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ABSTRACT

Top Incomes in Germany, 1871-2014*

This study provides new evidence on top income shares in Germany from the period of industrialization to the present. Income concentration was high in the nineteenth century, dropped sharply after World War I and during the hyperinflation years of the 1920s, and increased rapidly throughout the Nazi period beginning in the 1930s. Following the end of World War II, German top income shares returned to 1920s levels. The German pattern stands in sharp contrast to developments in France, the UK, and the US, where World War II brought a sizeable and lasting reduction in top income shares. Since the turn of the millennium, income concentration in Germany has been on the rise and is today among the highest in Europe. Regression analysis reveals that rising top income shares are positively associated with the capital share.

JEL Classification: D31, D63, J31, N30
Keywords: income inequality, income distribution, top incomes, welfare state, Germany

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1 Introduction

To what extent is income concentration affected by industrialization, globalization, regime change, or the expansion of the welfare state? Do we observe a more egalitarian income distribution in the aftermath of wars as destroyers of capital? Or is it the introduction of progressive income taxation, collective bargaining, and increased union power that radically reduces top capital incomes? German data provide the unique possibility to study the evolution and drivers of income concentration at the top from 1871 to 2014.

Germany's turbulent history allows us to investigate factors that may explain up- and downswings in top income shares over five very different eras: (1) The period of the German economy's evolution from a rural economy to one of the world's most advanced industrial economies, which was accompanied by a steady increase in the top percentile's income share up to the start of World War I;[1] (2) The era of the Weimar Republic from 1920 to 1932, also seen as a "laboratory of inequality reducing policies" (Kaelble, 2017, p.61), when employers' organizations met unions' substantial wage demands, dampening social and class struggles (Kocka, 1978, p.137) and top incomes dramatically declined; (3) The Nazi period, beginning in 1933, which saw an extraordinary rise in profits and top incomes among business owners while wages stagnated; (4) The post-World War II period, when top income shares returned to the levels of the 1920s, in contrast to the general perception of exceptionally low inequality in the *Golden Age* of post-war Germany; and finally, (5) The post-reunification period of rising inequality, when Germany caught up to UK and US levels after the elimination of the German wealth tax, the reduction in top tax rates, the weakening of trade unions, and the country's new status as world champion in exports.

The dramatic increase of the top percentile income share in the United Kingdom and the United States has revived interest in the evolution of top incomes. Since the seminal contribution of Piketty (2001, 2003), a succession of studies have sought to construct top income share series over the twentieth century for coun-

[1]These German data provide the empirical support for the inequality increasing part of the Kuznets curve (Kuznets, 1955).

tries around the world.[2] These studies use income tax statistics to measure the concentration of income within the uppermost part of the distribution. Since most countries introduced modern income tax systems at the beginning of the twentieth century, these series can be constructed for a time span of about 100 years for most countries.

This paper provides the first long-run top income share series for Germany covering the period 1871 to 2014. Series from Prussia, Saxony, and six other German states are merged to produce a German series extending from the foundation of the German Reich in 1871 to the end of World War I in 1918. This series improves upon the series provided by Dell (2005, 2007) in three ways. First, the aforementioned long-run series is restricted to Prussia from 1891 to 1918, thus excluding about 40% of the German population and overestimating German top incomes, as many of the super-rich of that time lived in Prussia undergoing rapid industrialization.[3] The time series in the present paper shows an additional 20 years of the industrialization period starting in 1871. Second, our new estimates show a larger drop in top incomes in the immediate post-WWII period than shown by Dell (2007). Finally, Dell (2007) ends in 1998, when Germany had just recovered from the post-reunification economic crisis. This paper's new series covers more than two decades of reunified Germany, when Germany went from being the *sick man of Europe* to the *economic superstar*, and shows that income concentration increased markedly in this period.

Despite the economic and political turbulences, top income shares in Germany have remained surprisingly stable over time. The top decile's income share was 40% in 1913 and in 2013. About 2% of gross market income accrued to the top 0.01%

[2]Among many others, Piketty (2003) estimated the series for France, Atkinson and Salverda (2005) for the Netherlands and the United Kingdom, Aaberge and Atkinson (2010) for Norway, Alvaredo and Saez (2009) for Spain, Roine and Waldenström (2008) for Sweden, and Piketty and Saez (2003); Saez (2005) for the United States and Canada. Dell (2005) provided the first long-run series for Germany 1891-1998. The estimated shares are available from the World Inequality Database (WID).

[3]There exist several studies on specific German states: Top income share series for Baden, Saxony, Hesse, and Wurttemberg are included in Dell's unpublished PhD thesis (Dell, 2008). Other previous estimates of income concentration using German income tax statistics include Procopovitch (1926) (1875,1896,1913,1919), Grumbach (1957) (1820-1938), Geisenberger and Müller (1972) (end of nineteenth century up to World War I), Tilly (2010) (1852-1875) and Dell (2007) (1891-1998). See Appendix Figures F.1 to F.7 for a comparison of previous estimates with this paper's estimates.

throughout the entire period. At all times, business income has been the most important income source at the top of the distribution, although increasing numbers of top wage earners have risen to the top since the 1980s. Dustmann et al. (2009) document the increase in wage inequality in Germany since the 1980s. However, wages still comprised less than a tenth of the top 0.01% income in the 2000s.[4] This stands in contrast to findings for the US, where the working rich gradually replaced rentiers over the course of the twentieth century, with the top 0.01% generating half of their income from wages by the 2000s (Saez, 2005). However, the share of capital income in total income has increased since the 2000s (Piketty et al., 2018).

Our analysis of explanatory factors reveals that the capital share in national income is strongly positively correlated with the top percentile's income share throughout all periods. Whereas trade was negatively associated with the top percentile's income share in the period of industrialization, during the post-reunification period it tended to enrich the German elite. Technological change measured by patent applications is positively correlated with income concentration both in the period of industrialization and in recent decades. The recent increase in top incomes has been accompanied by a decline of both average tax rates in the top percentile and union density.

One should note that top income share series based on income tax statistics suffer from crucial limitations. First, top income shares document income concentration at the top and do not capture changing inequality elsewhere in the distribution. Second, income tax data contain gross income before taxes, neglecting the redistributive role of the government. Frequent changes in the tax legislation modifying the definition of taxable income pose a challenge to creating homogenous series. The introduction of dual income taxation with a separate withholding tax on dividends and interest in Germany in 2009 is a recent example: since then, dividends and interest income are no longer systematically recorded in income tax data. We devote special effort to correcting for such changes, e.g., by imputing dividend and interest income after 2009 as described in Bartels and Jenderny (2015). Also, if tax avoid-

[4]This conclusion is shared by Bach et al. (2009), who integrated German income tax data and survey data to analyze changes at the bottom, middle, and top of the income distribution for the period 1992-2003.

ance and tax evasion change over time, we might obtain biased results. Finally, our top fiscal income shares by definition exclude the part of national income that is not captured by income taxation, which is approximately 10% of national income.

A new line of research aims to distribute the full national income as documented by internationally standardized national accounts in order to measure inequality before and after government intervention across the entire population. Piketty et al. (2018) and Garbinti et al. (2018) are the first two attempts to construct such distributional national accounts (DINA) series for the United States and France, respectively. Individual tax records are the main building block of these DINA series. These data are then supplemented with low-income individuals from survey data. In a final step, national income, tax, and transfer components are distributed across the synthetic distribution in order to obtain the inequality of pre- and post-tax national income. Income tax micro-files became available in 1962 in the United States and in 1970 in France, but only in 1992 in Germany. The aim of this paper is to provide a consistent long-run top income share series based on income tax data for Germany, which can serve as the central building block for DINA inequality measures for the entire distribution in Germany in future work.

The paper is organized as follows: Section 2 briefly describes the method used to construct top income shares and provides details on the data employed. The new top income share series 1871-2014 is presented and discussed in Section 3. A discussion of underlying forces behind the changing income concentration is given in Section 4. Section 5 concludes.

2 Data and Methodology

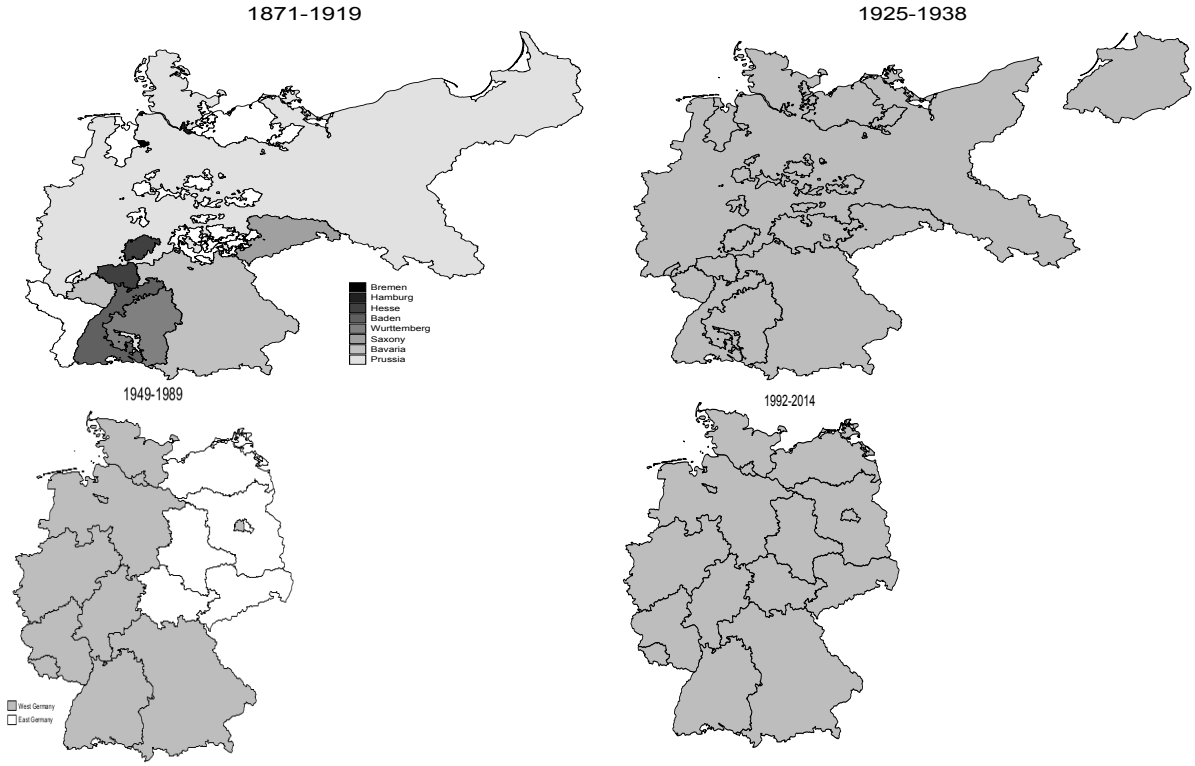
We use income tax statistics as the main data source to estimate top income shares. The series covers Germany as defined by the prevailing borders of the respective period of time.[5] Over the course of the nineteenth century, German states successively introduced a modern income tax system, in which the level of taxation

[5]We refrain from any attempt to estimate a series within constant borders, e.g., the territory of the BRD. Even a series within constant borders would cover a drastically changing population over time given the large number of displaced persons, particularly after World War II.

depended on the income of the household or individual: in 1869 in Hesse, in 1874 in Bremen, in 1874 in Saxony, in 1881 in Hamburg, in 1884 in Baden, in 1891 in Prussia, in 1905 in Württemberg, and in 1912 in Bavaria. At the same time, the statistical offices of these states began publishing tabulations showing the number of taxpayers per income bracket and aggregated taxable income per income bracket. In total, 27 income tax systems were introduced in the 39 German states, but only the states mentioned above published tax statistics regularly. In Prussia, income taxation for top income earners was introduced in 1851. However, the coexistence of income taxation for some and consumption taxation for all citizens in bigger cities makes it more difficult to estimate top income shares before 1874 (*urban-rural-dualism*). In 1874, the consumption tax was abolished and income taxation was extended to the entire population (see Appendix Section A for details on Prussian income tax regimes). We use income tax statistics from eight German states that together accounted for 90% of the German population in 1871 and covered almost the entire territory of the newly founded German Reich, as illustrated by Figure 1. Not included is about 10% of the population living in Mecklenburg-Schwerin, Sachsen-Weimar, Mecklenburg-Strelitz, Oldenburg, Braunschweig, Sachsen-Meiningen, Sachsen-Altenburg, Sachsen-Coburg-Gotha, Anhalt, Schwarzburg-Rudolstadt, Schwarzburg-Sondershausen, Waldeck, Reuß ältere Linie, Reuß jüngere Linie, Schaumburg-Lippe, Lippe, Lübeck and Elsaß-Lothringen. We merge these eight series into a single German series covering the period from 1871 to 1918. Appendix Table B.1 provides a list of the sources by state and year. Appendix Section E describes the merging procedure for the German series.

A nationwide income tax was introduced in Germany in 1920, but between 1919 and 1924, the statistical office did not compile income tax statistics. During the period of hyperinflation in 1923 and 1924, income tax legislation was temporarily suspended. From 1925 to 1938, most income tax statistics covered a smaller territory than before World War I, excluding the provinces of Poznan, part of West Prussia, Katowice (part of Silesia), Alsace-Lorraine, and North of Flensburg (part of Schleswig-Holstein), which had been lost after the war. From 1936 to 1938, income tax statistics again included Saarland, which was occupied and governed by

Figure 1: German territory covered by the series, 1871-2014



Note: Grey-shaded areas are covered by the series and white areas are excluded as either no income tax statistics were published (1871-1919) or the area was not part of the (West) German territory.

the United Kingdom and France under a League of Nations mandate from 1920 to 1935. In 1938, income tax statistics included Austria after its annexation by Nazi Germany.

The sweeping tax reform of 1920 also introduced a payroll withholding tax. This payroll tax abolished the obligation to file a tax return for large fractions of the population for whom wages were the only income source. Consequently, the bottom half of the top decile (P90-95) was no longer covered by the income tax statistics. As a consequence, the top decile income share cannot be computed from income tax statistics from this period. Payroll tax and income tax statistics cannot be merged *ex post* for two reasons. First, the tax units are sorted according to different income concepts (wages vs. overall income). Second, payroll tax statistics treat the individual as the tax unit and income tax statistics treat the household as the tax unit. However, the German statistical office published synthetic tabulations of both income and payroll tax statistics for 1926, 1928, 1932, 1934, 1936, and 1950, which we use to estimate top income shares in these years. We can estimate the

top percentile's share between 1925 and 1960, a period for which only income tax statistics are available. Appendix Figure A.2 shows that income tax tabulations produce almost identical results for the top percentile, but underestimate the share of the top decile. In 1961, the statistical office began publishing statistics that include both payroll tax and income tax in one table.

From 1949 to 1989, income tax statistics covered the territory of the Federal Republic of Germany (FRG). Hence, the about 18 million Germans living in the German Democratic Republic (GDR), which comprised one fifth of the German population in 1950, were excluded. On the other hand, about 7 million people fled from the former eastern territories of the German Reich (Silesia, Pomerania, and East Prussia) to the FRG between the end of World War II and 1950. After 1960, the statistics include West Berlin and Saarland. Saarland joined the FRG in 1957. In 1990, Germany was unified, which increased the number of taxpayers by 4 million and the number of non-filers by 5 million.

Using income tax statistics, thresholds and average incomes for top income groups are obtained by applying the Pareto interpolation method commonly used in the top income share literature since the seminal contribution of Piketty (2001, 2003), assuming that top incomes above the Pareto threshold k follow the Pareto distribution:

$$F(y) = 1 - (y/k)^{-b/(b-1)} \quad \forall\, y \geq k \tag{1}$$

The Pareto parameter b is obtained by dividing the average income above a certain income threshold documented in the tax statistics by the respective income threshold. Different Pareto parameters are obtained for different fractiles. For instance, to compute the Pareto parameter for the top 1%, we first identify the income bracket in which the top 1% starts, and then take the lowest income threshold of that income bracket. Empirically, b varies slightly across the top fractiles, which contradicts the basic property of the Pareto distribution that b is a constant. Empirically, however, the Pareto interpolation method provides an extremely good fit when comparing results to those obtained directly from individual tax records, where

we can obtain the total income of a fractile by simply adding up individual incomes.[6] Rearranging Eq. 1 and using the estimated b, we can compute the income threshold of the top x%. The income share of the top x% is then obtained by dividing the cumulative income above the income threshold by an external reference total income as follows

$$\text{Income share of top x\%} = b \cdot \text{income threshold of top x\%} \cdot \frac{\text{x\% of total tax units}}{\text{total income}} \tag{2}$$

As can be seen from Eq. 2, the total number of tax units and the total income are crucial for determining the income share of a fractile. The total number of tax units is constructed according to the bottom-up approach for the period 1871-1918 and according to the top-down approach from 1925 onwards. The bottom-up approach adds the (estimated) number of tax-exempt persons to the number of taxpayers documented in the income tax statistics. The top-down approach draws on official population statistics and obtains total tax units as the sum of the number of married couples and bachelors minus the number of children. Sources and the method used to construct the reference total tax units are described in the Appendix, Section C. For the computation of reference total income, we also adopt a bottom-up approach for the period 1871-1918 and a top-down approach from 1925 onwards. The bottom-up approach adds (estimated) income of tax-exempt individuals to taxpayers' income as documented in the income tax statistics. The top-down approach draws on national accounts and obtains reference total income as a fixed share of private household income. Sources and the construction of the reference total income are described in the Appendix, Section D. Following Piketty and Saez (2007), incomes are Pareto-imputed where only the number of taxpayers per income bracket is available.

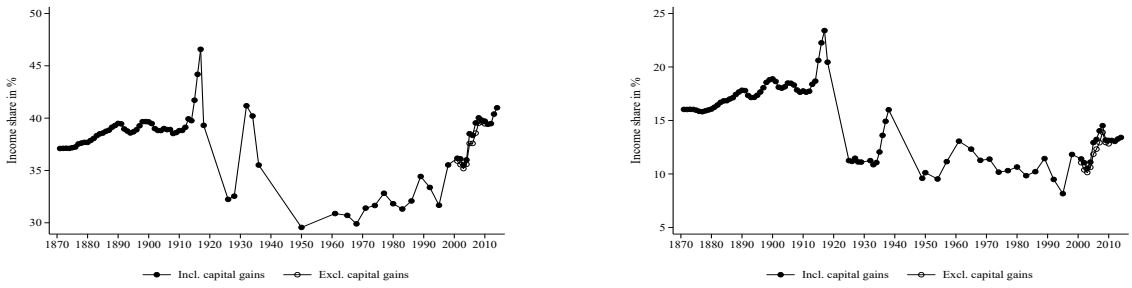
[6] Bartels and Jenderny (2015) compare German top income shares obtained from tabulated income tax statistics with income shares obtained from individual tax returns which have been available as microdata since the 1990s. Top income shares based on tabulated statistics deviate from those based on microdata by about one decimal point. Using microdata, top 1% incomes are obtained by simply calculating cumulative income moving downwards in the income distribution until reaching the fractile threshold.

3 Trends in top income shares

3.1 Top income shares in Germany, 1871-2014

We now turn to the top income share series for Germany from the foundation of the German Reich in 1871 until 2014. Figure 2 shows how the top decile's and top percentile's shares developed over time. Five periods should be distinguished, over which the German territory, the population living in this territory, and the political system changed quite radically. The industrialization period of the German Reich from 1871 to 1918 was characterized by high and increasing top income shares. During the Weimar Republic from 1920 to 1933, inequality was low, but it increased sharply after the Nazis came to power in 1933. Over the post-WWII period from 1949 to 1989, the top decile's income share increased relatively steadily after reaching a low point in 1950. The top percentile's income share quickly recovered from the slump immediately after World War II. Over most of the post-war period, their income share was even higher than it was in the 1920s, which was very different from the situation in many other industrialized countries at that time. German reunification in 1990 initially resulted in a decrease in top income shares, but by the mid-2000s, the top decile's share surpassed pre-World War I levels, and the top percentile's share surpassed post-World War II levels. As most of the capital gains were tax-exempt in Germany, excluding capital gains from the series does not greatly reduce the top decile's or the top percentile's income share. In the following, each period is discussed separately, and we focus on series including capital gains.

Figure 2: The top 10% and 1% income shares in Germany, 1871-2014



Source: Appendix Table A1.

In order to shed light on the distribution of income gains within the top decile,

Figure 3 displays the income share of the bottom half of the top decile (P90-95), the next 4% (P95-99), and the top 1%. Before 1918, most of the changes in the top decile were driven by changes in the top percentile. Even though the top 1% makes up a small share of the population, it captures about a sixth of total income before World War I and a seventh throughout the second half of the twentieth century. The top percentile lost relative to the bottom 9% after both world wars. Piketty and Saez (2003) observed the same pattern in the United States. In Germany, the top percentile's share was far higher before World War I, and fluctuated in size between the bottom 5% and the next 4% shares in the post-war period. In the United States, it was only slightly higher before World War I and substantially below the size of the bottom 5% and the next 4% shares in the post-war period. This indicates a relatively high income concentration at the top in Germany. Germany's trends by international comparison are discussed in more detail in Section 3.3.

The industrialization period from 1871 to 1918 marks a phase of moderately increasing income concentration at the top in Germany, which will be discussed by state in Section 3.2. The top percentile in Germany benefitted overproportionately from the period of industrialization, whereas the bottom 9% of the top decile merely kept up with overall income growth. The top percentile's income share increased from 16% in 1871 to 18% in 1913. In contrast, the income share of the bottom half (P90-95) stagnated at about 9% and the next 4% (P95-99) even lost out relative to the other fractiles.[7] During World War I, the top percentile's income share increased sharply from 18% in 1914 to 23% in 1917. This finding is in line with the widely accepted view of Kocka (1978) that World War I brought a large-scale redistribution from labor to capital, hence, substantially increased inequality, which the November

[7]We would obtain lower top income shares in the 1870s and a steeper increase over the industrialization period, if the criticism of the Hoffmann (1965) national income series would equally apply to the Hoffmann and Müller (1959) income series by state, which this paper relies on. The estimation of top income shares crucially depends on reference total income. The German national income series by Hoffmann (1965) has repeatedly been criticized to underestimate national income levels in mid-19th century and overestimate income growth during the industrialization period (see, e.g., Fremdling (1988)). (Hoffmann, 1965, p.167) himself suspected that his net national product series for Germany contained a downward bias of both capital income and more severely labor income. However, we believe that the critical discussion of Hoffmann (1965) does not apply to the elements of the Hoffmann and Müller (1959) series by state that we use, which closely builds on income tax data only supplementing wages of the tax exempt from other datasources (see Appendix Section D). For instance, Hoffmann and Müller (1959) report higher estimates for German national income in 1850 than Hoffmann (1965), which is also acknowledged by Fremdling (1988).

Revolution of 1918 sought to reverse (Kocka, 1978, p.136). Increasing business profits in the armament industry and, more generally, businesses benefitting from the particular demands of a war economy are behind the rise in income concentration during the war (Preussisches Statistisches Landesamt (ed.), 1920, p.71). Ritschl (2005) challenges this view arguing that "there is no such thing as redistribution towards capital during World War I in Germany". He computes the share of wages in industrial output and finds that the distributional position of labor deteriorated for war-related and intermediate industries, but not for civilian industries. However, he neglects in his analysis the increasingly important role of war bonds which rich private investors bought on a large scale earning high interest income (Hardach, 2017). The war-induced increase in top incomes, however, is almost offset by the drop in 1918 as inflationary income growth disproportionately boosted middle incomes and, by 1918, authorities managed to restrict extraordinarily high profits from military spending. Income shares of all fractiles of the top deciles dropped in 1918 compared to the preceding years, but not below the pre-war levels of the industrialization period. For instance, the top percentile's share increased from 19% in 1914 to 23% in 1917 and then dropped to 20% in 1918. World War I did not act as the great leveler in Germany, but rather exacerbated tensions between workers, business owners, and the government.

A comparison of the merged German series covering 90% of the German population with the Prussian series covering 60% (see Appendix Figure F.7) reveals that if we relied exclusively on Prussian data as in Dell (2007) we would underestimate the income share of the top decile, but overestimate the share of the top 0.01%. Before World War I, most German top income earners were in Prussia.[8]

The second period covers the Weimar Republic years[9] from 1919 to 1933. During this period, the governing parties changed frequently depending on the support of the elites, but also on the voting masses. This created a "laboratory of inequality-reducing policies" (Kaelble, 2017, p.61). The top marginal tax rate was raised from

[8]Almost two-thirds of German millionaires listed in the famous Yearbook of Millionaires (*Jahrbuch der Millionaere*) of 1913, produced by former civil servant Rudolf Martin, lived in Prussia. A fifth of all Prussian millionaires lived in the Rhine province, 15% in Berlin, and 10% in Silesia. In contrast, 15% lived in Bavaria, 9% in Saxony, and 8% in Hamburg.

[9]The constitution of the new republic was drafted in the city of Weimar.

5% (in Prussia) to 60% and unemployment insurance was introduced along with employment legislation and employment protections. In the aftermath of the revolution of 1918, employers' organizations accepted the unions as equal partners and met many of their sociopolitical demands, including substantial wage increases. In return, the unions cooperated with the employers' organizations and renounced class war (Kocka, 1978, p.137). Both wage increases curtailing business profits and hyperinflation likely contributed to reducing inequality.[10] The capital income share in national income declined from 40% before the war to 35% in the second half of the 1920s (Bengtsson and Waldenström, 2018). Capital flight to Switzerland among individuals fearing confiscation of property as war reparations and increased tax avoidance activities following the dramatic tax increases might be other reasons for the decline in top incomes.[11] The income share of the top percentile fell by almost half to 11% in the 1920s and remained virtually stable until 1933. However, according to the controversial *Borchardt-hypothesis* (Borchardt, 1982, p.176), it was the intensifying distributional conflict between the organized interest groups of labor and capital along with the large-scale redistribution beyond the country's means that made the economy of the Weimar Republic "sick". "Excessive" wage raises in the second half of the 1920s far exceeded productivity growth, thus curtailing business profits and limiting the scope of new investments.[12] Rapidly rising unemployment was another consequence. The nonfunctioning political and economic system during this period of exceptionally low inequality ended with the Nazi seizure of power in 1933.

The third period stretches from the Nazi takeover in 1933 to the eve of World War II in 1938. After 1938, the statistical office stopped publishing income tax

[10]Hyperinflation in the first half of the 1920s eroded financial assets, greatly reduced capital incomes, and thereby led to a redistribution from nominal to physical capital (Holtfrerich, 1980, p.273).

[11]Piketty and Zucman (2014) point out that Swiss data show a large increase in foreign-owned assets managed by Swiss banks in the 1920s. In all likelihood, a sizable fraction of these belonged to German households. Capital flight of foreign securities from Germany after World War I was acknowledged at the time by scholars such as Keynes (1920) (chapter 5, III:1).

[12]The large increase of the wage share can be seen from the inverse of the capital share presented in Figure 10, which sharply decreased in the second half of the 1920s. Wage growth was particularly high for workers in the consumer goods (paper, textile, clothing) and food industries (Gómez León and de Jong, 2018). In contrast, the return on equity was only 2.5% between 1925 and 1929 (Spoerer, 1996).

statistics, so we do not know how the income distribution changed during World War II. The Nazi period is marked by an extraordinary increase in the top percentile's income share from 11% in 1934 to 17% 1938.[13] In contrast, P95-99 gained only moderately. In Germany as in most industrialized countries, economic recovery from the Great Depression started in 1932. The boom that followed up to 1936 was driven by a rebound effect that could be predicted from late 1932 on according to Ritschl (2002a). The fiscal and monetary policy of the Nazis was immaterial to the upswing. Industrial firms saw their profits rise sharply between 1933 and 1939 with an average return on equity of 10.4% (Spoerer, 1996). Ferguson and Voth (2008) report that firms "betting on Hitler" outperformed unconnected firms in their stock market value by 5% to 8%. The effect of Nazi connections probably contributed to a further concentration of incomes at the top.[14] Larger firms were more likely to have connections with the Nazi regime. They included firms in all sectors, i.e., firms engaged in military activities and others as well.[15] Some large family fortunes originated during this period, for example that of the Quandt family, who bought BMW after the war. In 1933, unions were dissolved and wage controls enacted, such that average hourly wages in 1938 were lower than in 1928.

The fourth period from 1949 to 1989 was that of the Federal Republic of Germany (FRG), which did not include about a fifth of the German population who were living in the German Democratic Republic (GDR). Top income shares in post-war Germany are remarkable in three respects. First, income shares of the bottom half of the top decile and the next 4% were not significantly below the levels of either the pre-war industrialization period or the interwar period. In the 1950s and

[13]Fremdling and Staeglin (2014) show that hidden profits in the armament industry led to a substantial underestimation of national income in 1936. However, these hidden profits are likely to be missing from income tax statistics as well. If these hidden profits were concentrated at the very top of the distribution, the numbers presented in this paper would even underestimate the true income concentration at the top.

[14]Tendencies toward economic concentration are also evident in the steadily decreasing number of corporations between 1925 and 1938. The number of limited liability companies decreased from 64,398 in 1925 to 25,662 in 1938. The number of stock companies decreased from 13,010 in 1925 to about 9,634 in 1932 and then fell by almost half to 5,518 in 1938 (Statistisches Bundesamt, 1972).

[15]Part of the income increase recorded in tax statistics might be due to improved enforcement starting in 1937 (Statistisches Reichsamt, 1939). However, we can only speculate as to whether this improved enforcement disproportionately benefited the rich, thereby contributing to an increased income share of this group.

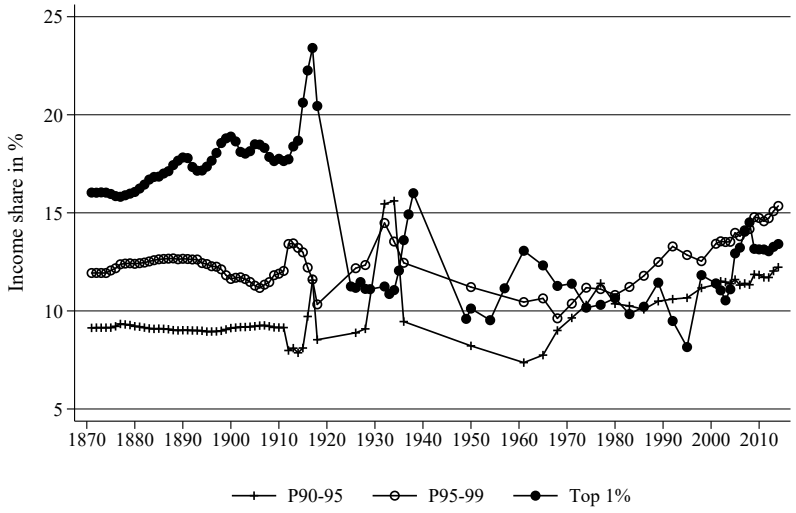
1960s, the top percentile's share was even higher than in the interwar period. This means that income concentration in post-war Germany was high from a historical perspective, thus contrasting with the general view that the social market economy of the post-war period was characterized by comparably low inequality. Several studies show striking continuity in post-war Germany in many areas. The same people who were behind the war economy of the early 1940s were at the helm of major German businesses and business associations in the 1950s, with the exception of a few of the most compromised Nazi collaborators (Grunenberg, 2006). Rather than embarking on radical reform, German policymakers in this decade quickly resurrected institutions inherited from the Weimar Republic and the mid-1930s, thus creating a tightly regulated economy with a corporatist system of organization. Institutional changes were only adopted as needed to avoid a rupture with the Allies (Eichengreen and Ritschl, 2009). Eichengreen and Ritschl (2009) argue that the institutional continuity provided accountability and predictability in the 1950s and enabled the German economy to grow and return to its historical trend after major disruptions in the aftermath of World War II. Second, the top percentile's income share in post-war Germany was also higher than in other industrialized countries like France, Sweden, the United Kingdom, and the United States, which we discuss in more detail in Section 3.3. Third, the post-war drop in top income shares in Germany was nothing new, but a return to the low levels already seen in the 1920s. The situation was different in other countries involved in the war, such as the United States, France, and the United Kingdom, where the first great decline in top income shares occurred after World War II. Comparing this part of the series with Dell (2007), we find that the post-war drop in the latter study is less pronounced than ours. Our top decile (top percentile) share estimates drop to 30% (10%), whereas Dell (2007) estimates 34% (12%) (see Appendix, Figure F.7). This divergence is puzzling as we use the same data source and almost the same reference total population and total income from 1950. Our estimate of the top percentile's share in 1949 shows a similar magnitude to our 1950 estimate. In the same line, our top income share estimates in 1989 are higher than those from Dell (2007) (see Appendix, Figure F.7), particularly for the top 1%, which cannot be explained by data source of reference totals.

The fifth and last part of the series covers reunified Germany. Political reunification on October 3, 1990, brought the Eastern states of Berlin, Brandenburg, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt, and Thuringia into the Federal Republic of Germany. The first few years after reunification were marked by exceptionally high GDP growth rates in the reunified German economy. GDP grew by about 8% per year from 1990 through 1992 although industrial production quickly collapsed in the East and unemployment skyrocketed. Those who kept their jobs benefited from an unprecedented hike in real wages achieved through negotiation by West German labor unions that aimed at reaching parity between East and West German wage levels by 1994 (Burda and Hunt, 2001). Accordingly, the inclusion of East Germans in the West German income tax system brought an overproportional increase in the number of unemployed non-filers. At the same time, wages of East Germans who were still employed kept pace with those of West Germans up to the highest percentile. Taking these effects together, the income share of the top percentile fell sharply, whereas the share of the bottom 9% of the top decile remained almost unchanged between 1989 and 1992. In 1995, income in the top percentile fell even though the economy was still growing, albeit at a slower pace.[16] Growth slowed even further after 1996. By 1998, the top percentile's income share reached pre-reunification levels as business and capital income continued to grow, along with unemployment. From that point on, the top 5% (P95-99 and top 1%) experienced enormous growth in their income share, which was only briefly interrupted by the burst of the dot-com bubble in 2003. The income share accruing to the top percentile rose from about 12% in 2000 to a post-war high of more than 14% in 2008. In 2009, in the wake of the Great Recession, Germany was hit by the largest output drop of the post-war era, and GDP declined by more than 5%. Unfortunately for researchers, the recession coincided with the introduction of dual income taxation in the form of a separate withholding tax on dividends and interest income (*Abgeltungssteuer*), after which income tax statistics no longer recorded

[16] A substantial portion of the top income decline in 1995 was due to tax loopholes for property renting and leasing, which included generous depreciation allowances, tax relief, and accounting rules in combination with tax-free capital gains. This created massive budgetary. Bach et al. (2009) use German tax microdata to estimate top income shares and find that when disregarding extreme losses in renting and leasing, the dip in 1995 disappears.

these income forms systematically. The shares presented include an imputed capital income share after 2009.[17] Hence, the remaining drop in the top percentile's income share is largely attributable to the economic crisis.

Figure 3: The income share of fractiles P90-95, P95-99 and P99-100, 1871-2014



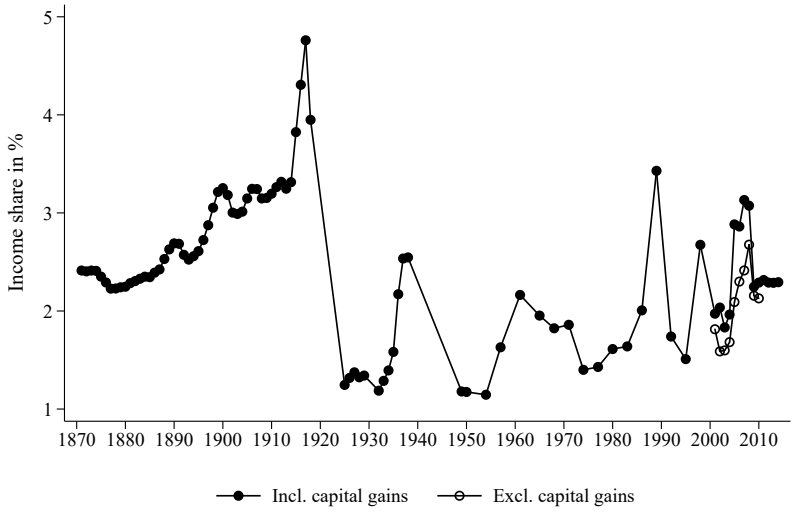
Source: Appendix Table A1.

The income shares of the top 0.01% are displayed in Figure 4. Despite high volatility between adjacent years, their income share is at a remarkably stable level of about 2% for 140 years. In the years in which microdata exist, excluding capital gains shows that even at the very top, taxable capital gains remain comparably small.

The bottom 50% lost out against the upper half of the distribution over the post-war period, as shown in Figure 5. In the years of the German *Wirtschaftswunder* (economic miracle), strong labor demand and high GDP growth rates coincided with powerful unions, low unemployment, and a relatively compressed wage distribution. The bottom 50% received a third of total income. With the oil crises and the onset of mass unemployment, the share of the bottom 50% collapsed to less than a quarter. In the 1970s, the share of employees in the service sector surpassed the share employed in the industrial sector. The decline of the bottom half is mirrored by an increase of the middle 40% who had been receiving slightly more than 40% of total income since the 1970s. The middle 40%'s share has remained relatively stable

[17]This imputation is explained in detail in Bartels and Jenderny (2015).

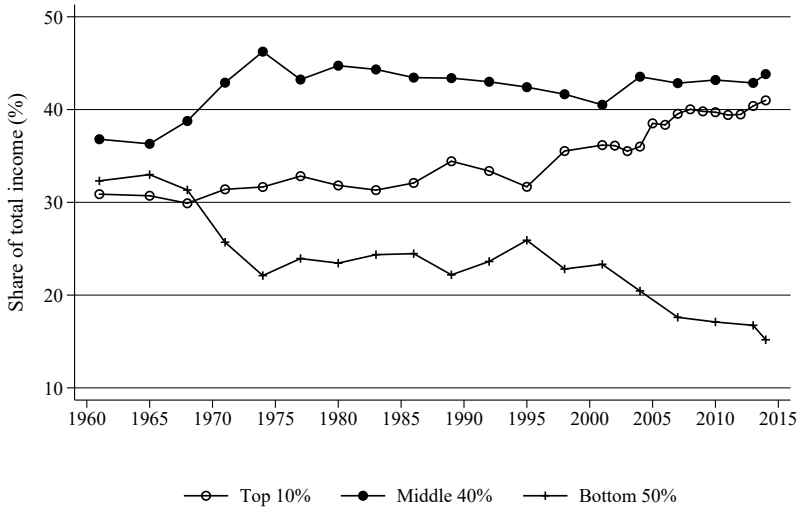
Figure 4: The income share of the top 0.01% in Germany, 1871-2014



Source: Appendix Table A1.

ever since, while the top decile has gained since the mid-1990s. With the growth of the low-income sector at the end of the 1990s, the share of the bottom half declined significantly from 22% in 2001 to 15% in 2014.

Figure 5: The income share of the bottom 50% and middle 40% in Germany, 1961-2014



Source: Appendix Table A1.

In 2014, the bottom half of the population had a 15% share of total income, while the top decile's share was 41%. The top decile's income share in Germany today has again reached the high levels of the industrialization period. As the data

used in Dell (2007) end in 1998, he did not capture this recent increase in income concentration in Germany. The increase was driven by the bottom 9% of the top decile, who have shown disproportionately high income gains in the second half of the twentieth century and in the first decade of the 2000s. The top percentile did not recover from the shocks that occurred between 1918 and 1945. Their income share was already high and increased to more than 20% during the period of industrialization, fell substantially to 11% during the years of the Weimar Republic, increased again sharply during the Nazi regime, reaching 16% in 1938, and then oscillated around levels of 10-11% throughout the post-war period. Since the turn of the millennium, the income share of the top percentile has been growing, with only a brief interruption from the burst of the dot-com bubble in 2003. The income share accruing to the top percentile rose from about 12% in 2000 to a post-war high of more than 14% in 2008 and was about 13% in 2014.

3.2 Top income shares in German states, 1871-1918

The level of income concentration between 1871 and 1918 varies greatly across German states. Figure 6 shows how the top percentile's income share evolved in eight German states. The sovereign city states of Hamburg and Bremen exhibit the highest levels of income concentration.[18] In contrast, largely agrarian states like Hesse and Baden appear more egalitarian. The top percentile's income share in the sovereign city-states fluctuates around 30%, which is more than twice the share of the same group in Wurttemberg or Baden. It is worth noting that the magnitude of income concentration observed in the sovereign city-states as well as in Prussia and Saxony before World War I was also quite high from a long-term perspective over the 20th century. Currently, about 13% of total income accrues to the top percentile in Germany.

Over the industrialization period, income concentration increased in German

[18]High volatility of the city series occurs for two reasons. On the one hand, cyclical variations in imports and exports likely translate into very volatile top incomes in Hamburg and Bremen, which are both major port cities and rely heavily on trade. On the other hand, the smaller population of these cities compared to large states such as Prussia automatically produces more volatile top incomes and total incomes (see Figure D.1). One percent of the tax population was about 800 tax units in Bremen in this period and 80,000 tax units in Prussia.

states. The income share accruing to the top 1% increased from 13% to 17.5% in Baden between 1890 and 1913, from 15.5% to 17.5% between 1873 and 1913 in Prussia, and from 15% to 17% between 1904 and 1912 in Wurttemberg. In Saxony, entrepreneurs in industry and trade obtain most of their income gains in top incomes, whereas the more traditional professions such as large landowners, higher officials, doctors, lawyers, professors, and higher clerks experience only marginal gains. Kaelble and Volkmann (1986) show that this phenomenon also applied to Prussia. It likely reflects trends in other industrializing states as well.

During World War I, income concentration rose sharply in Prussia and Saxony, where top income earners experienced disproportionately high income gains, most likely caused by increasing business profits in the armament industry. In contrast, the evolution of the top 1% share in mostly agrarian Hesse during World War I was almost stable. The other states did not publish income tax statistics during the war (see Section 3.1 for a more detailed discussion of the distributional changes during World War I). These differential developments across states are in contrast to a general convergence of per capita income levels in Germany as can be seen in Appendix Figure D.1.

There have been several attempts to analyze income inequality using income tax data from German states before 1918. The results of these studies, which either computed Pareto coefficients or top income shares as a measure of inequality, are displayed in the Appendix in Figures F.1 to F.6.[19] Most previous studies find signs of a slightly rising income concentration prior to World War I. The Soviet economist Procopovitch (1926) concludes that "tendencies towards plutocratic development are certainly in evidence in Germany" between 1875 and 1919. It is worth noting that Procopovitch (1926) provides the empirical support for the inequality-

[19]This paper's series includes (1) more data points; (2) Pareto-imputed top incomes, where only the number of taxpayers per income class is available; and (3) consistent adjustments, where corporate taxpayers are tabulated jointly with personal income taxpayers. The resulting trends are therefore less volatile than the top income share estimates by Dell (2008) and Geisenberger and Müller (1972), particularly for Baden, Hesse, and Wurttemberg. Consistently excluding corporate taxpayers generates lower top income shares. For instance, this paper's top decile share for Saxony is 4% points lower than the estimate of Dell (2008) (see Appendix Figure F.5) and is 2% points lower for Baden (see Appendix Figure F.2). For Saxony, the review (*Zeitschrift*) provides tables showing personal income taxpayers separately from corporate taxpayers, which the yearbook of the statistical office used by Dell (2008) does not. See Appendix Section A for the adjustment procedure applied to the Baden income statistics.

increasing part of the Kuznets curve (Kuznets, 1955). Grumbach (1957), who estimated Pareto coefficients for the period of 1822-1939 for various German states, speculates that growing, but unequally distributed business incomes contributed to the increase in income concentration at the top. He confirms our finding that income concentration was particularly high in the sovereign city-states of Hamburg and Bremen. Economists of the time, including Gustav von Schmoller (Schmoller, 1895), Werner Sombart (Sombart, 1919) and Adolph Wagner, shared the view that income concentration was increasing, and discussed this issue extensively.[20]

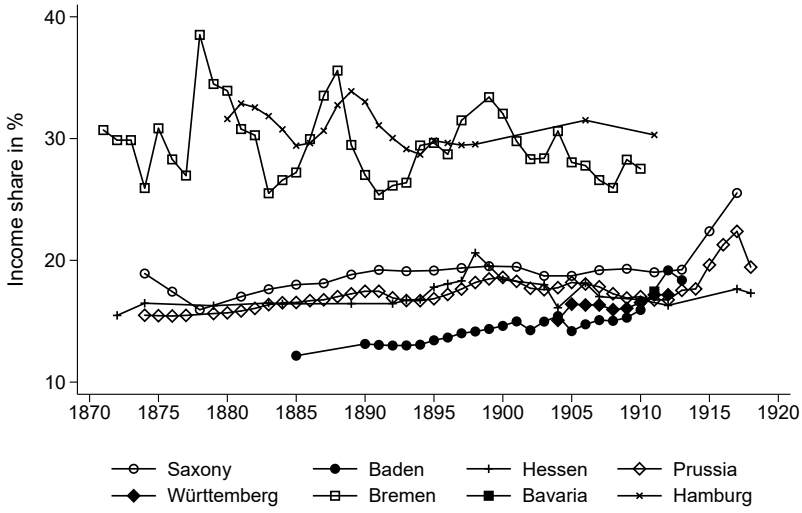
The degree of industrialization might explain part of the variation in income concentration levels across states. It is widely agreed that easy access to large coal deposits determined the regional pattern of industrialization in Germany and other industrialized countries (Sombart, 1919; Pollard, 1981; Holtfrerich, 1973; Fremdling, 1985; Tilly, 1991). According to Gutberlet (2012), access to coal in late nineteenth century Germany was decisive in determining where both metallurgy and cotton textile production were located. As a consequence, high growth rates in Saxony and the Prussian Ruhr area generated top incomes in these areas that could not be matched in agrarian areas. On the other hand, the growing importance of big cities for commercial trade (Hamburg, Bremen) and financial trade (Berlin) might have boosted top incomes disproportionately. According to Sombart (1919), banks, most of which were also located in bigger cities such as Hamburg, Frankfurt, and Berlin, were a driving force in German industrial production and trade. Finally, higher enforcement of tax collection might be another reason for higher income concentration in the sovereign city-states, as income tax was the main source of fiscal revenue in these cities (Ketterle, 1994, p.144).

3.3 International comparison

Comparing income concentration in Germany to other countries reveals a strikingly stable income concentration in Germany over the twentieth century. Figure 7 shows

[20]This group of economists was also referred to as "socialists of the chair" (*Kathedersozialisten*) for their support of social reforms. Wagner postulated that "a new, large economic (money-)aristocracy has arisen, which far supersedes the old one in numbers in income and wealth, next to an elevated laboring class and a depressed class." (Wagner, 1907, p.467)

Figure 6: The top 1% income share in German states, 1871-1918

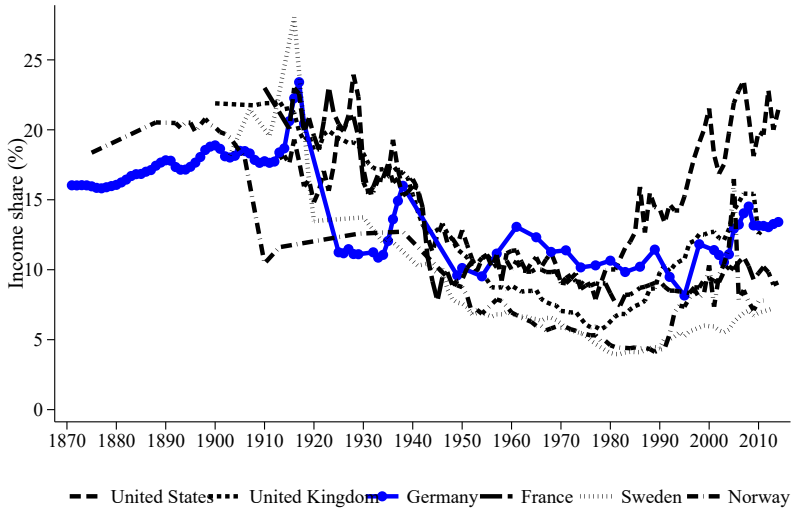


Source: Appendix Table A1.

the evolution of the top 1% income share in Germany in comparison to the trends observed in France, Sweden, the United Kingdom, and the United States. Although the German top percentile also experienced a U-shape pattern over the twentieth century, like other countries (Atkinson et al., 2011), the U-shape is rather flat and interrupted by the skyrocketing shares before and during the two world wars. The top percentile's share in Germany was comparably low in the first half of the twentieth century. As in Sweden, the decline in income concentration in Germany occurred toward the end of World War I and in the 1920s. In France, the United Kingdom, and the United States, by contrast, the most pronounced drop occurred during World War II. These contrasting developments in the United Kingdom and Germany are also reported by Gómez León and de Jong (2018). Even though they use a different data source – tables from social tables covering 78 income groups in the period 1900-1950 –, they also find exploding inequality in Germany during World War I, a large inequality decline thereafter, and an increase in inequality during the Nazi regime. Their findings for the United Kingdom are also in line with the evolution of top income shares in Germany, which showed a drop during World War I, an increase in inequality in the 1920s, followed by a relatively steady decline up to the end of World War II. In the post-war period, the top percentile's income shares in Germany were relatively high. In the 1960s, the top percentile accrued 11% to 13% of total income

in Germany, about 10% in France, about 8% in the United Kingdom and about 10% in the United States. The United States surpassed Germany in the 1980s, when the top percentile's income share in the United States started to increase sharply. This may come as a surprise, since this phase is viewed internationally as one of low inequality. One might speculate that the compressed wage distribution, which is well documented in a variety of survey and administrative data sources from this period, might have led to this view. However, neglecting the analysis of income tax data in the post-war period would leave the picture incomplete. Since the mid-1990s, Germany is on a path of increasing income concentration, increasingly resembling that of the Anglo-Saxon countries.

Figure 7: Top 1% income share in international comparison



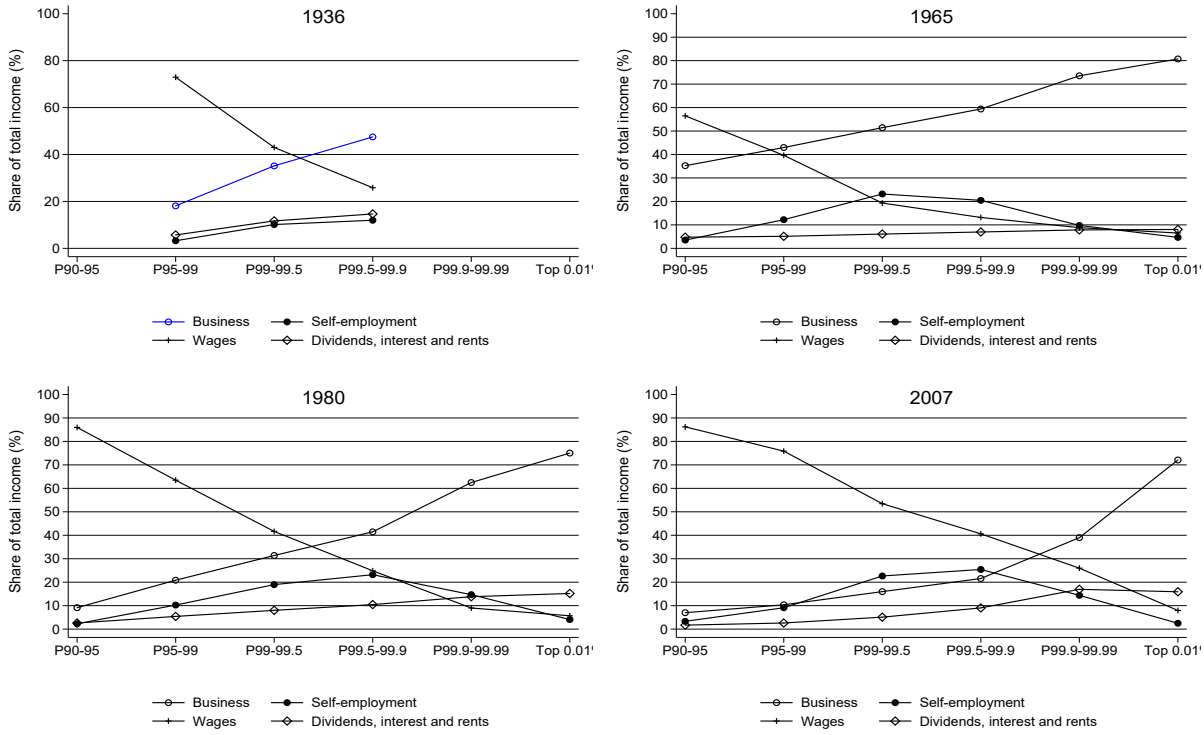
Source: WID.world and Appendix Table A1.

3.4 Composition of top incomes

In order to understand the sources of top incomes in Germany, Figure 8 displays the composition of top incomes within fractiles of the top decile moving toward the very top of the income distribution. Three basic conclusions apply to the four years presented for illustration. First, business income from unincorporated firms is always the most important income source of top income earners in the top percentile and among those at the top of the top. In contrast, P90-95 and P95-99 incomes are mostly composed of wages. Second, capital income, i.e., dividends, interest income and rents, is of minor importance across the distribution in Germany compared to other countries like France or the United States. Even for the top 0.01%, capital income never comprises more than 20% of total income. This is not surprising, as most German firms are unincorporated, often held by a few family members, and generate business income. Accordingly, Germany did not experience the dramatic decline in capital incomes from dividends and interest income after World War II that occurred in the United States. One should note, however, that business income includes both a labor and capital income component. It is unclear how much effort business owners invested in earning their business income or whether they worked for it at all. Third, the self-employed, such as lawyers, physicians, and auditors, earn top incomes but do not belong to the very top group.

Fluctuations in business incomes are indeed a major force behind the dynamics of top income shares in Germany. Figure 9 displays the composition of the top 0.1% income share from 1928 to 2014. Peaks in the top 0.1% income share are associated with 60% business income (1938, 1961) or 50% business income (2001, 2008). This pattern is even more pronounced for the top 0.01%, for which we can compute the income composition after 1961. This group generated 80% of their income from business in 1961 and 1965 and roughly 70% in 1989, 1998, and 2007. The increase in income concentration during the period of rearmament leading up to World War II can be attributed to a rise in business incomes at the top. The fall in income concentration in the late 1960s and after reunification in the 1990s also coincides with falling business incomes at the top. The declining portion of business income at the very top is mirrored by an increase in the portion of capital income. While

Figure 8: Income composition of top groups within the top decile in Germany



Source: Income tax data, own calculations.

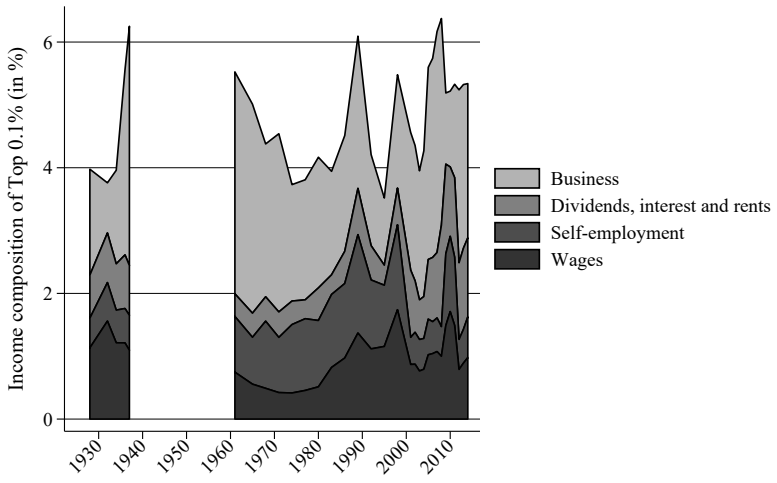
income from dividends, interest, and property income was 7% for the top 0.1% and top 0.01% in 1961, this portion increased steadily, reaching about a quarter for both top groups in the late 2010s.

Top managers and the highly qualified self-employed increasingly entered top income groups beginning in the 1980s. Whereas wages were less than a tenth of the top 0.1%'s income in the 1960s, the wage share increased to almost 30% in the first decade of the 2000s. The surge of top wage incomes in the second half of the twentieth century was a common phenomenon, found in Italy, the Netherlands, Spain, and the United States as well. This was in stark contrast to the rising importance of capital income at the top in Finland, Sweden, and the United Kingdom (Atkinson et al., 2011). It remains an open question to what extent these *working rich* were both CEOs and business owners at the same time, disbursing part of their business income as wage income. Rubolino and Waldenström (2017) find that income shifting between wage and capital income in response to tax differentials is substantial at the top of the income distribution.[21] Top incomes from wages still present a relatively

[21]The analysis is based on Australia, Canada, France, Italy, Japan, Korea, the Netherlands,

rare phenomenon in Germany. While the working rich replaced rentiers in Canada and the United States over the twentieth century, where the top 0.01% generated half of their income from wages in the early 2000s (Saez, 2005), the German top 0.01% only generated a tenth from wages.

Figure 9: Composition of top incomes in Germany - Top 0.1%



Source: Income tax data, own calculations.

If owning a business is the time-invariant key to earning top incomes in Germany, the question arises how business ownership is achieved and maintained, in some cases across generations. Even during the period of industrialization, aristocratic families played only a minor role as entrepreneurs in Germany. Kaelble (1990) studies the owners and top managers of large German companies both before World War I and in the Weimar Republic. He finds that intergenerational persistence of business ownership was high during both periods. Increasingly, sons were not working in the family business they had inherited but becoming top managers of other businesses. Inherited business wealth might therefore continue to play a central role in top incomes. Korom et al. (2017) investigate how likely the richest Americans were to remain on the Forbes list between 1982 and 2013, and report that lasting fortunes are likely embedded in families, as they erode less easily, if professionally managed, than self-made fortunes. According to Schröder and Westerheide (2010), about 90% of all German companies are family-controlled companies that generate

Spain, Taiwan, and the United States due to data availability.

more than half of the cash flow of German companies.

4 Seeking Explanations

Over the course of two world wars; a variety of political regimes (including constitutional monarchy, dictatorship, and democracy); and the rapidly changing technological frontiers that have accompanied periods of industrialization and digitalization, top income shares in Germany have remained both remarkably high and stable. There were temporary upswings over the period of industrialization, during the Nazi regime, in the immediate post-war period and, recently, since the turn of the millennium. On the other hand, both world wars were followed by a substantial decline in top income shares.

Focusing on Germany for a period of 140 years enables us to investigate whether potential drivers of top income shares operate uniformly across periods. We argue that relationships are likely to change over time. Moreover, if distributional regimes shift over time, the role of some factors may increase, while others decline in importance. For example, following the collapse of a high-inequality regime, trade unions may become more powerful and negotiate substantial wage increases, thereby reducing distributed profits in a new low-inequality regime.

In the following, we investigate the extent to which the functional income distribution, globalization, technological change, the power of trade unions, and redistribution through progressive income taxation have been associated with changes in top income shares, all of which are often suggested and investigated confounders of inequality. Figure 10 shows the development of our main variables from 1871 to 2014. For the functional income distribution, we use the capital share figures of Bengtsson and Waldenström (2018).[22] We measure the degree of globalization by the share of exports in GDP. The standard measure for technological knowledge is R&D stock, which is available for OECD countries from the 1960s. Madsen (2007) constructs a measure for OECD countries covering 135 years, which builds on patent applications per capita and which we use.[23] We construct our own time series of trade union density defined by the share of employees who are members of a trade

[22] Erik Bengtsson kindly provided an extended series for Germany starting in 1871.

[23] Jakob Madsen kindly provided an extended series of patents in Germany covering our entire period.

union, as the longest available series from OECD begins in 1960. To create measures of income taxation at the top, we compute the marginal tax rate and the average tax rate that would apply to the top percentile's average income according to the prevailing income tax legislation.

Even though substantial progress has been achieved in developing various building blocks, there exists no unified theory of income distribution integrating the various drivers (Atkinson and Bourguignon, 2000). This still remains true. Further, theoretical models and empirical results are far from conclusive regarding the direction and relevance of the potential drivers of inequality. We discuss theoretical hypotheses on each of the drivers' effects on inequality in the following.

A rising capital share is associated with increasing inequality, if the correlation between wage and capital income is sufficiently low and if the inequality of capital income is sufficiently high, as suggested by Atkinson (2009). Bengtsson and Waldenström (2018) study the correlation of functional and personal income distributions empirically for a large number of countries, finding that the correlation is 0.5 or higher and highly statistically significant in 13 of the 16 countries. According to their results, the correlation has been declining in continental European and Nordic countries in recent decades.

If economic growth is shared equally, then economic growth does not affect income inequality. Income shares of top earners only increase, if growth is pro-rich. There is large evidence that economic growth has been pro-rich in many countries of the world in recent decades (Alvaredo et al., 2017).

Technological progress may favor inequality as higher heterogeneity of tasks increases demand for high-skilled labor (*skill-biased technogoligal change*) (Acemoglu and Autor, 2011). Empirically, technological change is found to drive inequality, particularly in the upper part of the income distribution (IMF, 2007; OECD, 2011). A growing number of studies report evidence of trade-induced technological progress (see, e.g., Bloom et al. (2016)). Karabarbounis and Neiman (2014) show that the decrease in the relative price of investment goods, often attributed to advances in information technology and the computer age, induced firms to shift away from labor and toward capital, thereby increasing the global capital share.

Globalization is generally suggested to increase inequality in advanced economies. Following the predictions of the Heckscher-Ohlin (HO) model, trade increases relative wages of the high-skilled in advanced economies, as they will export goods that intensively utilize factors with which they are more highly endowed. However, increased competition may also reduce the monopoly power of *national champion* enterprises, and thereby reduce top income shares. Cross-country studies remain inconclusive about the long-run role of trade.[24] Among others, Roine et al. (2009) find no clear distributional impact of international trade.

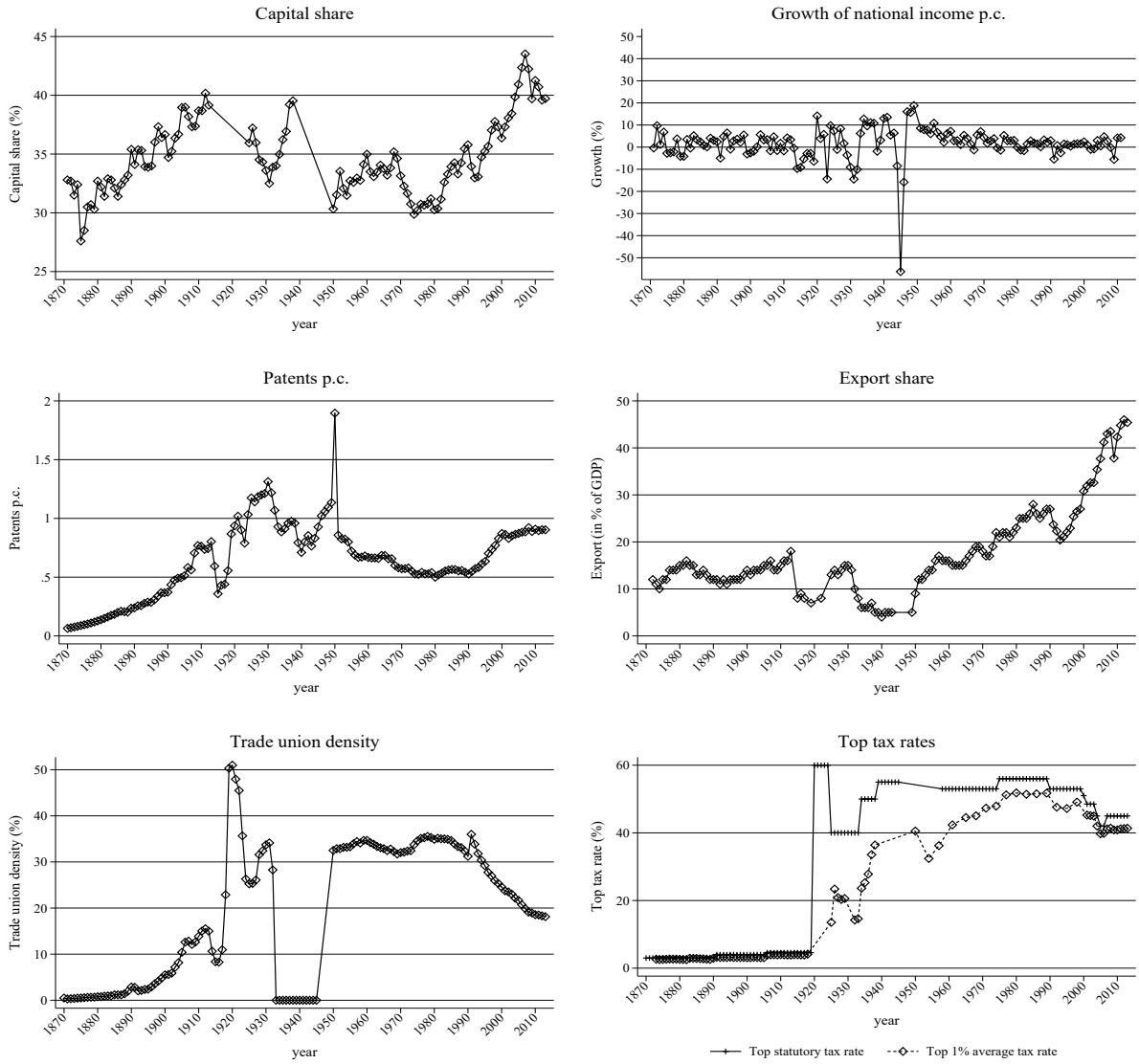
Trade unions are expected to have an equalizing effect not only directly, by increasing the earnings of their members and others, but also indirectly, by promoting the idea of a fair income distribution and establishing pay norms for employers. Most studies find that higher union density is associated with a more compressed wage distribution (Förster and Tóth, 2015).

Top tax rates have been argued to reduce top income shares through three channels: reduced labor supply (real response) (Feldstein, 1995), increased tax avoidance and evasion (Auerbach and Poterba, 1988; Slemrod, 1995; Goolsbee, 2000; Saez, 2017), and less aggressive wage bargaining of top managers as the marginal return to a pay increase is lower (Piketty et al., 2014). Figure 10 shows that top statutory tax rates in German states before World War I were small, with most top tax rates lower than 5%. States with the highest level of income concentration – Hamburg and Bremen – also charged the highest tax rates.

Table 1 shows that all of these variables strongly correlate with the income share of the top 1%. As developments of top income groups are largely driven by the top percentile, we restrict this analysis to the top percentile. While a higher capital share is associated with a higher income share of the top 1% when considering all periods jointly, average tax rates, trade, union density, technological change, and economic growth are associated with lower income shares. However, the sign of the correlation changes for some factors across the periods. The correlation matrices also show that the explanatory variables are (strongly) correlated with each other, such that a regression including all these variables jointly will suffer from multicollinearity.

[24] See Förster and Tóth (2015) for an overview.

Figure 10: Main variables



Source: Capital shares come from Bengtsson and Waldenström (2018). National income per capita in 2017 euro is from `https://wid.world/`. Patent applications per capita from Madsen (2007). Exports in % of GDP are from Rahlf (2015) available on `https://histat.gesis.org`. Union density has been calculated here based on union membership from Schneider (1989) and employment figures from `https://histat.gesis.org` for 1870-1932 as well as union membership from `http://www.dgb.de` and trade union density from `http://stats.oecd.org/` for post-war Germany. Top tax rates have been calculated here based on prevailing income tax legislation. Top 1% average tax rates 1871-1918 are computed applying Prussian income tax legislation to German top 1% average incomes.

The capital share in the German national income accounts data shows a strong positive correlation with the top percentile's income share in all four periods. The correlation is higher than 0.8 in all but the post-war period, 1949-1989.

Trade measured by the share of exports in GDP is associated with lower top income shares in three of the four periods. Only in the most recent period does trade seem to be associated with higher top income shares. In other words, the benefits from exporting to the global economy were shared more broadly from the

industrialization phase until the post-war era, whereas in recent years, these benefits tend to accrue to the elite.

Average tax rates of the top 1% show a strong negative correlation with the income share of the top 1% when all periods are considered jointly. However, splitting the periods reveals that this correlation was indeed positive until World War II and slightly negative in the post-war period. Only the most recent period shows a significantly negative correlation of -0.78. Income tax rates during the industrialization period were low and often increased in years when top income shares increased as well (see Figure 10). The same applies to the Nazi period, when rising top tax rates coincided with rising income concentration. Income taxation does not seem to play a predominant role for changing income concentration during this period, which is in line with the finding of Rubolino and Waldenström (2017) that top tax elasticities for 1900-1950 were very low in a set of 30 countries. In contrast, the top percentile's share growth after the turn of the millennium coincides with decreasing marginal and average tax rates. According to Rubolino and Waldenström (2017), top incomes in Anglo-American countries became more responsive to taxation over the period 1981-2014, with tax elasticities increasing to unprecedented levels of 0.92 among the top 0.1%. In contrast, they find that taxpayers in Nordic countries and continental Europe showed a much smaller response to tax changes.[25]

Trade union density is negatively correlated with top income shares in three of the four periods. During the industrialization era, trade union density was low, with less than 5% of employees being members of a trade union, but was increasing steadily. One might speculate about the extent to which increasing income concentration contributed to increasing trade union membership. Trade union membership and bargaining power substantially increased in the Weimar Republic, when top income shares fell dramatically. After the Nazi takeover, unions were banned and top income shares increased quickly. In the most recent period, declining union membership is strongly correlated with increasing top income shares.

Technological change, measured by the number of patent applications per capita, is negatively correlated with top income shares when considering all periods

[25]The estimated tax elasticity in Germany is 0.18 for the top 1% and 0.1 for the top 0.1%.

jointly. Splitting the periods reveals that technological change is only associated with lower income concentration in the middle of the twentieth century. Both in the industrialization period and since German reunification, technological change has been associated with higher top income shares.

The correlation between growth of per capita national income and the top percentile's income share is ambiguous. While the correlation is positive in the interwar period and in reunified Germany, it is negative during the industrialization period and in the post-war period. We thus confirm international evidence of pro-rich growth in recent decades.

Table 1: Correlation matrices by period

All	Top 1%	Cap.share	ATR	Trade	Union	Patents	Growth
Top 1%	1						
Cap. share	0.219**	1					
ATR	-0.845*	0.00656	1				
Trade	-0.336*	0.491*	0.566*	1			
Unions	-0.776*	-0.131	0.814*	0.358*	1		
Patents	-0.500*	0.421*	0.429*	0.233*	0.507*	1	
Growth	-0.256*	-0.00441	0.192**	-0.150*	0.0407	0.213**	1
1871-1919							
Top 1%	1						
Cap. share	0.817*	1					
ATR	0.683*	0.844*	1				
Trade	-0.384*	0.412*	0.0348	1			
Unions	0.609*	0.869*	0.894*	0.305**	1		
Patents	0.530*	0.881*	0.871*	0.361**	0.910*	1	
Growth	-0.370*	0.167	-0.287*	0.188	-0.205	-0.131	1
1925-1938							
Top 1%	1						
Cap. share	0.836*	1					
ATR	0.884*	0.851*	1				
Trade	-0.629**	-0.543**	-0.601**	1			
Unions	-0.587**	-0.589**	-0.613**	0.950*	1		
Patents	-0.449	-0.464*	-0.482*	0.954*	0.946*	1	
Growth	0.228	0.508*	0.361	-0.563**	-0.699*	-0.624**	1
1949-1989							
Top 1%	1						
Cap. share	0.528*	1					
ATR	-0.0948	-0.135	1				
Trade	-0.148	0.0114	0.843*	1			
Unions	-0.204	-0.362**	0.294*	0.421*	1		
Patents	-0.154	-0.113	-0.482*	-0.677*	-0.292*	1	
Growth	-0.207	0.00852	-0.548*	-0.705*	-0.311*	0.877*	1
1992-2014							
Top 1%	1						
Cap. share	0.893*	1					
ATR	-0.794*	-0.848*	1				
Trade	0.911*	0.881*	-0.908*	1			
Unions	-0.897*	-0.896*	0.852*	-0.956*	1		
Patents	0.886*	0.868*	-0.755*	0.883*	-0.951*	1	
Growth	0.152	0.300	-0.123	0.192	-0.127	0.177	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: See Note below Figure 10 for sources of explanatory variables.

We now turn to the analysis of potential drivers of top income shares using a multivariate regression framework. We compute three-year averages. We follow Roine et al. (2009) estimating a first-difference GLS regression

$$\Delta y_t = \Delta X_t' \beta + \mu_p + \epsilon_t \tag{3}$$

This standard first-difference regression includes fixed period effects μ_p to control for the numerous changes in borders as well as political and economic regimes. Period dummies are constructed for the German empire (1871-1918), for the Weimar Republic (1925-1932), the Nazi regime (1933-1938), post-war Germany (1949-1989), and reunified Germany (1990-2014). Following Roine et al. (2009), we use six different dependent variables y_t to capture different aspects of the income distribution given the limitation that tax data only cover the upper part of the income distribution. As the top decile is very heterogeneous, we use the top decile, the top percentile, and the top decile excluding the top percentile (P90-99). While labor incomes dominate in the lower part of the top decile, the importance of capital income increases further toward the top. The ratios 1/10 (0.1/1) measure the share of the top 1% (0.1%) within the share of the top 10% (1%) and have the advantage that they are not sensitive to the choice of total income. X_t is the vector of explanatory variables. We allow for serial correlation in the error term in order to take account of the correlation that remains after first-differencing. As a robustness check, we estimate the regression using 3-year averages (see Appendix Table G.1).

Our regression results, however, do not allow a causal interpretation, as we have not fully addressed potential endogeneity problems. First, our regressions might suffer from reverse causality. For instance, increasing income concentration might lead to less per capita income growth, to higher union membership or to higher income tax rates. Second, if some omitted variable influences both top income shares and the explanatory variables, results are biased. Third, income concentration and capital share may be codetermined, because more income accrueing to the top of the income distribution, where the capital owners are situated, may simultaneously create a higher capital share in national income.[26] In order to address multicollinearity

[26]There are two other concerns that render our simple multivariate analysis unsatisfactory. First,

between the regressors, we estimate the regression by stepwisely introducing controls.

Regression results including the full set of controls using different inequality measures as dependent variable are presented in Table 2. A higher capital share is associated with significantly higher income concentration at the top across all specifications expept for the bottom 9% income share of the top decile as dependent variable (P90-99). Trade is mostly significantly positively associated with higher income concentration at the top, but the coefficient turns significantly negative for some inequality measures when using 3-year averages instead of yearly values (see Appendix Table G.1). Higher per capita income growth is associated with a significantly lower top decile income share. However, the effect is insignificant for alternative inequality specifications. Union membership is associated with less income concentration at the top decile, but higher income concentration at the top 1%. The direction of the income tax effect is unclear. Average tax rates are significantly negatively related with the top 1% share within the top 10%, positively related to the top 10% income share, and insignificant for the top 1% and the top 0.1% share within the top 1%. This does not come as a suprise, because, taking a long-run perspective, income tax rates often increased in periods with increasing income concentration, for instance, during the industrialization period and the Nazi period (see bottom panel of Figure 10). Only in the first half of the 2000s, income tax reductions coincided with increasing income concentration. The coefficient of patents is significantly negative for some specifications. This also applies when using 3-year averages instead of yearly values (see Appendix Table G.1).

In order to check the robustness of the above regression results against likely multicollinearity of our explanatory variables, we subsequently introduce explanatory variables in Table 3. The coefficients of capital share and trade are positively significant in all specifications, while the average tax rate of the top 1%, and patents are insignificant in all specifications. Per capita income growth displays a significantly negative relationship with the top percentile's income share in most specifi-

inequality measures are typically bounded and non-stationary. Statistical inference that mistakenly uses standard asymptotic results leads to erroneous conclusions (Jäntti and Jenkins, 2010). Second, the timing of effects is unclear. While some factors may impact inequality immediately, others may take more time to show an effect.

Table 2: Regression results by inequality measure

	(1)	(2)	(3)	(4)	(5)
	Δ Top 10%	Δ Top 1%	Δ P90-99	Δ 1/10	Δ 0.1/1
Δ Cap. share	0.093**	0.106*	-0.019	0.222*	0.260*
	(0.045)	(0.037)	(0.035)	(0.081)	(0.098)
Δ Trade	0.035	0.062**	-0.039	0.156**	0.202*
	(0.034)	(0.028)	(0.026)	(0.061)	(0.073)
Δ Growth	-0.025**	-0.016*	-0.003	-0.039*	-0.011
	(0.013)	(0.010)	(0.010)	(0.023)	(0.026)
Δ Unions	-0.089*	0.020	-0.097*	0.100*	-0.058
	(0.021)	(0.016)	(0.016)	(0.038)	(0.043)
Δ ATR	0.124**	-0.013	0.166*	-0.219**	0.061
	(0.049)	(0.027)	(0.038)	(0.088)	(0.072)
Δ Patents	0.153	0.785**	-0.419	1.289	1.201
	(0.480)	(0.399)	(0.374)	(0.861)	(1.061)
Observations	111	114	111	111	114

Source: See Note below Figure 10 for sources of explanatory variables.
Notee: First-difference GLS estimations including period dummies. Standard errors are heteroskedasticity robust.

cations.

Table 3: Regression results subsequently introducing controls

	(1) Δ Top 1%	(2) Δ Top 1%	(3) Δ Top 1%	(4) Δ Top 1%	(5) Δ Top 1%	(6) Δ Top 1%
Δ Cap. share	0.088*		0.073**	0.096*	0.086**	0.106*
	(0.034)		(0.034)	(0.036)	(0.036)	(0.037)
Δ ATR		0.016				-0.013
		(0.037)				(0.027)
Δ Trade			0.069**	0.064**	0.056**	0.062**
			(0.028)	(0.028)	(0.028)	(0.028)
Δ Growth				-0.015*	-0.009	-0.016*
				(0.008)	(0.009)	(0.010)
Δ Unions					0.028*	0.020
					(0.016)	(0.016)
Δ Patents						0.785**
						(0.399)
Observations	116	119	115	115	115	114

Source: See Note below Figure 10 for sources of explanatory variables.
Note: First-difference GLS estimations including period dummies. Standard errors are heteroskedasticity robust.

In sum, correlations and regression results provide a similar picture. The capital share is the most important factor associated with increasing income concentration. Trade, patents and top average tax rates mostly show a positive association, while unions are negatively associated with income concentration at the top decile. Future research could overcome the endogeneity concerns discussed above by using instrumental variables or by exploiting a quasi-experimental setting.

5 Conclusions

This paper provides a new long-run top income share series for Germany from the early phase of industrialization up to the present. Constructing a homogeneous long-run series for Germany is challenging. The German territory, the population living in this territory, the political system, and, to some extent, the tax legislation have changed quite radically over time.

Eight series ranging from heavily industrialized Prussia and Saxony to largely agrarian Hesse and Baden document the evolution of top income shares from the period of industrialization up to World War I. Top income shares in the period of industrialization in Prussia and Saxony range between very high shares in the sovereign city-states of Hamburg and Bremen and relatively low shares in Wurttemberg and Baden. As many of the super-rich in imperial Germany lived in Prussia, we overestimate income concentration at the top when only looking at Prussia. Therefore, we merged these states into a single German series incorporating 90% of the German population.

In 2014, the share of total income received by the bottom half of the population was 15%, while the share of the top decile was 41%. In 1913, the share of the top decile was also 40%. The top percentile's share is lower today, however, than in 1913 (18% versus 13%). It increased sharply between the formation of the German Reich in 1871 and the establishment of the Weimar Republic in 1918. It decreased dramatically during the 1920s, when wage growth was high, profits were low, new social policies were implemented, and top marginal tax rates were raised from 5% (in Prussia) to 60%. The Nazi pre-war period was one of economic recovery, characterized by policies favoring large businesses and temporary surges in top income concentration. The top 1% share fell to 10-12% during the 1950-1990 period, while the bottom 9% of the top decile gained steadily. Since the turn of the millennium, the top percentile's income share has been on the rise, gradually catching up with the levels of the United Kingdom and the United States. By the mid-2000s, the top decile's income share in Germany exceeded the pre-war level.

Taking an international perspective, findings for Germany stand out compared to France, the United Kingdom, and the United States. While high income concen-

tration of the industrialization period declined in Germany in the 1920s, World War II brought strong and lasting reductions in income concentration at the top in the other countries. The top percentile's income share in Germany in the post-WWII period was high by international comparison. This finding collides with the general view that this was a period of low inequality.

Top income earners in Germany have been business owners throughout the twentieth century and up to the present. Even though highly qualified employees have increasingly entered top income groups in Germany, their share is negligible at the very top, particularly when compared to the working rich in the United States. Consequently, growth in top income shares in Germany is closely related to increasing profits of business owners and higher capital shares in national income as opposed to wages. Generous exemptions from the inheritance tax for family-owned firms, which is the case for most firms in Germany, are likely to perpetuate high income and wealth concentration in the future.

The rising capital share has shown the strongest association with increasing income concentration. Trade and patents mostly show a positive association, while unions are negatively associated with income concentration. Over the past three decades of reunified Germany, declining average tax rates, falling union density, but rising exports and technological progress have tended to enrich the German elite. Following the recent discussion on digitization, this capital share is likely to increase even further. If the relations observed for the past hold, this will favor more income concentration in the future. The challenge for policymakers aiming at reducing income concentration will be to find instruments for redistributing capital income across the population.

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A Income tax regimes and the definition of income

In the following, the evolution of income tax regimes in German states from the second half of the nineteenth century until 1919 and in Germany as a whole from 1920-2012 are briefly described. Special emphasis will be placed on the Prussian tax system, which applied to the majority of the German population in the nineteenth century. It also served as a model not only for similar systems in other German states, but also for the first federal German income tax system introduced in 1920 (Ketterle, 1994). In the second part of this section, we describe how incomes recorded in tax statistics were modified to estimate top incomes that are consistently defined over time.

The Prussian income tax legislation can be ordered into four phases: 1. class taxation from 1821 to 1850, 2. class taxation and classified income taxation coexisting with a consumption tax (grind and butcher tax) in bigger cities from 1851 to 1873, 3. class tax and classified income tax from 1874 to 1890, and 4. modern income tax from 1891 to 1918.

The class tax introduced in Prussia in 1820 is only of limited use for the estimation of income concentration because the assignment to a class hinges on the social class and not on income. Still, some contemporary authors argue that the class assignment was strongly related to the income position or earnings ability.[27] Twelve subclasses were distinguished, to which authorities of the municipality assigned all households[28]. The second important drawback of the class tax was that inhabitants of the biggest cities were not subject to the tax, but instead had to pay the grind and butcher tax (*Mahl- und Schlachtsteuer*) on flour and meat consumption.[29] We might thus be concerned about underestimating the concentration at the top (1) if class membership does not perfectly reflect the position in the income distribution, (2) if more top income earners lived in the biggest cities than in rural areas, and (3) if top income earners changed their residence to a bigger city subject to the grinder and butcher tax in order to evade the class tax. Figure A.1 shows that the distribution of the taxed population over the four main classes remained relatively stable between 1821 and 1848.

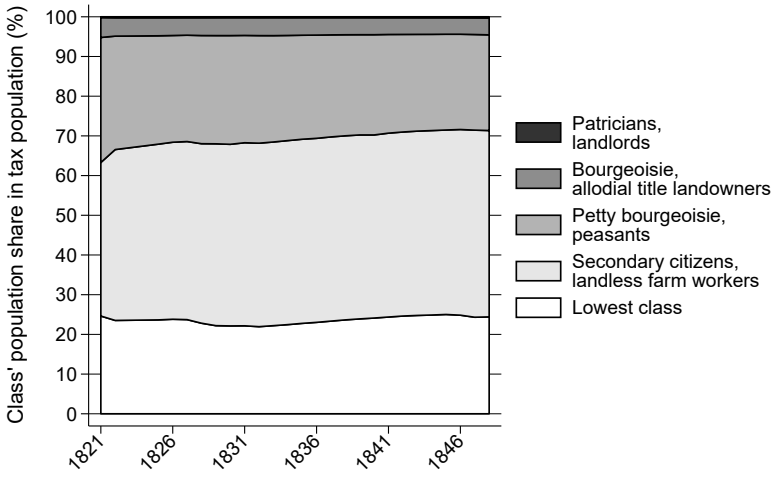
In 1851, a new classified income tax (*klassifizierte Einkommensteuer*) replaced both the class tax and the grind and butcher tax for all tax units with incomes

[27]Engel (1868), director of the Prussian statistical office, states that the four classes of the class tax encompassed the very rich, the rich, less wealthy city dwellers and peasants, and the lowest-class servants and day laborers. His predecessor Dieterici (1849) refers to the four classes as *patricians, bourgeoisie, petty bourgeoisie, secondary citizens* in the city and *landlords, landowners with allodial titles, peasants* and *landless farm workers* in rural areas. The tax was judged to be regressive by contemporary authors: The highest class paid 48 times the tax of lowest class, even though highest-class citizens probably earned more than 100 times more than the lowest class (Dieterici, 1849).

[28]Tax units generally consisted of close family members including relatives living in the same household without their own income. Tax units in the lowest class were individuals, but could not consist of more than two tax units per household (Geisenberger and Müller, 1972).

[29]In 1820, the grind and butcher tax applied in 132 bigger cities and was reduced to 83 cities in 1851 (Ketterle, 1994). urban-rural-dualism

Figure A.1: Prussian population by class, 1821-1848



Source: Prussian class tax 1821-1848, Mittheilungen des statistischen Bureau's in Berlin, Vol.1, 1849

above 3,000 marks. The new classified income tax applied to roughly the top 2% of the tax units (or 1% of the population) and was levied on income from real estate, business, wages, interest rates, and other capital income. However, incomes were estimated by a local committee, such that top incomes are most likely to be systematically underestimated.[30] The class tax now also incorporated explicit income bands, but the assignment to a class was the responsibility of the Prussian administration and was not revised annually, thereby potentially failing to capture annual income fluctuations (Grant, 2002). In the year 1874, the grind and butcher tax was abolished and income taxation (classified and class tax) applied to both cities and rural areas. Therefore, Prussian tax statistics are used for top income shares as of 1874.

In 1891, a far-reaching income tax reform finally abolished the class tax. All households with incomes higher than 900 marks were subject to a progressive income tax, which applied to 23% of the tax units or 31% of the population. The share of the population taxed steadily increased and reached 63% in 1913. Most importantly, the obligation to file a tax return was introduced for incomes above 3,000 marks (about 3% of tax units), which the authorities cross-checked with their own information. As a consequence, the recording of top incomes was greatly improved. For instance, the income share of the top 1% jumped by almost 4% between 1890 and 1891. We take the observed increase in income shares between 1890 and 1891 as an indicator of the disproportional underestimation of the respective top group, and adjust our Prussian series 1871-1890 upwards with this share difference.

Hesse introduced a modern income tax in 1869, Bremen in 1874, Saxony in 1874, Hamburg in 1881, Baden in 1884, Württemberg in 1905, and Bavaria in

[30]Taxpayers brought before court in the Prussian city of Bochum in 1891 admitted having earned incomes more than twice as high as estimated by the local authorities for tax collection (Wagner, 1891, p.587).

1912.[31]. All these income tax systems share some basic common characteristics. First, the tax burden was levied on the aggregate of different income sources, i.e., business income, capital income, income from employment, pensions, income from renting and leasing. Capital gains were tax-exempt in Prussia and Saxony, but taxable in Württemberg, Hamburg and Bremen. Second, income is aggregated at the household level, except in Saxony, where individual taxation is applied. Third, the ducal (Hesse and Baden) or royal (Prussia, Bavaria, Saxony and Württemberg) family as well as parts of the military were tax-exempt. Fourth, either all taxpayers were obliged to declare their income (Baden, Bremen, Hamburg) or those taxpayers whose income exceeded a threshold of 1,600 marks (Saxony), 2,000 marks (Bavaria), 2,6 marks (Hesse since 1895, Württemberg) (Ketterle, 1994). This means that the top 10% were obliged to declare in Saxony and Bavaria and the top 5% in Hesse and Württemberg.

The share of the population included in the tax statistics varies across states. In Prussia, the increased tax allowance in 1891 reduced the share of the taxed population from about 70% to about 30%, but then steadily increased to almost 70% before World War I. In 1918, Prussian income statistics already excluded Poznan and Bromberg.[32] In Saxony, about 70% of the adult population was taxed. In Württemberg, about 30% of the population was subject to income taxation in 1909. The importance of income taxation as a fiscal revenue also varied greatly. Whereas Saxony, Prussia, Württemberg, Baden, and Bavaria relied mainly on profits from state-owned enterprises in agriculture, forestry and, most importantly, railways (Ullmann, 2005, p.42), income taxation was indeed the central fiscal revenue for the cities of Hamburg and Bremen that were once part of the Hanseatic League (Ketterle, 1994, p.144).

In sum, income recorded in German states' income tax statistics 1871-1918 was based on a broad definition of income. Different levels across regions might be explained by the two following factors to some extent: First, the inclusion of capital gains in Württemberg, Hamburg and Bremen may produce more volatile top income share estimates. Second, higher tax enforcement in the Hanse cities, where income taxation represents the main fiscal revenue, may also lead to higher and more volatile top income shares.

The federal German income tax, which was introduced in 1920 after the revolution and the establishment of the Weimar republic, abolished privileges for the governing aristocratic elite and the military, which had been tax-exempt in many German states. The income recorded in the income tax statistics was defined more broadly than in the pre-war period, as capital gains from speculation were now taxable. Starting in 1932, income from agriculture and forestry was not taxable if below

[31]Bavaria, with its large and rich population, unfortunately only introduced income taxation in 1912 and published income tax statistics only once for the tax year 1912. Before, income sources were taxed separately in Bavaria: income from academic and artistic professions, from the mining industry and leasing was taxed jointly (group II), income from salaries, pensions, and life annuities was taxed jointly (group III) and, finally, capital income was taxed separately (*Kapitalrentensteuer*). As a result, the joint distribution of the three tax income types in Bavaria cannot be reconstructed.

[32]Checking the difference for 1917, where tabulations both including and excluding Poznan and Bromberg are available, shows that differences in top income shares are negligible.

6,000 marks and only partly if between 6,000 and 12,000 marks. This means that almost all income from agriculture and forestry was tax-exempt, which reduced the number of taxpayers. However, the top percentile generated only 2% of their income from agriculture and forestry as compared to about 40% from business and wages in 1928. Exemption rules were relaxed again in the following years.

From 1919 to 1924, the statistical authorities did not compile any income tax statistics. During the hyperinflation years 1923 and 1924, the new income tax legislation was temporarily suspended and taxes were collected under emergency decrees. Income tax statistics are available for 1925-1929 and 1932-1938. The introduction of a payroll tax for wage incomes and a capital income tax withheld at source presumably mark the two most radical changes. Both could be credited against income tax. Employees with wages lower than 8,000 marks, whose other incomes did not exceed a minimum of 500 marks, did not have to file a tax return and, consequently, were not included in income tax statistics. The introduction of the payroll tax poses a problem for the estimation of top income shares because the distributions of income tax and payroll tax cannot be merged *ex post* for several reasons. First, the income distributions are ranked by different income concepts. While the payroll tax statistics are ranked by wages, the income tax statistics are ranked by total income which includes wages, business income, capital income, etc. Second, the definition of the tax unit differs. The tax unit for payroll tax is the individual, while it is the household for the income tax. There are about 4 million households recorded in income tax statistics and about 24 million individuals included in payroll tax statistics. Third, some tax units are double-counted between 1925 and 1933, i.e., they appear in both statistics if their wages did not exceed 8,000 marks but their income from other sources was above a minimum threshold. The number of double-counted tax units was 272,137 in 1928 and 300,204 in 1932 according to the statistical authorities. Using income tax statistics, we can compute the top percentile share whose income threshold lies well above 8,000 marks throughout the period, above which a tax declaration was obligatory. For the top decile and top twentieth, we use synthetic tabulations provided by the statistical authorities for 1926, 1928, 1932, 1934, 1936, and 1950. Even though it remains unclear how the issues raised above were addressed in these synthetic tabulations, we decided to present tentative estimates rather than no estimates at all. Dell (2007) put the income tax distribution on top of the payroll tax distribution to estimate the shares of fractiles below the top percentile. Appendix Figure A.2 compares top income shares based on income tax statistics, synthetic tabulations from the statistical authorities, and estimations from Dell (2007). First, income shares of the top 1% and 0.01% are almost identical when using income tax statistics or synthetic tabulations. Second, shares of the top 10% and 5% are substantially underestimated when relying on income tax statistics only. Third, estimates from Dell (2007) are close to those based on synthetic tabulations of the statistical authorities, but deviated considerably in 1950.

For particular tax units, incomes recorded in income tax statistics are understated: If wage income did not exceed 8,000 marks, but income from other sources than earnings was above a minimum threshold, income tax statistics between 1925 and 1932 only recorded incomes other than wages. Since these tax units are likely to belong to the top 1%, the effect on our estimated income shares of the top 1% and above is likely to be small.

Recorded income in income tax statistics 1925-1938 is defined as

total income from income sources (business, wage etc.)

- professional expenses (*Werbungskosten*)

= total amount of income (*Gesamtbetrag der Einkünfte*)

- special expenses (*Sonderausgaben*)

= recorded income

Incomes recorded in payroll tax statistics include both professional expenses and special expenses so that we deduct twice the legislative lump sum for these items (2x240 marks) for incomes below 8,000 marks in order to harmonize the two income concepts.

In post-1949 Germany, the total amount of income (*Gesamtbetrag der Einkünfte*) defined by the German Income Tax Act was the income concept documented in the income tax statistics, which was the sum of the seven income categories (agriculture and forestry, business, self-employment, employment, capital income, renting and leasing, and other), plus tax-relevant capital gains less income-type-specific income-related expenses, savings allowances, and losses. A share of pensions (*Ertragsanteil*) is also included, which amounts to about 30% of the pension. For the cohort receiving their first pension in 2005 or after, the taxable share is gradually increased from 50% in 2005 to 100% in 2040. Old-age lump-sum allowances and exemptions for single parents are deducted. Since a number of large tax-deductible items, such as special expenses for social security contributions, are not deducted at that stage, the total amount of income is considerably higher for most tax units than the eventual taxable income to which the tax rate is applied.

Recorded income in income tax statistics since 1949 is defined as

total income from income sources (business, wage etc.)

- professional expenses (*Werbungskosten*)

= recorded income = total amount of income (*Gesamtbetrag der Einkünfte*)

We now turn to the modifications of the income tax data in order to harmonize data over time and across countries. The construction of the tabulations published by the statistical authorities varies widely over time. In order to harmonize tabulations both between states and over time, several adjustments have to be undertaken. First, years with tabulations containing both the number of tax units and aggregated incomes per income bracket are sometimes followed by years containing the number of tax units only. This applies to tax years 1886-1905 and 1911-1913 in Baden, 1873-1919 in Hesse, until 1891 in Prussia, 1896-1910 in Saxony, and 1905-1913 in Württemberg (indexed by b in Appendix Table B.1). Aggregate income per income bracket is then imputed under the assumption that incomes are Pareto distributed following (Piketty and Saez, 2007, p.222).

Second, some publications tabulate personal and corporate taxpayers jointly. Apart from the fact that we are interested in the distribution of personal income, this poses a problem to the estimation of top income shares because the distribution of corporate taxpayers' income is more skewed than the distribution of personal taxpayers' income. For Baden, the share of personal taxpayers in total taxpayers per income bracket in 1911 is used to adjust the number of total taxpayers downwards in the preceding and following years where only total taxpayers are given. The 1911 publication lists personal and corporate taxpayers split into more than 300 income brackets. It is assumed that the tax-exempt are all personal taxpayers. This assumption seems reasonable as the share of personal taxpayers in the lowest income bracket is 99.992% in Baden in 1911 and corporate taxpayers are present mainly at the top of the joint distribution. For Bavaria, income tax statistics are published only in 1912 such that the distribution of personal and corporate taxpayers cannot be separated. There are, however, 2,112,000 personal taxpayers and only 20,000 corporate taxpayers, whose share in total taxable income is 4.3% (Hoffmann and Müller, 1959).

Third, the number of recorded income brackets ranges from less than 10 to more than 200. In some cases, a large increase or reduction in the number of income brackets from one year to another, which makes the top income estimate either more or less precise, may lead to an abrupt change in the income share of a top group. However, this only applies to Bremen in 1871-1872, Saxony in 1895-1903 and to Württemberg in 1904-1906 and 1911. We correct the shares upwards by the differential between the last year with few brackets and the first year with many. In Saxony, 1876 is replaced by the mean of the two adjacent years as an unusually high number of tax units in a very broadly defined income class leads to outliers of the top 1% and top 5% income share.

Fourth, capital income, i.e., dividends and interest income, has been taxed separately at a flat rate since the introduction of dual income taxation in Germany in 2009 and, hence, is no longer systematically recorded in the income tax statistics. While it is still beneficial for some tax units to declare capital income in their income tax declaration, e.g., if the flat rate exceeds their personal income tax rate, the size of reported capital income in income tax statistics since 2009 is negligible. Additionally, between 2001/2002 and 2008, only half of the cash dividend (dividends net of the corporation tax) was taxable. The top income shares reported in this paper are based on the full amount of capital income since 2001 following the methodologies developed by Bartels and Jenderny (2015). We can recover the full amount of dividends from microdata for 2001 to 2008. Starting in 2009, capital income is imputed using dividends from firms included in the most comprehensive German stock index, CDAX, as a proxy for dividends, and the tax flow of the withholding tax on interest income as a proxy for interest income. Bartels and Jenderny (2015) provides a detailed description of the methods and of the tax reforms.

Table A.1: Thresholds

year	Top 10%	Top 5%	Top 1%	Top 0.5%	Top 0.1%	Top 0.01%
1961	23,517	31,772	76,945	120,325	330,414	1,450,225
1965	27,374	37,700	91,346	140,931	373,860	1,563,976
1968	32,380	45,259	93,455	145,659	378,510	1,478,574
1971	43,472	60,242	118,783	182,482	461,077	1,921,408
1974	49,026	66,135	121,580	177,704	442,736	1,657,330
1977	49,038	65,835	124,209	184,577	465,284	1,725,121
1980	54,023	72,860	137,084	203,351	502,315	2,080,987
1983	50,392	66,706	125,629	182,368	436,816	1,835,226
1986	52,992	68,865	139,877	201,966	460,727	2,119,279
1989	58,047	78,685	166,489	201,472	538,154	2,633,966
1992	58,161	76,432	159,198	202,284	500,325	2,118,642
1995	56,710	75,615	146,791	179,645	418,470	1,714,134
1998	56,944	79,046	148,647	207,153	508,231	2,542,701
2001	67,751	89,841	168,445	235,169	573,757	2,141,213
2002	65,860	87,468	161,152	221,257	513,120	1,826,390
2003	64,413	85,893	157,894	214,826	482,575	1,649,528
2004	64,816	86,667	162,590	224,438	522,388	1,730,085
2005	62,090	83,847	161,254	225,853	551,521	2,132,415
2006	61,679	83,756	165,398	233,824	585,467	2,248,600
2007	60,709	83,005	168,215	240,650	611,624	2,398,293
2008	59,040	81,189	168,024	243,237	639,325	2,449,566
2009	58,764	75,591	160,879	222,567	554,583	1,832,569
2010	58,616	75,346	159,877	220,153	548,341	2,014,839
2011	61,856	79,293	166,350	230,943	605,259	2,157,594
2012	62,064	80,789	182,808	215,779	597,348	2,124,771
2013	63,621	82,569	186,179	218,912	613,515	2,129,600
2014	65,111	84,755	166,770	247,431	626,444	2,207,310

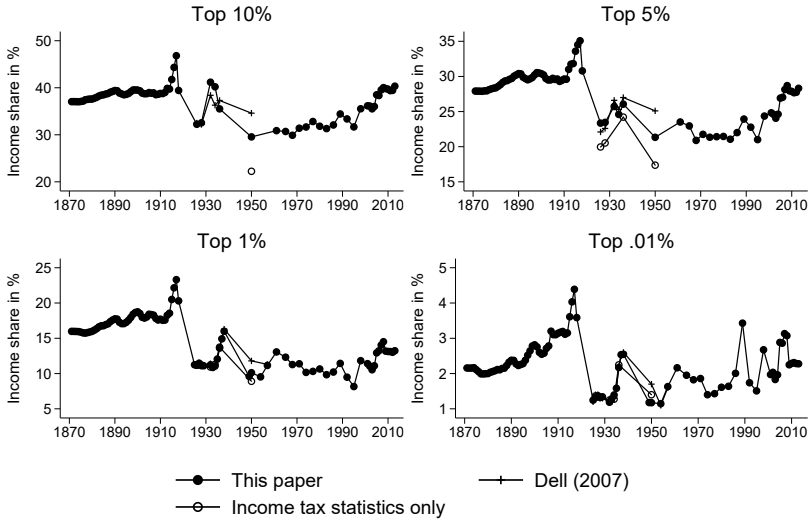
Source: Appendix Table A3. *Note:* All figures in 2010 euros. Fractile thresholds after the introduction of the withholding tax in 2009 are approximated from the corrected share (including a capital income proxy) using Pareto interpolation.

Table A.2: Average Incomes

year	Top 10%	Top 5%	Top 1%	Top 0.5%	Top 0.1%	Top 0.01%
1961	49,469	75,342	209,296	322,281	885,057	3,466,265
1965	58,706	87,788	235,532	359,185	958,182	3,734,346
1968	62,643	87,560	236,221	356,613	917,470	3,821,017
1971	82,132	113,817	297,823	450,208	1,187,677	4,862,581
1974	86,293	116,408	277,174	412,245	1,017,249	3,816,408
1977	92,270	120,442	289,838	430,704	1,070,468	4,017,993
1980	95,038	128,177	317,997	471,719	1,244,402	4,814,493
1983	86,501	116,352	271,737	394,465	1,088,929	4,526,381
1986	93,474	128,219	297,583	429,677	1,314,627	5,845,491
1989	107,501	149,467	357,217	614,345	1,902,687	10,700,000
1992	102,931	140,474	292,588	487,238	1,298,108	5,363,939
1995	96,973	128,633	249,717	410,808	1,077,147	4,620,813
1998	106,956	146,666	355,946	551,009	1,649,608	8,051,657
2001	110,380	151,534	348,042	521,006	1,412,608	6,020,040
2002	107,260	146,141	328,242	487,768	1,322,296	6,045,004
2003	105,328	142,647	312,502	458,012	1,205,497	5,433,168
2004	105,743	144,630	326,052	483,089	1,291,573	5,767,200
2005	112,589	157,357	378,102	578,407	1,677,273	8,428,358
2006	113,834	160,479	392,523	602,718	1,751,432	8,492,301
2007	117,720	167,558	417,821	644,719	1,884,901	9,323,665
2008	119,995	172,024	435,167	673,489	1,951,820	9,215,044
2009	115,120	161,629	380,711	568,091	1,511,980	6,497,603
2010	114,814	161,192	379,834	567,435	1,519,498	6,619,573
2011	121,611	170,957	405,194	609,686	1,656,967	7,145,497
2012	122,304	172,072	404,118	590,696	1,640,602	7,094,151
2013	124,635	174,988	409,415	597,450	1,656,384	7,059,384
2014	127,389	178,772	416,763	631,626	1,681,197	7,128,545

Source: Appendix Table A2. *Note:* All figures in 2010 euros.

Figure A.2: Income tax tabulations vs. synthetic tabulations



Note: The series in this paper is based on synthetic tabulations of the statistical authorities in 1926, 1928, 1932, 1934, 1936 and 1950, while the other data points between 1925 and 1957 are based on income tax statistics only. Accordingly, the series only differ in the years where synthetic tabulations are used.

B Sources of income tax statistics

German statistical authorities regularly publish tables containing the number of taxpayers per income bracket and aggregated taxable income per income bracket. These tables are the source of information for the distribution of top incomes. Their *statistical yearbooks* contain most of the income tax tabulations, but for some years, tabulations are found in additional publications such as the Review (*Zeitschrift*) or Notifications (*Mittheilung*) of the respective statistical office. Sources of the income tax tabulations used for the estimation of top income shares in German states up to 1918 and in Germany, 1925-2014, are given in Table B.1.

Table B.1: **Sources of Income Tax Statistics for German States and Germany**

Year	Source
Baden	
1886, 1891, 1892, 1893, 1894, 1895	Statistik der badischen Einkommensteuer, 1896[a]
1896, 1897, 1898, 1899, 1900	Statistik der badischen Einkommensteuer, 1901[a]
1901	Statistik der badischen Einkommensteuer, 1906[a]
1902, 1903	Statistisches Jahrbuch für das Großherzogtum Baden, 1903, Vol. 34[a]
1904, 1905	Statistisches Jahrbuch für das Großherzogtum Baden, 1905, Vol. 35[a]
1906, 1907, 1908 1909, 1910	Statistisches Jahrbuch für das Großherzogtum Baden, 1910 und 1911, Vol. 38[b]
1911	Statistik der Einkommens- und Vermögensteuer im Großherzogtum Baden, 1911[b]
1913	Statistisches Jahrbuch für das Großherzogtum Baden, 1913, Vol. 40[a,b]

Continued on next page

Table B.1 – continued from previous page

Year	Source
1914	Statistisches Jahrbuch für das Großherzogtum Baden, 1915, Vol. 41[a,b]
Bavaria	
1912	Statistisches Jahrbuch für das Königreich Bayern, 1915, Vol. 13[a]
Bremen	
1872, 1873	Jahrbuch für Bremische Statistik, 1882
1874, 1875, 1876	Jahrbuch für Bremische Statistik, 1891
1877, 1878, 1879	
1880, 1881	
1882, 1883, 1884	Jahrbuch für Bremische Statistik, 1888
1885, 1886	
1887, 1888	Jahrbuch für Bremische Statistik, 1892
1889, 1890, 1891	Jahrbuch für Bremische Statistik, 1894
1892, 1893	
1894, 1895, 1896	Jahrbuch für Bremische Statistik, 1899
1897, 1898	
1900	Jahrbuch für Bremische Statistik, 1905
1901, 1902, 1903,	Jahrbuch für Bremische Statistik, 1906
1904	
1905, 1906	Jahrbuch für Bremische Statistik, 1910
1907, 1908, 1909	Jahrbuch für Bremische Statistik, 1912
1910, 1911	
Hamburg	
1881, 1882	Statistik des Hamburgischen Staats 1886, Vol. 13
1883-1892	Statistik des Hamburgischen Staats 1895, Vol. 17
1893-1899	Statistik des Hamburgischen Staats 1902, Vol. 20
1907	Jahresbericht der Verwaltungsbehörden der Freien und Hansestadt Hamburg 1909
1912	Jahresbericht der Verwaltungsbehörden der Freien und Hansestadt Hamburg 1914
Hesse	
1870, 1873, 1875	Statistisches Handbuch für das Großherzogtum Hessen,
1880, 1884, 1885	1909, Vol. 2[b]
1890	
1893	Mittheilungen der Großherzoglich Hessischen Centralstelle für die Landesstatistik 1893, Vol. 23[b]
1894	Mittheilungen der Großherzoglich Hessischen Centralstelle für die Landesstatistik 1894 Vol. 24[b]
1895	Mittheilungen der Großherzoglich Hessischen Centralstelle für die Landesstatistik 1895 Vol. 25[b]
1896	Mittheilungen der Großherzoglich Hessischen Centralstelle für die Landesstatistik 1897 Vol. 27[b]
1897	Mittheilungen der Großherzoglich Hessischen Centralstelle für die Landesstatistik 1898 Vol. 28[b]
1898, 1899	Mittheilungen der Großherzoglich Hessischen Centralstelle für die Landesstatistik 1899 Vol. 29[b]
1900	Mittheilungen der Großherzoglich Hessischen Centralstelle für die Landesstatistik 1900 Vol. 30[b]

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Table B.1 – continued from previous page

Year	Source
1901, 1904, 1905	Mittheilungen der Großherzoglich Hessischen Centralstelle
1907, 1908	für die Landesstatistik 1909 Vol. 39[b]
1911	Mittheilungen der Großherzoglich Hessischen Centralstelle
	für die Landesstatistik 1911 Vol. 41[b]
1913	Mittheilungen der Großherzoglich Hessischen Centralstelle
	für die Landesstatistik 1913 Nr. 945[b]
1918	Mittheilungen der Großherzoglich Hessischen Centralstelle
	für die Landesstatistik 1919 Nr. 994[b]
1919	Mittheilungen der Großherzoglich Hessischen Centralstelle
	für die Landesstatistik 1920 Nr. 1[b]
Prussia	
1821	Mittheilungen des statistischen Bureau's in Berlin, Vol. 1, 1849[b,c]
-1848	
1852	Zeitschrift des Königlich Preußischen Statistischen Bureaus, Vol. 8, 1868[b]
-1866	
1867, 1870, 1873	Zeitschrift des Königlich Preussischen Statistischen Bureaus, Vol. 44, 1904[b]
1874	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1875[b]
1875	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1876[b]
1876	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1877[b]
1877	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1877/78[b]
1878, 1880	Zeitschrift des Königlich Preussischen Statistischen Bureaus, Vol. 44, 1904[b]
1881	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1882[b]
1882	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1882/83[b]
1883	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1883/84[b]
1884	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1885[b]
1885	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1886[b]
1886	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1887[b]
1887	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1888[b]
1888	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1889[b]
1889	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1890[b]
1890	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1890/91[b]
1891	Anlagen zu den Stenographischen Berichten über
	die Verhandlungen des Hauses der Abgeordneten, 1892[b]
1892	Statistisches Jahrbuch für den Freistaat Preußen, Vol. 17, 1921

Continued on next page

Table B.1 – continued from previous page

Year	Source
-1919	
Saxony	
1875, 1877	Zeitschrift des Königlich Sächsischen Statistischen Bureaus, 1877, Vol.23
1879	Zeitschrift des Königlich Sächsischen Statistischen Bureaus, 1889^b, Vol.35
1882, 1884	Zeitschrift des Königlich Sächsischen Statistischen Bureaus, 1885, Vol.31
1886	Zeitschrift des Königlich Sächsischen Statistischen Bureaus, 1889, Vol.35
1888, 1890	Zeitschrift des Königlich Sächsischen Statistischen Bureaus, 1891, Vol.37
1892, 1894	Zeitschrift des Königlich Sächsischen Statistischen Bureaus, 1894, Vol.40
1896, 1898, 1900	Statistisches Jahrbuch für das Königreich Sachsen, 1906^b, Vol.34
1902, 1904	
1906, 1908, 1910	Statistisches Jahrbuch für das Königreich Sachsen, 1912^b, Vol.40
1912	Statistisches Jahrbuch für das Königreich Sachsen, 1913, Vol.41
1914	Statistisches Jahrbuch für das Königreich Sachsen, 1916/1917, Vol.43
1916, 1918	Statistisches Jahrbuch für den Freistaat Sachsen, 1918/20, Vol.44
Württemberg	
1905, 1906, 1907	Statistisches Handbuch für das Königreich Württemberg, 1910/11^b
1908	Württembergische Jahrbücher für Statistik und Landeskunde, 1909^b
1909	Württembergische Jahrbücher für Statistik und Landeskunde, 1910^b
1910	Württembergische Jahrbücher für Statistik und Landeskunde, 1911^b
1911	Württembergische Jahrbücher für Statistik und Landeskunde, 1913^b
1912	Statistisches Handbuch für das Königreich Württemberg, 1912/13^b
1913	Württembergische Jahrbücher für Statistik und Landeskunde, 1914^b
Germany	
1920	Statistik des Deutschen Reichs, Vol. 312, Table 14
1925	Statistik des Deutschen Reichs, Vol. 348 (income tax)
1926	Statistisches Reichsamt (1939): Die Einkommenschichtung im Deutschen Reich, Wirtschaft und Statistik, 660-664. *Statistik des Deutschen Reichs, Vol. 375 (income tax), Vol. 359 (payroll tax)*
1927	Statistik des Deutschen Reichs, Vol. 375 (income tax)
1928	Statistisches Reichsamt (1939): Die Einkommenschichtung im Deutschen Reich, Wirtschaft und Statistik, 660-664. *Statistik des Deutschen Reichs, Vol. 391 (income tax), Vol. 378 (payroll tax)*
1929	Statistik des Deutschen Reichs, Vol. 430 (income tax)
1932	Statistisches Reichsamt (1939): Die Einkommenschichtung im Deutschen Reich, Wirtschaft und Statistik, 660-664. *Statistik des Deutschen Reichs, Vol. 482 (income tax), Vol. 492 (payroll tax)*
1933	Statistik des Deutschen Reichs, Vol. 482 (income tax)
1934	Statistisches Reichsamt (1939): Die Einkommenschichtung im Deutschen Reich, Wirtschaft und Statistik, 660-664. *Statistik des Deutschen Reichs, Vol. 499 (income tax), Vol. 492 (payroll tax)*
1935	Statistik des Deutschen Reichs, Vol. 534 (income tax)
1936	Statistik des Deutschen Reichs, Vol. 534 (income tax), Vol. 530 (payroll tax)
1937, 1938	Statistik des Deutschen Reichs, Vol. 580 (income tax)
1949	Statistisches Jahrbuch füer die Bundesrepublik Deutschland 1953, p.454
1950	Statististisches Bundesamt (1954): Zur Frage der Einkommenschichtung, Wirtschaft und Statistik 6, 265-273. *Statistik der Bundesrepublik Deutschland, Vol. 125, Table 22*

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Table B.1 – continued from previous page

Year	Source
1954, 1957	Fachserie L, Finanzen und Steuern, Series 6.1, p.74 and p.141
1961	Fachserie L, Finanzen und Steuern, Series 6.1, p.51, Table 2
1965	Fachserie L, Finanzen und Steuern, Series 6.1, p.45, Table 2
1968	Fachserie L, Finanzen und Steuern, Series 6.1, p.29, Table 3
1971	Fachserie 14, Finanzen und Steuern, Series 7.1, p.18
1974	Fachserie 14, Finanzen und Steuern, Series 7.1, p.20
1977	Fachserie 14, Finanzen und Steuern, Series 7.1, p.22
1980	Fachserie 14, Finanzen und Steuern, Series 7.1, p.25
1983	Fachserie 14, Finanzen und Steuern, Series 7.1, p.25
1986	Fachserie 14, Finanzen und Steuern, Series 7.1, p.25
1989	Fachserie 14, Finanzen und Steuern, Series 7.1, p.30
1992	Fachserie 14, Finanzen und Steuern, Series 7.1, p.16
1995	Fachserie 14, Finanzen und Steuern, Series 7.1, p.14
1998	Fachserie 14, Finanzen und Steuern, Series 7.1, p.1
2001	Fachserie 14, Finanzen und Steuern, Series 7.1.1, Table 3
2002	Fachserie 14, Finanzen und Steuern, Series 7.1.1, Table 3
2003	Fachserie 14, Finanzen und Steuern, Series 7.1.1, Table 3
2004	Fachserie 14, Finanzen und Steuern, Series 7.1.1, Table 3
2005	Fachserie 14, Finanzen und Steuern, Series 7.1.1, Table 3
2006	Fachserie 14, Finanzen und Steuern, Series 7.1.1, Table 3
2007	Fachserie 14, Finanzen und Steuern, Series 7.1.1, Table 3
2008	Fachserie 14, Finanzen und Steuern, Series 7.1.1, Table 3
2009	Fachserie 14, Finanzen und Steuern, Series 7.1.1, Table 3
2010	Fachserie 14, Finanzen und Steuern, Series 7.1.1, Table 3
2011	Fachserie 14, Finanzen und Steuern, Series 7.1.1, Table 3
2012	Fachserie 14, Finanzen und Steuern, Series 7.1, Table A3
2013	Fachserie 14, Finanzen und Steuern, Series 7.1, Table A3
2014	Fachserie 14, Finanzen und Steuern, Series 7.1, Table A3

Note: Year refers to tax year. a. Personal and corporate persons are tabulated jointly. b. Only number of tax units available and no information on incomes. c. Only class tax.

C Reference total population

There are two approaches to derive the reference total population. The bottom-up approach adds the (estimated) number of tax-exempt units to the number of taxpayers documented in the income tax statistics. The top-down approach draws on population statistics and obtains total tax units as the sum of married couples plus bachelors minus the number of children. The top-down approach is applied from 1925 onwards. For the period 1871-1918, annual information on population by age and marital status is not consistently available in German states. Therefore, the bottom-up approach is applied and the reference total population 1871-1918 is obtained as

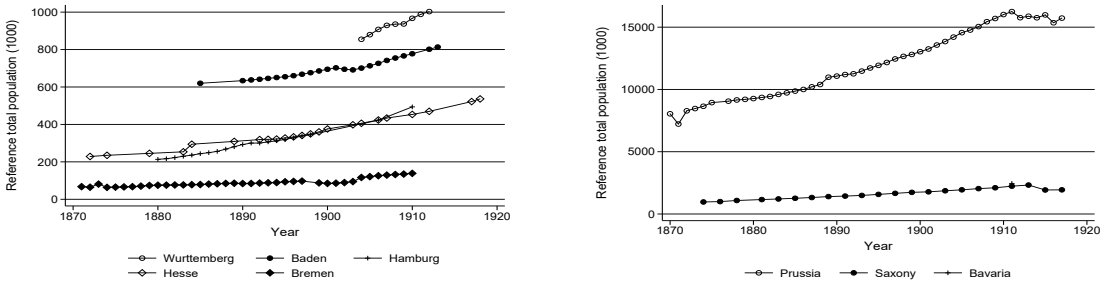
number of tax units recorded in tax statistics

\+ tax exempt

= reference total population

The number of tax-exempt units is documented in income tax statistics in Hesse (until 1883), Prussia, and Saxony. For the other German states, we take the number of tax-exempt entities estimated by Hoffmann and Müller (1959).[33] In Bavaria, only joint tabulations of personal and corporate taxpayers are available, such that corporate taxpayers are included in the control population . Particular social groups such as the military or ruling royal families were exempt from paying taxes. Since their income is unknown, the number of these exempted cases is not added to total tax units. Figure C.1 presents reference total population by state from 1871 to 1918.

Figure C.1: Reference total population by state, 1871-1918



Source: Appendix Table A2.

[33] In Baden, Bremen, Hamburg, Hesse, and Württemberg, Hoffmann and Müller (1959) estimate the number of tax exempt as difference between the workforce as documented by occupation census data and the number of taxpayers. This method is also used by Statistisches Reichsamt (1932). On the one hand, this residual potentially underestimates the number of tax-exempt entities by not accounting for unemployed persons. On the other hand, the residual potentially overestimates tax-exempt entities if households consist of more than one earner. In the first step, a number that appears too low is subtracted from the workforce. In the second step, the resulting number gives earners and not tax units.

From 1925 to present, we adopt the top-down approach and the reference total population is given by

Married Couples/2

+ Bachelors

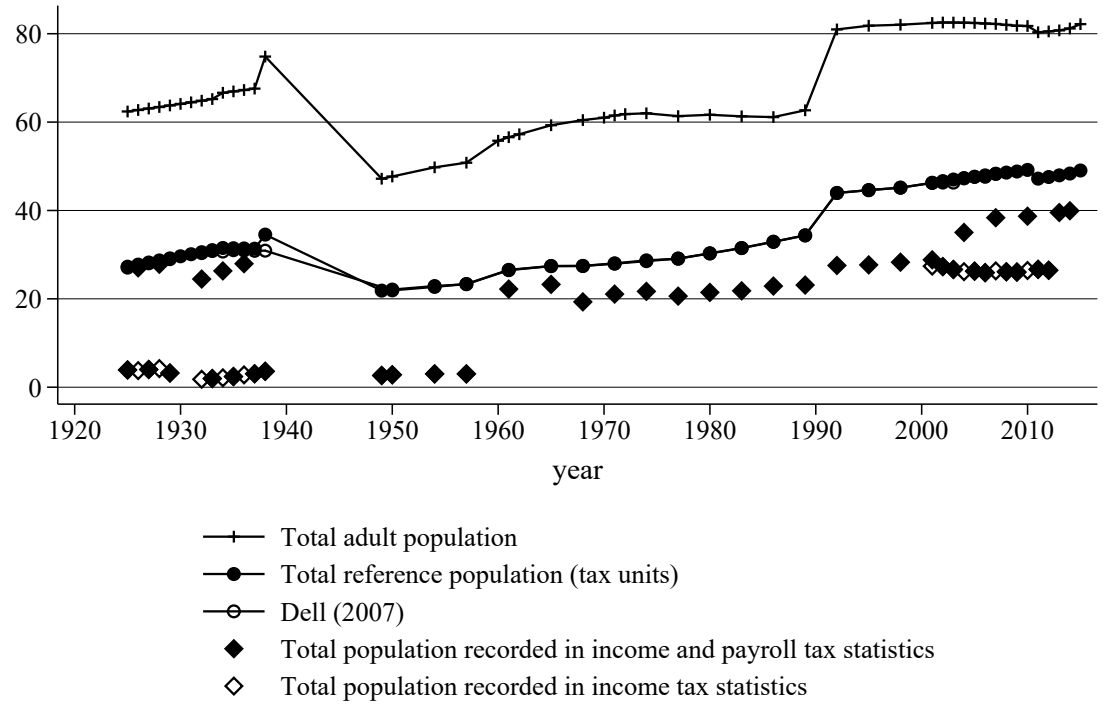
- Children (up to 19 years)

= reference total population

Reference total population is displayed in Figure C.2. The evolution of both reference total population and total adults reflects the frequent changes of the German border over the twentieth century. The population spike in 1938 was due to the annexation of Austria, whose population was immediately included in the German income tax system. Figures after 1949 exclude the population of the GDR (about 18 million), but include about 7 million refugees from the former Eastern territories. In 1990, Germany was reunified, adding a population of 16 million living in the former GDR to a population of 64 million in the FRG. The population census in 2011 showed a smaller population size than estimated by the Federal Statistical Office. Furthermore, the number of married spouses was larger than estimated before. These two effects produce a one-time reduction of our reference total population in 2011.

The number of taxpayers recorded in tax statistics also fluctuated over time as shown by Figure C.2. These fluctuations are largely explained by the introduction of a payroll tax on wage income withheld at source and to a comparably smaller extent by the changing population that was subject to the income tax legislation. Therefore, we display figures including the sum of income and payroll taxpayers and income taxpayers only. Tabulated payroll tax statistics are available in 1926, 1928, 1932, 1934, 1936, but cannot be merged with income tax statistics by the researcher (see Appendix SectionA). Only after 1961 did the Federal Statistical Office begin to merge the two distributions into a single income distribution. Therefore, only 6% to 14% of the reference total population is captured by income tax statistics from 1925 to 1960, but about 70% thereafter. From 2001 to 2012, the Statistical Office provided annual income tax statistics that again excluded payroll taxpayers who did not file a tax return. However, in 2001, 2004, 2007, 2010, 2013, 2014 there are also joint statistics available including both payroll and income taxpayers.

Figure C.2: Reference total population and total taxpayers in tax statistics in Germany, 1925-2014



Source: See Appendix Table Germany.

D Reference total income

There are two approaches to derive the reference total income. The bottom-up approach adds the (estimated) income of tax-exempt entities to the taxpayers' income documented in the income tax statistics. The top-down approach draws on national accounts data and obtains reference total income as a fixed share of private household income documented in the national accounts. National accounts provide a useful benchmark both regarding consistency over time and comparability across countries through the United Nations' System of National Accounts (SNA), first charted in 1947, and the European System of Accounts (ESA), which is a modification of SNA. German national accounts follow ESA 1995 over the period 1970-1990 (sectoral accounts only since 1980) and ESA 2010 since 1991. The bottom-up approach is applied for German states 1871-1918, when national accounts were not yet produced. The top-down approach is applied for Germany from 1925 onwards.

For the period 1871-1918, incomes recorded in income tax statistics represent the most reliable source for national income (Helfferich, 1917, p.91). The most consistent series of national income (*Volkseinkommen*) in Germany and German states is the series of Hoffmann and Müller (1959). Their numbers are based on tax incomes augmented by estimated non-filer income, and cover Baden, Bavaria, Bremen, Hamburg, Hesse, Prussia, Saxony, and Wurttemberg as well as Germany as a whole over the period 1851 to 1957. Despite repeated criticism of this series,

no attempt at replacing it has been undertaken.[34] In order to compute household income, Hoffmann and Müller (1959) estimate non-filers' income in German states. Applying the bottom-up approach, the reference total income 1871-1918 is obtained as

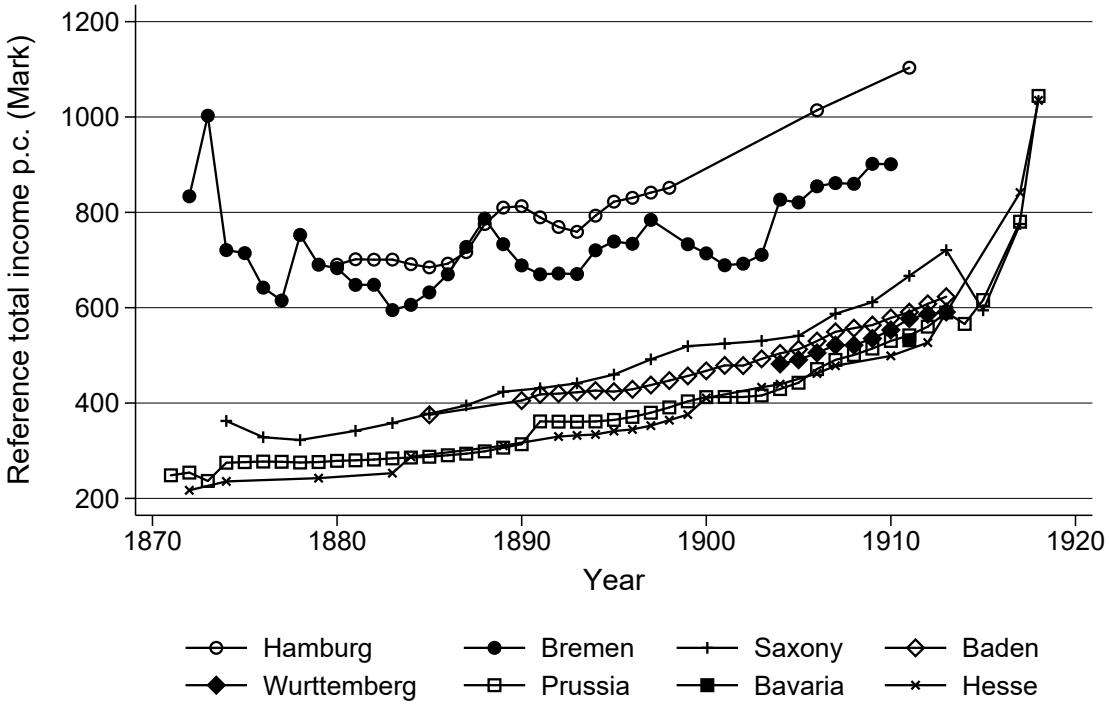
Tax income recorded in tax statistics (1)

+ Income of non-filers with income beneath the tax allowance (from Hoffmann and Müller (1959)) (2)

= Reference total income

Tax income (1) is taken directly from income tax statistics. In Bavaria, only one joint tabulation of personal and corporate taxpayers is available in 1911, such that income of corporate taxpayers is included in (1) and, hence, in reference total income for Bavaria. Average income of non-filers (2) in each state in 1913 is provided by the statistical authorities (Statistisches Reichsamt, 1932, p.24) taking into account that tax-exempt rural incomes must be augmented by income-in-kind. Hoffmann and Müller (1959) deflate the 1913 figures with the wage index for average gross wages in the industrial and agricultural sector from 1870 to 1914 from Kuczynski (1947). Figure D.1 displays the evolution of total reference income per capita in German states.

Figure D.1: Reference total income per capita by German state, 1870-1918



Source: See Appendix Table Germany.

[34]See, e.g., Fremdling (1988).

For 1925-2014, the top-down approach is used, and reference total income is obtained as a fixed share of household income documented in national accounts. Household income in national accounts exceeds total income recorded in tax statistics. The difference is explained by income of non-filers (1) and incomes or parts of incomes not covered by tax statistics (2). A fixed share of national accounts' private household income is used because we want to include (1) but not (2) in our reference total income (Atkinson, 2007).

National accounts' household income is an overestimate of our reference total income for three reasons. First, business and property income in national accounts is much higher than the aggregate documented in income tax statistics. This item is calculated as a residual in national accounts since there are no representative primary statistics on business income in Germany. This introduces a substantial amount of measurement error.[35] Also, tax avoidance might occur at a larger scale with business and property income than with employment income, understating business and property income in tax statistics. Second, retained earnings by corporations (undistributed profits) and imputed rents are included in national accounts, but do not appear in income tax data. Third, income from non-profit institutions serving private households (NPISH) are included in the household sector in Germany, augmenting household income in national accounts.[36] However, national accounts' household income also excludes income types that are included in tax data. Pensions have increasingly been subject to taxes in recent years and are thus included in our income measure from income tax statistics.

In order to determine the fixed share of national accounts' household income, a reference point is needed. The only attempt to estimate both non-filers' and filers' income using income tax definitions – to the knowledge of the author – is the study by Bach et al. (2009), who construct an integrated database of both household survey data covering the bottom of the distribution and income tax data covering the middle and the top for the years 1992 to 2003. Their estimate of gross market household income of both filers and non-filers is between 80.9% and 84.4% of the national accounts' household income. We decide to take 90% of total household income of private households and, thereby, follow Dell (2007). We take a higher share than 84.4% because pensions are not included in national accounts' household income, but are included in our tax income. The remaining gap may be seen as income missing from tax statistics such as retained earnings, undeclared business and property income, and imputed rent (assuming that these are distributed proportionately to recorded incomes) and to differences in the income definition or the income recipient such as NPISH. Additionally, a higher reference income generates lower income shares, meaning that we can interpret our results as a lower bound for income concentration levels. Roine and Waldenström (2010) use 89% of national accounts' household income for the Swedish top income share series,

[35]The German Federal Statistical Office (Destatis, 2009) acknowledges that "balancing differences" with respect to the production and expenditure approach of GDP calculation amounts to about 1% of GDP. Bach (2013) estimates that the gap between adjusted national accounts' business income and tax-recorded business income was about 90 billion euros in 2004, which is more than 4% of GDP in that year.

[36]However, Schwarz (2008) estimates that income of NPISH amounts to only 2% of the household sector's income.

Aaberge and Atkinson (2010) use 72% for the Norwegian series and Piketty and Saez (2007) use 80% for the US series 1913-1943.

For 1925 to 1938, we use the figures from the statistical authorities' publications which are assembled by Hoffmann and Müller (1959) in Table 24 on p.56. It should be noted, that tax income statistics still formed the "main pillar" of the national accounts at that time (Statistisches Bundesamt, 1972, 40). We rely on the Hoffmann and Müller (1959) series for our preferred reference total income because they deduct government transfers such as unemployment benefits and social assistance from the original figures from the statistical authority. These transfer incomes are not part of tax incomes and should therefore be excluded from our reference total income. Salaries and wages are estimated by Hoffmann and Müller (1959) on the basis of social insurance statistics as well as financial statistics. Reference total income in 1935 is adjusted downwards subtracting national income from Saarland as Saarland is included in the tax statistics only as of 1936. Reference total income in 1938 is computed using the share of national income including Austria (*Grossdeutsches Reich*) in national income without Austria, as Austria is included in the tax statistics in 1938. Total household income is the sum of

Salaries and wages (*Lohn und Gehalt*)

+ Civil servant pensions (*Beamtenpensionen*)

+ Income from renting and leasing (*Vermietung und Verpachtung*)

+ Business and self-employment income (*Handel, Gewerbe, freie Berufstätigkeit*)

+ Income from agriculture and foresty (*Land- und Forstwirtschaft*)

+ Capital income (*Kapitalvermögen*)

= Total household income

x 0.9

= Reference total income

Ritschl (2002b) and Fremdling and Staeglin (2014) criticize the series of Hoffmann and Müller (1959) or Hoffmann (1965), respectively. The two critical points raised by Ritschl (2002b) concern two elements of the Hoffmann and Müller (1959) series, which are two necessary elements of national income: the underestimation of social security contributions paid by employers and the overestimation of public debt. However, both are not part of the definition of tax income and, therefore, not included in this paper's reference total income. Fremdling and Staeglin (2014) use input-output tables to estimate a new benchmark for national accounts in Germany in 1926. Their results point at a dramatic underestimation of profit incomes in official statistics and by Hoffmann (1965) due to hidden profits in the armament industry: Their estimate of profit incomes in 1936 is 33,167 mio. reichsmarks as opposed to 13,622 mio. reichsmarks estimated by Hoffmann (1965). However, their estimates for the compensation of employees are also dramatically different, but in the other direction: They estimate 35,915 mio. reichsmarks as opposed to 56,941

mio reichsmarks estimated by Hoffmann (1965). In sum, the net national product estimate of 69,963 mio. reichsmarks by Hoffmann (1965) is slightly reduced to 69,082 mio. reichsmarks through the revisions by Fremdling and Staeglin (2014). Implementing the new profit income estimate from Fremdling and Staeglin (2014) for 1936 into our reference total income series and keeping labor income unchanged, would increase reference total income and, consequently, produce lower top income shares. We refrain from providing an alternative estimate of our series incorporating Fremdling and Staeglin (2014) for two reasons: First, they only provide figures for 1936 and the extent of hidden profits in other years is unclear. Second, it is likely that these hidden profits did not appear income tax statistics as well. If these hidden profits were concentrated at the very top of the distribution, the numbers presented in this paper would even underestimate the true income concentration at the top.

For 1949 to 2014, we rely on figures published as part of the national accounts by the Federal Statistical Office. Total household income is the sum of

Compensation of employees (Residents) (*Arbeitnehmerentgelt (Inländer)*)

\- Employers' social security contributions (*Sozialbeiträge der Arbeitgeber*)

\+ Property income (*Vermögenseinkommen*)

\+ Operation surplus (*Betriebsüberschuss*)

\+ Income of self-employed (*Selbständigeneinkommen*)

= Total household income

x 0.9

= Reference total income

Compensation of employees is from Statistisches Bundesamt (1955) Table 2 in Chapter 23 for 1949, from Statistisches Bundesamt (2016a) Table 12.1 in Chapter 12 for 1950-1969, and from Statistisches Bundesamt (2016b) Table 1.3 for 1970-2012. Employers' social contributions are from Statistisches Bundesamt (1955) Table 2 for 1949, result from the difference between compensation of employees (*Arbeitnehmerentgelt (Inländer)*) and gross wages (*Bruttolöhne und -gehälter*) given in Statistisches Bundesamt (2016a) Table 12.1 for 1950-1969, and are from Statistisches Bundesamt (2016b) Table 1.8 for 1970-2012.

Property income, operation surplus and income of self-employed is from Statistisches Bundesamt (1991) Table 2.3.5 for 1950 to 1979 and from Statistisches Bundesamt (2016b) Table 1.10 for 1980-2012. In 1949, we take the residual from national income (*Volkseinkommen*) minus compensation of employees given in Statistisches Bundesamt (1955) Table 1 and 2 for 1949. However, a major revision of the series from 1980 on after the introduction of ESA in 1995 leads to a break in the series.[37] For the years 1980 to 1990, we have both revised and unrevised figures.

[37]Property income, operation surplus, and income of self-employed persons jumped from 131 in 1979 to 160 billion euros in 1980. One explanation for the break in 1980 is the addition of Financial Intermediation Services Indirectly Measured (FISIM), which estimates the value of financial intermediation services that financial institutions do not charge explicitly. FISIM was 17 billion euros in 1980.

Unrevised figures are, on average, 85% of the revised figures. Therefore, we adjust the unrevised figures 1950-1979 from Statistisches Bundesamt (1991) upwards by 17% ($100/85 \approx 1.17$).

We deduct the sum of capital gains observed in income tax microdata from the income control when we estimate shares excluding capital income.[38]

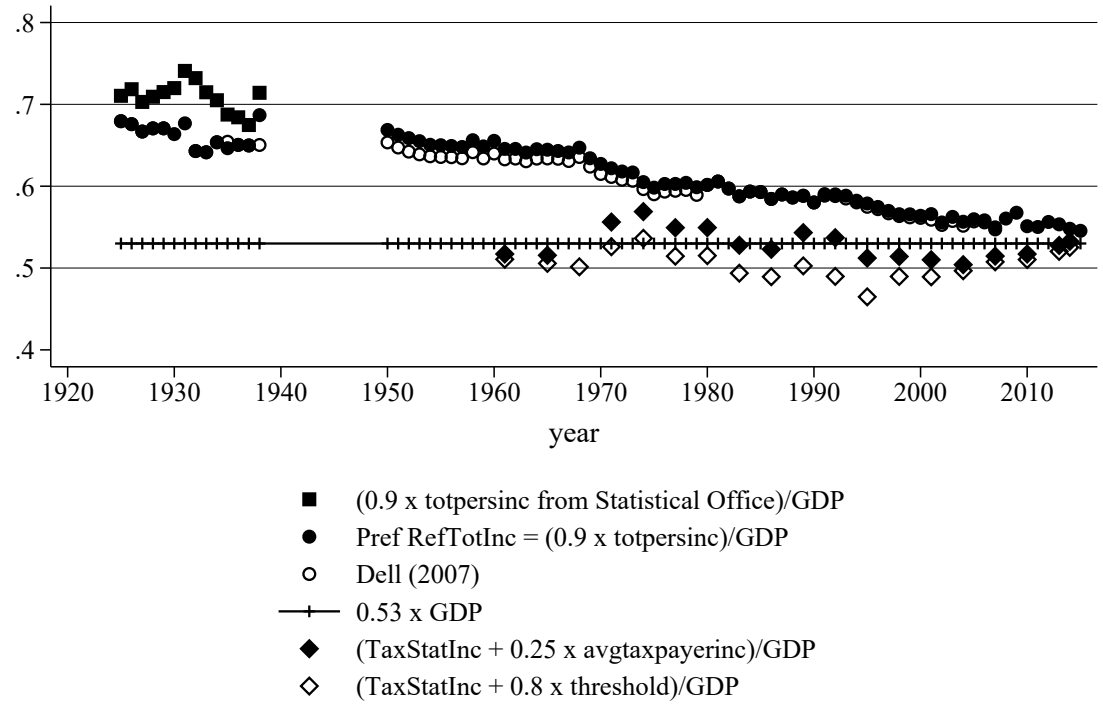
In order to check the robustness of the selected reference total income, we constructed several alternative total income measures which are displayed in Figure D.2. Total household income estimated by Bach et al. (2009) for the years 1992 to 2003 is about 53% of GDP. Hence, Figure D.2 shows different measures of total income compared to 53% of GDP. GDP is taken from Ritschl and Spoerer (1997) for 1925 to 1938 and from the Federal Statistical Office in the post-war years. Our preferred reference total is 90% of total household income. We follow Roine and Waldenström (2010) and construct two alternative measures based on incomes recorded in tax statistics. For the first measure, we add 25% of taxpayers' average income multiplied by the number of non-filers to incomes recorded in tax statistics. For the second measure, we add 80% of the income tax threshold multiplied by the number of non-filers to the incomes recorded in the tax statistics.

For 1925 to 1938, two points are worth mentioning. First, both total personal income from the statistical authorities and our reference total income increase in the crisis years of the early 1930s relative to GDP. German GDP shrank massively from more than 80 billion reichsmarks in 1930 to less than 60 billion reichsmarks in 1933. However, the figure from the Statistical Office shows an even greater increase, which is due to the inclusion of government transfers, which rise in crisis years. As these incomes are not part of tax incomes and should therefore be excluded from our reference total income, we rely on the Hoffmann and Müller (1959) series for our preferred reference total income. Second, in 1938, both total personal income measures increase relative to GDP as they were augmented to include Austria to match the population recorded in tax statistics.

For 1949 to 2014, our reference total covers a declining share of GDP. This is at least partly due to the growth of the public and private sector in the post-war period. The measure that adds 25% of average taxpayer income to the incomes recorded in tax statistics fluctuates around 53% of GDP. In contrast, adding 80% of the income tax allowance yields even lower levels in most years.

[38]This strategy enables us to easily interpret the difference between the series including and excluding capital gains. However, it should be noted that the income total in the national accounts does not include capital gains.

Figure D.2: Different reference total incomes as shares of GDP in Germany, 1925-2014



Source: See Appendix Table Germany.

E Estimation of German series, 1871-1918

The aggregated top income share series for Germany is computed in a two-step procedure. First, a point estimate for 1909 is constructed, where data are available in most of the eight states. The top income share in each state i is weighted by the state's fraction in German total income or German total population, respectively. The German top income share in 1909 is thus given as

$$share_{Germany,1909} = \sum_{i=1}^{n} w_{i,1909} \cdot share_{i,1909}$$

where $w_{i,1909}$ is the fraction of state i in German total income or total population, respectively, in 1909. 1909 is the year when the highest number of state-specific point estimates of top incomes shares is available. For Bavaria, 1911 estimates are taken for 1909 estimates since income taxation in Bavaria was only introduced in 1912 applying to incomes from 1911. The series is extended backwards to 1871 and forwards to 1918 by multiplying the aggregated point estimate of 1909 with the average growth rate of top income share over n states. This can be written as

$$share_{Germany,t} = \sum_{i=1}^{n} w_{i,t}(1 + g_{i,t}) \cdot share_{Germany,1909}$$

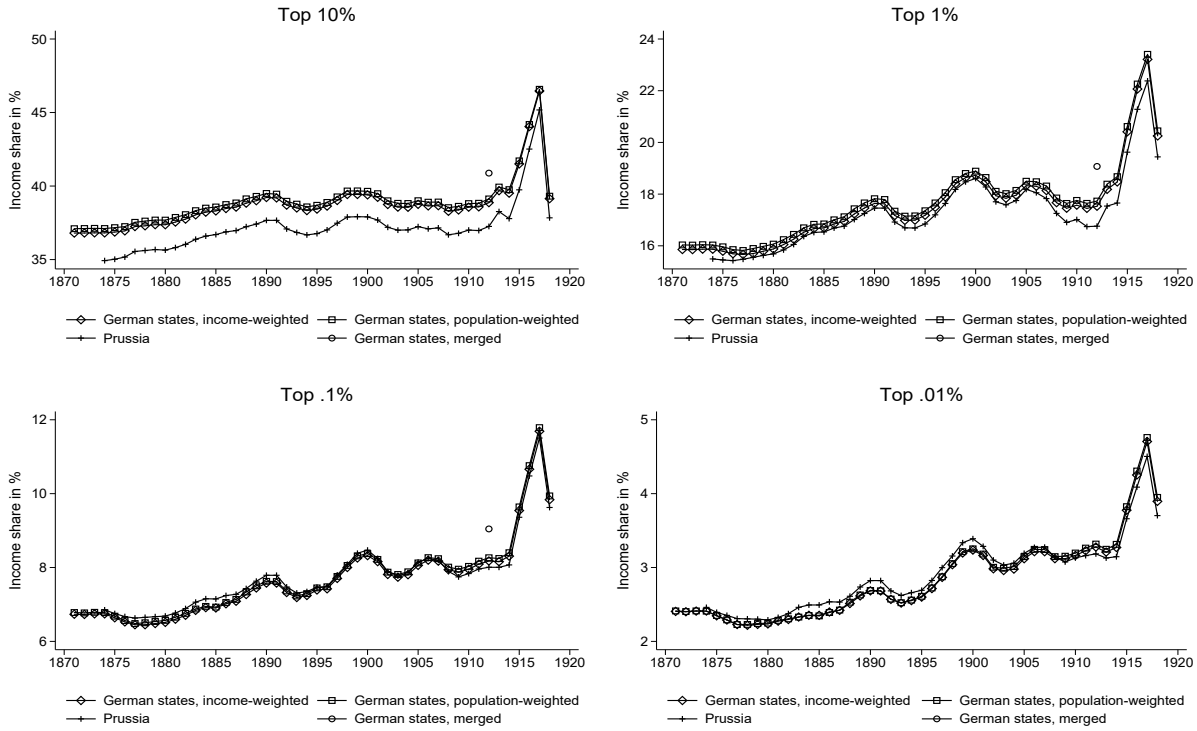
where $g_i = \frac{share_{i,t+1} - share_{i,t}}{share_{i,t}}$ is the growth rate of a fractile's top income share

in state i between year t and $t+1$.

Figure E.1 displays the income- and population-weighted German series in comparison to the Prussian series. The overall trend is driven by the Prussian series as Prussia includes the majority of the German population. But the level of income concentration turns out to differ fairly substantially. Looking at Prussia only, we would underestimate income concentration at the top decile. The picture reverses moving further to the top of the distribution. The income share of the top 0.01% in Prussia exceeds the share of this group in Germany as a whole. Since many of the super-rich at that time lived in Prussia, particularly the heavily industrialized Ruhr area, we would overestimate income concentration at the very top if relying on Prussian data only.

As a reference point in 1912, we can merge a joint tabulation of German states with the same income brackets for all states for the year 1912 (1910 in Bavaria, 1911 in Wurttemberg) (Statistisches Reichsamt, 1932, p.126). The joint tabulation includes all of our eight states except Bremen. The data point of the merged series is slightly above our income- or population-weighted aggregate series. The comparably higher level is partly explained by the inclusion of legal persons in the statistics from Saxony, Baden, and Bavaria in the joint tabulation. In sum, the estimate from the joint distribution is very similar to our aggregate series. This means that the estimation error from not taking between-state inequality into account is likely to be small.

Figure E.1: Top income shares Germany, 1871-1918

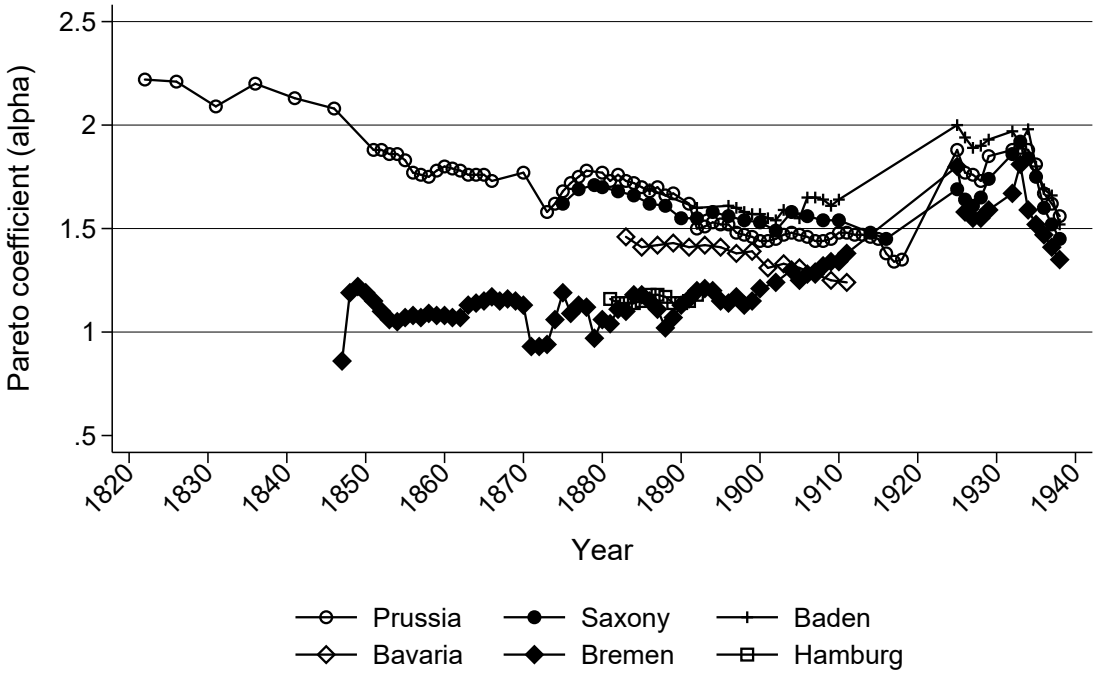


Source: Appendix Table x.

Note: German states, merged, are obtained from a joint tabulation (Statistisches Reichsamt, 1932, p.126).

F Comparison with previous estimates

Figure F.1: Pareto coefficient α, previous estimates, 1822-1938



Source: Grumbach (1957)

G Regression robustness checks

Figure F.2: Top income shares in Baden, 1885-1913

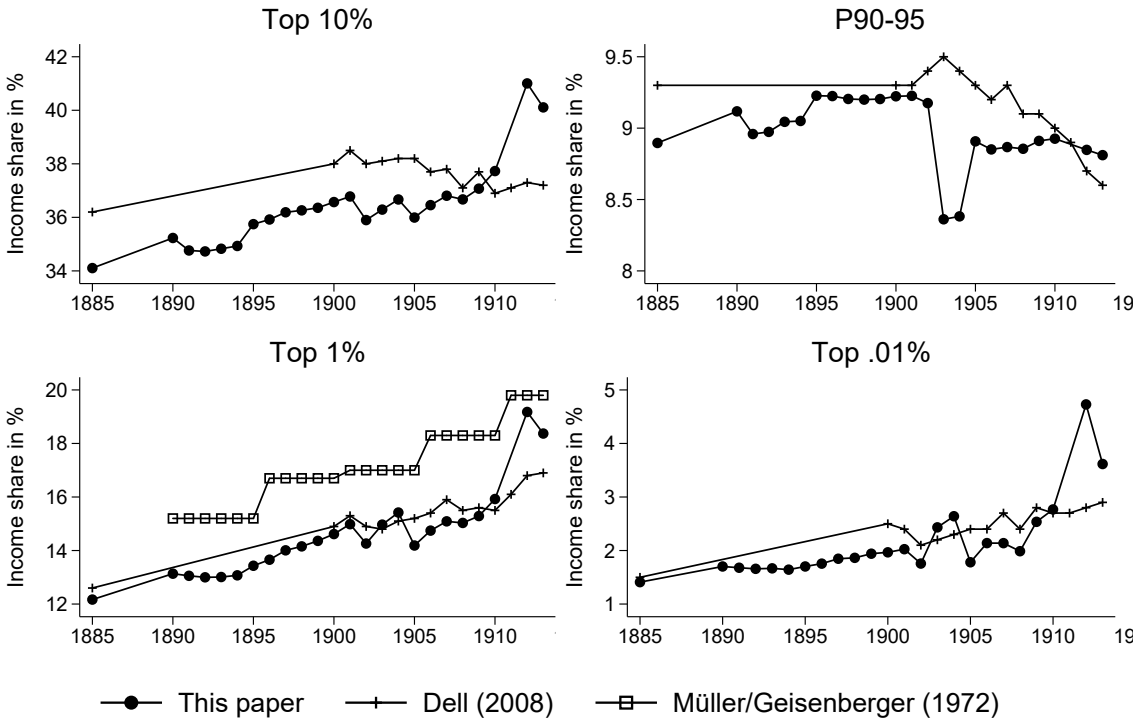


Figure F.3: Top income shares in Hesse, 1872-1918

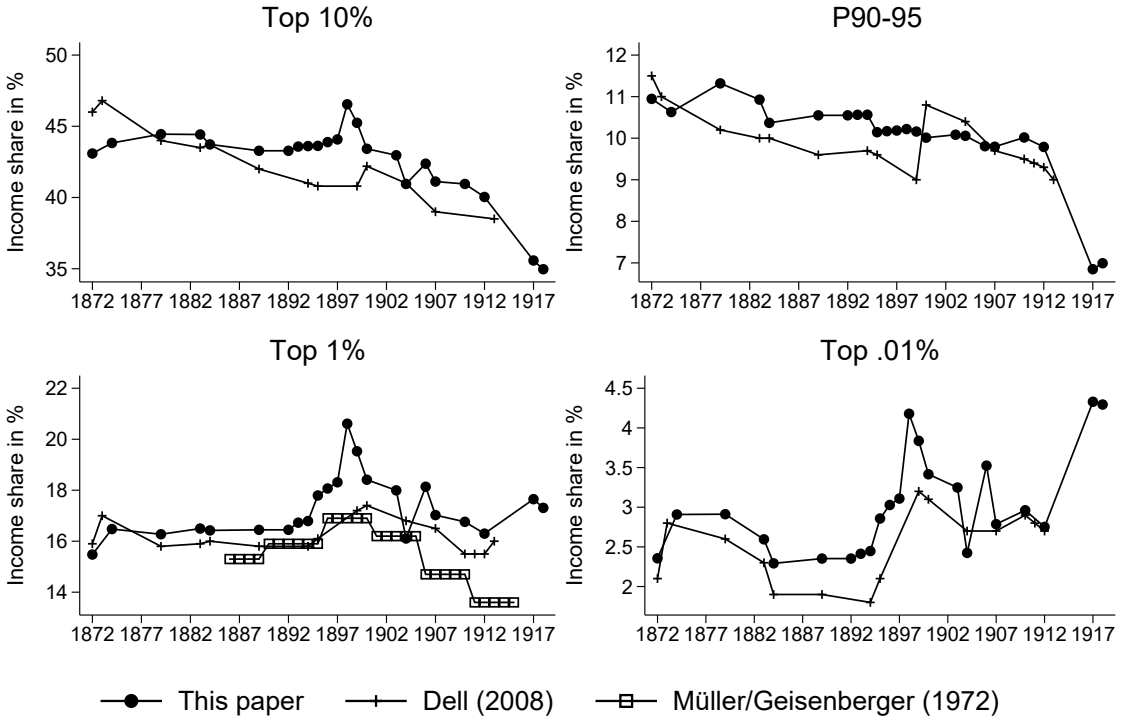


Figure F.4: Top income shares in Prussia, 1874-1918

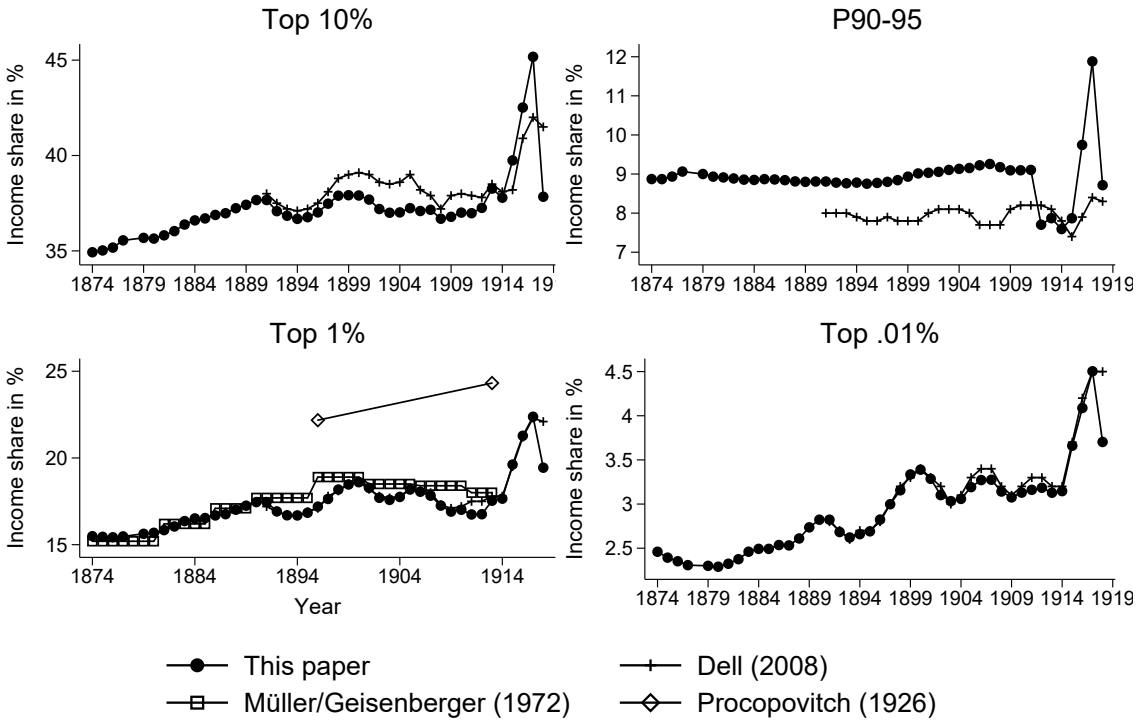


Figure F.5: Top income shares in Saxony, 1874-1917

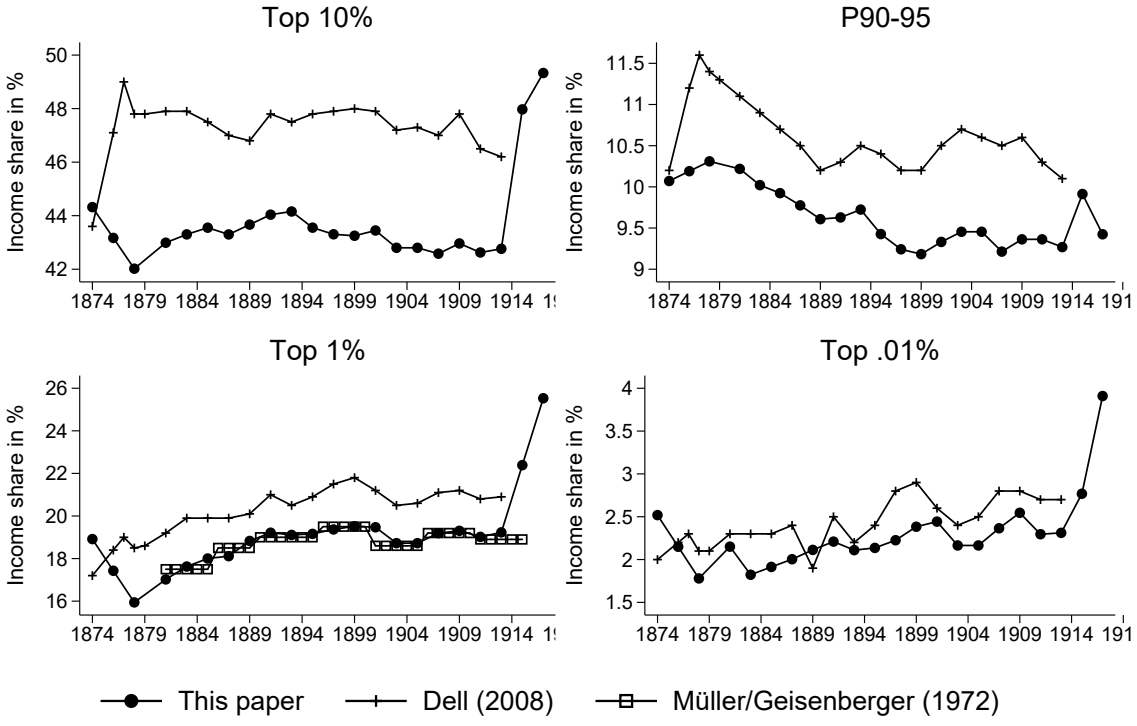


Figure F.6: Top income shares in Wurttemberg, 1904-1912

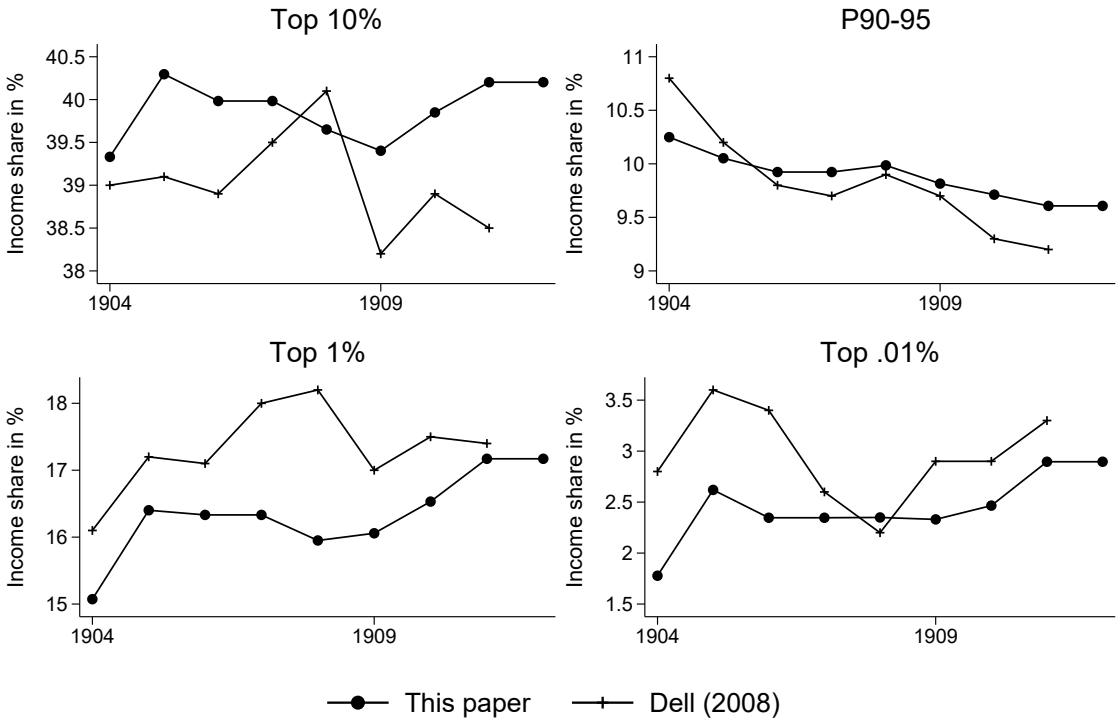


Figure F.7: Top income shares in Germany: This paper vs. Dell (2007)

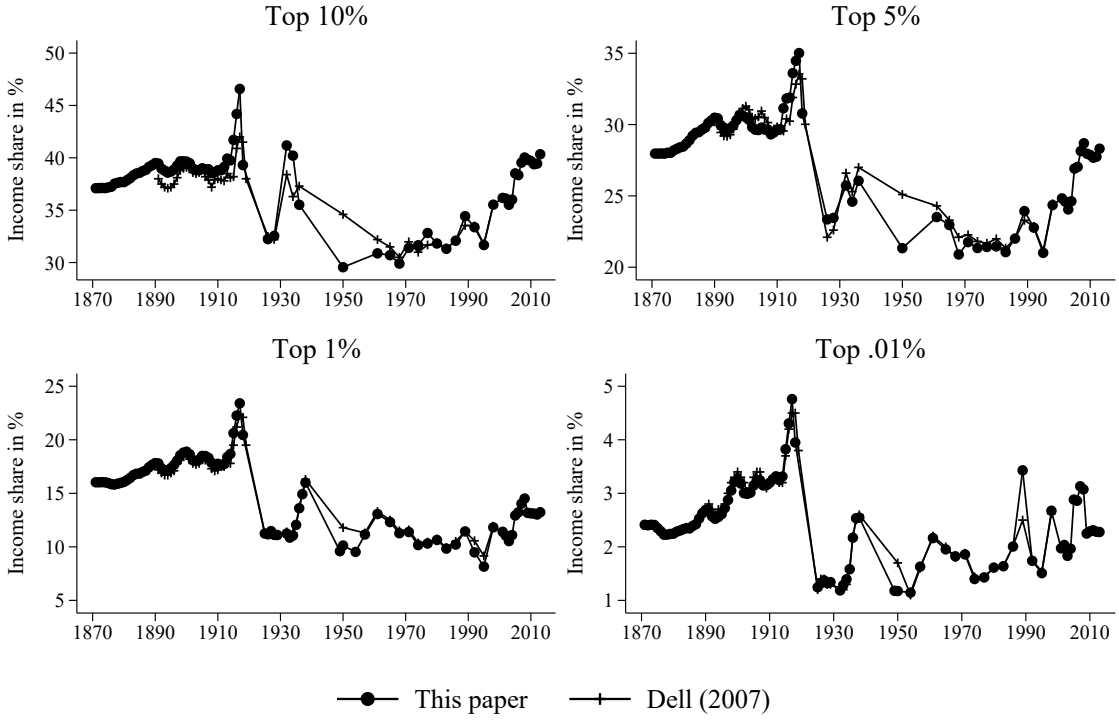


Table G.1: First-difference GLS regression results, 3-year averages

	(1)	(2)	(3)	(4)	(5)
	Δ Top 10%	Δ Top 1%	Δ P90-99	Δ 1/10	Δ 0.1/1
Δ Cap. share	0.051	0.383*	-0.287*	0.914*	0.999*
	(0.067)	(0.047)	(0.054)	(0.112)	(0.136)
Δ Trade	-0.127*	-0.003	-0.144*	0.136	-0.163
	(0.067)	(0.048)	(0.053)	(0.112)	(0.139)
Δ Growth	-0.083**	-0.109*	0.002	-0.172*	-0.077
	(0.040)	(0.027)	(0.032)	(0.066)	(0.078)
Δ Unions	-0.087*	-0.056*	-0.021	-0.103	-0.009
	(0.052)	(0.032)	(0.041)	(0.086)	(0.093)
Δ ATR	-0.245*	0.198*	-0.365*	0.547*	0.046
	(0.053)	(0.037)	(0.042)	(0.088)	(0.107)
Δ Patents	2.477*	-0.886	4.096*	-6.760*	1.526
	(1.323)	(0.949)	(1.052)	(2.199)	(2.757)
Observations	98	100	98	98	100