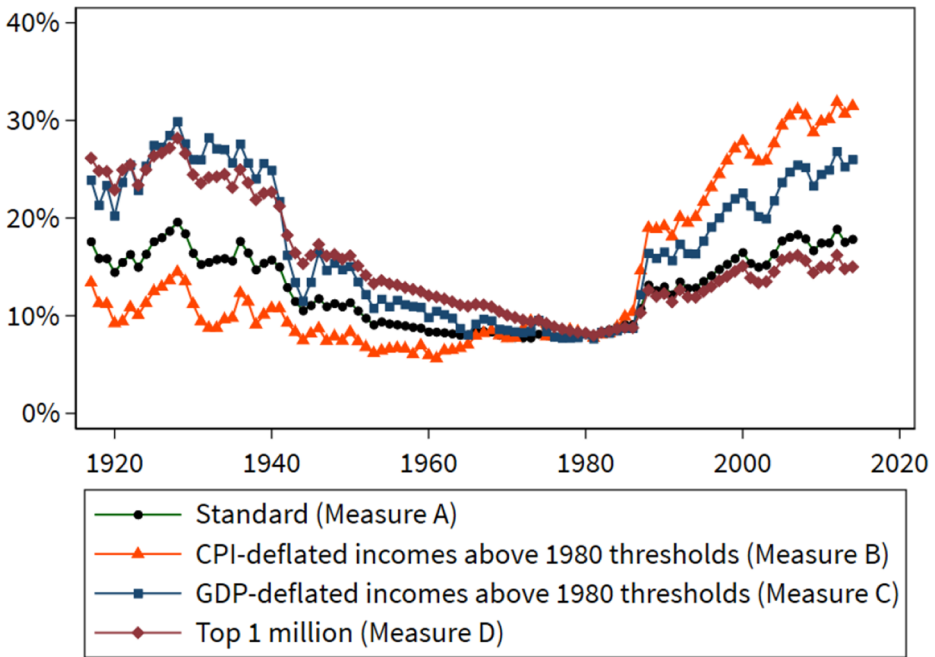
Fig. 1 Different measures for the top 1 percent *Notes*: This figure plots income shares for the four different top inequality measures (as described in Section 2): the standard measure (A), the income shares of those earning above the CPI-deflated (B) or GDP-deflated (C) 1980 income threshold, as well as the income share of the top 1 million taxpayers (D). The measures are constructed such that they equal each other in 1980 (see Supplementary Material Figure A.6 for 1917 and 2014 as baseline year). The figure is based on authors' calculations using data from the WID Database (see Section 2 for details). The income concept is pre-tax fiscal income, excluding capital gains

the level it had amounted to a century ago. Finally, measure D shows the income share of the top 1 million tax units – the approximate number of tax units in the baseline around 1980. This series is the most similar to the baseline, with deviations primarily reflecting the effect of differences in group size (being relatively larger before 1980 and relatively smaller afterward).[13]

The difference between the baseline and the fixed threshold series reflects that not only the relative incomes of top earners matters, but also the size of their group. Deflating the threshold using GDP provides information about the distribution of the economy's overall productivity gains: from the 1930s to the 1950s, they went mostly to the bottom 99 percent, while they subsequently were roughly equally distributed between the top 1980 percentile and the rest till the late 1980s. From then onward, they predominately accrued to the upper part of the earnings distribution. However, this development is partly attributable to a rising fraction of individuals sharing the productivity gains above the GDP-deflated 1980 threshold.

Next, we examine the evolution of top population shares using the four different measures. This analysis differs from the analysis of top income shares since it addresses partly

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[13]Qualitatively, the results do not change by much when we analyze incomes including capital gains (c.f. Figure A.5 in the Supplementary Material).

distinct questions. For example, top population shares are informative regarding the degree of concentration among the rich (see also Atkinson 2008) and the absolute number of high-earning individuals in an economy. Although only population shares for measures B and C are informative by construction, Fig. 2 shows these for each of the four different measures for completeness.[14]

The share of tax units with an income above the CPI-deflated 1980 threshold (measure B) has increased during the past century. This effect is due to both productivity growth – increasing real incomes over time – and changes in the income distribution. Between the 1980s and the 2000s, the top population share increased threefold, which reflects that top incomes increased more than consumer prices. The share of taxpayers above the GDP-deflated 1980 top percentile threshold (measure C) – which should follow a flat trajectory if tax units along the entire income distribution benefit similarly from productivity growth – has been subject to different developments during the past century. The share decreases quite sharply in the first half of the twentieth century, and increases again from the 1990s onward, albeit at a much lower level than the CPI-deflated shares. In other words, when requiring that a top percentile income should match the 1980 level deflated using GDP, fewer and fewer top earners have been able to make it to the top in the previous century. This group has expanded again in recent years.

To further analyze the difference between trends in top shares, Table 1 summarizes average annual growth rates of top income shares and top population shares across subperiods in the past century.

Looking first at growth in top income shares, the table indicates a fairly large correspondence across measures. The signs in growth rates are the same in all periods except for one. This similarity suggests an overall robustness in capturing broad historical developments regardless of top income share measure. The single period when signs differ is the 1950-1980 period, when CPI-deflated top shares increase while all other measures show decreases. The magnitudes of growth rates vary more between the measures, especially during the post-1980 period. Between 1980 and 2000, the standard measure of top income shares increased by 4.4 percent annually, whilst the CPI- and GDP-deflated income measures increased by 7.5 and 6.7 percent respectively. The measure rose by only 4.0 percent annually in the fixed top million group.

These differences are quantitatively important: the top percentile income share has hovered between 20 and 30 percent in the deflated income measures both in interwar era (GDP-deflated incomes only) and in the post 1990s era (both CPI- and GDP-deflated incomes). By contrast, the standard top income share measure has been between 10 and 20 percent during these periods, which is an order of magnitude lower.

Looking next at the growth in top population shares over the past century, a large difference between the measures emerges. In the standard measure, population shares are constant by construction and in the fixed top group measure D, population shares tend to decrease as a consequence of overall population growth. The two deflated income measures offer a more mixed picture. In the CPI-deflated measure B, the change in top group size is the largest, being on average around three percent per year before 1980 and 6.2 percent per year during 1980–2000 but only 0.5 percent per year in the latest period. In the GDP-deflated measure, the top group size has changed much less. It did not grow at all before 1980, and

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[14]Measure A, the baseline, is by construction fixed at the one percent level and entirely uninformative about inequality trends. Similarly, measure D falls steadily along with population growth since the share of a fixed group size (the top 1 million) falls as the population grows.
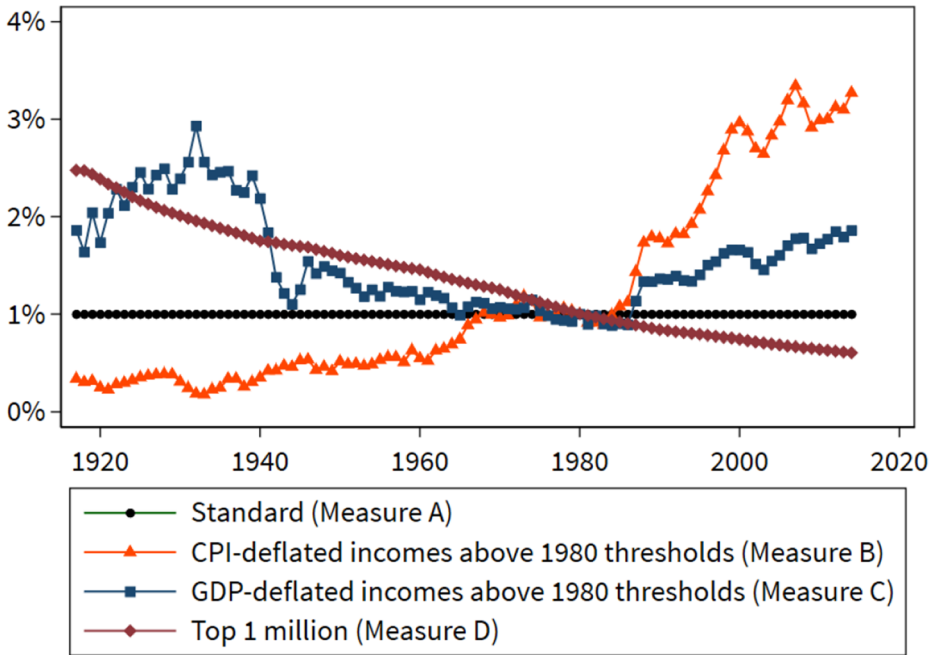
Fig. 2 Population share of top 1 percent earners across measures *Notes*: This figure plots population shares for the four different top inequality measures (as described in Section 2): the standard measure (A; equal to 1 percent by construction), the population shares of those earning above the CPI-deflated (B) or GDP-deflated (C) 1980 income threshold, as well as the population share of the top 1 million taxpayers (D). The measures are constructed such that they equal each other in 1980 (see Supplementary Material Figure A.6 for 1917 and 2014 as baseline year, respectively). The figure is based on authors' calculations using data from the WID Database (see Section 2 for details). The income concept is pre-tax fiscal income, excluding capital gains

even decreased by around one percent per year between 1929 and 1980. During 1980–2000, it grew by 2.7 percent per year but has not grown at all thereafter.

These results show that the differences in top income share growth rates between measures is mainly due to changes in the distribution of incomes rather than to changes in group size. The standard measure A, the fixed group size measure D and the GDP-deflated absolute threshold measure C all have fairly small swings in group size across the historical episodes, and yet their top income shares grow in the same direction and relatively similarly in magnitude. However, the exception is the CPI-deflated absolute threshold measure B, which exhibits larger changes in top group size and also larger differences in the growth in top income shares. As we discussed in the previous sections, whether to deflate incomes by CPI or GDP when calculating top groups and top income shares depends on the questions at hand, but that this decision has implications for the results on long-run trends in top income shares is clear from the present analysis.

3.2 Subgroup analysis

We now zoom in on the different alternative top share measures by taking a closer look at the long-run developments of different top fractiles and their income shares in the different top share measures. In order to highlight differences along the top, shares are displayed for

Table 1 Average annual growth rates of income and population shares for different top 1 percent measures

Annual growth in income and population shares

Period	Standard (Measure A)		CPI-deflated top thresholds (B)		GDP-deflated top thresholds (C)		Top 1 million (D)	
	Income	Pop.	Income	Pop.	Income	Pop.	Income	Pop.
1917-1929	2.4	0	3.4	3.1	2.0	0.1	1.4	−1.6
1929-1950	−2.1	0	−1.8	3.0	−2.1	−1.4	−2.3	−1.1
1950-1980	−0.7	0	1.0	2.9	−1.1	−0.8	−1.8	−1.5
1980-2000	4.4	0	7.5	6.2	6.7	2.7	4.0	−1.5
2000-2014	0.4	0	0.6	0.5	0.7	0.0	0.0	−1.5

Notes: This table shows average annual growth rates of the top percentile share in percent for the different measures during subperiods over the period of analysis. The four different top inequality measures (as described in Section 2) are: the standard measure (A), the income shares of those earning above the CPI-deflated (B) or GDP-deflated (C) 1980 income threshold, as well as the income share of the top 1 million taxpayers (D). The measures are constructed such that they equal each other in 1980. The figure is based on authors' calculations using data from the WID Database (see Section 2 for details). The income concept is pre-tax fiscal income, excluding capital gains

the brackets in between the thresholds. This analysis hence decomposes the top 1 percent shares reported in Figs. 1 and 2 into three groups: top 1–0.5, 0.5–0.1 and top 0.1 percent and additionally shows the group just below: top 5–1 percent.
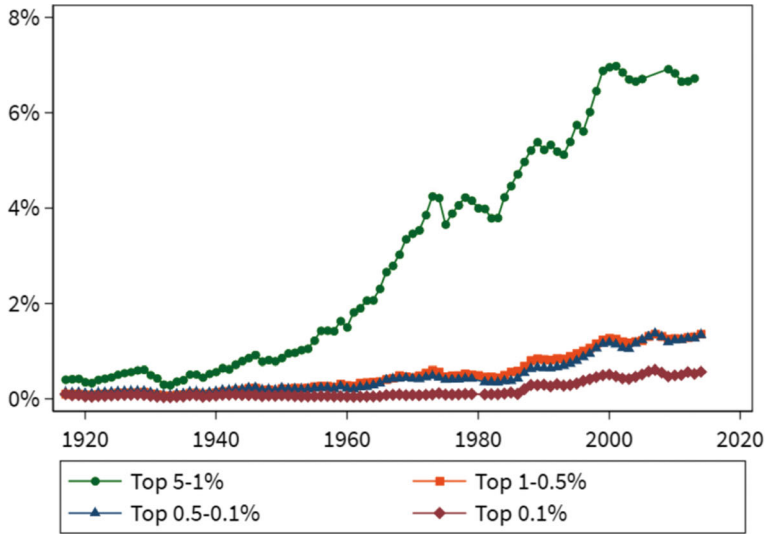
Measure B (CPI-deflated) We start with measure B in Fig. 3. Accounting for population growth reveals different developments to the well-known top fractile results (c.f. Figure A.3 in the Supplementary Material). The respective trajectories follow different patterns, deviating from the familiar U-shaped one. The developments of income shares do not closely follow the growth of population shares above thresholds. Instead, the income share between the top 1-0.5 percent thresholds remains rather constant, with some growth in the 1990s. In contrast, the income share above the uppermost threshold has experienced a large increase since the 1980s, while declining and then remaining at a roughly constant level in previous decades. The income share of taxpayers between the 1 percent and 5 percent thresholds has almost continuously grown since the early 20th century. These developments cannot be fully explained by economic growth or by a simple fanning out of the income distribution. A proportional growth of all incomes or an increased dispersion of incomes would shift the tail of the distribution outward, leading to higher income shares for all – not just some – upper thresholds. Instead, Figure 3 points to a more nuanced development than one might infer from the evolution of standard top income shares. Possible drivers are discussed in detail in Section 4.2.

Measure C (GDP-deflated). The above results are driven partly by economic growth. If economic growth was equally distributed across the income distribution, the population and income shares above the GDP-deflated thresholds should remain roughly constant over time. However, as Fig. 4 shows for measure C, such constant population and income shares cannot consistently be found in the data for GDP-deflated thresholds.[15]
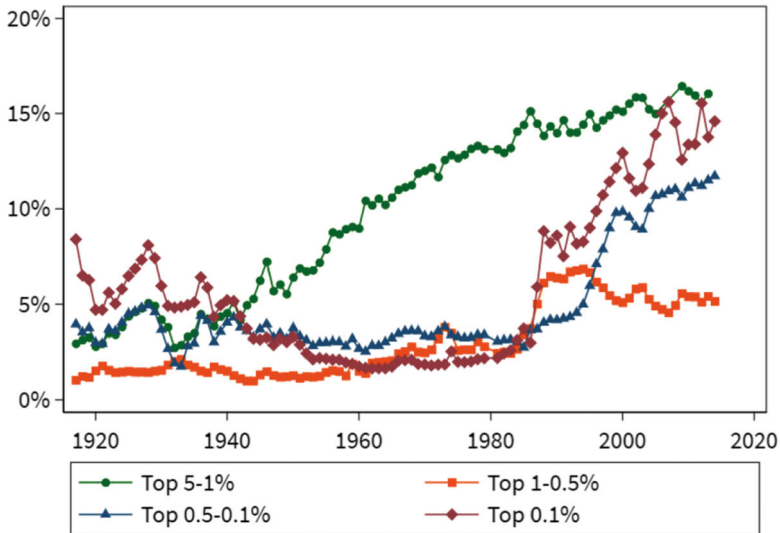
As shown in subfigure (a) of Fig. 4, the percentage of tax units above all GDP-deflated top thresholds declined around World War II. The 1950s and 1960s witnessed diverging developments: more and more tax units exceeded the GDP-deflated 5 percent threshold during the mid-twentieth century, whereas the fraction of taxpayers above the GDP-deflated top 0.1 percent threshold shrank. Hence, more and more people with high – but not extremely high – incomes have benefited more than proportionally from economic growth. As, at the same time, the percentage of tax units above very high income thresholds continued to decline throughout the mid-twentieth century, incomes at the larger top of the distribution became more equal. In the late 1970s, the result reverses. From then onwards, the share of tax units above the 5 percent threshold ceased to grow, whereas the number of tax units at the very top grew significantly. Conversely, the upper middle class shrank in relative terms.

For income shares shown in subfigure (b) of Fig. 4, the picture looks a little different. In line with other findings in the literature, the income share of those above the GDP-deflated 1980 0.1 percent threshold – the highest in our computations – experienced a stark decline throughout the first half of the twentieth century. Remaining rather low until roughly 1980, this group's income share has seen rapid increases over the past three decades. Since the beginning of the twenty-first century, the income share of the top bracket has been subject to even more pronounced fluctuations than the fraction of tax units above those thresholds. However, whilst decline and growth periods coincide with the baseline, the share develops at

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[15]Similar findings as for the 1980 threshold also emerge for 1917 and 2014 thresholds. See Fig. A.8 in the Supplementary Material.
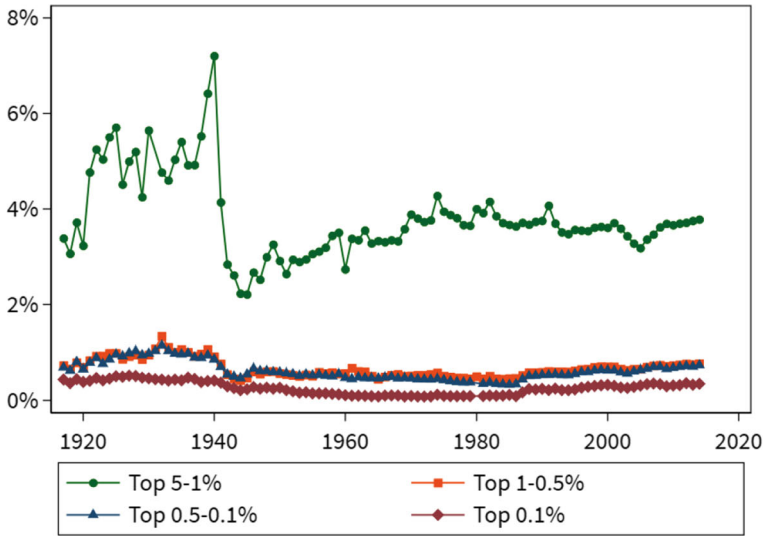
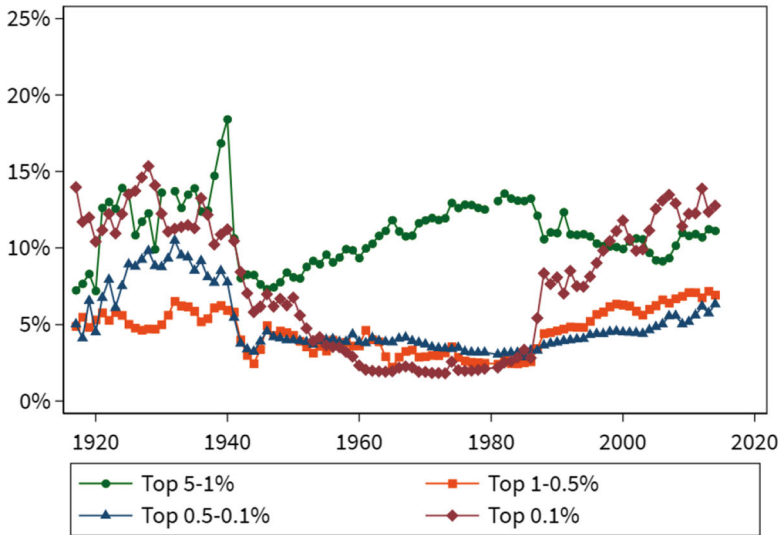(a) Percentage of taxpayers above CPI-deflated 1980 top thresholds

(b) Income shares of taxpayers above CPI-deflated 1980 top thresholds

Fig. 3 Top shares of those above CPI-deflated 1980 top thresholds (Measure B) *Notes*: This figure plots population and income shares of those earning above the CPI-deflated 1980 income threshold (Measure B, as described in Section 2). The measure is constructed such that it equals the standard top 1 percent share in 1980 (see Supplementary Material Figure A.7 for 1917 and 2014 as baseline years). See Fig. A.3 for the baseline measure. The figure is based on authors' calculations using data from the WID Database (see Section 2 for details). The income concept is pre-tax fiscal income, excluding capital gains

(a) Percentage of taxpayers above GDP-deflated
1980 top thresholds

(b) Income shares of taxpayers above GDP-deflated
1980 top thresholds

Fig. 4 Top shares of those above GDP-deflated 1980 top thresholds (Measure C) *Notes*: This figure plots population and income shares of those earning above the per capita GDP-deflated 1980 income threshold (Measure C, as described in Section 2). The measure is constructed such that it equals the standard top 1 percent share in 1980 (see Supplementary Material Figure A.7 for 1917 and 2014 as baseline years). See Fig. A.3 for the baseline measure. The figure is based on authors' calculations using data from the WID Database (see Section 2 for details). The income concept is pre-tax fiscal income, excluding capital gains

a much larger magnitude. The income shares between the GDP-deflated top 1-0.5 and 0.5-0.1 percent brackets shrank in the first half of the twentieth century and began growing again in the 1980s. The time trend is substantially less pronounced than for the tax units above the top GDP-deflated threshold. In contrast, the decline of the 5-1 percent share halted after World War II, with the share then rising until the early 1980s. From the late 1980s onward, it experienced a slight decline, only to remain roughly constant in more recent years. Hence, the dispersion of incomes does not evenly affect all high incomes.

Constant Number of Top Tax Units (Measure D). While the comparison of income shares above thresholds indicates a pronounced growth-exceeding increase only for incomes at the very top, it is driven by two effects: first by changes in the number of taxpayers above those income thresholds and, second, by changes in the income allocated to them. Hence, from Fig. 4 alone, one cannot seamlessly infer which part is attributable to the presence of more or fewer taxpayers exceeding the threshold, and which is attributable to individual taxpayers above the threshold increasing their respective incomes. Therefore, to separate these two effects, we analyze how the income share of a fixed number of taxpayers evolves over time hence netting out the effect of population growth. For this, we assess the income shares of the top 500 thousand, 500 thousand - 1 million, 1-2 million, and 2-5 million taxpayers.[16]

Recall that distributionally neutral population growth should lead to a proportional decline in measure D. However, as it becomes visible from Fig. 5, this is not the case and this measure likewise shows an increase in inequality in recent decades. Most importantly, the different income brackets at the top do not follow the same general trend. Instead, while incomes at the very top experience the widely discussed increase since the 1980s, this increase does not necessarily apply to the slightly lower tier of top income recipients.

In line with previous research, the income share of the uppermost income group – here, the top 500,000 – sharply declined until 1980, when it began to substantially increase. A possible explanation is that the richest individuals derive a substantial share of their income from capital and entrepreneurial activities and from performance-tied compensation, e.g., via bonus payments and stock options. These sources of earnings are more volatile and more tied to the business cycle than wages in lower income brackets. In line with this, the spikes and troughs in recent years may be explained by the Dot-com bubble and the Great Recession. The picture completely changes for the top 0.5 to 2 million, who did not improve their income share over time. This starkly contrasts with the top 2 to 5 million, who, similar to the very top, have seen increasing income shares since the 1980s. General trends in these developments are fairly robust to excluding or including capital gains.

The above findings accentuate that the top 1 percentile (which would have encompassed several of the above groups in 2014) is far from being a homogeneous group. Instead, there seem to be differential forces at work that distinguish the top segments from one another. An explanation might well be found by differentiating why certain taxpayers belong to the top. In other words, to what extent are rentiers, who derive most of their income from capital, entrepreneurs, and top managers, who all receive rather high incomes, subject to different time trends? The decomposition in Section 4.2 sheds light on this question.

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[16]For the early 1900s, the income share of the top 5 million tax units cannot be calculated because they constituted more than 10 percent of all taxpayers in these years.
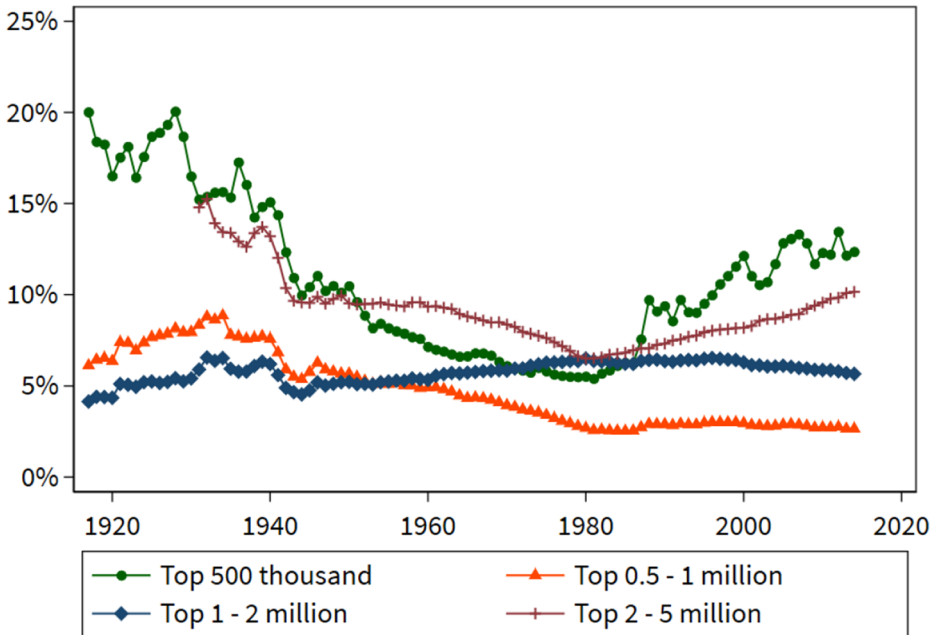
Fig. 5 Top shares of fixed numbers of earners (Measure D) *Notes*: This figure plots income shares of fixed numbers of top tax units (Measure D, as described in Section 2). The figure is based on authors' calculations using data from the WID Database (see Section 2 for details). The income concept is pre-tax fiscal income, excluding capital gains

4 Decomposition analysis

4.1 The role of income and population changes

We conduct two different decomposition analyses of the top share measures in order to gain further insight into the forces driving them. The first one, which is new in the context of top income shares, is to decompose changes in the top percent income share into the contributions of population size, group size (for measures B and C), overall income and average income growth in the top and bottom groups. More precisely, the income share S_i of top fractile i can be decomposed as

$$S_i = \frac{\bar{Y}_i N_i}{\bar{Y} N} \quad \Leftrightarrow \quad \Delta ln S_i = \Delta ln \bar{Y}_i + \Delta ln N_i - \Delta ln \bar{Y} - \Delta ln N, \tag{1}$$

where $\bar{Y}$ $(\bar{Y}_i)$ indicates average income (in fractile i) and N (N_i) indicates the number of tax units (in fractile i). This decomposition allows us to more precisely identify the extent to which changes in top income share measures are driven by changes in average top incomes, changes in the number of taxpayers, and changes in the denominator, i.e., in the incomes and size of the remaining population.

Applying (1) to each of the four different measures separately, Fig. 6 shows the decomposition of the change in the log income share (black) of the top percentile into changes in its average income (light blue), in the average income of the bottom 99 percent (orange), as
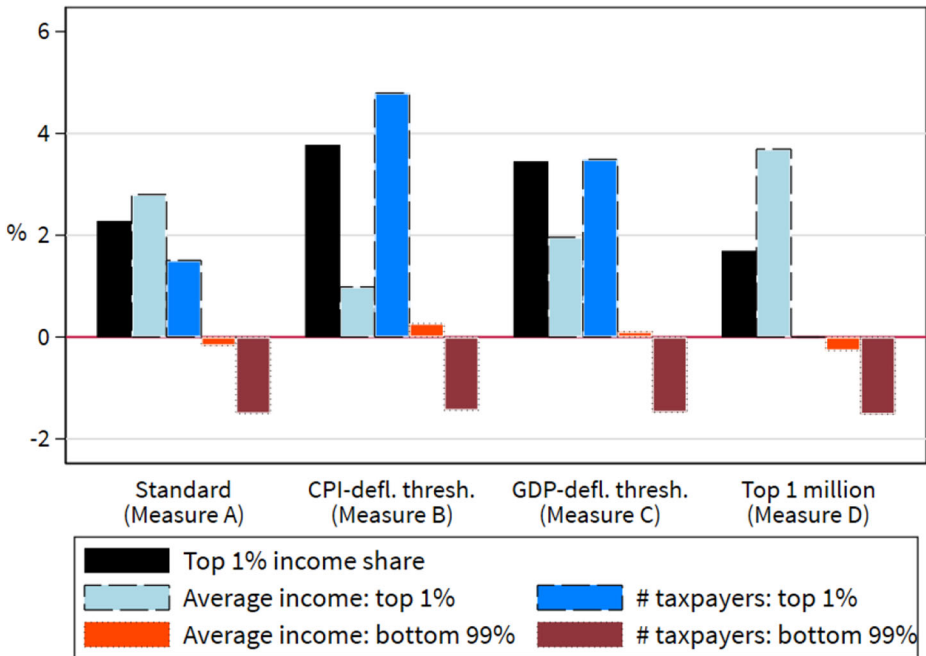
Fig. 6 Decomposing the top percentile growth, 1980-2014 *Notes*: This figure plots the results from the decomposition analysis presented in Section 4 (see Eq. 1), which decomposes changes in the log income share of the top percentile into changes in its average income, in the average income of the lower 99 percent, and of overall population growth (number of taxpayers in top vs. bottom). Results of this decomposition over the 1980-2014 period are presented for standard measure (A), the income shares above CPI- (B) and GDP-deflated (C) 1980 top 1 percent thresholds, and the top 1 million taxpayers (D). In order to be consistent with Eq. 1, increases in the bottom (top) population and income share appear as negative (positive) numbers in the figure. The figure is based on authors' calculations using data from the WID Database (see Section 2 for details). The income concept is pre-tax fiscal income, excluding capital gains

well as the changes in the number of taxpayers in the respective top 1 percent (dark blue) and bottom 99 percent (red).

The income share above the CPI-deflated threshold (measure B) grows more on average than the baseline top income share (measure A). While average incomes above the threshold experience positive average growth, the effect is driven substantially by an increasing number of taxpayers exceeding the threshold. More precisely, the number of taxpayers above the threshold experiences much faster growth than the overall number of taxpayers. That is, in both absolute and relative terms, an increasing number of taxpayers earned at least as much real income as the top 1 percent in 1980.

To a lesser degree, this also holds true for the income share above the GDP-deflated 1980 threshold (measure C). The growing income share is substantially driven by the increasing number of taxpayers at the top, again rising at a much faster pace than the overall number of taxpayers. Growing average income at the top also plays an important role. This development is however partly attributable to the threshold increasing with per-capita GDP, which ceteris paribus results in growing average income above the threshold.

By construction, the number of taxpayers in the top 1 million (measure D) stays constant. The positive growth in their income share is thus driven entirely by the top 1 million

experiencing substantially higher income growth than the rest of the population. Nevertheless, the remainder of the population was also able to increase their real incomes, albeit at a much smaller scope.

4.2 Differential effects by income source

In a second decomposition, we analyze the effect of different sources of income on overall income trends: wages, capital income (excluding realized capital gains) and business income. According to past research (c.f. Section 1), wage income became increasingly important for top percentiles in the second half of the twentieth century. At the same time, the relative importance of capital income declined. While these results have been widely discussed, our previous question also applies here: To what extent are these findings driven by changes in the denominator? With the population increasing threefold over the course of the past century, taxpayers with comparably lower incomes – and hence a larger share of wage income on average – moved to higher fractiles of the income distribution. Hence, we ask to what extent is the increasing importance of wage income attributable to more and more taxpayers belonging to the top 1 or top 0.1 percentiles?

As before, we strive to neutralize the effect of population growth by fixing a certain number of top taxpayers and tracking the development of their incomes over time.

We again track the same top 500 thousand, 1 million, 2 million, and 5 million taxpayers as above and decompose their incomes according to their sources. When the number of taxpayers in each income bracket is held constant, a different picture emerges than that for top percentiles, which do not account for population growth.

Wage income This category encompasses all income derived from dependent labor, i.e., wages, salaries and pensions. Figure 7 displays wage income's share in the overall population's aggregate income.

The shares of top income groups' wages in aggregate income have grown since the 1980s for both the top 500,000, as well as for the top 2 to 5 million. In particular, the overall income shares of the uppermost category's wages have roughly tripled during the past three decades. In contrast, the top 0.5 to 2 million's wages have not increased relative to overall income.

Capital income Capital income is composed of rents, dividends and interest. The share of capital income followed a rather flat trajectory from the 1940s to the 1970s for the top 500,000 to 5 million – see Fig. 8. This holds for both the share in aggregate income and its importance relative to top earners' other income sources.

For the uppermost 500,000, however, capital income has increasingly contributed to their income in recent years. Nevertheless, the recent increase pales in comparison to the income shares that top earners obtained from dividends, interest and rents prior to World War II.

Business income Revenues from entrepreneurial activities have been subject to large changes. While for all top income brackets, the importance of entrepreneurial income declined from World War II throughout the 1970s, it has seen a sharp rise since the 1980s – see Fig. 9. Not only has the proportion of income generated by entrepreneurs multiplied, but overall entrepreneurial revenues have also contributed to overall US incomes at increasing rates for the top 500,000 and, to a much lower extent, the top 2–5 million. Strikingly, while entrepreneurial income has played less of a role for the top 500,000 than for taxpayers with incomes just below theirs, this relation reversed after 1980.
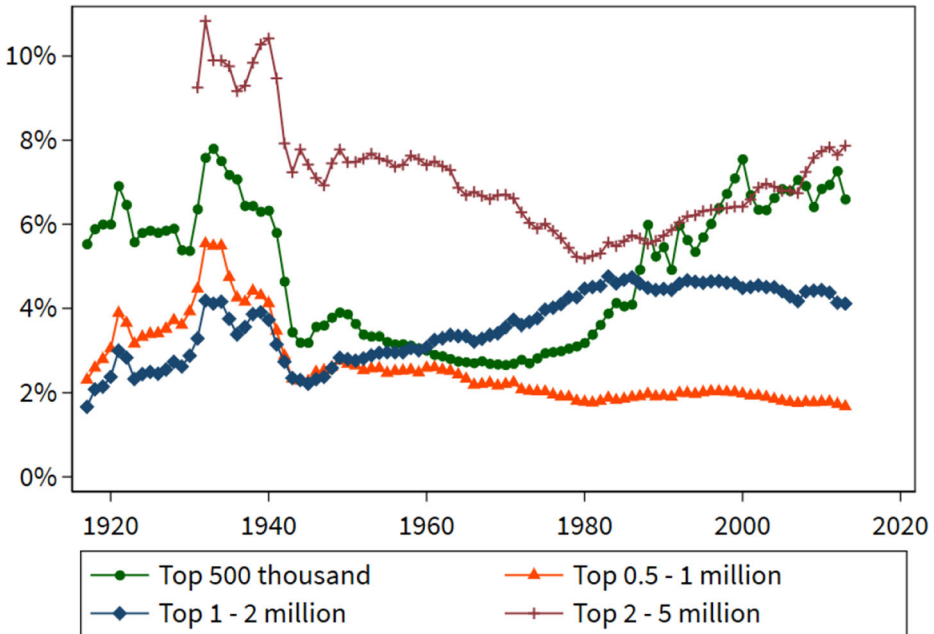
Fig. 7 Wage shares of top income brackets (Measure D) *Notes*: This figure plots wage income shares of fixed numbers of top tax units in aggregate income (Measure D, as described in Section 2). The figure is based on authors' calculations using data from the WID Database (see Section 2 for details). The income concept is pre-tax fiscal income, excluding capital gains

Discussion While the baseline results show an increasing importance of wage incomes at the top, our results in Figs. 7, 8 and 9 point to a more nuanced development. Note, though, that while we track a constant number of top income earners, we cannot track individuals. Salary increases for top-earning executives might have lifted them into a higher bracket, in turn shifting taxpayers who are less dependent on wage income – and therefore did not benefit from a similar increase – to a lower income bracket. Hence, the lack of an increase in the top 0.5 to 1.5 million's wage shares might be partly attributable to changing compositions of taxpayers at the top.

However, the recent growth at the very top is consistent with the 'superstar' hypothesis of Rosen (1981). Globalization and technological change, particularly in the realm of information and communication technologies, have led to expansions of scale during the past three decades. Hence, those with the very highest abilities have managed to obtain larger and larger rents. The reach of those with 'second-best' abilities, however, is limited by these 'superstars', explaining why the importance of wages has not risen for the top 0.5 to 2 million. Another potential contributing factor to the rising importance of wages is the increased assortative mating that has occurred since the 1970s (Schwartz 2010). Because income is measured at the tax unit level, the increased propensity to marry a spouse with a similarly high income should increase both the importance of wages and overall income shares over time.

A further popular explanation for this development are tax reforms, particularly the 1981 and 1986 Tax Reform Acts (Bargain et al. 2015; Feldstein 1995; Auerbach and Slemrod
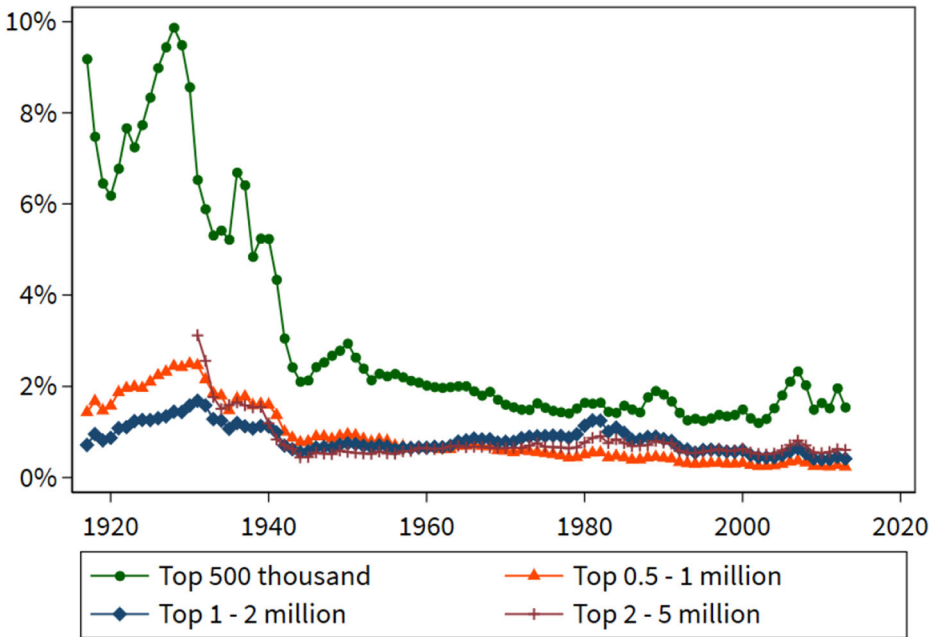
Fig. 8 Capital shares of top income brackets (Measure D) *Notes*: This figure plots capital income shares of fixed numbers of top tax units in aggregate income (Measure D, as described in Section 2). The figure is based on authors' calculations using data from the WID Database (see Section 2 for details). The income concept is pre-tax fiscal income, excluding capital gains

1997; Hausman and Poterba 1987).[17] In addition to a broad range of measures, the 1986 TRA reduced top marginal tax rates from 50 to 28 percent but broadened tax bases. The 1980s constituted a tipping point in the development of top wage incomes. After the tax reforms, the shares of top wages in overall national incomes increased, but the previously increasing importance of wages relative to other income sources of top earners came to a halt. That is, while top earners became relatively richer and their wages grew over time, their earnings increases were driven by both wages – possibly driven by the developments described above – and other income sources.

The spike in the early 1980s in capital income (see Fig. 8) was accompanied by a sharp drop in business income (see Fig. 9). Part of this development may therefore be related to reclassification of incomes in response to changing tax incentives. First, the abolition of the general utilities rule made C-corporations less attractive. Prior to the reform, such corporations had allowed for lower tax rates than the personal income tax. As a result of the reform, many C-corporations were converted into S-corporations. Thereby, previously excluded corporate income was included on personal tax returns, counting towards entrepreneurial income (Feldstein 1995). Top earners' higher capacity for tax avoidance might also explain why the effect was larger for the top 500,000 than for the subsequent high-income earners.

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[17]Other reforms of income tax rates did not have such pronounced effects. Notably, the Omnibus Budget Reconciliation Act of 1993 increased top marginal tax rates from 31 to 39.6 percent, but this increase can be associated at best with small fluctuations in wage shares.
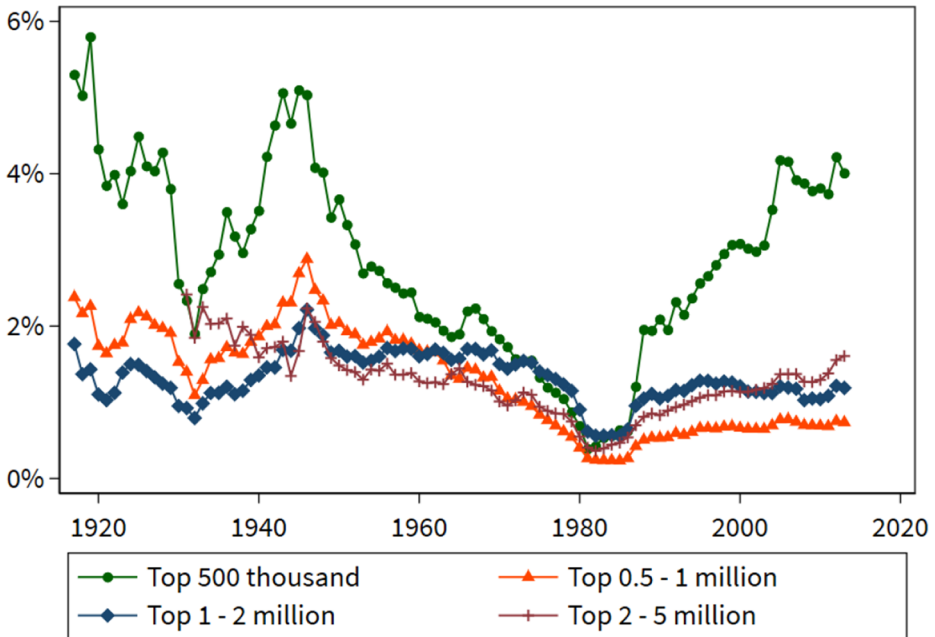
Fig. 9 Entrepreneurial income shares of top income brackets (Measure D) *Notes*: This figure plots entrepreneurial income shares of fixed numbers of top tax units in aggregate income (Measure D, as described in Section 2). The figure is based on authors' calculations using data from the WID Database (see Section 2 for details). The income concept is pre-tax fiscal income, excluding capital gains

To sum up, we find that for the very top, the relative importance of wages vis-à-vis capital and entrepreneurial income has been slightly declining over the past three decades. That is, when you fix the absolute number of top earners, there is no rise in the share of national wage income going to top earners. There are (at least) two potential reasons for this: First, it could be either because millions of low-wage workers immigrated to the US which would imply that technology growth or tax policy had nothing to do with the observed rise in standard top shares. Second, it could be because natives had been growing in population at a rate that exactly offset a rising share of natives' wage income going to the top two million earners. This would imply that technology and tax mechanisms could be potential causes of the rising inequality. And, of course, it could be a combination of both. Future research, with proper data on migration and population growth by natives along the income distribution, could study these effects based on our measures.

5 Concluding discussion

The long-run evolution of top income shares has received tremendous attention in the research literature. Despite this, relatively little focus has been put on the extent to which results depend on how one measures top income shares. The current standard measure, which shows the share of total income earned by a fixed percentile of the population, is but one of several possible representations of the top income groups and their relative income

shares. We complement the standard analysis with other top share measures, using either fixed income thresholds or fixed group sizes to define top groups.

Our empirical analyses of US historical evidence show how trends in top income shares vary across measures. Although the overall picture changes only little, there are important qualifications concerning subperiods and also across source of income.

Naturally, no single measure shows the correct picture. We think that using several different measures sheds additional light on these multi-faceted inequality patterns. We hope that future research will continue working on refining the way income inequality is measured.

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