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Equality Before the Welfare State

The Norwegian Income Distribution 1892-1929

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Executive Summary

We estimate the complete income distribution in Norway for 1892, 1906, 1913 and 1929. Compared to previous research, we benefit from better data and more advanced estimation techniques. Our thesis identifies several data weaknesses which have caused bias in previous studies. Much of the data previously used does not distinguish between individual taxpayers and impersonal entities such as stock companies and banks. Another weakness is that before 1921, dividends were not included in the income data. For 1929, the data allows us to create local-level estimates for each Norwegian municipality.

We find that the pre-tax, pre-transfers Gini index is stable for the years we analyse, starting at 52 percent in 1892 and ending at 54 percent in 1929. The top 1% income share before taxes and transfers falls over time, declining from 19 percent in 1892 to 12 percent in 1929. We find that shocks to wealth might play a role in this development. Our results differ significantly from those of previous studies. First, we find a Gini index lower than Aaberge, Atkinson and Modalsli (2016). Second, we find lower top incomes and a different development over time than Aaberge, Atkinson and Modalsli (2013).

Our results suggest that Norway was already among the most egalitarian countries in Western Europe between 1892 and 1929 in terms of income. However, our estimates are sensitive to total income and to the estimation of stock dividends. Historical estimates from other countries are likely to be sensitive too, leaving a considerable risk of error when comparing.

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1. Introduction

Why are some people rich and some poor? This is perhaps the first economic question that humans have grappled with. How we understand equality shapes the debate on leading issues such as moral obligations to the poor and disadvantaged, discrimination, relations between countries and even competing political and ideological systems. At the individual level, lifetime income determines one's effective freedom to engage in a diverse set of activities and experiences. The distribution of income reflects, largely, the distribution of resources, opportunity and welfare. Understanding how and why the income distribution has developed over time is crucial to understanding the development of our society.

Research by Piketty and others into long-run trends have contributed to this understanding (Piketty & Saez, 2006). They find high levels of inequality in the 19th and early 20th century as measured by top income shares, followed by a large decline around World War II. In more recent years, most advanced countries have seen income inequality rise again (Atkinson & Bourguignon, 2014, p. 492). This has started a new debate on inequality and its causes. Research by Piketty and others did not just show that income inequality was growing in the United States of America, but that it was close to a record high. According to Piketty, only the Roaring Twenties can match today's top income shares in America. In 2015, the richest 10 percent earned 50 percent of all income, the first time in the recorded history of the USA (WID, 2017).

The American income distribution stands in stark contrast to Norway's. Today, Norway has one of the world's most equal income distributions (OECD, 2017). However, there is disagreement on when equality first appeared. Researchers clash over whether Norway was an egalitarian society at the dawn of the 20th century, or if equality developed later. A popular notion is that equality was conceived by Norway's welfare state, which became large in the 1960s (Hodne & Grytten, 2002).

The most recent Gini estimates by Aaberge, Atkinson and Modalsli (2016) indicate high historic levels of income inequality in Norway. According to their estimates, income inequality in Norway by 1900 was comparable to what we see in Latin American countries today. This seem to be at odds with historical accounts portraying Norway as a fairly equal society of independent farmers and no aristocracy. At the time, the official story was that Norway was among the world's most equal societies.

SOCIAL CONDITIONS

AMONG civilised states, there is scarcely any that is so fortunate with regard to the equality of its social conditions as Norway. There is no nobility with political or economic privileges, no large estates, no capitalist class. The cultivable land is divided among a number of small freeholders, who constitute the most numerous class of society and its sound nucleus. To make a livelihood in that rude climate and on that weather-beaten coast, calls for energy and endurance, and accustoms the worker to self-restraint.

It may also be said that an evenly distributed prosperity is proved by the number of depositors in the savings-banks established in nearly every community. There is an average of 1 savings-bank to every 5600 inhabitants, and 1 depositor in every 2.8 inhabitants, with 119 kroner to every inhabitant. With regard to the deposits in other banks cf. the special article «Banking».

The highest and lowest strata of society are on the whole no farther removed from one another than that there is constant reciprocal action between them, and transition from the one to the other. The primary school, which is obligatory, is the common basis whence the higher educational institutions organically rise to impart the knowledge required by the various positions, and to insure to all that popular education which contributes so largely to raise individual self-esteem, and give to our democracy, with its universal suffrage, the feeling of security in living under the badge of liberty, equality and fraternity.

The shifting of the strata which the economic development of the century causes everywhere in the social structure, has there-

Exhibit 1: *The first page of the chapter on social conditions from Norway's official publication for the Paris world exhibition 1900. Håvard Emanuel Berner, a radical MP for Venstre, an intellectual and the first editor of Dagbladet, wrote the chapter. Source: Konow & Fischer (eds.) (1900)*

At the Paris 1900 world exhibition, Norway declared that “[a]mong civilized states, there is scarcely any that is so fortunate with regard to the equality of its social conditions as Norway. [...] The statistical information recently obtained by public agency concerning income and property, chiefly shows a surprisingly small difference between the principal economic groups of the population” (Konow & Fischer (eds.), 1900). Hagbard Emanuel Berner, a radical MP for Venstre, an intellectual and the first editor of *Dagbladet*, wrote the exhibition article.

Anders Nicolai Kiær, the first Director of Statistics Norway, agreed. Having created an early estimate of the national income distribution, Kiær concluded that income in Norway was more equally distributed than in most other countries. “*There are fewer larger incomes and less striking poverty*”, Kiær (1892) wrote. From Kiær’s writings, we know that he had access to income data from Saxony and later from several other countries (Kiær, 1911). Another early pioneer, Lee Soltow (1965), found that inequality had decreased from high levels in the middle of the 19th century to fairly low levels at the start of the 20th century. Soltow only studied eight cities in the counties of Østfold and Aust-Agder, but believed his findings also reflected national developments.

Later historians have disagreed with Berner, Kiær and Soltow. At least partly, the disagreement depends on the basis of comparison. One can draw different conclusions from a 19th century cross-country comparison and a comparison of 19th century Norway with today. Berge Furre (1992), an historian and socialist MP, argued that the rich captured a large share of all income in 1905. In his view, differences were large even among working people. Bergh, Hanish, Lange and Pharo (1983) convey a similar view, even naming their history book “*Norway, from Third-World to First-World*”. They argued that if “*developments in the second half of the 19th century were to predict the future, it would look dark for large parts of the country and a great number of people. [If progress is defined as improvement experienced by the vast majority], then progress did not occur before after World War II*”.

Danielsen and Hovland (1991) concluded that incomes were unequal, but stressed the lack of reliable economic data. They also looked at health data, which could offer a different view on inequality. International studies have found strong associations between measures of health and income inequality (Wilkinson & Pickett, 2006). Danielsen and Hovland noted that Norwegian infant mortality was low¹ compared to other countries. If we look at average height

¹ For a systematic international comparison, see Regidor *et al.* (2011).

among men during the 19th and early 20th century, we also see that Norwegians were among the tallest Europeans (Hatton & Bray, 2010). A tall population would imply that sufficient food was available to a large number of people. Literacy in the population was also high (A'Hearn, B., & Crayen, 2009). These indicators might suggest greater equality.

The debate on whether 19th century Norway was an egalitarian society is far from settled. Is Norwegian equality an ancient or a recent accomplishment? To understand the causes behind Norwegian equality, we need to know *how* and *when* equality developed in Norway. Previous research by Lee Soltow (1965) placed a large, long-run shift towards equality between the last part of the 19th century and the first part of the 20th. Aaberge, Atkinson and Modalsli (2016) point to World War II. Revisiting this period could therefore hold valuable lessons for policymakers and society today.

In this thesis, we estimate pre-tax, pre-transfer Gini coefficients and top income shares for Norway in 1892, 1906, 1913 and 1929. We analyse how the level of inequality changed over time, and decompose inequality for different segments of the population. Compared to previous research, we benefit from better data and more advanced estimation techniques. For 1929, we have local-level data which allows us to explore regional differences in detail. We also do a thorough review of data sources, locating data weaknesses which have biased previous estimates. Much of the data previously used does not distinguish between individual taxpayers and impersonal entities such as stock companies. We use data on individual incomes only. Another weakness is that before 1921, income from stock dividends is not included. We correct for this. This is shown to have a sizeable effect on top income shares and a more modest effect on the Gini index.

We find that the pre-tax, pre-transfers Gini index is stable, starting at 52 percent in 1892 and ending at 54 percent in 1929. The estimates are strikingly similar to Danish estimates created by Søgaaard and Atkinson (2013). Compared to modern data, the Gini estimates are within the range of pre-tax, pre-transfers inequality in West-European countries today. We find low top income shares compared to other European countries in the same time period. In 1892, we find a top 1% income share of 19 percent. This falls to 12 percent by 1929. The share of total income going to the richest 1% declines strongly, falling by a third in the period. We find that shocks to wealth might play a central role. Top income shares decrease after both the Kristiania crash and the recessions in the 1920s. Looking at local level data suggests that top incomes

were highly concentrated in that the largest cities, and that local developments such as the Kristiania crash sometimes played an important part in shaping the national top income level.

Our results differ from the result presented by other researchers. First, we find a Gini index significantly lower than the one found by Aaberge, Atkinson and Modalsli (2016). This is largely a result of the previous authors assuming lower incomes for the non-taxed part of the population. Second, we find a trend in top income share that differs largely from the estimates by Aaberge, Atkinson and Modalsli (2013). For example, they find a 6.4 percentage point decline in the top 1% income share between 1906 and 1913, while our comparable estimates show a 1.5 percentage point increase. This effect come from the removal of impersonal tax units from our sample, and the addition of an estimate of dividends.

In terms of income, our results suggest that Norway was already among the most equal countries in Western Europe between 1892 and 1929. However, our estimates are highly sensitive to the size of total income and to the estimation of stock dividends. The question of whether early 20th century Norway was an egalitarian society is not settled, but we hope that our work will help move the debate forward.

The rest of the thesis is organized as follows. In chapter 2, we provide an overview of relevant literature on income inequality, with a special emphasis on empirical research using Norwegian data. In chapter 3, we present a detailed description of the data, the “*dirty details*” of the Norwegian tax system and its implications for the measurement of income inequality. In chapter 4, we present the methods used to produce reliable measures of income inequality. We present the findings from our analysis and discuss their implications in chapter 5 and 6. In chapter 7, we analyse the robustness of our results. We summarize and conclude in chapter 8.

2. Literature review

Research on inequality has deep historical roots (Atkinson & Bourguignon, 2014). Over the years, many have tried to explain how inequality has changed and why. To set the Norwegian developments in context, we begin by summarizing long-run international trends in income inequality. For brevity and relevance, we will limit the summary to developed countries. Then, we review existing empirical research on long-run income inequality in Norway. Last, we summarize the most widely recognized theories on the long-run development of income inequality.

2.1 Long-run international trends in income inequality

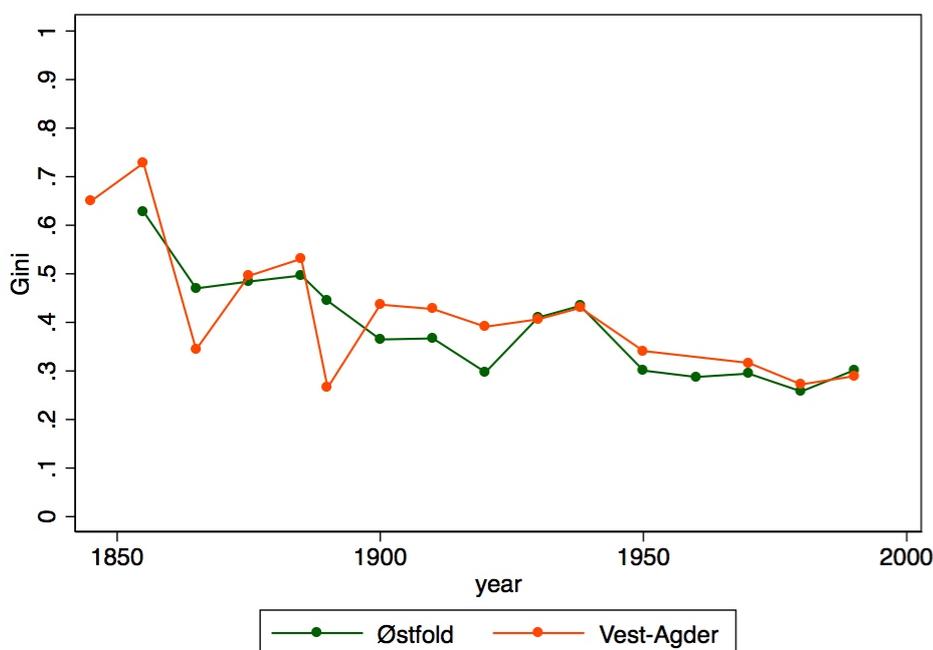
Before 1900, reliable data only exists for a handful of countries (Atkinson & Bourguignon, 2014, p. 492). Some studies point to increased inequality during industrialization, while others find stable, relatively high levels of inequality. Measuring inequality as top 1 percent income shares, the overall picture is that inequality was high between 1870 and World War I in the few countries where data exists. Inequality then declined throughout the 20th century. There are clear similarities across countries. All countries register sharp declines in inequality in proximity to World War II. After the 1980s, trends depend on the country in question. In continental Europe and Scandinavia, top income shares seem to have flattened out or increased somewhat from a lower level. In the US and Great Britain, top income shares have increased even more. In figures 2-3, we show long-run Gini and top income series for Norway and Denmark. Inequality in Denmark seems to have dropped rapidly at the end of the 19th century, gradually after World War I, and then rapidly again just after World War II.

2.2 Income inequality in Norway

Anders Kiær, the first director of Statistics Norway, used administrative tax data and the 1890 census to create an estimate of the national income distribution for 1888 (Kiær, 1893, p. 105). Kiær notes that the data has several weaknesses. The data only contains information about a fraction of the working population, and he had to make assumptions about lower incomes. Kiær compared Norway with Saxony, and suggested that Norway had a more equal income distribution than other developed countries. He also examined how income was distributed across professions and regions. He later made estimates of the pre-tax income distribution for

1892, 1906 and 1910 (Statistics Norway, 1910; 1915). Here, Kiær used a large survey from 1894 ordered by the Parliamentary Labour Commission to estimate income for people who did not pay tax (Den parlamentariske arbeiderkommission, 1899). Lee Soltow, an American economist, made the next major contribution to research. Having heard of the Norwegian tax data, Soltow travelled to eight Norwegian cities in the counties of Østfold and Vest-Agder to collect data. In 1965, he published Gini coefficients on each city from 1840 to 1960 in the book “Toward Income Equality in Norway” (Soltow, 1965). Soltow used micro data, drawing a representative sample of incomes of men from the tax assessments records in each city. Doing this, he found income data on a large share of the adult male population. He also estimated a minimum income for the men who did not pay tax. Soltow’s results are shown in Figure 1 together with an extension created at Statistics Norway. Soltow estimated high levels of inequality during the first part of the 19th century. Inequality then rapidly declined until the 1920s. Soltow believed the decrease was associated with industrialization, which led to stable wages and the elimination of mercantilist privileges. Soltow did not calculate national Gini coefficients, and the development in urban Østfold and Vest-Agder might not be representative for the entire country. Furthermore, the estimates would not account for inequality stemming from differences between municipalities.

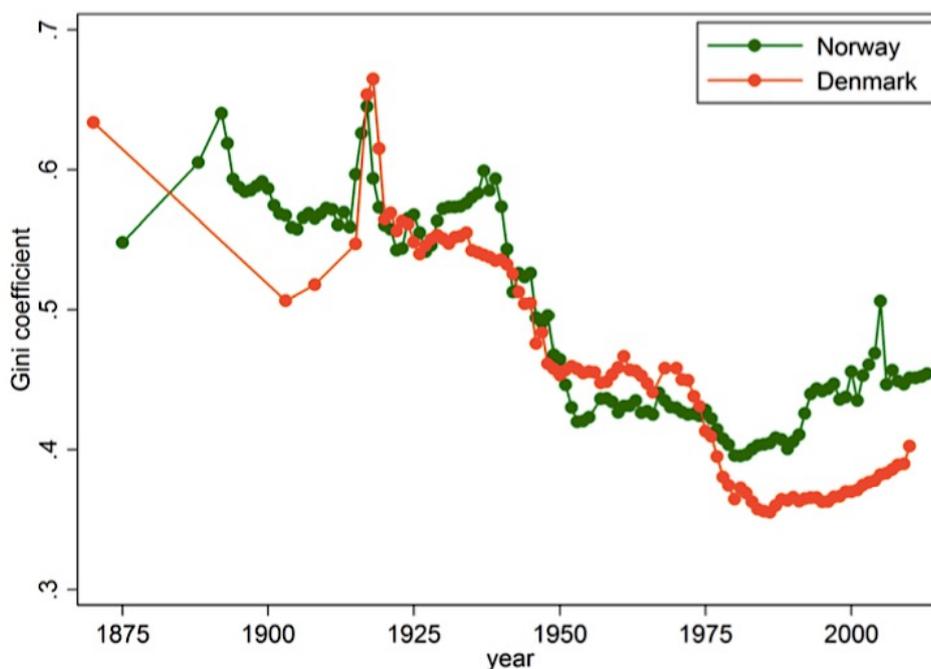
Figure 1: Average Gini coefficients



Note: County averages of the municipal Gini coefficients calculated by Soltow (1965) and Mjelve (1998) for 8 cities in Østfold and Vest-Agder.

In recent years, researchers have made progress in assessing historical inequality in Norway. Aaberge, Atkinson and Modalsli (2016) have estimated Gini coefficients on income from 1875 to 2013. The estimates are shown in Figure 2. The Gini is pre-tax, but includes transfers. The Gini is based on tax units to make the estimates comparable over time. The authors find high levels of inequality in the 19th and early 20th century. In 1900, they estimate that the Gini coefficient was between 58 and 60 percent. This is similar to inequality found in Latin American countries today. Their estimates fluctuate around a high level before decreasing rapidly during World War II, stabilizing at a low level in 1955. The study uses data from historical tax tables. As not everyone paid tax, the authors assign an income to poorer households based on the government spending on poverty relief and the tax data. Using different assumptions about this income, the authors estimate upper and lower bounds for the Gini coefficient. The bounds are then averaged.

Figure 2: Averaged bounds on the Gini index



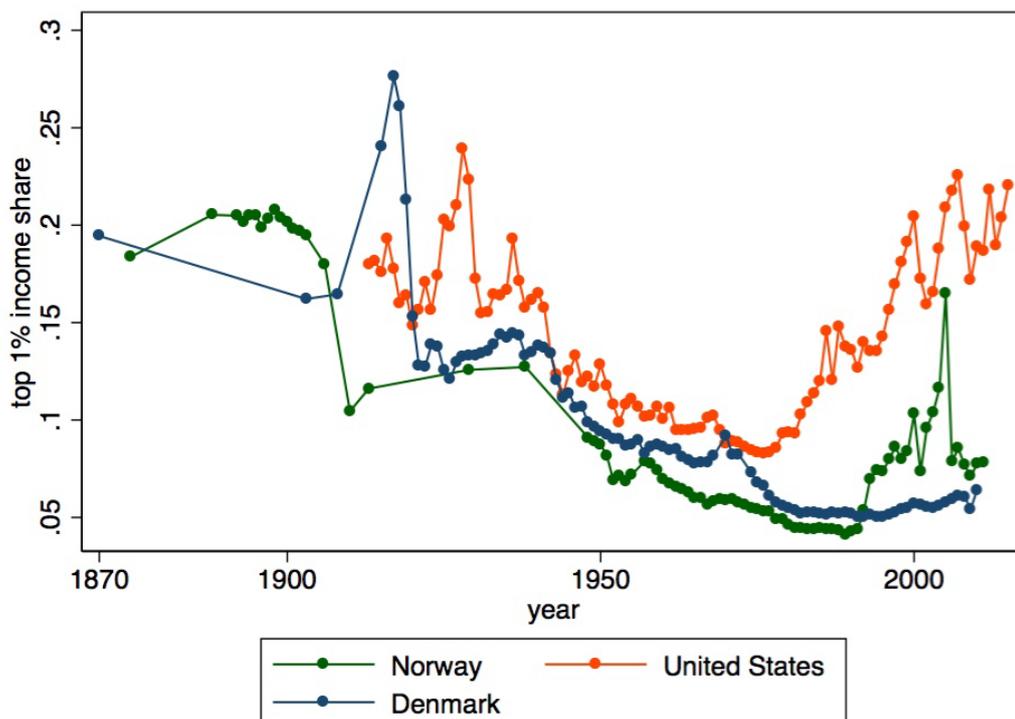
Note: Average of the upper and lower bounds on the Gini coefficient for Denmark and Norway. The figure is from Aaberge et al. (2016). Data from Sogaard & Atkinson (2013) and Aaberge et al. (2016).

Modalsli (2016) estimated local-level income Gini coefficients for 1868, but only for men aged 25 years or older. Combining data from several sources, he estimated inequality at municipal level and within 19 occupations. Inequality in cities was on average twice as large as in the countryside. Comparing men with the same occupation, Modalsli found substantial

inequality within all high- and medium-income occupations. The Gini for all men in 1868 was 54.6 percent. Modalsli concludes that Norwegian income inequality was high.

Top income shares are another measure of inequality which has attracted considerable attention in research (Atkinson, Piketty, & Saez, 2011). Aaberge and Atkinson (2010) and Aaberge, Atkinson and Modalsli (2013) estimate top income shares for Norway 1875-2010, using much of the same data as their 2016 Gini study. The results are shown in Figure 3. The authors suggest that top income shares in the 19th century Norway were high. At the end of the 19th century, 20 percent of all income went to the top 1 percent. Similarly, the top 0.5 percent earned about 15 percent of total income. In the 20th century, the top income shares fall rapidly. By 1910, the top 1 percent earned 12 percent of all income. By 1950, they earned 7 percent. The United States and Denmark follow a similar trajectory.

Figure 3: Top 1% income shares



Note: Historical top 1% income shares for Norway by Aaberge, Atkinson and Modalsli (2013). Danish and US series from the World Wealth & Income Database (2017) are added for comparison.

Kiær did not calculate Gini coefficients or modern top income shares, and Soltow only covered eight municipalities. The time series composed by Aaberge, Atkinson and Modalsli (2016) are based only on nationally level data and use simple, transparent assumptions for the part of the population that did not pay tax. With more information on low incomes and local-level data, it should be possible to create estimates with greater precision.

2.3 Economic theory explaining long-run changes in inequality

2.3.1 Early literature

Most literature before World War II suffers from scant data and often lacks formal economic reasoning. We will briefly mention some historical contributions. Early writers such as Adam Smith² (1786) had discussed inequality, but it was first at the turn of the 20th century that economists started to analyse inequality using modern methods. Vilfredo Pareto published his proposed law on wealth distribution (Pareto, 1897), while Corrado Gini created the Gini index as a way to quantify income inequality in his 1912 work *Variabilità e mutabilità* (Ceriani & Verme, 2012; Gini, 1912). In the US, Harvard economist F. W. Taussig (1923) devoted a chapter to inequality in his book, *Principles of Economics*. He noted that little data was available, but presented some figures from Prussia and the United Kingdom. He suggested that inequality fell in these countries between 1880 and 1913. Taussig did not try to explain the trend. In his view, inequality arose from differences in natural endowments and inheritance.

2.3.2 International trade

The Heckscher-Ohlin model of international trade was first proposed by Eli Heckscher and Bertil Ohlin during the 1920s, and later expanded³. The model has clear implications for how inequality would develop if countries with different levels of skilled labour (human capital) and capital start trading with each other (Atkinson & Bourguignon, 2014, p. 548). Countries with abundant capital will see increased inequality. In countries abundant with low-skilled labour and little capital, inequality will decrease. The mechanism is as follows: Trade causes the capital-rich country to specialize in capital-intensive production, while the labour-rich country will specialize in labour-intensive production. In the capital-rich country, demand for labour and wages fall. Demand for capital and profits increase. Because capital income is more concentrated, this leads to high levels of inequality. In the labour-rich country, wages rise and profits fall, creating the opposite effect.

² For instance, Adam Smith discusses compensating wage differentials in chapter 10, Book 1 in *Wealth of Nations*.

³ For an introduction to the Heckscher-Ohlin model, see any undergraduate textbook on international trade, such as "En liten åpen økonomi" by Victor Norman (2004) or "International Trade: Theory and Policy" by Krugman and Obstfeldt (2014).

The Heckscher-Ohlin model has been criticised for not fitting empirical data, and evidence for the model is mixed. In modern trade theory, the predictions are less clear. Venables (2008) and Leamer (2007) suggest that trade between dissimilar countries could lead to a hollowing out, i.e. gains to the global top and the bottom, but losses to individuals in the middle of the global income distribution. The effect on inequality would then depend on the country in question.

While trade is one side of globalisation, migration is the other. According to the Roy model of emigration, we should expect inequality to be correlated with migration (Borjas, 1987). The model does not explain inequality, but simply shows that inequality should affect the migration patterns we observe. A high level of inequality would usually entail higher rewards to skills, which would attract high-skilled immigrants from countries with lower levels of inequality. In other words, there would be positive selection. Boustan, Abramitzky and Eriksson (2012) found positive selection among Norwegian migrants from rural areas to the US in the late nineteenth century and negative selection among Norwegian migrants from urban areas.

2.3.3 Skill-biased technological change

Technological change could favour skilled workers (Acemoglu & Autor, 2011). In brief, new technology can lead to low-skilled jobs being automated, while increasing demand for high-skilled labour, which can operate and develop the new technology. This will boost the wages of the high-skilled, while creating downward pressure on the wages of the low-skilled. The increasing wage differential would then lead to higher income inequality. Education counteracts the effect. When the education level in the population rises, the supply of skilled workers expands, while the supply of unskilled workers shrinks. In other words, the level of inequality is decided by a race between technology and education. According to Acemoglu and Autor, such a model has been empirically successful in explaining US wage dispersion in the last decades. However, the theory does not imply that skill-biased technological always creates inequality, since inequality is jointly determined by education. Also, not all technological changes are skill-biased. For instance, during the industrial revolution, mechanisation allowed low skilled labour to replace skilled artisans (Atkinson & Bourguignon, 2014, p. 557).

2.3.4 Superstar effects

Skill-biased technological change, as outlined above, does not offer a good explanation why we might see high levels of inequality within the group of highly skilled (Atkinson & Bourguignon, 2014, p. 557). Superstar effects specifically aim to explain wage dispersion among the top. Superstar effects were first proposed by Rosen (1981) and Frank and Cook (1995). The theory suggests that technological change induces “Winner takes it all-markets”. Before the advent of mass production and modern infrastructure, much goods and consumer durables had to be produced locally. This created numerous small, local markets with local producers of varying ability. With markets being unified by new infrastructure, and mass production now possible, the best producers could outcompete the rest, earning large rewards. The superstar effect might fit the 19th century advent of America’s robber barons and large monopolies such as Standard Oil (McGee, 1958). However, superstar effects do not seem to explain long run trends, such as the decline in inequality in the mid-20th century (Atkinson & Bourguignon, 2014, p. 557).

2.3.5 Demography

Income inequality could also arise from demographic changes (Paglin, 1975). Both theoretical models and empirical results suggest a strong relationship between age and earnings (Heckman, Lochner, & Todd, 2003). Changes in demography could therefore change the level of inequality and explain long-run trends. For example, Almås, Havnes and Mogstad (2011) found that baby boom cohorts reaching the peak of the age-earnings profile to some extent caused the increase in Norwegian income inequality during the 1980s and 1990s. At the end of the 19th century, Norway was going through a demographic shift, with lower birth rates and greater lifespans (Statistics Norway, 2012). The demography was also affected by migration (Grytten & Hodne, 2002). Before World War I, Norway experienced large-scale emigration to the US. After the war, the US tightened immigration rules, which reduced the opportunity of moving overseas. The effect of these events on inequality is not straightforward, but should be investigated empirically.

2.3.6 Compensatory wage differentials

Many of the standard models that economists have developed also imply income inequality. Under many circumstances, wage differentials will be necessary to clear the labour market. For instance, time invested in education should be compensated, usually with higher wages

(Chiswick, 1974). Some occupations are simply less appealing or riskier, requiring the employer to pay more. Wage differentials could also arise if workers have different tastes. However, these theories generally lack the ability to explain the long-run trends we observe.

2.3.7 Wealth, wars and major financial crises

Piketty and Saez (2006) propose that large macroeconomic shocks such as wars and major financial crises explain why inequality changes (Atkinson & Bourguignon, 2014, p. 557). These shocks destroy large amounts of wealth, which hits top incomes hard. Income from wealth generally constitutes a much larger share of top incomes than of ordinary incomes. In Piketty's view, when wealth falls, top incomes fall, which reduces income inequality. According to Piketty and Saez, such events have often been followed by policy shifts which have kept inequality at a lower level. The theory seems to fit the war-related reductions we see in both US, Norwegian and Danish data (see figures 2-3). What is odd is that the US mainland did not see active fighting, and could not have undergone the same wealth destruction as the European continent. Indeed, US top wealth shares change little during the war years 1941-45 (World Wealth and Income Database, 2017). The 1929 depression did not have an immediate impact either. Instead, 10 percent top wealth shares started declining in 1933, while 10 percent top income shares started declining in 1940 (a year before the US entered the war).

Piketty and Saez are not the first to propose that the distribution of wealth and income is jointly determined. Meade (1964) and Stiglitz (1969) have proposed models not related to war, but to savings and demographics. In Meade's framework, individual wealth grows with savings and returns to capital. Wealth diminishes across generations as the wealth is divided among a growing population. However, this model does not seem to explain observed trends and shifts (Atkinson & Bourguignon, 2014, p. 552).

Modern economists often treat land as type of capital. Historically, land was regarded as an independent input in production with its own special characteristics. 19th century economist J. E. von Thünen formalized how rent (i.e. income from land) depends on the land's *first nature* and *second nature* (Krugman, 1993). The first nature is simply the yield of the land, while the second nature is the cost of transporting the yield to the market. Differences in these characteristics would result in different rents and thus affect income inequality. In a pre-industrial society, where land constituted most of the wealth, land rents were probably much more important than today.

2.3.8 Tax

Taxes will affect inequality after taxation. Through cumulative effects over time, they can also affect inequality before taxes (Atkinson & Bourguignon, 2014, p. 557). According to Piketty, shocks to wealth, combined with the cumulative impact of high marginal taxes, can explain why inequality remained at low levels after World War II. With high marginal taxes, recovery of capital holdings takes time. In the short run, the effect from taxes could be small, while the cumulative effects over time could be larger (Roine, Vlachos, & Waldenström, 2009).

2.3.9 The Kuznets curve hypothesis

The Kuznets curve hypothesis is arguably the most studied and debated theory in inequality research. Because of the large literature, we will give a more thorough review of the Kuznets curve than of other theories. Still, we conclude that the evidence in support of the theory is at best inconclusive. Simon Kuznets set out the modern research agenda on income inequality in his 1954 Presidential Address to the American Economic Association (Kuznets, 1955). He proposed that inequality first increased, then decreased, with the level of development. In other words, Kuznets suggested that the development in income inequality had followed an inverted U-shape. He believed this pattern could be explained by demand-side forces (Higgins & Williamson, 1999). This is often referred to as the strong version of the Kuznets curve hypothesis.

At first, technological and structural change would increase demand for capital and skills, while reducing demand for unskilled labour. Assume that preindustrial agriculture had much lower wages than the non-agriculture sector. As demand changes, labour shifts out of agriculture and into the non-agriculture sector. This creates increasing between-group inequality between the large agriculture sector and small non-agriculture sector. When the non-agriculture sector has grown sufficiently at the expense the agriculture sector, further shrinking the agriculture reduces between-group inequality. This dynamic leads to an inverted U-shaped relationship between income inequality and growth, according to Kuznets. In the weak version of the Kuznets curve hypothesis, other influences on inequality can offset or reinforce the effects described above.

Kuznets had little actual data when he created the hypothesis. Using data from the US, UK and Germany, Kuznets noted that incomes had become more equal, perhaps since the 1920s (Kuznets, 1955). Kuznets did not have data on the prior period, but merely assumed that

inequality had been lower. Even if empirical research in the 1970s apparently confirmed the strong-version Kuznets curve, by 2000 a new review of the field asserted that research had failed to find a systematic relationship between inequality and economic development, at least in cross-sectional data (Kanbur, 2000). New, long-run time series do not seem to give much support to the strong version of hypothesis either. Piketty & Saez (2006) failed to find evidence of an inverted U-shaped relationship. Barro (2000; 2008) used a large panel data set ranging from the 1960 to 2004. He found an inverted U-shape pattern across countries, which was fairly stable over time. However, the curve does not explain the bulk of the observed variation in income inequality across countries or over time.

There has been less research interest in the weak version of the Kuznets curve hypothesis. A correlational study by Milanović (2000) decomposed cross-sectional differences in an 80-country sample into inequality due to income level (the Kuznets effect) and political choice. Milanović found that inequality attributed to the Kuznets effect first increases and then decreases with income with a turning point at around 2100 USD PPP. Ho-Chuan and Shu-Chin (2007) found an inverted- $\sqrt{\quad}$ shape rather than the conventionally inverted-U curve, using a 75-country cross-sectional sample and controlling for transfers, government employment share, inflation and regional dummies. According to their estimate, inequality starts off at a moderately high level, increases with industrialization, before turning sharply, declining to a level lower than before industrialization. The pattern is not visible without the added control variables.

Altogether, modern empirical research does not seem provide good evidence in favour of the strong version of the Kuznets curve. For the weak version of the hypothesis, the evidence seems to be mixed. Note that the hypothesis rests on a crucial assumption, i.e. that pre-industrial societies were more equal than newly industrialized societies. If agricultural wages were more unequal than industrial wages, perhaps due to unequal ownership of land, movement out of agriculture into industry could decrease inequality right away (Gallup, 2012). Milanovic, Lindert, & Williamson (2011) estimated inequality in pre-industrial societies, ranging from the Roman Empire AD14 to China in the 1880s. They mostly found high levels of inequality, casting doubt on Kuznets' original assumption that inequality started at low levels before industrialization. "*Feudalism didn't promote a particularly equal distribution*", Gallup (2012) remarks. On the other hand, Modalsli (2016) concludes that Norwegian cities in the late 1860s had higher income inequality than the countryside, which is more in accordance the Kuznets curve hypothesis.

Movement between sectors might also not be the dominant effect on inequality. Industrialization could be associated with a wide range of dynamic effects, such as increased international trade, the spread of education, and infrastructure linking previously isolated regions. This could affect the income distribution in ways that do not naturally suggest an inverted-U shaped curve.

3. Data

In this chapter, we describe and review the data we use. We start by describing what the ideal data would look like. Then, we summarize how our data diverges from the ideal. In the second section, we describe the available sources on income data and assess which sources contain individual taxpayers only. We review how changes in the tax system could affect registered income and describe data weaknesses. Special attention is paid to the basic tax allowance, a tax rule which we suspect can lead to significant bias. In the third section, we provide summary statistics of the data.

3.1 The ideal data

What would the ideal data look like? A good place to start would be Kuznets's five requirements for estimating income inequality (Kuznets, 1955):

1. Income units should be family-expenditure units, properly adjusted for the number of persons in each.
2. The distribution should be complete.
3. If the unit's main income earner is still in learning or is retired, the unit should be segregated.
4. Income should be defined as income received by individuals, including income in kind, before and after direct taxes, excluding capital gains.
5. Units should be grouped by secular levels of income, free of cyclical and other transient disturbances.

In today's terminology, what Kuznets would have wanted is a panel data set of individuals, preferably spanning several generations and countries. In making his first point, Kuznets emphasises that we should measure welfare, not monetary value alone. Kuznets viewed welfare as a more meaningful economic concept, arguing that welfare is ultimately why people earn income. In order to measure welfare, the data should make it possible to adjust income for family size. This allows for an analysis of relative living standards. To properly measure welfare, we would also need to know if the price level and the cost of living differed between areas. According to the second point, the data should cover the entire population, giving a comprehensive representation of how income is distributed. When Kuznets next proposes that

students and retired should be excluded from the distribution, this is due to welfare concerns. These groups have a standard of living which is not reflected by their incomes because they are provided for. According to point four, income should be well defined. The income definition should cover all types of income realised each year, ensuring that the analysis is not biased by the type or source of income. Today, researchers sometimes also look at broader income definitions, such as including capital gains and retained earnings (Alstadsæter, Jacob, Kopczuk, & Telle, 2016). Tax systems can create incentives to shift revenue between businesses and individuals, a problem that a broader income definition will help sort out. However, including retained earnings and capital gains demands more data, which is sometimes not feasible. According to point five, the income definition should remain identical across time and individuals. Lastly, the data should be free of disturbances: Economic cycles, discrepancies, disturbances arising from the tax law and measurement error should not occur.

3.2 The data we have

Ideal data is not available for the period we want to analyse. Comprehensive individual data on incomes in Norway is only available from 1967 (Aaberge, Atkinson, & Modalsli, 2016). Before this year, only grouped data on income before tax is available for some years. For some years, grouped data is available for each municipality. In others, only county-level or aggregate data is available. The data was assembled for tax purposes, not for research on the income distribution. This creates complications of its own:

1. The units measured are tax units which are not necessarily identical to families or households.
2. The data only covers taxpayers, not the adult population. Estimates on non-taxpayers are seldom available.
3. Firms and non-personal entities are often included.
4. There are measurement errors, but also important flaws and inaccuracies due to the tax law and tax evasion.
5. The data is not adjusted for the local price level
6. Only select years are available, making it difficult to rule out the effect of cycles
7. The income definition varies over time and possibly across regions. Specifically, dividends are not included before 1921.

Because of the limitations above, the data only allows us to reconstruct the pre-tax income distribution for tax units for some years. The reconstructions will be approximations, requiring assumptions and data from supplemental sources. The estimates will unavoidably be affected by measurement error. In the next sections, we will describe the sources on income data, before moving on to how income is defined.

3.2.1 Source I: Income data including firms: Tax reports for 1888, 1892-1903 and 1906

Tabulated data on parts of the income distribution exist for the years 1888, 1892-1903 and 1906. This data is used by Aaberge *et. al* (2013; 2016) to estimate national top income shares and the Gini index. The data includes income from corporations, joint stock companies and large banks (Kiær, 1892; 1910). In reports from this time period, the term taxpayer (*Norwegian*: “*skattyter*”) covers individuals, but also estates of deceased, stock companies and other impersonal entities. When listing data on living individuals only, reports use the term individual taxpayer (*Norwegian*: “*personlig skattyter*”), e.g. in Statistics Norway (1910).

Before parliament introduced the state tax in 1892, it received two reports on the municipal tax and on incomes for 1888. The reports covered a representative sample of 178 municipalities. The sample was then used to estimate national aggregates. The reports included total income before tax and the number of taxpayers. The first report had 10 income groups, while the second had 55 income groups. After the state tax was introduced, parliament received reports on the new state tax each year until 1903. These are reported at tax district level, which we have matched to municipalities. They have a varying numbers of income groups, ranging from 5 to 15. The reports include total state tax paid by each income group and the number of taxpayers in each income group.

For the two reports on 1888, Kiær (1892, p. 96) lists four major data weaknesses:

1. Several taxpayers with low incomes have not had all of their income reported
2. A non-negligible number of taxpayers with low incomes have no income reported
3. The income from several rural areas is too low due to tax rules concerning farms
4. The data on the highest income brackets contains banks and joint stock companies

Kiær (1892) concludes that the highest incomes are too high, while the lower incomes are too low. These concerns are relevant for the state tax data from 1892-1903 and the 1906 report as well.

We exclude this data in our main analysis because the impersonal tax units will bias our estimates. We will get back to the difference impersonal entities makes when presenting our results. In appendix F, we estimate the impact of impersonal entities for two counties using microdata, concluding that the impersonal entities bias local income inequality significantly.

3.2.2 Source II: Income data on individual taxpayers only Statistical bulletins from 1892, 1906 and 1913

Two publications from Statistics Norway (1910; 1915) report urban and rural numbers on individual taxpayers in 1892 and 1906, and 1913 respectively. Total income and the number of individual taxpayers is reported for 22 income groups. The publications use data from the state tax and report numbers separately for rural and urban areas. The 1913 publication also include information from the municipal tax. An estimate by Kiær on incomes of people who did not pay tax is included (see section 3.2.6).

3.2.3 Source III: The 1930 census income data

The 1930 census includes detailed data on net income in each municipality, tabulated over 22 income groups. The data was never published, but was rediscovered in Statistics Norway's archives. The data refers to income earned in 1929, and was assembled from individual level data (Statistics Norway, 1930). Census forms for each taxpayer were sent to the tax authority in each municipality. On each form, the local authorities listed wealth, income and tax class for 1929, the latest year available. People who had moved to the municipality after 1 January 1930 were excluded. The local tax authorities used data from the municipality's state tax record. If a person only paid local taxes, authorities used the records for local tax. Later, the census forms were used to create tabulations for each municipality. The local tax authorities were unable to match about 102.000 taxpayers with the census, which means that about 10 percent of the taxpayers are missing from the data.

3.2.4 How income is defined

Since the data originates from tax records, the income definition follows from the tax system. The income reported is *net income* (Norwegian: *antatt inntekt*). This is defined as income after deducting work-related expenses and interest (Gerdrup, 1998):

$$\text{Net income} = \text{gross income} - \text{work related expenses} - \text{interest paid}$$

Work-related expenses include all expenses related to earning the income in question. Life insurance premiums and employee contributions to social security is deducted, as they are regarded as work-related. Interest on debt was also fully deductible (Gerdrup, 1998). Losses from previous years are not deducted. Net income includes the tax authority's estimate of income in kind and imputed rent (Soltow, 1965). Certain transfers, such as pensions and bonuses are included as income. In theory, capital gains were included, but in practice the rules varied. The rules on dividends varied too. We will later get back to capital income in detail. Before 1935, it was easy to evade tax on interest earned. We can therefore assume that interest earned is often not part of net income.

According to Soltow (1965), the tax authorities' definition of net income was stable throughout the time period. However, this does not rule out regional differences. Because taxation was largely under local control, municipalities could apply rules differently, and local practice could change over time. We will review how tax authorities assessed income during the period in question (see section 1.2.8).

3.2.5 How tax units are defined

The units reported are tax units. We will use the word taxpayer and tax unit interchangeably. Married couples were taxed together and income attributed to the husband (Soltow, 1965). Unmarried individuals were taxed separately. A tax unit can therefore either be an individual or a married couple. Other constellations, such as two sisters living together, would register as two separate tax units. We cannot adjust for the size of the household or dependents. When comparing inequality estimates, we need to keep the tax unit definition in mind.

The tax unit definition follows from the data, but it could be argued that income for tax units might not be far from the income of actual households. Under the 1902 criminal law,

unmarried couples were prohibited from living together (Lovdata, 2013). Even if there were few cases of the law being enforced, cohabitation was uncommon (Statistics Norway, 2009).

3.2.6 How Kiær estimated the bottom part of the income distribution

A full description of the estimates of the bottom part of the income distribution for 1892 and 1906 can be found in the special report “Indtægtsforhold” (English: “*On income*”) (1910). The report was written by Statistics Norway director A. N. Kiær for the Ministry of Social Affairs. The same method was later applied on 1910 data (Statistics Norway, 1915, p. 50*). According to the report, the estimates are based on survey data⁴ from 1894. The survey was ordered by the Parliamentary Labour Commission, and had a sample on 21,444 persons from cities and 60,498 persons from the countryside (Den parlamentariske arbeiderkommission, 1899) Kiær finds that incomes reported to the commission are higher than those reported by the tax authorities. He adjusts income from the survey with a factor of 0.815 for the countryside and 0.943 for the cities, to make incomes consistent with the tax data. For later years, Kiær extrapolated from the data. It seems that he used incomes from 1894 adjusted for wage growth. He also extrapolated the number of people per income group, using the ratio of people in the survey to the number of taxpayers in the survey year. He then multiplied the ratio with the number of taxpayers in other years.

3.2.7 Dividends, capital gains and the number of stock companies

Dividends were never taxed at the municipal level (Rygh, 1923; Statistics Norway, 1930). Between 1882 and 1921, earnings of Norwegian stock companies were taxed solely as company profits⁵ (Statistics Norway, 1930, pp. 1-2; Amundsen, 1960). In 1921, the government introduced a state tax on dividends. To avoid double taxation, dividends were deducted when calculating the company’s profits for the state tax (Bugge, 1933). The dividends were then taxed as individual income. This means that dividends are included in individual net income after 1921. Prior to this year, dividends are not part of individual incomes. This introduces a break in the time series, meaning that incomes before and after 1921 are not comparable without adjusting for dividends. Between 1890 and 1930, the number

⁴ This data is available, see (Den parlamentariske arbeiderkommission, 1899a;1899b)

⁵ According to Gerdrup (1998), dividends were taxed by the national government after 1892. We believe Gerdrup got this wrong as other sources claim the opposite and he gives no source for his claim.

of stock companies increased tenfold (Statistics Norway, 1910; 1923; 1930). In 1892 there were 2,527 stock companies. This number grew to 4,363, 13,567 and 20,132 in 1906, 1921 and 1928 respectively. Since dividends were tax free before 1921, the strong growth in the number of stock companies will likely affect reported income. If more income is treated as dividends, reported net income could be artificially low for rich individuals. This bias would have increased together with the number of stock companies.

Statistics Norway director Kiær made estimates of the income distribution including dividends for 1892 and 1906 (Statistics Norway, 1910). In the chapter on method, we will describe how we use Kiær's approach to estimate dividends for 1892, 1906 and 1913. The approach is conservative, so there is still a possibility that we will be unable to fully account for the effect of dividends.

Income from partnerships (*Norwegian: ansvarlig selskap*) and limited partnerships (*Norwegian: kommandittselskap*) were assigned to each partner according to his ownership share (Rygh, 1923). The income was then taxed as individual income. Income from sole proprietorships was taxed as individual income. Capital gains were taxable and losses deductible from 1911, but the rules were vague. From 1916, capital gains and losses on shipping stock would always be taxable/deductible. After 1921, the rules changed again (Trones, 2007). Now, capital gains and losses were only taxable/deductible when selling a company intact. That meant that a majority of the company stock had to be sold at the same time. In other words, capital gains tax could be avoided for common stock.

3.2.8 How tax authorities assessed income

Between 1836 and 1892, Norway did not impose any direct national taxes (Gerdrup, 1998). Instead, the national government relied on indirect taxes such as tariffs, export duties and a liquor tax. Local governments commissions could tax income, wealth and land. Taxes were levied for specific purposes such as schools or poverty relief. Because rules were unclear and local governments levied a number of different taxes, it is generally difficult to compare income data over time and across municipalities before 1882.

In 1882, local government taxes were radically reformed (Gerdrup, 1998). Taxes were no longer tied to specific government spending, and the legal definition of *net income* was introduced. Net income was not yet based on tax returns from individuals, but decided by a local tax commission. The commission consisted of six to eight commissioners chosen by the

municipal government (Soltow, 1965). The commission would estimate net income based on the taxpayer's known property and the income of his occupation, with adjustments for sickness, accidents or other losses. If the taxpayer believed the estimate to be unfair or too high, he could appeal the decision. After 1882, tax on personal income was to be paid to the municipality of residence, no matter where the income was earned. However, business income was still taxed where the income was earned (Thomle, 1930). This included small business owners (e.g. shop owners and sole proprietorships), so municipal tax records might still only list partial income for such tax payers. Only after a national income tax was introduced in 1892 did the tax authorities list each taxpayers' total net income earned in the entire country.

In 1911, a new reform introduced individual tax returns (Norwegian: selvangivelse) (Gerdrup, 1998). The number of taxpayers and reported net income jumped as a consequence, perhaps by about 15 percent (Statistics Norway, 1930). Taxpayers would disclose both *gross income* and *deductible expenses* in the returns (Thomle, 1930; Gerdrup, 1998). By 1930, only 49 percent of taxpayers filed tax returns, and the share varied between counties (Statistics Norway, 1930). Taxpayers with low incomes were often not required to file returns. The tax law allowed the municipal council to decide if people earning less than a pre-specified limit should be required to file tax returns. For rural areas, the law proposed a limit of 1,500 NOK in net income (Thomle, 1930). For cities, the proposed limit was 2,000 NOK (Skattelov for byene, 1928). For taxpayers who failed to file returns or were not required to do so, the commission would appraise net income using discretion (Thomle, 1930; Skattelov for byene, 1928).

3.2.9 Variable lowest taxable income

Two taxpayers could have identical incomes, but only one of them might pay tax and be included in the tax data (Statistics Norway, 1930). This happens because the lowest taxable income varied according to the taxpayer's number of dependents (Gerdrup, 1998). With more dependents, you would get a larger basic tax allowance, being allowed to earn more before paying tax. This tax rule was introduced in 1882 and lasted until after World War II. The rule makes it difficult to consistently estimate the incomes of those who did not pay tax. Statistics Norway was aware of this, and we assume that Kiær considered the problem when creating his estimate on non-taxpayers. For 1929, we have no historical estimates on this group, and we therefore need to look closer at this particular tax rule.

It could potentially introduce bias along three dimensions:

1. Each year, a number of income earning units with incomes in the low taxable income groups will disappear because of dependents.
2. The impact could differ across municipalities. Municipalities could adjust the basic tax allowance. Differences in family size might also play a part.
3. The effect could differ across time because of falling fertility rates and changes in tax rules.

We will look at each of these problems in turn. To assess the impact within a single year, we need to look at two factors: Who could be recognized as dependents, and which income groups might be affected. Table 1 shows the basic tax allowances suggested in the tax law. In rural municipalities, the lowest taxable income could vary from 200 NOK to 1,250 NOK. For cities, the range was even larger, from 400 NOK to 2,500 NOK. This means that income earning units with incomes in this range could be affected. These are large ranges, which again implies that a high number of income earning units might be affected.

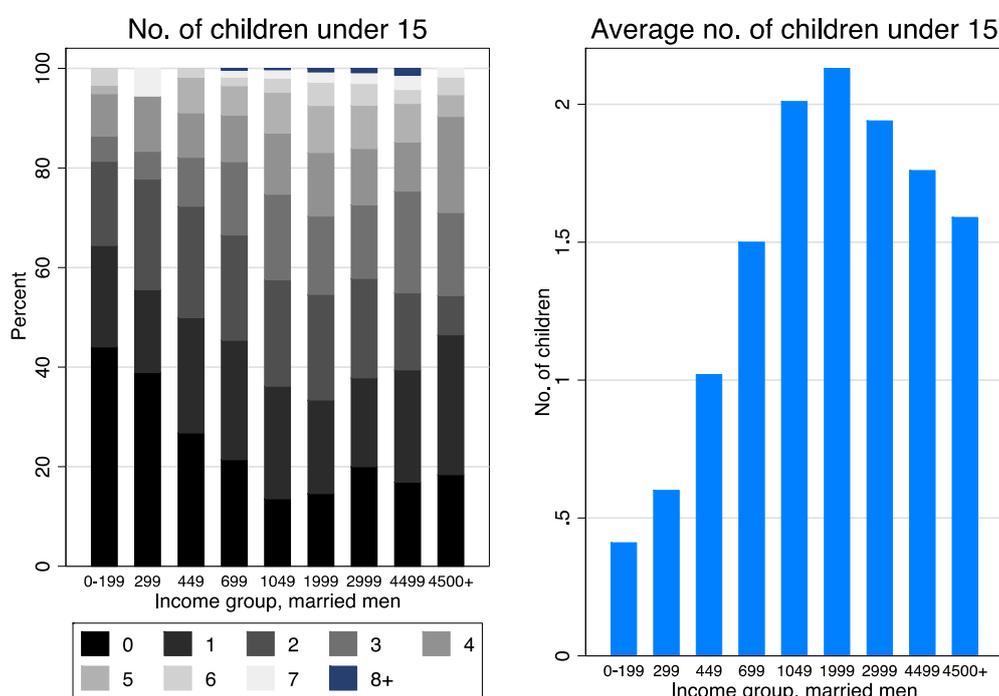
According to Gerdrup (1998), children, one's wife and old parents living with the family were always recognized as dependents. This is a fairly large group of possible dependents. We do not have data on the number of dependents, but we have 1894 survey data on the average number of children grouped by their fathers' incomes. Children were the most common type of dependents. The survey can therefore give a rough indication on the average number of dependents.

The results are plotted in Figure 4. Between 1894 and 1930, average fertility rates declined and families became smaller, which would imply lower numbers in 1929 (Statistics Norway, 1935). From the survey, we see that men with lower incomes had few children on average. In 1894, those earning 449 NOK on average only had a single dependent child. Very large families seem to have been uncommon. Those with high incomes of 2,000 NOK had two dependent children on average. These effects, i.e. fewer children in low-income families and overall relatively small family sizes, would reduce the impact of the tax rule.

Table 1: Standard tax-free income in 1927

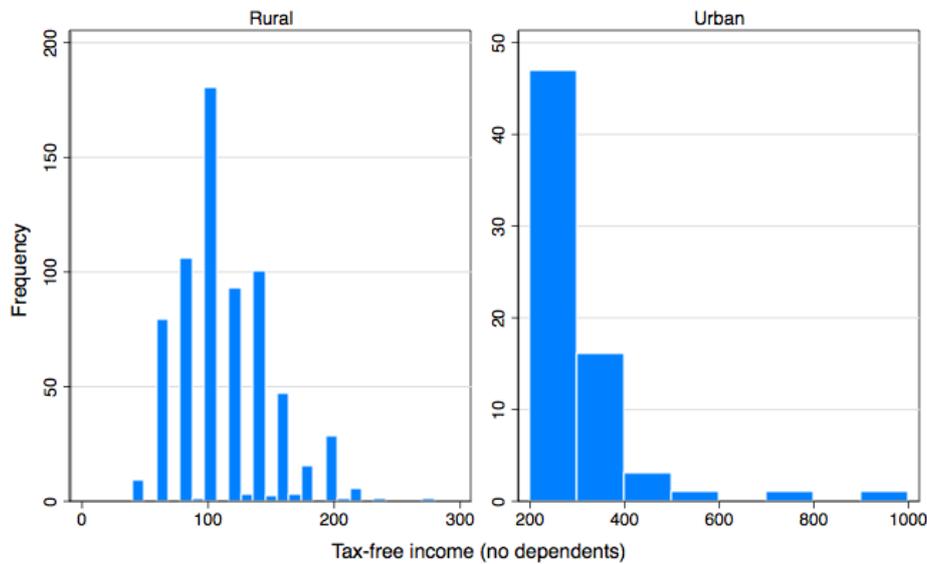
Tax class	Tax class							
	1	2	3	4	5	6	7	8
No. of dependents	0	1	3	4	5	6	7	8 or more
Tax-free income								
Rural	200	350	500	650	800	950	1100	1250
Cities	400	700	1000	1300	1600	1900	2200	2500

Note: Tax-free incomes according to the number of dependents in 1927, as suggested in the tax law (*Skattelov for byene, 1928; Thomle, 1930*). Municipalities were free to adjust each value up or down by 50% and sometimes more. The number of dependents were referred to as tax classes. Currency in nominal NOK.

Figure 4: Children by father's income in 1894

Note: The number of children (under 15 at the time of the survey) of married fathers in 1894, grouped according to the father's income. Married men with no children are included. Children born out of wedlock are probably not included, although this is not explicitly stated. Data from *Kiær (1910)*. The left graph shows the distribution of children within each income group. The right graph shows the average number of children in each income group.

Next, we turn to variations between municipalities. From 1927, municipalities could increase or reduce the basic tax allowance in Table 1 by 50 percent, and sometimes more. In 1929, we know that most local governments made large changes, resulting in the lowest taxable income varying from 50 NOK to 1,000 NOK (Statistics Norway, 1930). The municipal council could also apply more lenient rules on whom a taxpayer could list as a dependent (Gerdrup, 1998; Thomle, 1930). In special cases, a dependent could be counted as two or more people if the dependent was costly.

Figure 5: Tax-free income with no dependents, 1929

Note: The figures show the distribution of tax-free income for a taxpayer with no dependents. Data from (Statistics Norway, 1930).

Finally, we note that both fertility and the tax rules changed over time (Statistics Norway, 1935). Over time, the system grew in complexity and size. In the 1882 tax law, cities and rural municipalities had four tax classes (i.e. four levels for the basic tax allowance) (Norsk Lovtidende, 1882). Municipal councils could adjust the amounts if they wished, but by 1887, few councils had exercised this power (Stortinget, 1887). In 1911, the number of tax classes were extended to eight (Gerdrup, 1998). Municipalities could now choose between six standards. Then, in 1927, the system was changed to the one in Table 1.

Altogether, it is difficult to determine the size of the potential bias. Can we say something about the sign? How the tax rule affects measured inequality depends on how the non-taxpayer group is treated. If non-taxpayers are allocated too low incomes, the tax rule could lead to artificially high inequality because a large number of households with moderate wages are misrepresented as poor. As late as 1930, only about two thirds of income earning units paid taxes. In an estimate for the entire population, assumptions on the non-taxpayer group will be influential.

3.2.10 Other data weaknesses

Net income will be affected by measurement error (Gerdrup, 1998). We know that the census takers were incapable of matching about 10 percent of the population with the tax records, but we do not know if this affected some parts of the distribution more than others (Statistics

Norway, 1930). We assume that the 10 percent is randomly drawn from the income distribution of taxpayers, and correct for it by reducing the size of the non-taxpaying population. Another source of measurement error is that people often tried to deduct personal consumption as a business expense. Measurement error could also arise from how the governments appraised gross income. In principle, all payments for work were taxable, but tax authorities generally assigned low values to payments in kind, since they were harder to value than monetary payment. Municipalities with much primary industry, where payments in kind were important, were likely reporting artificially low incomes. In the late 19th century a large fraction of households still produce most of what they consumed themselves or received a share of their salaries in kind (Grytten & Hodne, 2000). A special rule allowing local governments to cap farm income at 2-7% of the farm's market value also reduced net incomes from farms (Gerdrup, 1998). From 1892, the government levied a national tax on income and profits. This created an incentive for local governments to introduce the cap, as this would also reduce the national tax on agriculture. Statistics Norway (1933) conclude that rural incomes reported in the census are too low. Artificially low rural incomes could exaggerate national income inequality. On the other hand, if rich farmers could cap their incomes, this could in some instances perhaps bias inequality downwards at municipality level.

As interest is fully deductible as an expense, this would reduce reported net income from individuals who could take on credit. If these are mainly high-income earners, interest deduction would lead to lower reported incomes in this group. Experts at the time believed tax evasion and legal tax mitigation to be widespread (Gerdrup, 1998). A 1923 government commission believed net incomes were underreported by a magnitude of 20 percent. The historical national accounts produced in 1953 reported 15 percent (Statistics Norway, 1953). At this point, we cannot say if outright tax evasion had a level effect or if it affected some parts of the distribution more than others.

Historically, there was disagreements about using tax data to measure income inequality (Statsøkonomisk tidsskrift, 1908). During a discussion in the Norwegian Economic Society in 1908, Kiær argued for the usefulness of the data and that inequality had decreased from 1888 to 1906. Sofus Arctander, the chief municipal executive in Kristiania, disagreed. He believed the data was of poor quality, and that any decline in inequality could have been the result of the tax authorities trying to improve the accuracy of the tax assessments. Arctander claimed that the real income for farmers could be multiplied by a factor of three to account for a more realistic valuation of payments in kind. Arctander argued that the incomes of industry workers

were more correctly assessed, but that even they were too low. Arctander here refers to an investigation in Drammen, which found that incomes among manufacturing workers were between 50 to 100 percent higher than what the tax authorities had registered.

3.2.11 Supplemental data

In addition to the data described above, we use some supplemental data sources. We obtain data on the size and composition of the population from Statistics Norway (1948). Local level from the 1930 census and covariates are obtained from the NSD Municipal Database (NSD, 2017). We have digitized the lowest basic tax allowance for each municipality in 1929, using the review from Statistics Norway (1930). We also use data on total wealth and total income in Oslo (Kristiania) from 1892 to 1930, obtaining the data from the Statistical Bulletins series (Statistics Norway, 1892–1930). From this series, we also obtain total wealth for the richest individuals in Norway, using figures from the 1921–1926 emergency wealth tax.

3.3 Summary statistics

3.3.1 National level income data

Data on individual taxpayers is available from the state tax in 1892 and 1906, and both the municipal tax and the state tax in 1913 and 1929. These sources have been reviewed earlier. Summary statistics for data on individual taxpayers and estimated units is shown in Figure 6.

Figure 6: Summary statistics



Note: Summary statistics from the tax data on individual tax units), including estimates by Kiær (1910; 1915) on those who did not pay tax. Average incomes are shown for taxpayers and non-taxpayers, with separate numbers for the countryside and cities. In 1913, estimated income for non-taxpayers is from 1910. We will adjust it nominal wage growth before performing calculations. Similarly, we show total income each year and the total number of units. The working-age population (as defined in 1948) from the censuses is shown for reference (Statistics Norway, 1948). Currency in nominal NOK.

Looking at households with income data, it is striking that only a small share of households paid state tax. For 1892 and 1906, for which we have access to the income distribution of personal state taxpayers, the tax data only cover a small fraction of the population. At the time, Statistics Norway estimated the income distribution among the remaining households. These estimates are included, and are shown in grey. The estimates were based on surveys (Kiær, 1910). Since the taxpayer group is small, the validity of the estimates will be important. The

data on 1913 and 1930 include data from the municipal tax. The share of households on which we have tax income data increases greatly. Statistics Norway did not make estimates for the non-taxpayer part of the income distribution in 1930.

Looking at reported average incomes in Figure 6, all groups report significantly higher incomes in 1906 than in 1892. However, the number of state taxpayers actually falls in this period because the lowest taxable income limit is raised. Higher average incomes reflect who were taxed, and should not necessarily be interpreted as wage growth. In 1913, when a much larger share of the population is included in the tax data, the average wage for taxpayers declines. Another distortion would stem from changes in monetary value. Between 1892 and 1930, there are periods of strong inflation (World War I) and deflation (the 1920s).

3.3.2 Local level income data (1929)

The 1930 census includes tax data on municipal level. Maps of average incomes at the municipal level are included in appendix B. Looking at average income, we find that there is a large cluster of high-income municipalities (above 2,000 NOK) around Oslo. The cluster is bordered by moderate-income municipalities (between 1,500-2,000 NOK). Together, these municipalities cover most of eastern Norway. Large cities such as Kristiansand, Stavanger, Bergen and Trondheim also exhibit high income levels above 2,000 NOK. Some isolated rural municipalities on the countryside also stand out, such as Sauda, Tinn and Odda. These are industrial towns with hydroelectric industries. In Southern Norway, there is a concentration of low-income municipalities in the counties Møre og Romsdal and Sogn og Fjordane. Such a concentration is also apparent in the mountainous interior of the country. In Nordland, cities such as Brønnøysund, Bodø, Svolvær and Narvik have high average incomes, while rural municipalities had low incomes. Note that in Nordland, city municipalities also covered large, sparsely inhabited areas. The high incomes probably do not reflect the remote, rural areas. The same pattern is evident in Finnmark and Troms, with cities Tromsø, Harstad, Hammerfest, Kautokeino and Kirkenes (Sør-Varanger) having high average incomes.

As shown in Table 4, we find that there is considerable variation in the share of the men paying tax. This reflects the large difference in the basic tax allowance, but probably also that some municipalities had poorer residents. There are large differences in average taxed income per municipality, with the income ranging from above 6,000 NOK to 549 NOK. This difference is probably exaggerated by the effect of the basic tax allowance. The data allow us to separate

between male and female tax units. While the clear majority of tax payers are men, several municipalities with a high share of women tax payers exist. On average, female tax payers have income significantly lower than men. As wives were taxed together with their husbands, this calculation is biased downward.

Table 4: Summary statistics: Net income in 1929

Variable	N	Mean	S.D.	P10	P90	Max	Min
Lowest taxable income (NOK)	726	130	75	60	200	1000	40
Taxpayers – Men							
Share of adult men	742	71 %	8 %	60 %	81 %	94 %	45 %
Total income (in 1,000 NOK)	742	2 102	12 283	224	3 168	296 580	74
Average income (NOK)	742	1 503	799	795	2 691	6 156	539
Taxpayers – Women							
Share of adult women	742	21 %	8 %	9 %	31 %	47 %	2 %
Total income (in 1,000 NOK)	742	407	3 547	43 004	476	90 865	42 951
Average income (NOK)	742	772	373	409	1 298	2 590	251

Note: Summary statistics on net income from the local 1930 census data. We observe 742 municipalities, and show the mean, standard deviation, 10th percentile, 90th percentile, the maximum value and the minimum value observed. The data shows the share of men and women who were taxpayers, average income, and total income in the municipality. The number on men includes income from wives. Currency in nominal NOK.

4. Methods

In this chapter, we explain how we solve data difficulties and measure inequality. We start by introducing the Lorenz curve, the pre-tax Gini index and pre-tax top income shares as tools of measurement. Then we present the methods and assumptions we use to reconstruct the income distributions. Non-technical readers can skip the highlighted parts.

4.1 How to measure inequality

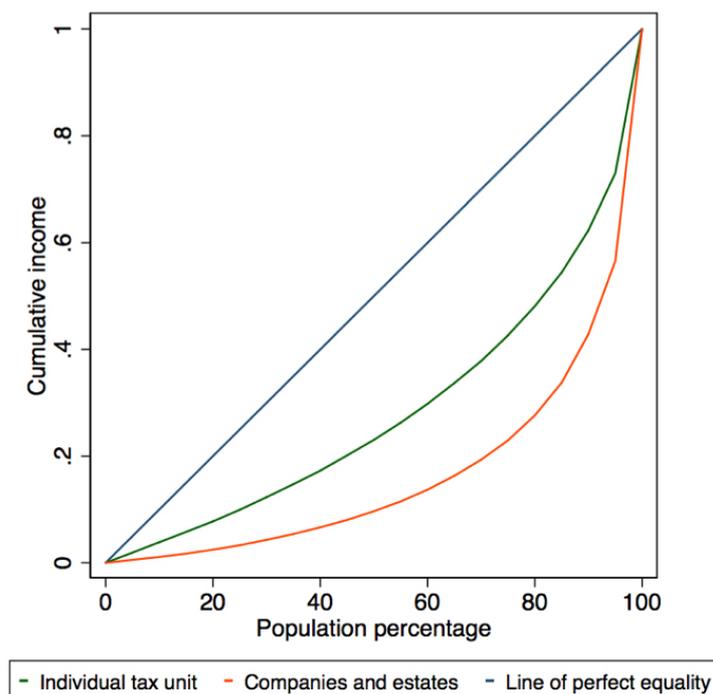
4.1.1 The income distribution

The most basic method of analysing income inequality is simply looking at the income distribution itself. One way of drawing the distribution would be to plot the incomes in the population as a histogram. Still, comparison would be difficult because currency value differs over time and across countries. Drawing the relative distribution makes comparison possible. The most common way of showing the relative income distribution is by a Lorenz curve. The Lorenz curve shows the proportion of income earned by any given percentage of the population. In mathematical terms, the Lorenz curve $L(y)$ can be expressed as:

$$L(y) = \frac{1}{\mu} \int_0^u F^{-1}(t) dt, \quad 0 \leq u \leq 1$$

where F^{-1} is the inverse function of the cumulative income distribution F with mean μ (Aaberge R., 2006). We explain by example. With perfect income equality, i.e. if everyone earned the same, then the bottom 10 percent of the population would earn 10 percent of all income, the bottom 20 percent would earn 20 percent, etc. The Lorenz curve would be a straight 45° line from the lower left to the upper right corner of the diagram. In reality, perfect income equality does not occur. For instance, the bottom 20 percent might only earn 10 percent of all income. In this case, the Lorenz curve will lie to the right of the line of perfect equality. We draw two examples of the Lorenz curve in Figure 7, using data for persons and stock companies/estates in Kristiania 1894. From a visual inspection, we see that the Lorenz curve for companies and estates always lies to the right of the Lorenz curve of individual tax payers.

Figure 7: The Lorenz curve for tax units with incomes above 2,000 NOK in Kristiania 1894



Note: We have drawn the Lorenz curves for two types of tax units in Kristiania 1894. All observations have incomes above 2,000 NOK. Source: *Lignings- og Overligningskommissionens Kontor (1894)*.

Strictly stated, the Lorenz curve of estates and firms exhibits first order stochastic dominance against the Lorenz curve of individual taxpayers. We can therefore conclude that the income of firms is more unequally distributed than for individual tax payers in Kristiania 1894. The Lorenz curve make comparison between income distributions possible, but it gets difficult to use once we increase the number of distributions. To be able to systematically compare the equality of income distribution, we would like to represent the entire Lorenz curve as a single number. The Gini index does so.

4.1.2 The Gini index

The Gini index was created by the Italian statistician Corrado Gini and published in 1912 (Ceriani & Verme, 2012). It is widely used by academics and has become the standard inequality index for applied work (Cowell, 2000). We use it because it is well known and represents inequality as a single number. Being the standard measure of inequality, it gives us the possibility to compare the index with other studies across time and countries. The Gini index is a number between 0 and 100 percent. A Gini of 0 percent represents perfect equality, while a Gini of a 100 percent represents perfect inequality. The first example imply that everyone earns the same income, while the second imply that one person earn all income.

The Gini index is derived from the Lorenz curve (Cowell, 2000). It is calculated as twice the area between the Lorenz curve and the line of perfect equality. In mathematical terms, that is:

$$Gini\ index = 1 - 2 \times \int_0^1 L(y) dF.$$

The Gini index is monotonous. That is, if the index is higher in one country, inequality is greater than in all countries with a lower Gini. This holds as long as we measure inequality by the Gini. If we use other measures, the ranking of countries might change. The drawback of the Gini is that a single coefficient (e.g. 25 percent) could represent many different distributions. For instance, the inequality could be concentrated among a group of very poor. In another case, the poor could be moderately affluent, while the rich have extremely high incomes. The Gini index could be identical, but the two societies might be very different.

The Gini index can also be derived from the absolute difference between all income pairs in the population:

$$G = \frac{\frac{1}{2} n^2 \sum_{i=1}^n \sum_{j=1}^n |y_i - y_j|}{\frac{1}{n} \sum_{i=1}^n y_i}$$

The expression implies that the Gini index is not additive if we divide up the population and calculate the Gini index for subgroups (Pyatt, 1976). If we divide the population, we would only compare incomes within each group, possibly missing out an important part of income inequality. Therefore, the average local-level Gini estimate will be lower than the national Gini estimate. National estimates and local-level estimates will not be directly comparable.

4.1.3 Top income shares

Income shares follow from the income distribution, and show the fraction of income going to a specific fraction of the population. For instance, on the Lorenz curve above, we see that the bottom 40% earn about 20 percent of all income. Using income shares, we can describe the income distribution in more detail than a single number such as the Gini index. Top income shares show the fraction of all income going to a rich segment of the population, such as the top 10% or the top 1% (Atkinson & Bourguignon, 2014).

Top income shares are an important measure because top incomes often represent a large fraction of total income. Other measures such as the Gini index are sensitive to top incomes (Atkinson, Piketty, & Saez, 2011). Top income shares also have an intuitive interpretation. If the top 1% have a share of 10 percent, that means that their mean income is 10 times greater than mean income in the society at large. For each percentage point of income going to the top 1%, their mean incomes increase by the mean income of the entire population.

Another advantage of focusing on top incomes is that it requires less data. Using the methods described later in this chapter for estimating the income distribution, we can estimate income received by a given percent of the population. The challenge is to estimate total income and the size of the population. These measures are called control totals in the research literature. We use control totals from Aaberge, Atkinson & Modalsli (2010; 2013) to ensure that our top income shares can be compared to theirs. We also look at alternative control totals as top income shares are highly sensitive to their accuracy (Atkinson, Piketty, & Saez, 2011).

4.2 Reconstructing the income distribution

4.2.1 The income distribution for taxpayers

We start by reconstructing the income distribution for taxpayers and deal with the non-taxpayers later. Taxpayers will mostly form the upper half of the income distribution. There will also be a few taxpayers who had little income, but were taxed because they had high wealth. We need to construct the income distribution for taxpayers using grouped data. The challenge is to get as close to the actual distribution as possible. Because the data on taxpayers is grouped, we are forced to make assumptions on the distribution within each income bracket. Since we have detailed groups, the potential error on inequality estimates is negligible in large regions, such as Norway in its entirety. However, in municipalities with small populations such assumptions will have large implications for measured income inequality. As late as the 1930s, about 70 percent of municipalities had less than 1,000 taxpayers and 32 percent less than 500 taxpayers. Keeping this in mind, we follow two lines of reasoning. First, we use interpolation techniques to approximate the real income distribution of taxpayers. Second, we construct bounds that maximize and minimize inequality for taxpayers. We can be sure that the actual distribution must be within the bounds, so the bounds can serve as an indication of possible error.

4.2.2 Adjusting for dividends

Before 1921, stock dividends were not taxed by the tax authorities. Stock dividends are therefore not included in our tax data from 1892, 1906 and 1913. Dividends are included in the tax data for 1929. Dividends are likely an important source of income, especially for top incomes (Atkinson, Piketty, & Saez, 2011). For our estimate of the income distribution to be accurate, we must add an estimate of stock dividends. We do this by following the approach proposed by Kiær (1910). First, we calculate the ratio of stock wealth to total wealth independently for cities and the countryside.

$$\text{Stock to wealth ratio} = \frac{\text{Stock wealth}}{\text{Total wealth}}$$

Then, we retrieve data on the total wealth per income group for years before 1921, and use the stock to wealth ratio to calculate total stock wealth per income group.

$$\text{Stock capital}_j = \text{Total wealth}_j \times \text{stock to wealth ratio}$$

where j denotes the income group. We assume an average dividend pay-out d . Kiær assume that d is equal to 6 percent of stock capital for 1892 and 1906 (Statistics Norway, 1910). For 1913 we assume average dividend pay-out of 8 percent. This was the average dividend payout in 1913 according to Statistics Norway (1978, p. 511).

Total dividend per income group is calculated as:

$$\text{Dividend}_j = \text{Stock capital}_j \times d$$

The total Dividend_j per income group is assumed to be uniformly distributed to all income earners in income group j . Since wealth is significantly more unequally distributed than income, the highest earning units receive a much larger share of estimated dividends than the lower earning units. This method gives only a rough approximation. It leads to higher top income shares and a higher Gini index. As one could expect stock wealth to be more unequally distributed than total wealth, the inequality of estimated dividends is likely to be a lower bound.

4.2.3 Approximating the income distribution of taxpayers

We use two of the most common interpolation techniques for grouped income data. This is the mean-split histogram approach and the Pareto interpolation. These techniques are used in most country specific studies of top incomes in recent years (Atkinson and Piketty, 2007; 2010). The mean-split histogram technique is used for top income shares in New Zealand, the Netherlands, UK, Australia, Norway and Singapore. Pareto interpolation is used for top incomes in Ireland, Germany, Switzerland, Canada, France and the US.

The easiest method of interpolation is simply using a histogram, uniformly distributing incomes from the lower to the upper income group threshold (Cowell, 2011). Using this method, estimated total income in a group will normally not equal the actual group income. The mean-split histogram technique is only slightly more advanced, but produces more reliable results than many more sophisticated techniques. It splits the income group in two before using the histogram approach, ensuring that mean income remains correct within the original income group.

Mean-split histogram

The mean-split histogram method splits the density function of each income group in two constant densities above and below the group mean. It ensures that the given group mean is intact and that all incomes are between the lower and upper limit. Density functions are calculated in the following way (Cowell, 2011):

$$f_L = \frac{n_j}{n} \frac{a_{j+1} - 2\mu_j + b_j}{[a_{j+1} - a_j][a_{j+1} - b_j]} \quad y \in [a_j, b_j]$$

$$f_U = \frac{n_j}{n} \frac{2\mu_j - b_j - a_j}{[a_{j+1} - a_j][a_{j+1} - b_j]} \quad y \in [b_j, a_{j+1}]$$

f_L and f_U are the densities in the lower and upper income groups respectively. The density function produced using this method is discontinuous at b_j , with constant densities at either side. By splitting each group at the income mean μ_j , we use the variant called *mean-split histogram*. This is achieved by setting $b_j = \mu_j$, and we arrive at new and simpler density formulas:

$$f_L = \frac{n_j}{n} \frac{a_{j+1} - \mu_j}{[a_{j+1} - a_j][a_{j+1} - \mu_j]} \quad y \in [a_j, \mu_j]$$

$$f_U = \frac{n_j}{n} \frac{\mu_j - a_j}{[a_{j+1} - a_j][a_{j+1} - \mu_j]} \quad y \in [\mu_j, a_{j+1}]$$

To simplify further we want to calculate the absolute number of taxpayers in the lower (N_L) and upper (N_U) group.

$$N_L = n_j \frac{a_{j+1} - \mu_j}{[a_{j+1} - a_j]} \quad y \in [a_j, \mu_j]$$

$$N_U = n_j \frac{\mu_j - a_j}{[a_{j+1} - a_j]} \quad y \in [\mu_j, a_{j+1}]$$

Individual incomes are obtained by linearly interpolating N number of taxpayers between the new lower and upper limits.

While the mean-split histogram is a robust technique, we cannot use it to model the very top income tail of the distribution. The mean-split histogram requires an upper limit on income, but in our data, the highest income group is an open interval. This is a problem, as we wish to estimate the complete income distribution for calculating the Gini index. Our solution is to model the top income tail using a parametric Pareto interpolation. Top incomes have been found to approximate a Pareto distribution and the technique can be used for open income intervals (Cowell, 2011).

We do not use the Pareto interpolation when estimating top income shares. Top income shares do not use the distribution within the top. Instead, the measure only relies on the total income in the top groups. The mean-split histogram technique gives us this information already. This choice of method is consistent with the literature (Atkinson and Piketty, 2007; 2010).

Pareto interpolation

A Pareto distribution has two defining properties (Cowell, 2011):

1. The mean income of taxpayers earning more than amount y_i is always equal to y_i multiplied with β (the inverse Pareto coefficient).
2. There is a linear relationship between $\ln y_i$ and $\ln (1 - F(x))$, where $F(x)$ is the share of taxpayers with incomes lower than y_i .

The first property states that the mean income above y_i is equal to $y_i \times \beta$ (Cowell, 2011).

The inverse Pareto coefficient is calculated as:

$$\beta = \frac{Y_j^*}{a_j}$$

where Y_j^* is the total income of taxpayers richer than the income limit a_j . For the income distribution to be Pareto distributed we need β to be constant.

We can test this visually by plotting the β for each income limit (Figure 8). For the male population in Oslo in 1929, we see that β stabilizes for the highest incomes, but the coefficient still varies slightly. We consider this variation to be small enough. Some deviation from theory is to be expected in in real data.

There is no need to test if the second property of the Pareto distribution holds, as it can be shown that the slope of the curve is equal to the Pareto coefficient α (Cowell, 2011). This coefficient can be calculated as the inverse of β .

$$\alpha = \frac{\beta}{\beta - 1}$$

Given that β is approximately fixed, $\log y_i$ and $\log (1 - F(x))$ will have a linear relationship (Cowell, 2011). In Figure 9 we plot these two variables, confirming this. Still, it is clear that even the right tail deviates from the perfect Pareto distribution. These calculations can be shown for all municipalities and tax districts in our dataset and they will look about same. A challenge is that the estimates get less reliable as the population size decreases. The estimates are therefore less reliable for small municipalities and the very highest incomes.

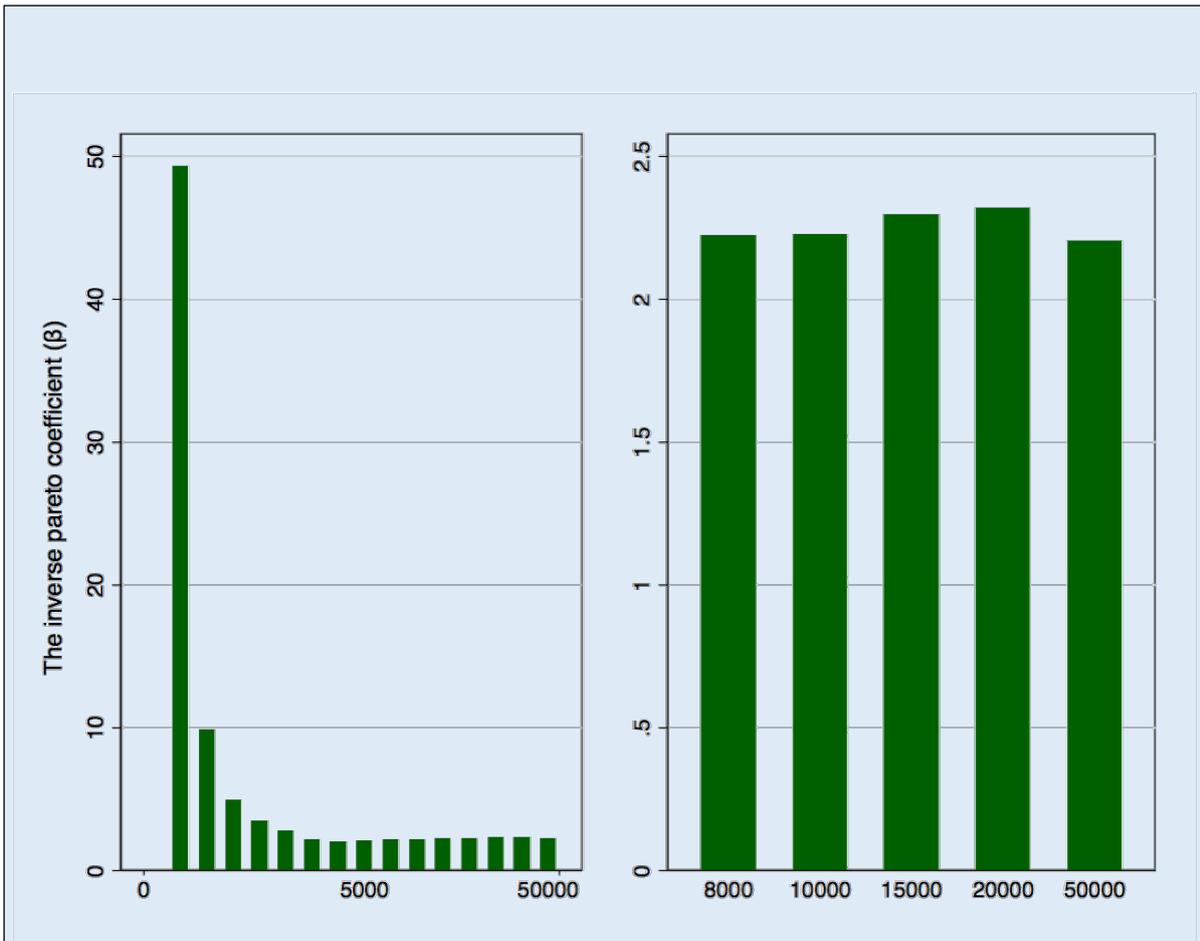


Figure 8: The inverse Pareto coefficient for the full income distribution for taxpayers in Oslo 1929 (left) and zoomed in on the top (right). Net income on the horizontal scale.

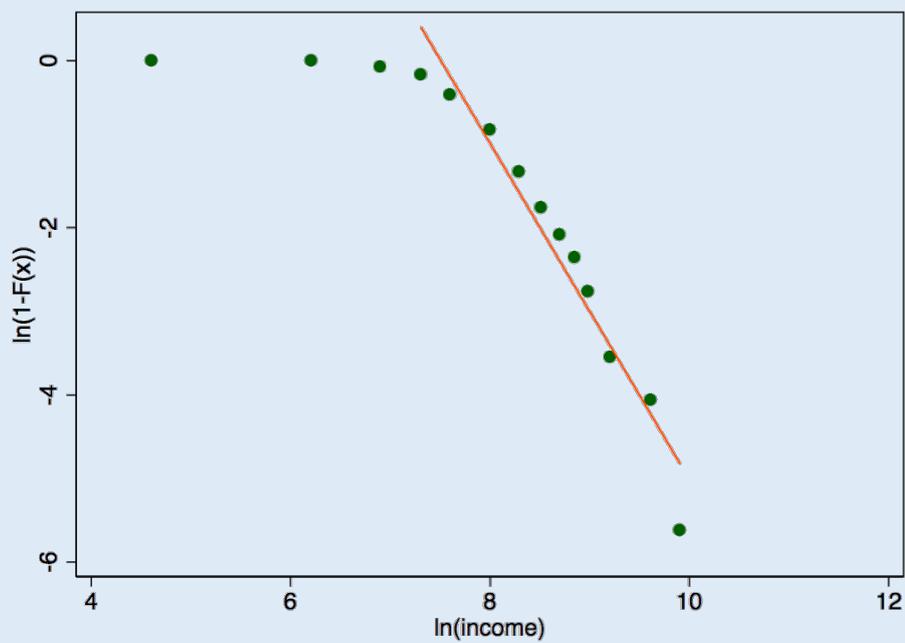


Figure 9: Visual representation of the second property of the Pareto distribution. The orange line is linear fit of 11 highest income data points. The log of net income on the horizontal scale.

There are two basic methods of interpolation using the Pareto distribution, based on the first and second property. We use the technique based on the first property for all years. This method is preferable as it utilizes data on both frequency and total income in income brackets.

To interpolate based on the first property, we use formulas from Piketty & Saez (2001) and information on both mean income and the number of taxpayers in each income bracket.

$$k_j = a_j p_i^{1/\alpha_j}$$

We calculate a new parameter k (Piketty & Saez, 2001). Top incomes are estimated using the exact cumulative density of top income earners.

$$y_i = \frac{k_j}{(1 - F(x_i))^{1/\alpha_j}}$$

With large populations, this technique gives estimates that are consistent with group averages and population size. For smaller populations, we adjust the average estimated incomes to ensure that the estimated income totals match exactly what is given from the tax statistics.

4.2.4 Bounds on the income distribution of taxpayers

Creating upper and lower bounds on inequality means making assumptions that maximize and minimize measured inequality. These bounds can serve as an indication of possible error. The most equal distribution within a group is to assign everyone the group's mean income. The most unequal distribution possible is to allocate everyone to the group's income thresholds while holding total income constant. This method is perhaps best explained by an example. Assume that we have an income group of 100–200 NOK. There are two people in the group. In total, they earn 300 NOK. Now, the lower bound on inequality would be to assign both the mean income, i.e. 150 NOK. The upper bound would be to assign one person an income of 100 NOK and the other person 200 NOK, which implies higher inequality. The actual income distribution must lie between these two estimates.

Upper and lower bounds

To maximize inequality, we split each income group into two new groups (Cowell, 2011). The first group has income equal to the lower threshold of the old income group, while the second group has income equal to the upper threshold. As an example, in the income group 2,000–2,900 NOK, one group will have 2,000 NOK in income while the other will have 2,900 NOK. The number of taxpayers in an income group is the number that ensures that total income remains the same:

$$\mu_j = \lambda_j^L \times a_j + (1 - \lambda_j^L) \times a_{j+1}$$

where a_j and a_{j+1} are lower and upper income threshold for income group j and λ_j^L is the share of the group population assumed at the lower income threshold in income group j . We arrive at the following formula for λ_j^L .

$$\lambda_j^L = \frac{\mu_j - a_{j+1}}{a_j - a_{j+1}}$$

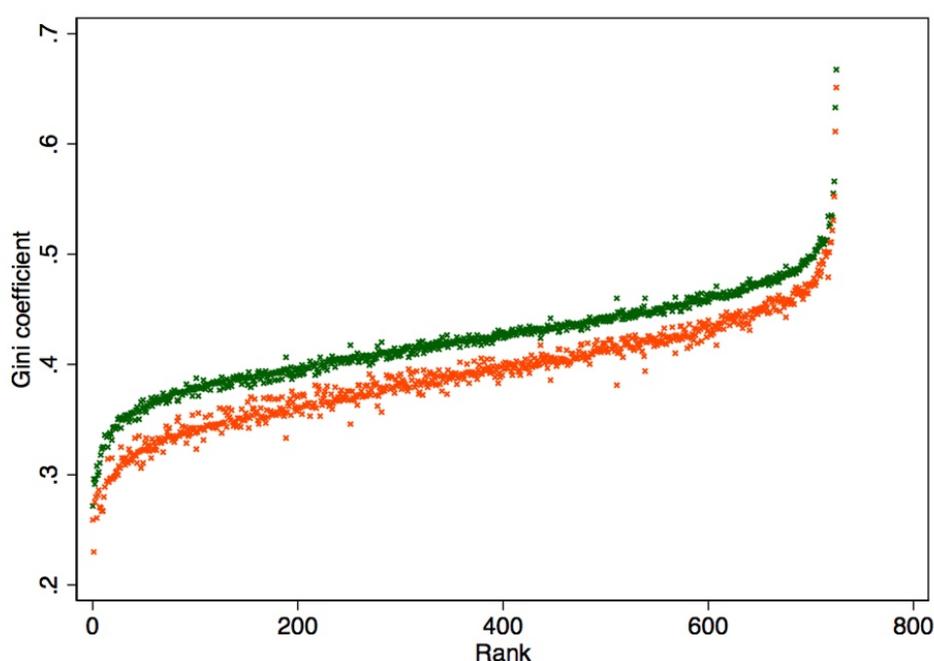
Conditional that the number of taxpayers in each income group must remain the same, the share of the group population at the upper threshold can be written as:

$$\lambda_j^U = 1 - \lambda_j^L$$

The 1930 census data leads to wide bounds on municipal level. This is largely because of the lower tail of the distribution. This income group normally ranges from 100 NOK to 400 NOK, and in some cases from 100 NOK to 900 NOK. We know that all taxpayers in our dataset have income above the basic tax allowance, which is individually set by each municipality. To narrow the bounds, we therefore replace the lower income limit with the lowest basic tax allowance from each municipality. Data on the basic tax allowance is obtained from Statistics Norway (1930). Sometimes, especially in cities, the tax-free allowance can be higher than the upper limit in the lowest income group in the data (i.e. above 400 NOK). That means that the lowest income bracket will be empty or nearly empty. In these cases, we adjust the lower limit in the second lowest income group instead.

In Figure 10, we have plotted the bounds for the taxpayers as Gini coefficients. The municipalities are ranked according to local taxpayer Gini. The green dot signifies Gini resulting from the upper bound, while the red dot denotes the Gini resulting from the lower bound. The bounds on the Gini index are narrower than before, but the potential differences are still significant for most municipalities. The mean difference between the upper and lower bound is around 3.1 percentage points, with the highest difference being 8.0 pp. in Gravvik municipality and the smallest 0.7 pp. in the city of Bergen.

Figure 10: Local Gini bounds for taxpayers 1929 after adjusting for lowest taxable income



Note: Upper (green) and lower (red) bounds on the local Gini index for taxpayers. 742 municipalities ranked according to the average of the upper and lower bound.

4.2.5 The income distribution for non-taxpayers

The income distribution for taxpayers will only take us so far. It leaves out a substantial number of units at the bottom part of the income distribution. We are forced to piece together information from different sources. Previous research has followed two different strategies. Anders Nicolai Kiær (1892, 1910), founding director of Statistics Norway, estimated the income distribution for non-taxpayers using a large survey from 1894. Based on this data, he created estimates for 1892, 1906 and 1910. The 1910 numbers are close enough to be used for 1913 after adjusting for wage growth. Soltow (1965) and Aaberge, Atkinson & Modalsli

(2016) chose a more modest approach. They did not estimate the income distribution, but made assumptions about the mean income and number of non-taxpayers.

We will use Kiær's estimates. These are official statistics and amount to the best information available at this point. When calculating the Lorenz curve, the Gini index and top income shares, we use Kiær's estimates together with the tax data and use interpolation techniques as explained above. This gives us a synthetic microdata set. Kiær did not create estimates for 1929. To our knowledge, there are no historical estimates of the incomes of non-taxpayers for this year. This forces us to create our own approximation.

In 1929, the share of non-taxpayers is 35 percent, 2 pp. lower than in 1913. We therefore assume that we can approximate the 1929 income of non-taxpayers by adjusting the average income estimates from 1910. To estimate the growth factor, we have survey data from household budgets and the aggregate numbers on household disposable income in the national accounts (Statistics Norway, 1917; 1921; 1929; 1953). If we use the nominal growth factor of household disposable income from the national accounts 1910–1929, we arrive at a new mean income of 546 NOK. If we use the household budget survey for 1913 and 1927 and the income of workers, we arrive at 563 NOK. The surveys only allow us to compare workers in cities over this period, which might be less representative for rural areas. However, because both the national accounts and the surveys give similar results, we choose to use 550 as our best approximation. According to the 1927 survey, the poorest worker families on average spent 504 NOK per person in clothing, food and rent this year (Statistics Norway, 1929). Even if prices were lower in the countryside, the subsistence level of consumption was probably in the neighbourhood of this number.

To account for local differences, we assume that the national mean income of non-taxpayers is 550 NOK, but let the local average vary with the local basic tax allowance. The mean income in municipal m is therefore given by:

$$\textit{Average income}_m = x + \textit{basic tax allowance}_m$$

subject to:

$$\frac{1}{N} \sum_{m=1}^M x + \textit{basic tax allowance}_m = 550 \textit{ NOK}$$

To solve this equation, x needs to be 349 NOK. This means that the non-taxpayer mean income is allowed to vary from 398 NOK to 1,349 NOK.

5. Results

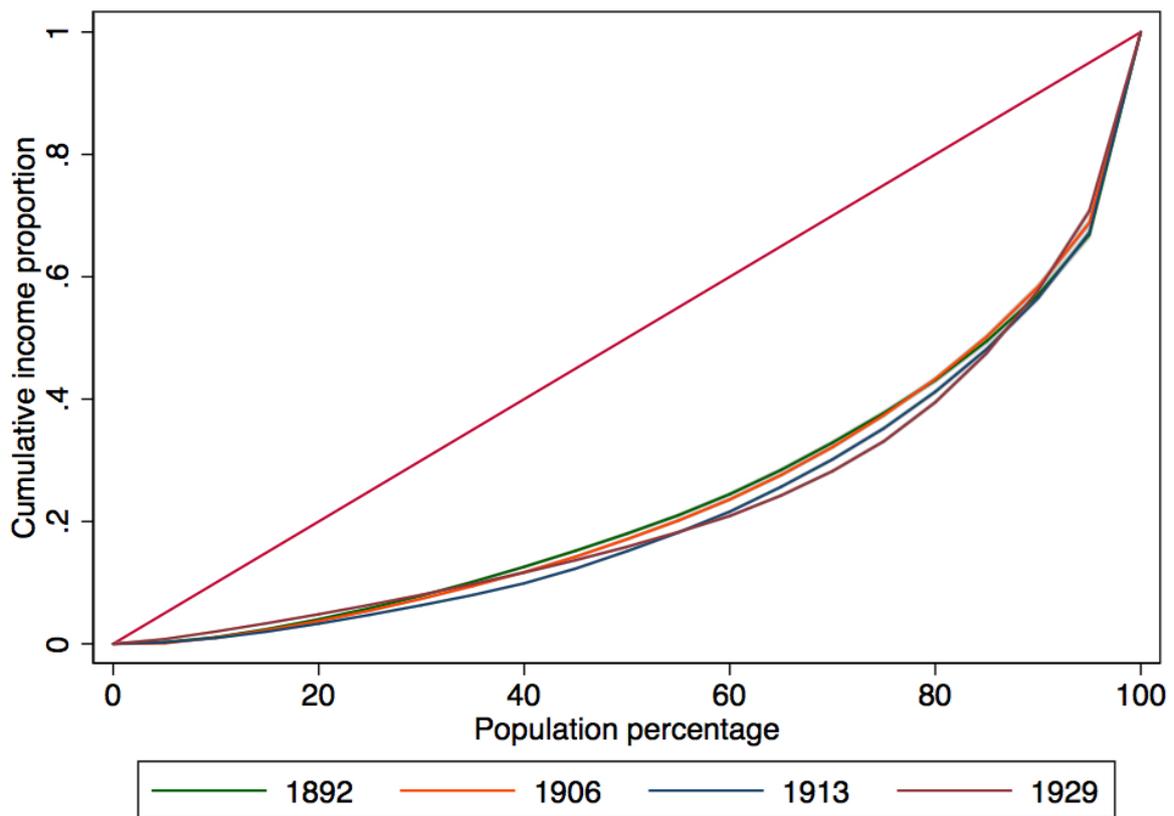
This chapter is divided in five parts. First, we introduce the reader to our best estimates of the income distribution for 1892, 1906, 1913 and 1929. Second, the national Gini index is presented. Third, we zoom in on the top incomes. The Gini and top incomes are discussed in detail, and compared with research on both historical and contemporary levels of inequality. Forth, we focus on regional heterogeneities. Lastly, we discuss if a comparison over time or between countries is meaningful.

5.1 The distribution of income

In the 37 years between 1892 and 1929, Norway went through her largest booms and busts in modern history, claimed independence and navigated through a world war (Hodne & Grytten, 2002). Yet, we find fairly similar income distributions. In Figure 11, we have drawn the Lorenz curves for 1892, 1906, 1913 and 1929. The Lorenz curves are produced for a full population of all income earning units, i.e. all adults minus married women. Statistics Norway did not produce an estimate of the full distribution for 1929. The bottom half of the 1929 distribution is only a coarse approximation, assuming an average income of 550 NOK.

The curves are difficult to separate visually. Similar Lorenz curves indicate stable inequality. By visual inspection we find that the Lorenz curves for the years 1892 and 1906 are very similar. The curves intersect as at least one time, and as a result we cannot conclude that the distribution one year is more unequal than the distribution the other year. The difference between the 1906 and 1913 Lorenz curves is clearer. The 1913 curve lies to the right of the 1906 curve, although the details for the very top and bottom incomes are difficult to see. In 1929, there seems to be several changes occurring at once, with a slight decrease for top and lower incomes, and a gain for the moderately rich, that is, those between the 70th and 95th percentiles.

The Lorenz curve is not an ideal tool for comparing similar distributions. Table 2 displays the relative distribution in more detail. The numbers are normalized to 1892-levels to make comparison over time easier. Now, we see patterns in the development of income inequality that were not easily discerned from the Lorenz curves.

Figure 11: Lorenz curves for income 1892-1929

Note: Lorenz curves for 1892, 1906, 1913 and 1929, showing our estimates of the complete income distributions.

From 1892 to 1906, the income share going to both the bottom 45% and the richest 5 percent decreased significantly. The upper 45-95% seem to have gained. In 1906, Norway was still recovering from the 1899 Kristiania crash (Hodne & Grytten, 2002). During the recovery between 1906 and 1913, the top 5% almost regained their losses, while the bottom 45% seems to have declined further. In sum, the moderately rich seem to have gained, while the poor got a smaller share of income between 1892 and 1913.

By 1929, Norway had gone through a war boom and two severe recessions. Unemployment stood at record high levels and wages had risen greatly (Hodne & Grytten, 2002). Compared to 1913, the moderately rich increased their income shares drastically, while the shares going to the poor and the very rich decreased. The richest 5 percent is the only rich group that received a smaller fraction of total income in 1929 than in 1892. The bottom part of the distribution is removed for 1929 as it is not comparable with previous years. The bottom is also the most error-prone part in earlier years, and should be interpreted with caution.

Table 2: Changes in the relative income distribution

Population group	Income share		Index (1892=100)		
	1892	1892	1906	1913	1929
0-5%	0,3 %	100	35	93	
5-10%	0,8 %	100	113	95	
10-15%	1,3 %	100	94	85	
15-20%	1,6 %	100	92	85	
20-25%	1,8 %	100	93	85	
25-30%	2,0 %	100	94	81	
30-35%	2,3 %	100	92	78	
35-40%	2,4 %	100	92	80	
40-45%	2,6 %	100	96	93	
45-50%	2,8 %	100	102	104	
50-55%	3,0 %	100	102	104	80
55-60%	3,4 %	100	100	99	76
60-65%	4,0 %	100	101	103	85
65-70%	4,5 %	100	102	102	89
70-75%	4,9 %	100	108	105	101
75-80%	5,4 %	100	109	111	119
80-85%	6,4 %	100	108	107	126
85-90%	7,5 %	100	108	110	136
90-95%	9,9 %	100	106	107	132
95-100%	33,1 %	100	94	98	88

Note: The table shows the fraction of income going to different percentile intervals. The 0-5% is the poorest 5%, 95-100% is the richest 5%, and so on. The lower part of the 1929-distribution is removed. This part of the distribution is not comparable with the other years. Later years are normalized to 1892 levels for comparison.

5.2 The Gini index

5.2.1 The national Gini index

Table 3 presents the pre-tax, pre-transfers Gini coefficients at the national level, as well Gini indices calculated separately for rural and urban municipalities. Just as we would expect from the Lorenz curves, the Gini index remains fairly stable, ranging from 52 percent in 1892 to 54 percent 1929. There are probably fluctuations during the war and the post-war recessions, but we do not have any observations for these years. The Gini index is sensitive to key assumptions. Increasing the assumed average income of non-taxpayers with 100 NOK will decrease the Gini index from 52 percent to 45 percent in 1892. A decrease of 100 NOK results in a Gini of 62 percent. An in-depth sensitivity analysis is given in the robustness chapter.

The urban/rural decomposition shows that while the national Gini is stable, large changes occur at a regional level. From 1892 to 1929, the level of inequality in cities and the countryside converges significantly. The difference starts out at 17 percentage points in 1892, decreases in each following observation and is mostly gone in 1929.

A reason could be the growing number of suburbs and industrial towns that were not defined as cities by Statistics Norway. This will increase the inequality between municipalities in the countryside, while not necessarily increasing the national Gini. Interestingly, we find that about half of the countryside Gini is a result of inequality between municipalities and not within. Similarly, only about 20 percent of the urban Gini is decided by variations between cities. We will come back to this when discussing our local results.

Table 3: Gini index estimates

	1892	1906	1913	1929
Gini index before taxes and transfers	52 %	52 %	54 %	54 %
Rural Gini index	44 %	46 %	48 %	51 %
Urban Gini index	61 %	57 %	58 %	51 %
Difference	17 %	12 %	10%	0 %

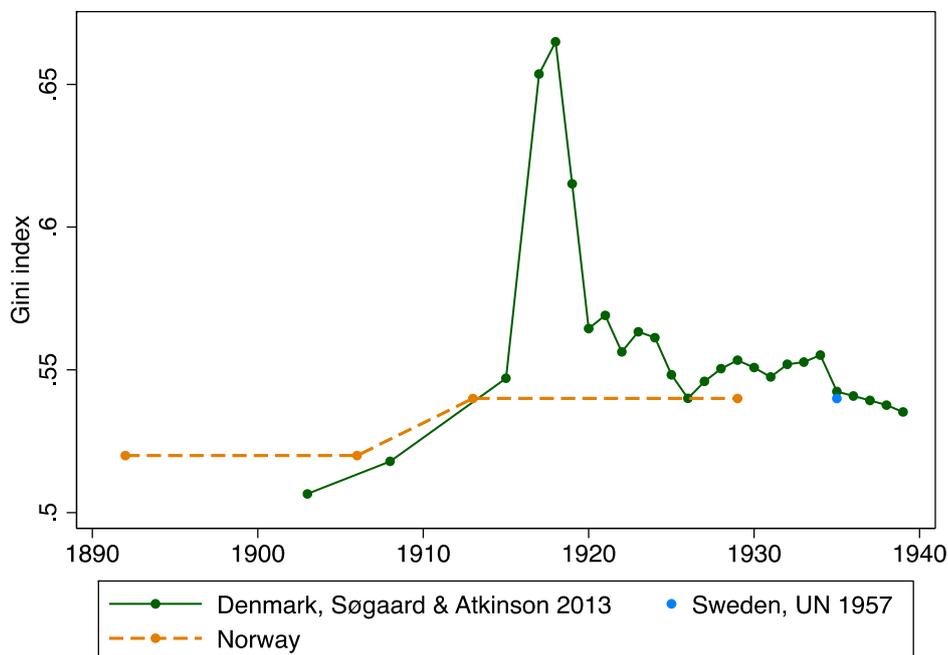
Note: Our estimates of the Gini coefficients. Coefficients are also estimated separately for the population in cities and in rural municipalities. The difference between the rural and urban Gini coefficients are shown on the last line.

5.2.2 Comparing with other countries

In Figure 12, we compare our pre-tax, pre-transfer Gini with other countries at the time. Finding comparable estimates have proven to be difficult, as few comparable Gini series exist for this period. We have obtained the pre-tax, post-transfers Danish series calculated by Søggaard and Atkinson (2013) and a single pre-tax, post-transfers data point on Sweden in 1935 (WIID, 2017). These series include government transfers, but according to Søggaard such transfers were only small part of total income. The series should therefore be fairly comparable.

We find that our Gini coefficients are remarkably similar to the Danish series. One might speculate on whether the association remained through World War I. If so, the fact that our Gini estimates show stable levels of inequality is merely a product of when it was measured. The 1935 estimate for Sweden is identical to the Norwegian 1929 estimate. In brief, the Gini indices for the Scandinavian countries seem to have been fairly similar.

Figure 12: Gini series for Norway, Denmark and Sweden

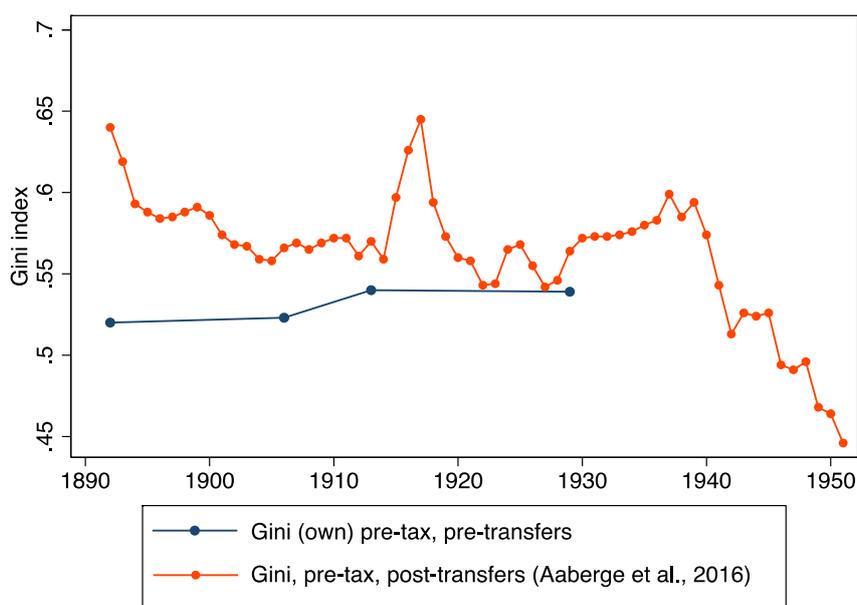


Note: Our Gini index for Norway, before tax and transfers. Estimates for Denmark (Søggaard and Atkinson, 2013) and Sweden (UN, 1957) are shown for comparison. These are before tax, but including transfers.

5.2.3 Comparing with previous research

Several researchers have estimated parts of the historical income distribution in Norway. Kiær (1910; 1915) created an estimate of the full distribution in the form of tables. Soltow (1965) estimated long Gini series for selected municipalities. None of these authors calculated national Gini series that we could use for comparison. However, a new paper by Aaberge *et al.* (2016) have presented long run national Gini series for Norway. They use pre-tax and post-transfers income to estimate income inequality from 1875 to 2013. Our Gini index is before tax and transfers, and therefore not fully comparable with their series. The two series are plotted in Figure 13. We find significantly lower levels of inequality than Aaberge *et al.* (2016). For 1892, our estimate of the Gini index is 12 percentage points lower. We estimate a more equal income distribution for all years, but the difference is strongly decreasing. There are four main reasons why the series differ. First, we do not include transfers. Within their framework, we estimate the effect of transfers to be between 3 and 5 percent, depending on the business cycle. Second, we add an estimate of dividends to years before 1921, when this is not already included. This increases the Gini by about 2 percentage points. Third, we exclude impersonal tax units such as stock companies, banks and estates. This affects the estimates before 1910 and reduces the Gini by about 2 percentage points. Fourth, we assume higher income for the non-taxpaying part of the population. This is the main cause of the difference, decreasing the Gini by roughly 15 percentage points in 1892 and less in later years.

Figure 13: Comparison with Aaberge *et al.* (2016)



Note: Comparing our Gini index with the Gini index for Norway from Aaberge *et al.* (2016)

5.2.4 Comparing with inequality today

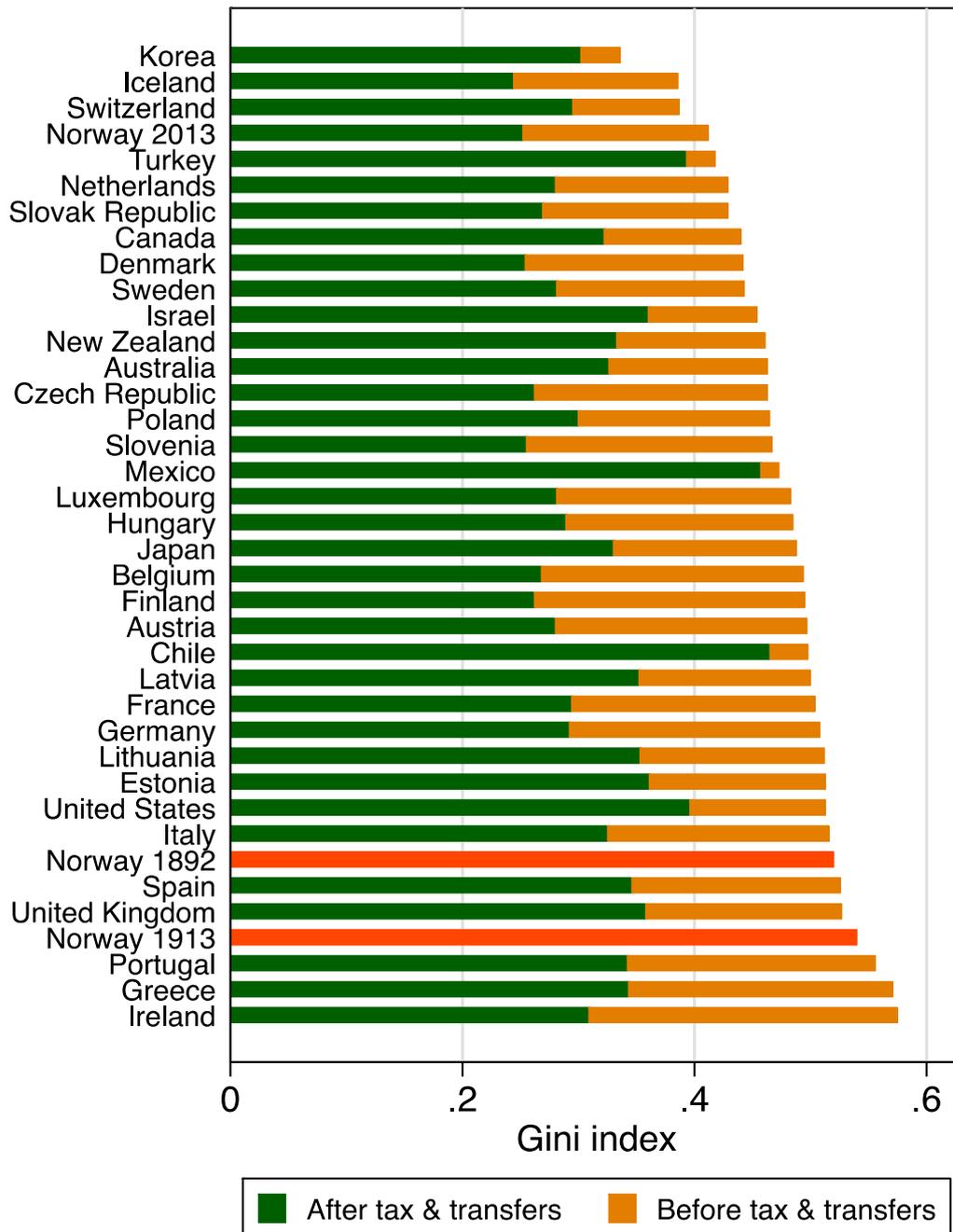
To compare our Gini estimates with today's, we use 2013 Gini coefficients for the OECD countries (OECD, 2017). These Gini coefficients are at household level, which is somewhat different than our tax unit measure. We present the Gini both *before* tax and transfers and *after* tax and transfers. The first measure would be used to compare inequality in market income (i.e. income before redistribution), and the second to compare inequality in household disposable income. The pre-tax, pre-transfer Gini indices are the closest modern equivalents to our historical estimates. The after tax and transfer Gini reflects household disposable income, and is therefore the preferred measurement of inequality today. However, we lack the necessary data to fully adjust the historical estimates for taxes and transfers.

Using data for 1913, we find that subtracting taxes reduced the Gini coefficient by 1 percentage point. Within the framework used by Aaberge et al. (2016) we find that transfers decrease the Gini by between 3 and 5 percent. However, we believe that this framework exaggerates the effect of poverty transfers. We also know from the national accounts that transfers to households were only a small part of total income (Statistics Norway, 1965). We believe a makeshift comparison with both Gini indices is possible, but the reader should keep the mentioned caveats in mind.

The pre-tax, pre-transfers Gini coefficients are compared in in Figure 14. We see that the historical income distribution in Norway was about as equal as that of the UK, Italy and Spain today. Early 20th century Norway is among the most unequal in the comparison group, but interestingly, not outside the group range. Portugal, Greece and Ireland all have higher levels of income inequality. The ranking stands in contrast to modern Norway, which is ranked as one of the most equal countries in the group.

If we look at the Gini index after redistribution, historical Norway is more unequal than all countries in the 2013 sample. In terms of disposable incomes, it is fair to say that early 20th century Norway was likely far more unequal than advanced economies today. If we compare with modern Norway, incomes have become more equal, both before and after redistribution.

Figure 14: Current levels of inequality in the OECD



Note: Gini coefficients before and after taxes and transfers for 2013 (or if not available, from 2012). Historical estimate on Norway in 1906 is not significantly different from 1892, while the 1929 estimate is not significantly different from 1913. They are therefore not shown. Other countries from OECD (2017).

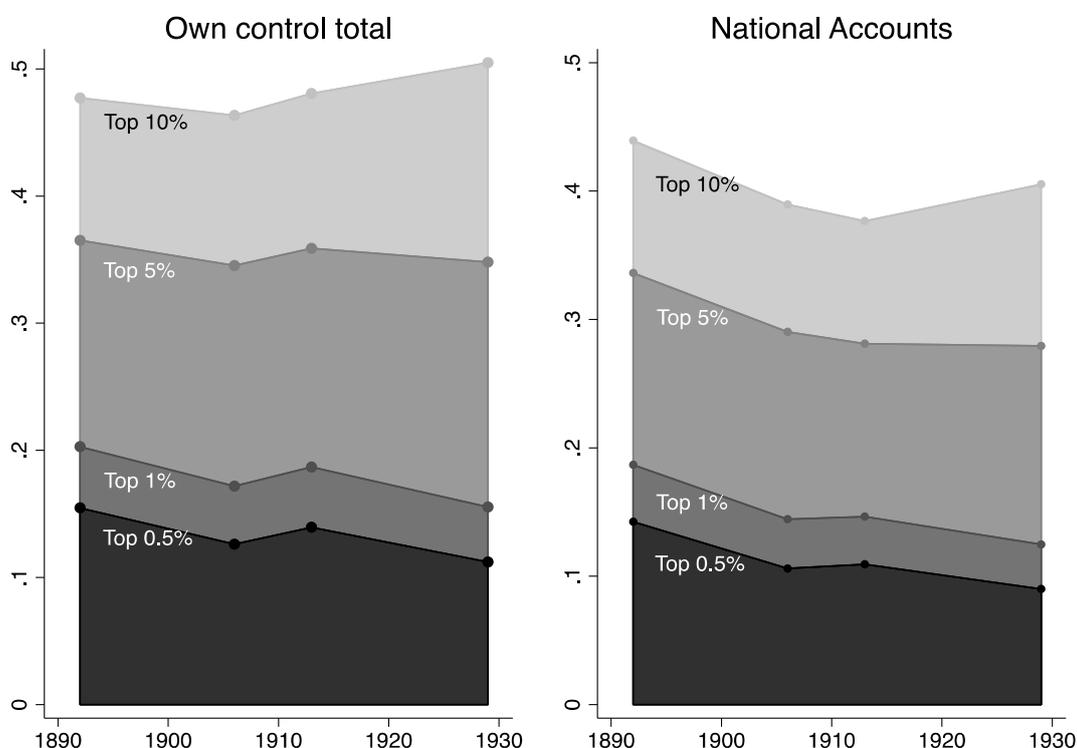
5.3 Top income shares

5.3.1 National top income shares

Our top income shares estimates follow international practice, i.e. we use a population total of all adults, not subtracting married women. In other words, we use the top part of the presented income distribution, but add a larger population to the bottom. This will have the effect that top income shares will be somewhat higher than if we subtracted married women, and the percentiles will not be directly comparable.

We present two estimates: One using total income from the already presented income distribution, and another using total household income from the national accounts according to Aaberge *et al.* (2016). The national accounts approach follows the recommendation by Piketty *et al.* (2011), and should in principle be comparable to other estimates in the World Wealth & Income Database (2017). Top income shares are very sensitive to total income, and we therefore estimate shares using our own income totals as well. The two estimates tell very different stories, illustrating the sensitivity to getting total income right.

Figure 15: Top income shares in Norway



Note: Share of total income going to the richest 10%, 1% and 0.5%. The difference between the estimates are entirely due to the denominator, i.e. the income control total. Sources: See data chapter.

Table 3: Top income shares in Norway

	Top 10%		Top 5%		Top 1%		Top 0.5%	
	Own	Nat. acc.	Own	Nat. acc.	Own	Nat. acc.	Own	Nat. acc.
1892	48 %	44 %	37 %	34 %	20 %	19 %	15 %	14 %
1906	46 %	39 %	35 %	29 %	17 %	14 %	13 %	11 %
1913	48 %	38 %	36 %	28 %	19 %	15 %	14 %	11 %
1929	50 %	41 %	35 %	28 %	16 %	12 %	11 %	9 %

Note: Top income shares using different assumptions. Both use the population control totals from Aaberge *et al.* (2013) and our estimate of dividends. The national accounts estimates are calculated using total income estimates from Aaberge *et al.* The estimate marked as “own” use total income from the tax records and the income we assume non-taxpayers earn.

We start by looking at the estimate using our own control total in Figure 15 and Table 3 (left). Since we have few observations, there could be considerable fluctuations that we do not observe. At least three trends stand out. First, the top 10 percent gain throughout the whole period, except for a 2-percentage points dip from 1892 to 1906. In 1892, 48 percent of all income went to the top 10%. This implies that the top 10% had an average income close to five times the national average. Second, the top 1 percent decrease their share of total income. In 1892, 20 percent of income went to the top 1 percent, implying that they earned 20 times the population average. By 1929, the top 1 percent income share had declined by a fifth. Third, if we decompose the top income shares further we find that the decline is largely driven by the top 0.5 percent.

To make our estimates comparable to the shares produces by Aaberge *et al.* (2013) and the World Wealth & Income Database (2017), we estimate top income shares using their control totals. These are shown in Figure 15 and Table 3 (right). We refer to these estimates as the national accounts estimates. Their income control total is 72% of disposable household income in the national accounts. The resulting top income shares are lower than our first estimates because the national accounts definition of total income is larger than our own. Using the national accounts estimates, we find a strong decline in top income shares over time. For instance, between 1892 and 1906, the top 10% decline 2 percentage points in our main estimate, while the national accounts estimate show a 5 percentage point drop. The difference between the two series increase further over time.

The top 5%, top 1% and top 0.5% register declines in both series. This makes us fairly sure that the income share going to richest declined. The two estimates show widely different results for the top 10% income shares. Our own estimate shows an increase from 1892 to 1929, while the national account estimate registers a drop. The difference is entirely due to the denominator, i.e. the definition of total income. The national income total and our own control total develop differently, with the national income total growing more strongly. In our view, the top 10% income shares are too sensitive to the control totals for us to conclude definitively on the correct trend. The conflicting results show how sensitive top income shares are to assumptions. We will need to use the national accounts estimates for international comparisons, as it follows the standard used in most international series.

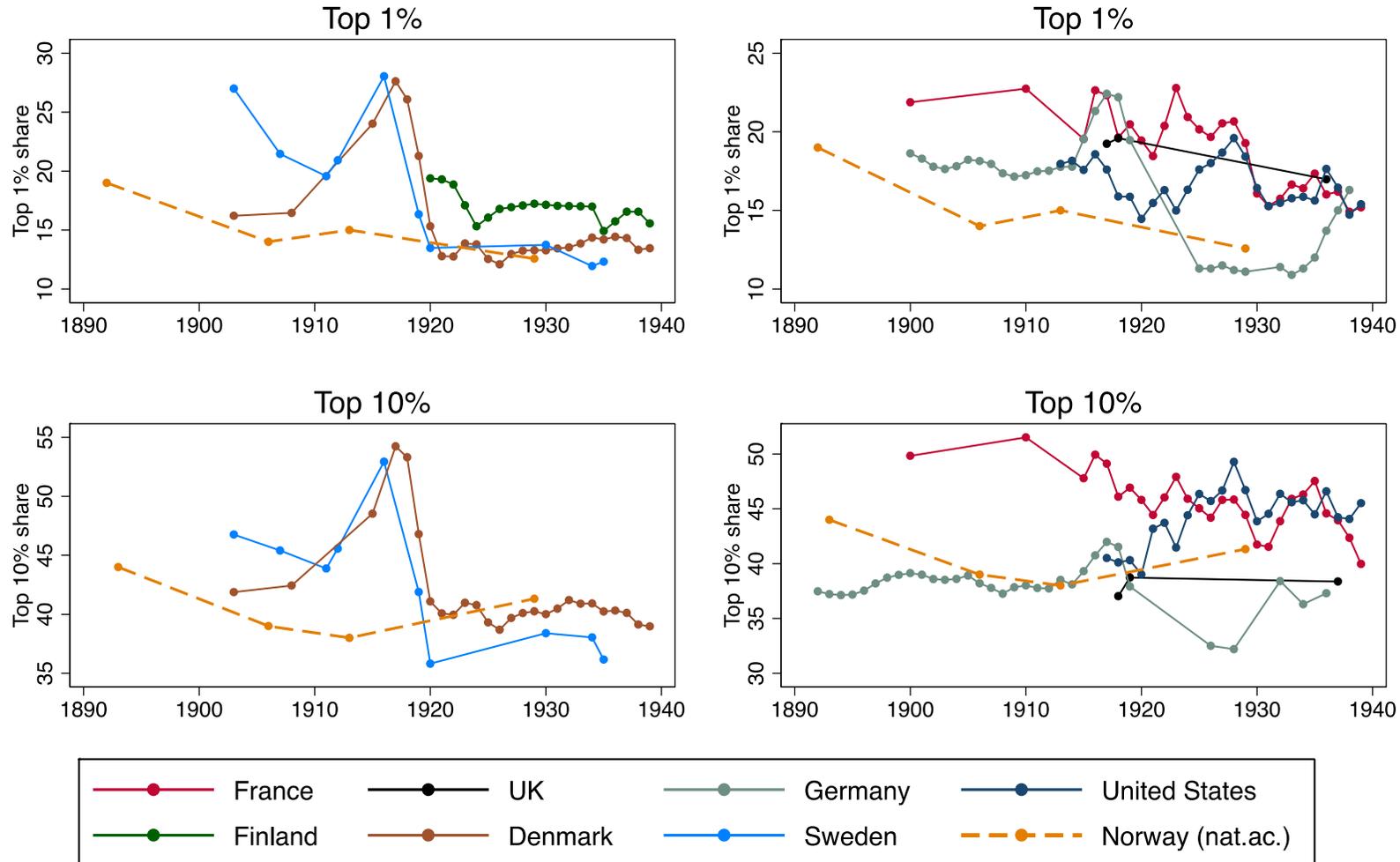
5.3.2 Comparing with other countries

Top income shares are available for a large sample of countries back to the beginning of the 20th century (WID, 2017). Keeping in mind the large potential for error, we can do a makeshift comparison with the national accounts estimates. We collect estimates of the top 1 and 10 percent for seven countries from the World Income and Wealth Database (2017). These top income shares are shown in Figure 16 (next page), together with our national accounts estimate of top income shares.

Looking at the top 1 percent, we find that Norway had lower top income shares than the other six advanced economies shown. There is one exception: Germany in 1929 have slightly lower top income shares. Germany's top 1% income shares fell strongly after World War I. This is not surprising given severe destruction and economic turmoil after the war. In 1929, Norway's share is close to Sweden and Denmark. For earlier years, Swedish shares are significantly higher. The Danish shares seem to follow Norway's more closely. The Danish 1908 and 1903 shares are about two percentage points higher than Norway's 1906 share. Both Denmark and Sweden register large increases during the First World War, but since we do not have Norwegian data for this period, a potentially similar pattern would not show.

If we look at top 10% shares, we see that Norway starts out at a higher level than Germany. In 1906 and 1913, Norwegian and German shares are approximately the same, being lower than Denmark, Sweden and France. After the war, we have data on more countries. Denmark, Sweden and Germany have all undergone large drops in top income. Norway now ranks higher

Figure 16: Comparing top income shares



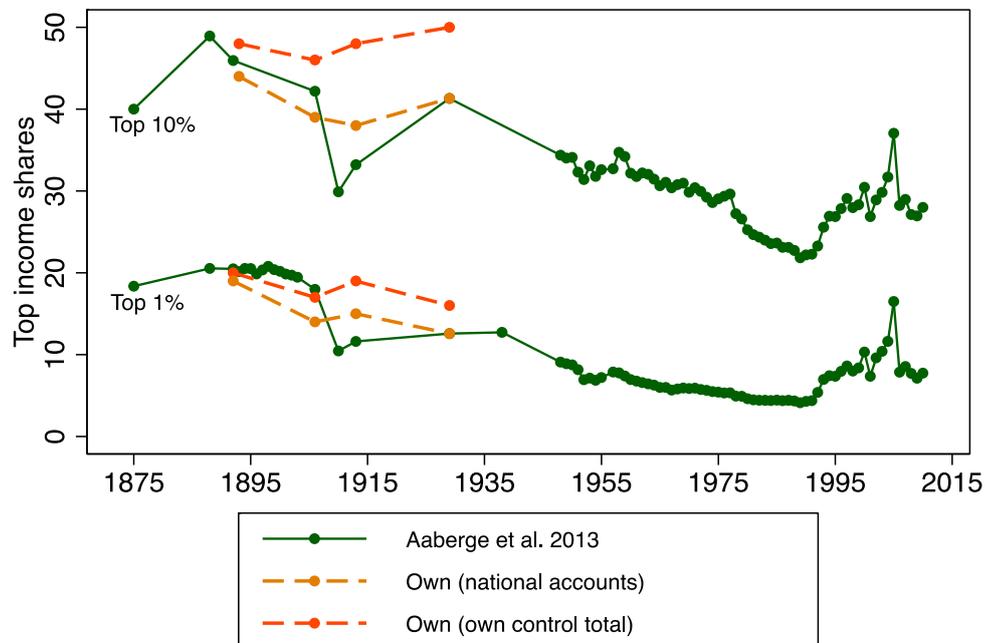
Note: Our top income shares estimates for Norway with estimates from the World Income and Wealth Database (2017). Top 10% shares for Finland were not available. In the left columns, we compare with the Scandinavian countries. In the right column, we compare with other advanced economies.

than Sweden and Germany, and just higher than Denmark. Of the countries we observe, Norway seems to be in the mid-range of top 10% income. Norway generally seems to have low top income shares compared to other advanced countries, even though the picture is a bit more mixed for top 10% income in 1929.

5.3.3 Comparing with previous research

Long run top income shares for Norway exist from 1875 to 2010 (Aaberge *et al.*, 2010; 2013). Figure 17 show their top income shares as well as our own estimates. Our first estimate uses an estimate of total income from the national account. Our second estimate uses total income from Kiær (1910, 1915). For comparability, we focus on the first estimate. The population control total is identical in all estimates. We find that our estimates are lower than the shares reported in Aaberge *et al.* (2013), even though we use the same assumptions as them. This is mainly because their data includes impersonal tax units before 1910 (Statistics Norway, 1915). We also include an estimate of dividends. In 1892, eliminating impersonal entities reduces the top 1% income share by 3 percentage points. Adding dividends then increased the estimate by 2 percentage points. In 1906, the net effect is larger. Removing impersonal entities reduces the top 1% share by 6 percentage points, while dividends add 2 percentage points.

Figure 17: Comparison with previous national studies



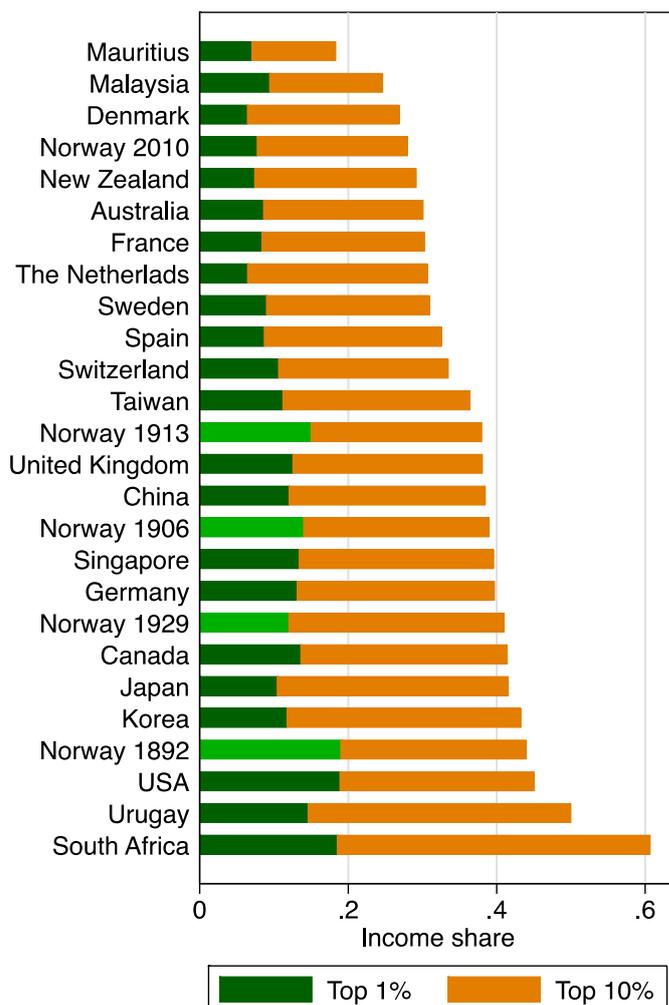
Note: Comparing our top income shares with the top income shares for Norway from Aaberge *et al.* (2013). The level of the red line is not directly comparable because it uses another income control total. However, it shows a different trend for top 10% incomes, indicating how sensitive top income shares are to the control total.

The trajectory we find is significantly different from Aaberge et al. (2013). The previous authors find a large drop in top 1% income share between 1906 and 1911. This turns out to be entirely caused by impersonal entities. We find that a large drop in top income share instead occurred between 1892 and 1906. We find higher top income shares using our own income control total. These are not directly comparable to international series or to Aaberge et al., because they use a narrower income definition in the control total. Still, the trend is very different, with large gains to the top 10% by 1913. The difference shows that some of the trends are not driven by the top incomes themselves, but by the income control total.

5.3.4 Comparing with top income shares today

Modern top income shares are available for a large number of countries (WID, 2017). We present top income shares for a group of countries in Figure 18, and include our own national accounts estimates for 1892, 1906, 1913 and 1929.

Figure 18: Comparison with 2010 top income shares



Note: Figure 18 compares our estimates on historical Norwegian top income shares with top income shares in 2010 (WID, 2017). All countries for which estimates were available are shown.

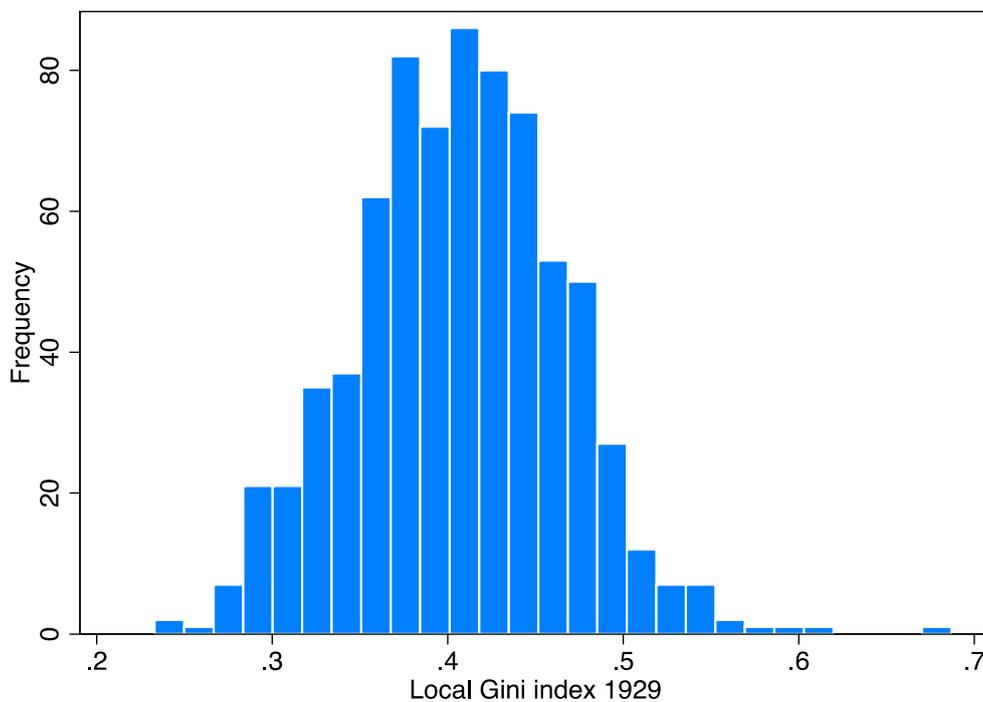
While Norway's top income shares are among the most equal today, the historical estimates are significantly more unequal. Still, they are not outside the range of modern countries. Save for Norway in 1892, all of the historical estimates show smaller top 10% income shares than the United States in 2010. In 1892, Norway had top income shares equal to United States today. It would seem that historical Norway had top incomes shares similar to those in many developed countries today.

5.4 Local-level estimates

5.4.1 Municipal Gini coefficients in 1929

What can explain a national Gini coefficient of 52-54 percent? With local-level data, we can see if inequality was stable across regions, or if certain areas were much more unequal. Using local data within a single country, we can look at variations in economic conditions while the legal and cultural contexts are held fairly constant. This allows us to test hypotheses of economic growth and inequality, although within the cross-section of a single country. We do this in the next chapter. Now we present the local Gini indices themselves.

Figure 19: Estimated local level Gini coefficients

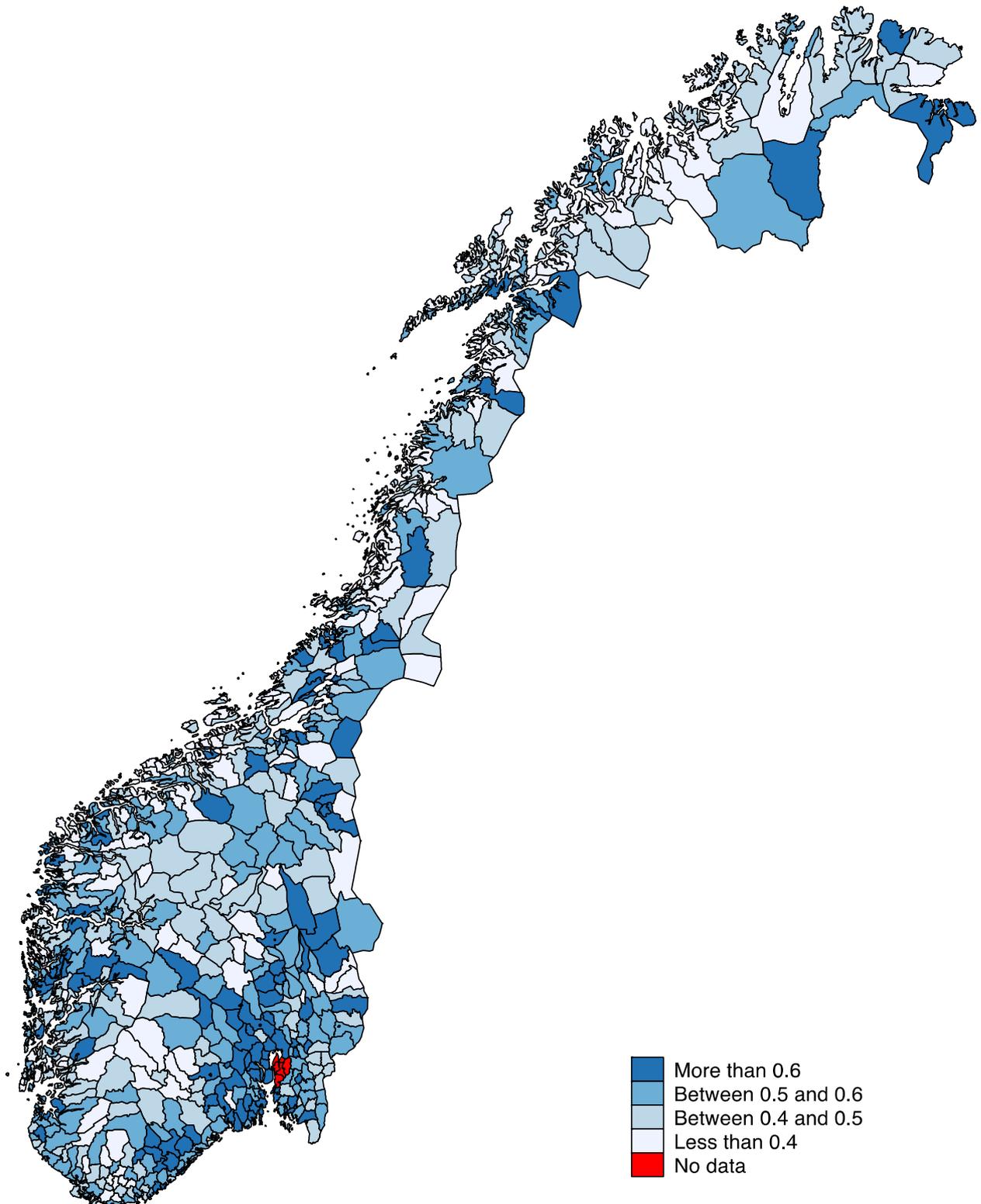


Note: The distribution of Gini coefficients (best estimate) for all municipalities in 1929. N = 742.

Local Gini indices are shown in map 1.1 and 1.2, and the distribution is illustrated in Figure 19. The 1929 median Gini for Norwegian municipalities was 40.8 percent. This is lower than the national Gini of 54 percent because the local Gini coefficients do not compare the population across municipal borders. It also reflects the large number of small, rural municipalities with lower levels of inequality. The municipality on the 10th percentile has a Gini coefficient of 33%, while municipality on the 95th percentile has a Gini coefficient of 50%. Map 1.1 and 1.2 reveals higher levels of income inequality in the central area around Oslo. The area extends as a belt along the coast and has branches into the interior of Southern Norway. Large cities such as Trondheim, Bergen and Stavanger also light up. Northern Norway generally has lower levels of inequality, except for the municipalities of Karasjok and Kautokeino. These are sparsely populated municipalities with mainly indigenous population, which could affect data quality.

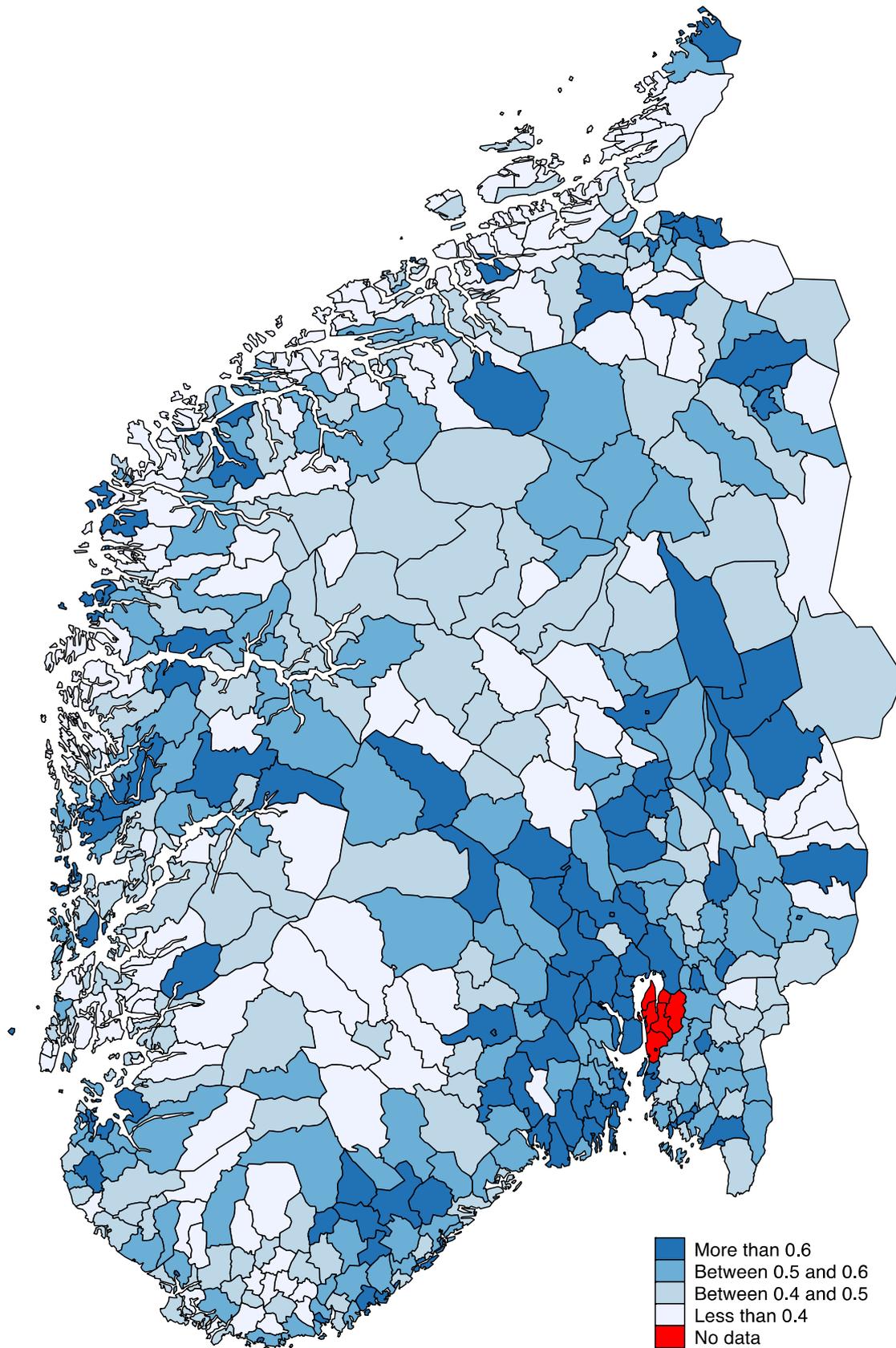
The inequality between municipalities can be expressed as a Gini of 22 percent. The intuitive interpretation is that the national Gini coefficient would be 22 percent if everyone earned the average income in their municipality. This implies that about 40 percent of the national Gini coefficient is determined by variation between municipalities. Interestingly, the inequality between municipalities seem to be larger in the countryside than in the cities. We find that about half of the countryside Gini is a result of inequality between municipalities, while only about 20 percent of the urban Gini is decided by variations between cities. This suggest that the there is substantial variation between rural municipalities. One reason could be the growing number of suburbs and industrial towns that were not defined as cities by Statistics Norway.

Map 1.1: Local Gini coefficients for Norway



Note: The geographic distribution of Gini coefficients (best estimate) for all municipalities in 1929. *The six municipalities missing from the data are highlighted in red.*

Map 1.2: Local Gini coefficients (Southern Norway)



Note: The geographic distribution of Gini coefficients (best estimate) for municipalities in Southern Norway in 1929. The six municipalities missing from the data are highlighted in red.

5.4.2 The location of top incomes

In the previous section, we uncovered large variation in regional inequality as measured by the Gini. We suspect there could be large regional variations in top incomes as well. By determining the geographical distribution of top income, we can locate regions that were important in shaping the national top income level. First, we decompose top incomes by income going to cities and income going to the countryside. Next, we look closer at top incomes in specific cities and suburbs. These calculations are independent of the income control total. The decompositions will therefore be identical for both the national accounts estimate and the estimate using our own income control total.

We find that top incomes were strongly concentrated in cities, as shown in Table 4. In 1892, 62 percent of top 10% income went to cities. The urban concentration increases until 1913. By 1929 years, urban concentration has decreased for all top income shares. This might be a result of industrialization, but also of growth in suburbs such as Asker, Bærum and Fana, which are not defined as cities. Keeping in mind that about 1/3 of the population lived in cities, our results show that top incomes were highly concentrated in the cities in the entire period. We also see that urban concentration increases as we move closer towards the top of the income distribution, although the effect weakens over time

Table 4: Share of top income going to cities

	Top 10%	Top 5 %	Top 1 %	Top 0.5%
1892	62 %	66 %	74 %	77 %
1906	64 %	66 %	74 %	76 %
1913	66 %	69 %	76 %	80 %
1929	60 %	63 %	65 %	65 %

Note: *The share of top income going to cities. The sum of all top income is 100%. Cities are those municipalities that were legally designated as such by the government.*

In 1913 and 1929, the data allows us to decompose top income by city. The results are shown in Table 5, which reveals a striking pattern. We find that top incomes are not only concentrated in cities, but highly concentrated in the largest cities. In 1929, 52 percent of the top 1% income in Norway went to Oslo or its suburbs Aker and Bærum. Next follows Bergen, Trondheim and Stavanger with smaller shares. In 1913, the shares going to each city are even higher, except for Stavanger.

Table 5: Share of top 1 percent individuals and income, by municipality

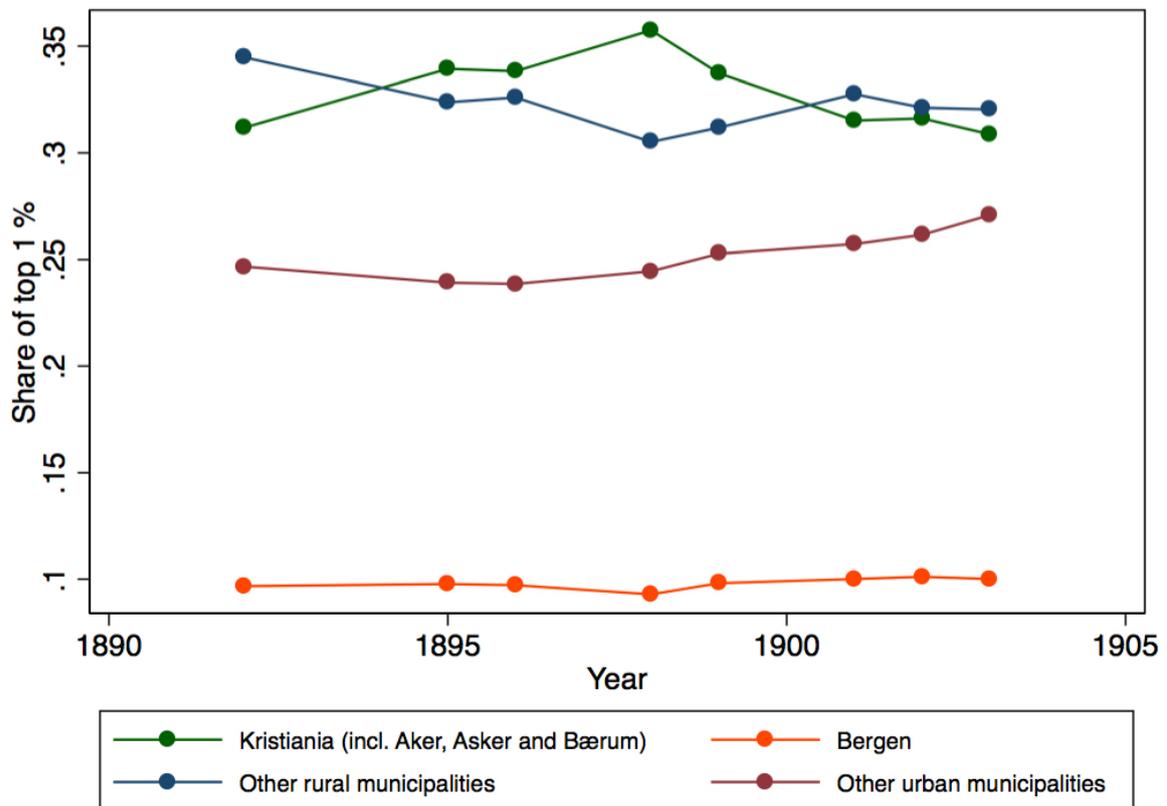
Municipality	1929		1913	
	Share of top 1% income individuals	Share of top 1% income	Share of top 1% income individuals	Share of top 1% income
Oslo	32.42 %	33.97 %	31.25 %	34.92 %
Aker	12.19 %	15.18 %	-	-
Bergen	7.94 %	8.84 %	8.29 %	10.28 %
Nidaros (Trondheim)	3.63 %	3.09 %	5.01 %	4.86 %
Bærum	3.00 %	3.09 %	-	-
Stavanger	2.77 %	2.53 %	2.16 %	2.44 %
Drammen	1.59 %	1.57 %	2.35 %	2.44 %
Fana	1.51 %	1.51 %	-	-
Kristiansand	1.39 %	1.20 %	-	-
Tønsberg	0.98 %	1.01 %	-	-
<i>Norway</i>	<i>100 %</i>	<i>100 %</i>	<i>100 %</i>	<i>100%</i>

Note: The share of national top 1% income individuals and top 1% income in selected municipalities. There have been minor revisions in the municipal boundaries between 1913 and 1929.

For years earlier than 1913, we do not have city data on individual taxpayers. However, we do have data which includes impersonal entities such as stock companies, banks and estates. We can therefore decompose top incomes including company profits. Our assumption is that impersonal entities are roughly proportionate to top personal income earners. If this assumption holds, the numbers will give an indication of where top incomes went between 1892 and 1903. Figure 20 (next page) shows that results are fairly similar to the previous results for individual taxpayers. Oslo, Asker and Bærum have around a third of the top 1% income. Bergen is the next largest city in terms of top 1% income, with approximately 10 percent of the top 1% income. For simplicity, we have bundled all the other municipalities into the categories “Other rural municipalities” and “Other urban municipalities”. We find the shares to be quite stable, although the shares of Oslo, Aker and Bærum seem to be decreasing around the time of the Kristiania crash, and other urban municipalities seem to gain throughout the period.

The data does not allow us to estimate top 10 percent because the sample is too small. Top 5 percent is approximately similar to what we found for top 1%. If we estimate top 5 percent, we find that top 5 percent income is evenly split between Kristiania, rural municipalities and cities less Bergen, with approximately 30 percent each. About 8 percent accrues to Bergen.

Figure 20: Share of top 1% income including firms and estates, by municipality



Note: Share of top 1% income (including firms and estates) going to different regions (1892-1903). Source: The state tax, see data chapter for more information.

Kristiania and Bergen seems to be the dominating cities in terms of top incomes from 1892 to 1929. Kristiania is so dominating that for most of the period, it receives about the same fraction of top incomes as all other cities less Bergen combined. Bergen is stable with approximately 10 percent of top 1% incomes. Because of their magnitude, how top incomes develop in Oslo and Bergen would have had large effects on national developments.

5.4.3 Top 1% individuals in the local population, 1929

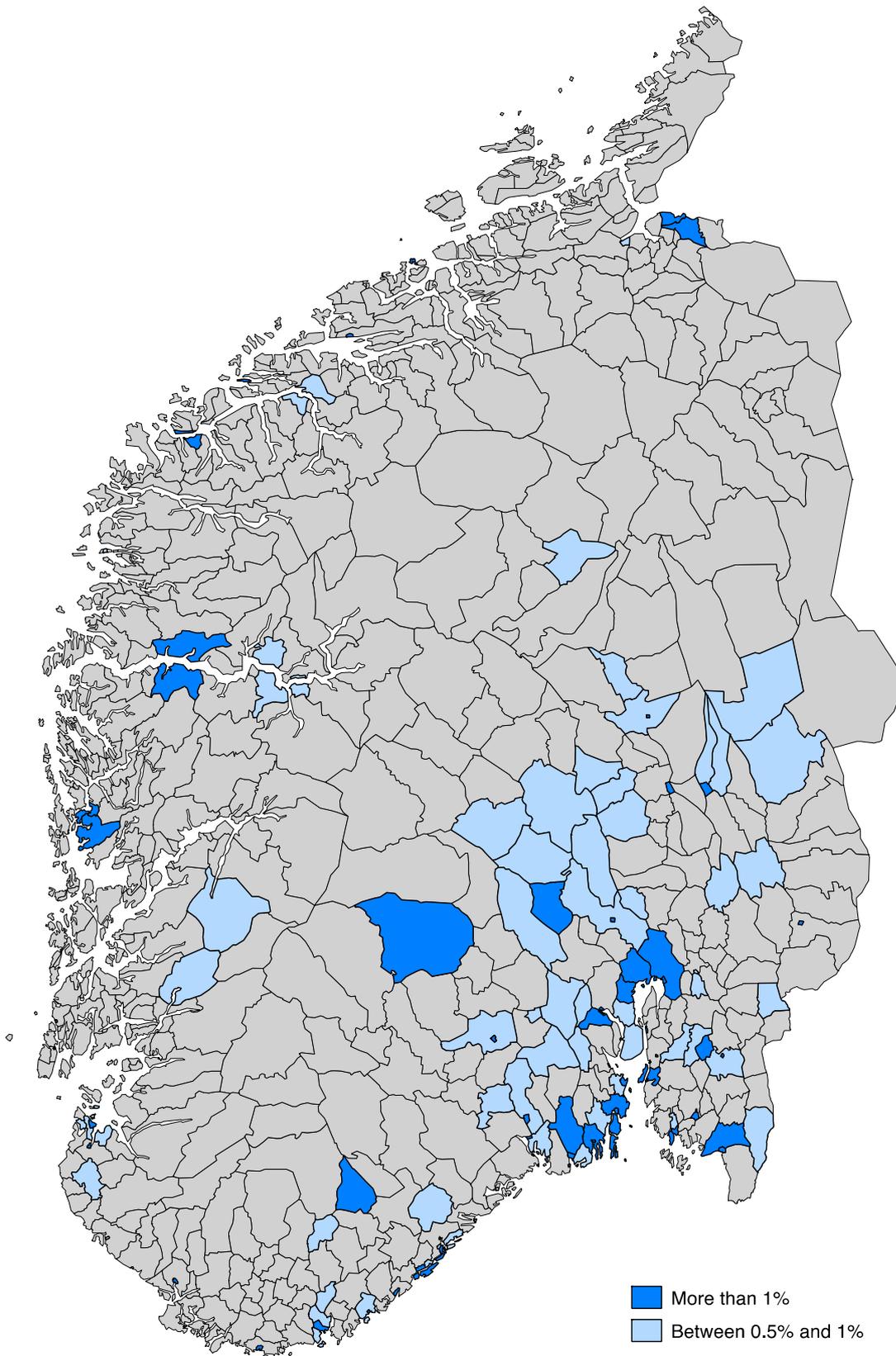
The decompositions we just did give a top-down picture of top incomes, showing which cities were important in explaining national top income shares. However, population size will drive much of the results; it is only natural that a large share of top income goes to cities with the largest populations. Another way to look at top incomes would be to estimate which municipalities had an overrepresentation of the top 1%. By definition, the top 1% constitute 1% of the national population. This is not the case locally.

In map 2, we have highlighted the municipalities where people belonging to the top 1 % constitute more than 1 percent of the local adult population. Most municipalities had significantly fewer. 305 municipalities had no residents belonging to the top 1 %. About half of the municipalities had at least a single individual among the top 1 %. There are 81 municipalities that have at least one person included in the national top 1 %. About 75 percent of the municipalities are located in Southern Norway, and nearly all are located either in eastern Norway or along the coast. Of the 81 municipalities, 52 are cities of varying sizes, 22 are suburbs and the remaining 7 are periphery.

The suburbs are found around five cities: Oslo, Bergen, Tønsberg and Arendal. If we look at the economic geography of these areas, some facts stand out. Oslo and Bergen were Norway's largest cities and the country's main centres of economic activity. Tønsberg is close to Oslo, but also had large shipping and whaling industries (Hodne & Grytten, 2002). Industrial towns also stand out. In Arendal, Sam Eyde and Norsk Hydro had established new industry using hydroelectric power to smelt silicon carbide and aluminium. Likewise, Tinn in Telemark lights up. Here, Norsk Hydro had established a chemical fertilizer industry using hydroelectric power. Høyanger lights up as the only municipality in Sogn og Fjordane county. Here, the Norwegian Aluminium Company had established a hydropower plant and a large factory in 1916. A single municipality stands out in interior Aust-Agder: Tovdal, with a total population of 234 and four top 1 percent income-earners. Together, these four people earned 86,500 NOK. We have not managed to find any explanation; the observation might be an anomaly in the data.

If we also look at municipalities where between 0.5% and 1% belong to the national top 1%, we find a large cluster of municipalities in eastern Norway. Some municipalities neighbouring cities light up in the rest of the country. The industrial towns of Odda and Etne light up in Hordaland county, while Leikanger, the local county capital, lights up in Sogn og Fjordane.

Summing up, we see that top incomes were very unequally distributed geographically, even when taking into account differences in population size.

Map 2: Top 1% individuals as a share of the local population 1929.

Note: Lower values than 0.5% are not shown. The map shows the percent of the local adult population (excluding wives) who have top 1% incomes in 1929. The cities Bodø, Svolvær, Mosjøen, Sandnessjøen, Harstad, Vadsø, Narvik, Hammerfest, Vardø, Mo i Rana and the municipality Berlevåg have more than 1%, but are outside the map.

5.5 Do comparisons make sense?

Historical comparison is difficult as we can never eliminate all potential sources of error. Even cross-sectional comparisons within Norway encounters problems, and should be interpreted with caution. Differences in the lowest taxable income, the share of people filing tax returns and low valuation of payments in kind could introduce noise and systematic bias in the results. We also need to keep in mind that interpolation works less well with municipalities with small populations.

Comparison across countries run even higher risks of error, and current comparisons will only be superficial. Few estimates exist, and these estimates are likely to have many of the same data difficulties that we found in the Norwegian data. Without a systematic review of all estimates and their sources, we cannot be sure that they are comparable, and we cannot be sure of their margin of error. The estimates are likely to be very sensitive to assumptions made about the part of the population which did not pay tax, but also each country's tax system and country-specific effects.

It is also difficult to compare early 20th century Norway with inequality levels today. This is for somewhat different reasons. First, modern inequality measures and definitions usually differ from the ones we can hope to construct from historical data. It is not straightforward how modern measures should be adjusted for comparability. Concepts used today, such as equalized household income, increase accuracy. Calculating modern series on the basis of historical definitions (e.g. tax units) might introduce noise or bias which modern methods have resolved.

Even more importantly, historical data and modern data probably have dissimilar types of bias. For instance, we know that low incomes were underreported historically because of the tax rules. Tax avoidance might also play an important part. New research indicates that the ultra-rich 0.01% in Scandinavia perhaps evaded as much 30 percent of personal taxes in the early 2000s (Alstadsæter, Johannesen, & Zucman, 2017). This is sufficient to have a significant effect on today's top income shares and inequality measures. How tax evasion has affected historical data is an unexplored field. What we do know is that the effect could be large. Historical national accounts assume that 15 percent of all taxable income was withheld from taxation (Statistics Norway, 1953). The newest estimates from Alstadsæter *et al.* indicate that

today, about 3 percent of personal taxes are evaded in Scandinavia, which is mainly by the rich.

Another problem arises from retained earnings. A hundred years ago, stock companies and impersonal entities were much less common, meaning that a larger share of business profits registered as individual income. As stock companies became more prevalent, a larger share of profits became retained earnings. Alstadsæter, Jacob, Kopczuk, & Telle (2016) find that accounting for retained company profits today roughly doubles the share of income going to the top 1%. They conclude that “*traditional measures of top income shares become misleadingly low, even when accounting for capital gains.*” Because businesses are organized differently today, inequality measures may not be directly comparable.

This could also be relevant when looking at historical developments over shorter periods of time, as growth in retained earnings could create an artificial downward trend. We have shown that the number of stock companies increased by a tenfold between 1890 and 1930. This could have shifted profits away from individuals and into stock companies, where profits not paid out as dividends will disappear from our income data on personal tax units.

Even if we could adjust modern measures to conform perfectly to historical definitions and correct for biases, a more fundamental issue would still be in play. The ultimate aim of earning income is gaining welfare. However, consumption opportunities today and a hundred years ago are vastly different. The connection between relative income and relative welfare might have changed. Comparing welfare over long periods of time is an important topic which we cannot pursue further here. Still, the reader should be aware of the problem of relating changes (or the lack of changes) in the income distribution to changes in the distribution of welfare.

6. Exploring Norwegian inequality

So far, we have only presented descriptive results. Next, we explore how our inequality measures relate to other economic variables. Particularly, we want to see if our estimates correspond to predictions from theory. We start by looking at shocks to wealth and top incomes over time. Then, we turn to the 1929 local Gini coefficients. Looking at the cross-section of Norwegian municipalities, we explore differences in local endowments and infrastructure, industrialization and emigration. The following analysis should not be interpreted as causal, but merely as a first venture into an uncharted territory.

6.1 The role of capital

Why did the very richest see their income shares decline, while the moderately wealthy top 10%-5% gained? To be among the latter, it would suffice to work as a junior official in a government ministry⁶. On the other hand, the top 0.5% consisted mainly of capital owners. Comparing 1892 and 1929 in Table 6, we find that the top 0.5% have lost more than a fourth of their top income share. Those among the top 10% to top 5% see steady gains, increasing their share by close to a fifth.

Table 6: Change in income shares

Year	10%-5%	5%-1%	1%-0.5%	0.5%
1892	100,0 %	100,0 %	100,0 %	100,0 %
1906	105,4 %	106,9 %	94,7 %	81,5 %
1913	108,9 %	105,9 %	98,4 %	90,2 %
1929	118,9 %	107,2 %	84,2 %	74,1 %

Note: Change in top income shares for different top income groups. Shares are normalized to 1892 levels (1892=100%) to better allow for comparison.

Piketty & Saez (2003) found that wealth often drives the change in top income shares. As wealth is strongly concentrated among the richest, a high share of capital income will go to this group. If wealth declines or returns decrease, the richest will be disproportionately affected. Three periods stand out when shocks to wealth might be large enough to affect income inequality. First, in 1899 a bubble burst in Kristiania's stock and real estate market, causing a significant economic downturn. Second, World War I induced a boom followed by large

⁶ See Grytten (2007) for wages classified by industry.

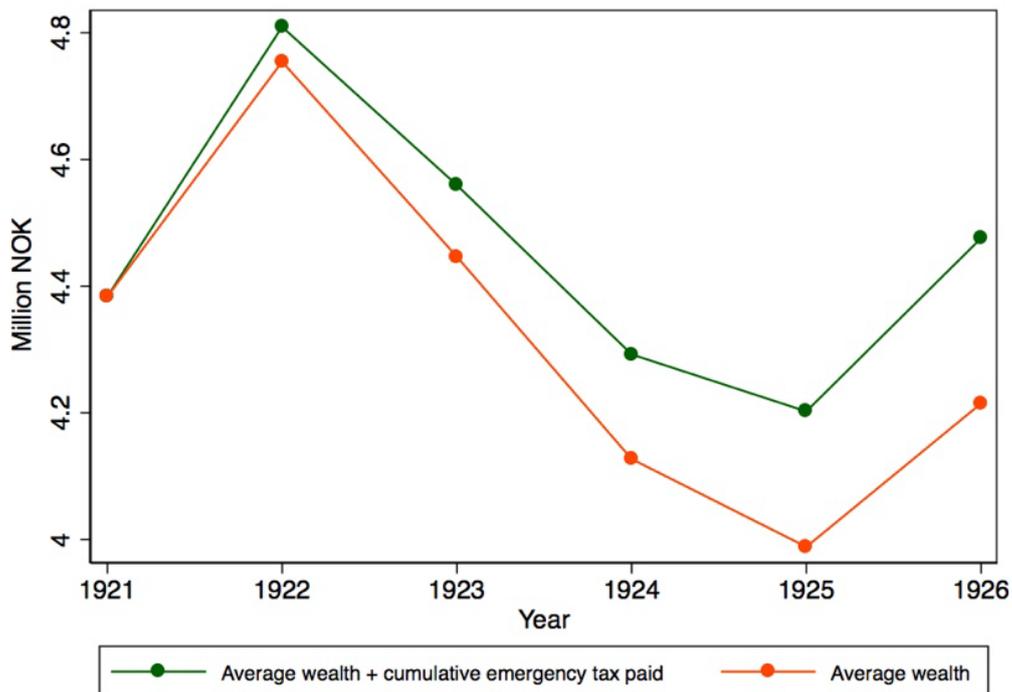
changes in nominal values and the real economy. Third, Norway experienced strong downturns during the 1920s and instituted a confiscatory emergency wealth tax. We will discuss these three events in order.

In 1894, a stock bubble started to build up in the capital Kristiania (Søbye, 1999). The number of stock companies rose rapidly, and real estate organized as stock companies was especially prevalent (Knutsen, 2008). The boom in Kristiania turned into a crash during summer 1899. From the crash to 1906, nominal wealth in Kristiania declined by about 20 percent, while income saw a more modest dip. Kristiania and her suburbs accounted for about a third of the top 1% income of tax units, so a local crisis could have had a large impact on national top income shares. With the current data, we know that top incomes including firms declined in Kristiania after the shock. Therefore, we believe it is probable that individual top income shares declined as well, and that the national top income shares declined as a result.

The year 1913 was the start of an economic upturn, which turned into a boom during the war (Statistics Norway, 2008). The business cycle might explain why top incomes among the 1% and 0.5% recover somewhat in 1913. We don't have data during World War I. Between 1913 and our next data point in 1929, there could be large fluctuations. During the war, top income shares in Denmark and Sweden show large increases (Roine & Waldenström, 2010; Atkinson & Sjøgaard, 2013). Written testimony from the war seems to indicate similar developments in Norway. Director at Kristiania county jail, Segelke Thrap, wrote the following (Statistics Norway, 1918):

During the war, disproportionately large fortunes were won in short time and concentrated in a few hands. This has rapidly transformed our society and brought forth a growing number of discontent people, who look at the better off with envy and malice. [Authors' translation]

The other contributors to the report seem to share Thrap's perception. Norway experienced great economic hardship between 1920 and 1929 (Hodne & Grytten, 2002). A post-war recession started in 1920, followed by yet another downturn from tight monetary policy. Unemployment reached unprecedented levels. An extraordinary wealth tax instituted in 1921 allows us to look at how wealth levels developed for Norway's 200 richest individuals, i.e. the upper part of the top 0.5%. Their real wealth decline by 11.3% from 1922 to 1926. This is shown in Figure 21.

Figure 21: Average wealth of the 200 richest individuals

Note: The development in average personal wealth for the 200 richest people in Norway. The red line shows nominal wealth, while the green line shows wealth plus emergency wealth tax paid.
 Source: Statistics Norway (1930).

The top marginal tax rate was 3% for the largest fortunes, with lower tax rates for smaller fortunes. The tax itself had a significant effect on total wealth among the richest, as shown by reversing the tax paid in the graph above. According to Piketty and Saez (2006), the combination of economic crises and high tax rates could have long-lasting and increasing effects on top incomes. By 1929, the top income share of the richest 0.5% was reduced to 74% of the share they received in 1892, which is a large drop from the top income share we find for 1913.

Generally, it seems plausible that destruction of capital explains at least parts of the changes in top income shares. However, we are not convinced that shocks to capital was the dominating force behind inequality. The Gini coefficients are relatively stable. Even if Piketty's theory on capital could explain what happens to the top of the income distribution, there are probably also other effects having an impact on inequality.

6.2 The role of land: Endowments and infrastructure

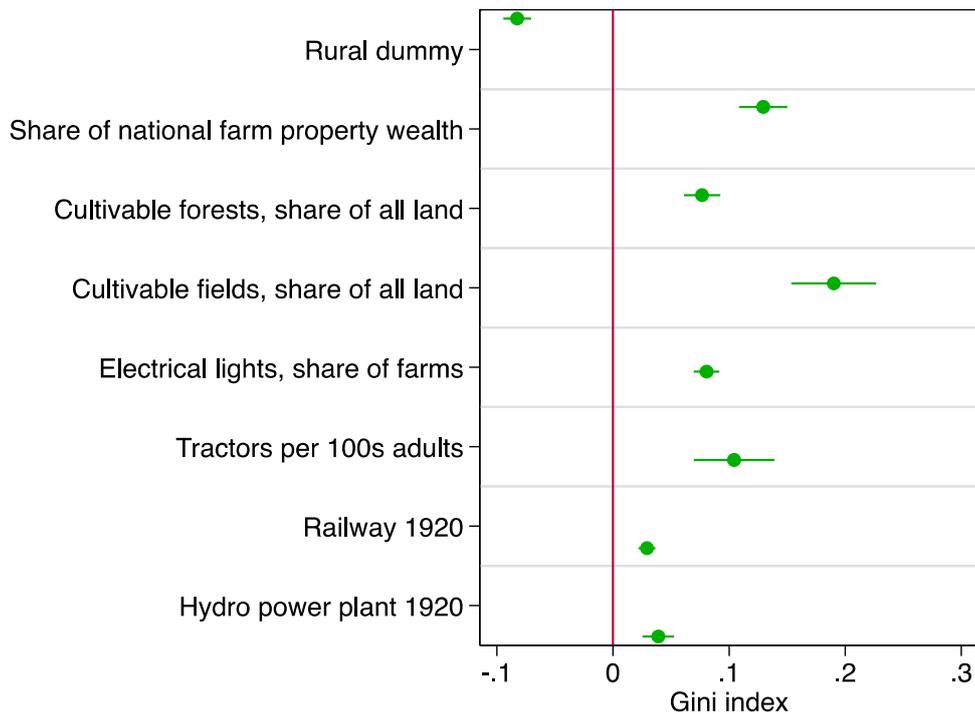
Modern economists often treat land as type of capital. Historically, land was regarded as an independent production factor with its own special characteristics. 19th century economist J. E. von Thünen formalized how rent (i.e. income from land) depends on the land's *first nature* and *second nature* (Krugman, 1993). The first nature is simply the yield of the land, while the second nature is the cost of transporting the yield to the market. Differences in these characteristics would result in different rents and thus income inequality. If municipalities differ in respect to these characteristics, this would lead to inequality between the municipalities. But as land and capital is unevenly distributed, higher land rents could easily lead to more income inequality also within each municipality. We will explore these mechanisms using univariate analysis. The regression equation is given by:

$$(1) G_i = \beta_0 + \beta_1 X_i + \varepsilon_i$$

where G_i is the local Gini index in municipality i , β_0 an intercept, X_i the covariate, β_1 the correlation and ε_i the idiosyncratic error term. We sometimes extend the analysis with county-fixed effects to check if the effect remains constant within smaller regions:

$$(2) G_i = \beta_0 + \beta_1 X_i + \sum_{i=1}^{20} \text{County}_i D_i + \varepsilon_i$$

Regarding the role of land, we will only look at rural municipalities as cities had little or no agriculture. We note that rural municipalities on average had a 7-percentage point lower Gini index than cities. However, there were even larger differences within the rural group. The share of cultivable fields and forests can be thought of as a proxy for the land's first nature. We see in Figure 22 that both are highly correlated with increased income inequality. This correlation persists, even if we control for county-fixed effects. This is what we would expect from theory.

Figure 22: Endowments and infrastructure

Note: Univariate regressions on the Gini index. The first and the two last covariates are dummy variables. The dots indicate point estimates, while the lines indicate 5% confidence intervals. Tractors are per 100 adult men and women. **Blue:** Cities. **Green:** Rural

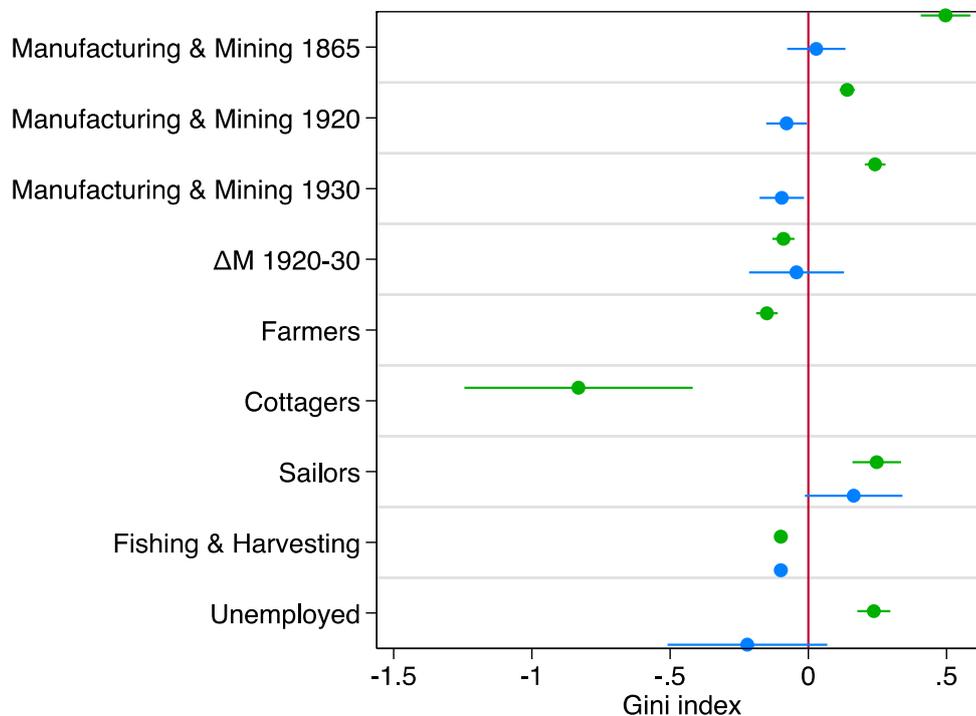
A railway connection would reduce transportation costs and improve the land's second nature. Electrical lights and motorization would do the same. We see that all these measures are correlated with increased inequality. However, we cannot rule out reverse causation, i.e. central areas getting these improvements first.

The share of national farm wealth is based on the sale values between 1926 and 1929 in the municipality, and should pick up both yield and transportation costs. As expected we see that farm wealth is positively associated with income inequality. Hydro power plants, which would give land owners new sources of rent, are also positively correlated with inequality. Such power plants were often connected to industrialization, to which we turn next.

6.3 The role of industrialization

Kuznets (1955) hypothesized that income inequality would first increase and then decrease with industrialization, giving rise to an inverted u-shaped relationship between economic development and inequality. Between 1892 and 1929, inequality rose strongly in the countryside, bringing about convergences with the cities. In this period, Norway experienced her industrial breakthrough, where new industrial towns centred around hydropower in remote areas were a major force (Venneslan, 2007; Grytten & Hodne, 2002). In an area with little prior industry, the Kuznets hypothesis predicts that inequality would increase once industrialization begins. The development in the countryside would therefore be in accordance with the Kuznets hypothesis. We see that inequality falls slightly in cities. If cities had industrialized during earlier industrialization waves, as some economic historians believe, we should expect cities as a group to develop differently than rural areas. We also need to keep in mind that the Kuznets hypothesis assumes the existence of an agricultural sector. From the employment data, we see that cities had little or no agriculture, so we should not expect Norwegian cities to follow the Kuznets curve.

Figure 23: Male employment shares



Note: Univariate regressions on the Gini index. Units are in shares of all adult men in the municipality. The dots indicate point estimates, while the lines indicate 5% confidence intervals. **Blue:** Cities. **Green:** Rural

Local covariates give some support for this notion. Looking at Figure 23, we see that employment shares in manufacturing in 1920 and 1930 are associated with higher inequality in the countryside and lower inequality in the cities. Local regression indicates a non-linear relationship between inequality and manufacturing in the countryside, where inequality first increases and then stabilizes when industrial employment passes 30 percent. For cities, there is a linear decreasing relationship.

If we look at early industrialization (i.e. the share of men working in manufacturing in 1865), this measure is associated with higher inequality in the countryside. This is contrary to what we should expect from the Kuznets hypothesis. On the other hand, nearly all the rural municipalities in question had low manufacturing shares, so it is perhaps not correct to interpret this covariate as proper industrialization. The change in manufacturing between 1920 and 1930 also seems in conflict with the Kuznets curve, with changes in manufacturing shares being correlated with lower inequality in the countryside. However, local regression reveals a u-shaped pattern. Rural municipalities which strongly reduced their manufacturing employment have high levels of inequality, and so did municipalities which strongly increased manufacturing employment. If we restrict the sample to only include municipalities with positive growth in manufacturing, that growth is correlated with higher inequality. A 1 %-pp. increase from 1920 to 1930 is associated with a 0.22 pp. increase in the local Gini coefficient.

Employment in primary industries such as agriculture and fishing and harvesting is correlated with lower income inequality, which is what the Kuznets hypothesis assumes. The share of cottagers (Norwegian: "*husmenn*"), i.e. poor farmers with small plots of rented land, is strongly correlated with lower inequality. The system of cottagers disappeared between 1900 and 1950, and a high share of cottagers might indicate low levels of economic development (Grytten & Hodne, 2002). On the other hand, we cannot rule out reverse causation. Agriculture was particularly prevalent in western Norway and fishing and harvesting in northern Norway, both of which were regions with less inequality. The correlation of primary industries with equality could be caused by more equal wages within these industries, but it is also possible that payments in kind and self-sufficiency farming affects valuation, artificially reducing income inequality.

The share of unemployed is positively correlated with inequality in the countryside and negatively correlated in cities. If we look closer at the countryside using local regression, we see that inequality increases together with unemployment, but then levels out when

unemployment hits 17 percent. Geographic factors might account for the effect: In western Norway and northern Norway, there are rural municipalities with both low unemployment and low inequality, where employment is mainly in farming and fishing. In central eastern Norway, there are rural municipalities with high inequality and high unemployment in manufacturing and services. Finally, in the northern part of eastern Norway, there is very high unemployment in forestry, but lower levels of inequality.

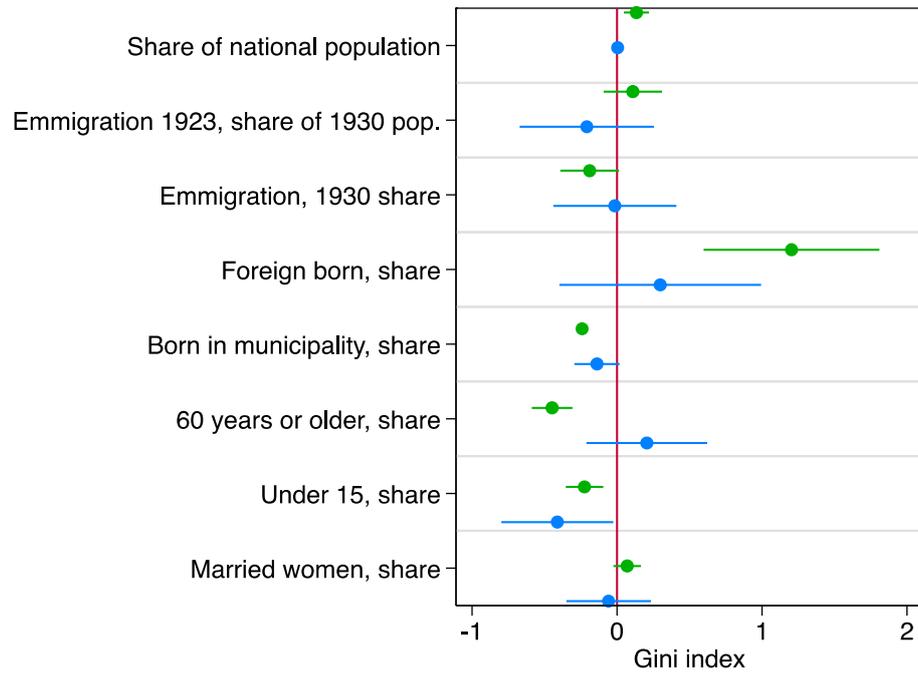
Because we only have correlational evidence, we cannot conclude in favour of the Kuznets hypothesis. However, the idea that rural industrialization lead to increased rural inequality and convergence with cities is worth to investigate further.

6.4 Emigration and demography

Next, we turn to overseas emigration. We have included overseas migration in 1930 as a share of the local population. We also include 1923, which according to the numbers was the last large emigration wave. We have little reason to believe overseas migration determined local inequality. Rather, we expect the correlation to run the other way. According to the Roy model of migration, high-ability individuals would migrate from areas with low inequality to areas with higher inequality, where their payoff would be higher (Borjas, 1987). Most overseas migration from Norway was to the US. If we believe the US to have higher inequality than Norway, we should see positive selection, i.e. migration from areas with lower inequality.

In Figure 24, we see that overseas migration in 1930 is correlated with lower inequality in the countryside at a 10% confidence level. There is no correlation looking only at cities. Migration during the 1923 migration wave is not significant at all. The share of foreign born (i.e. immigrants from other countries) is correlated with higher inequality in the countryside. The effect is insignificant in cities. The share of residents born in the same municipality (i.e. few immigrants) is associated with lower inequality, both in cities and the countryside.

For reference, we have included three pure demographic variables. The share of children is correlated with lower inequality. So is the share of people older than 60 in the countryside. A larger population is associated with slightly higher inequality in the countryside, but is not significant in cities. Because married women were taxed together with their husbands, differences in the marriage share might affect estimated inequality. However, the share of married women is statistically insignificant.

Figure 24: Emigration and demography

Note: Univariate regressions on the Gini index. The units are in shares. Emigration is overseas emigration, i.e. out of Europe. The dots indicate point estimates, while the lines indicate 5% confidence intervals. **Blue:** Cities. **Green:** Rural.

7. Robustness and sensitivity

We develop a model to analyse the sensitivity of the national Gini index estimates. We show how the Gini index varies when changing the main assumptions: the average income of non-taxpayers, the estimated size of the population, and inequality within the non-taxpayer group. We also discuss what would be reasonable bounds on each assumption. Lastly, we discuss the robustness of the municipal level Gini estimates and estimates of stock dividend.

7.1 A model for sensitivity analysis

Soltow (1965), Aaberge *et al.* (2016) and Kiær (1910; 1915) all used different assumptions about the non-taxpayers. We have developed a model with four parameters to analyse how sensitive the Gini index is to changing assumptions.

The Gini index (G) for the complete income distribution is given by the following formula:

$$G = AB \times G^{**} + (1 - A)(1 - B) \times G^* + B - A + r$$

G^* is the Gini index for taxpayers

G^{**} is the Gini index for non-taxpayers

A is the share of income earned by non-taxpayers

B is the share of non-taxpayers in the population

r is a small, positive residual occurring if the incomes of taxpayers and non-taxpayers overlap.

The derivation of the model is shown in the mathematical appendix. The model is illustrated in Figure 25 within the framework of a Lorenz curve. The baseline parameters of the model are calculated from Kiær (1910, 1915) and presented in Table 1. We will test how the Gini index changes when changing A , B and G^{**} . The Gini for taxpayers (G^*) is defined by the income distribution for taxpayers and will not be changed.

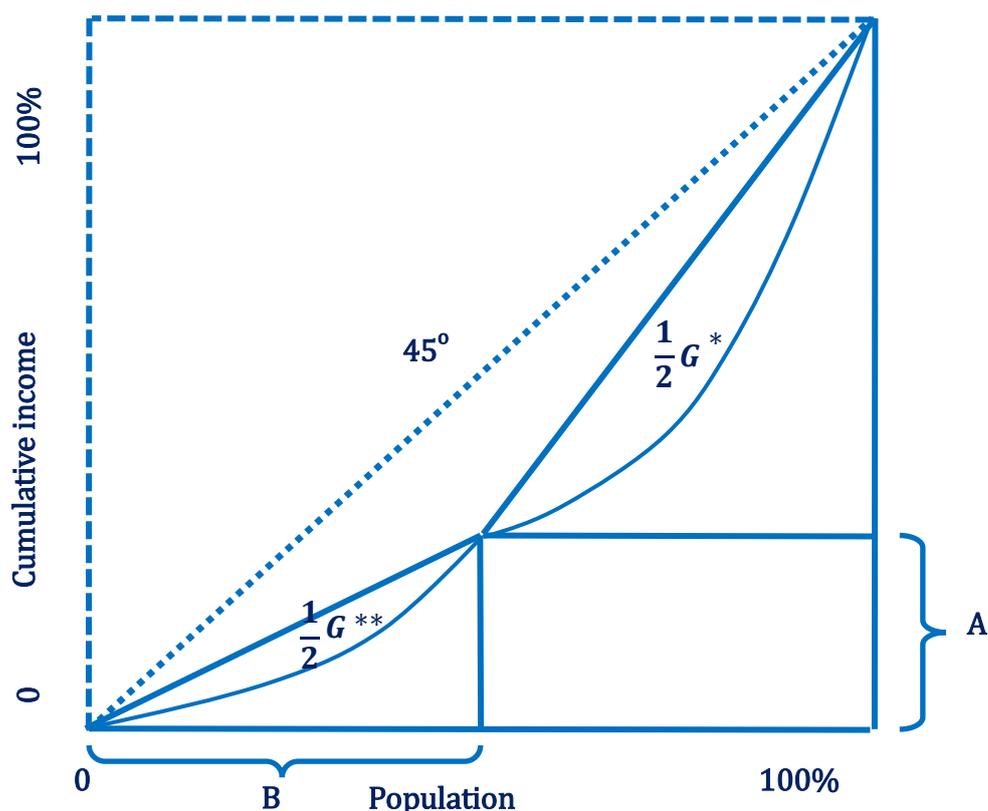


Figure 25: Outline of the model for the Gini index within the framework of the Lorenz curve. The model splices data on taxpayers with assumptions on the income of non-taxpayers. The parameters are defined on the previous page.

7.1.1 A – the share of income earned by non-taxpayers

The share of income earned by non-taxpayers (A) depends on their average income holding other factors constant. We plot the Gini index as a function of average income of non-taxpayers. As a purely theoretical lower bound we use an average income of zero for non-taxpayers in the data. The average incomes assumed by Soltow (1965) and Aaberge *et al.* (2010; 2013) are listed for reference in appendix G.

7.1.2 B – the share of non-taxpayers in the population

The number of non-taxpayers is a residual which is decided by how we define the total number of income earning units. Kiær (1910; 1915) and Aaberge *et al.* (2016) approximated all income earning units by subtracting married women from the adult population. We follow the same approach and use the estimates created by Kiær for 1892, 1906 and 1913, and the estimate by

Aaberge *et al.* for 1929. To measure sensitivity, we plot the Gini index as a function of the population estimate.

As a purely theoretical lower bound, we assume zero non-taxpayers. The Gini index would then be identical to the Gini index of the taxpayers. A lower bound which is extreme, but not impossible, is to set the number of income earning units equal to the number of employed heads of households. The last option assumes that every household head not working is voluntarily unemployed and should be segregated from the income distribution. We derive the number of employed head of households using linear interpolation between census years.

7.1.3 G^{**} – the Gini index for non-taxpayers

We have derived the Gini for non-taxpayers (G^{**}) from Kiær's estimate of the income distribution for non-taxpayers. We plot the Gini index as a function of the Gini index for non-taxpayers, letting G^{**} vary from 0 to 1. For 1929, the Gini is derived from our approximation of the income of non-taxpayers in each municipality. This is explained in the chapter on methods. Alternatively, one could use the Gini from 1913. As we will show in the sensitivity analysis, this will have close to no effect.

7.1.4 Table of baseline model assumptions

We summarize our baseline assumptions in Table 7 below:

	A(x,z) The share of income earned by non-taxpayers	x Average income of non-taxpayers	B(z) The share of non-taxpayers in the population	z Estimate of all income earning units	G* Gini for taxpayers	G** Gini for non-taxpayers
1892	47.12 %	259	83.17 %	985,017	44.0946 %	30.5767 %
1906	60.59 %	349	91.06 %	1,133,197	40.1234 %	36.9019 %
1913	13.27 %	242	37.28 %	1,230,511	49.6575 %	36.6857 %
1929	12.44 %	550	35.16 %	1,368,062	51.5103 %	11.9992 %

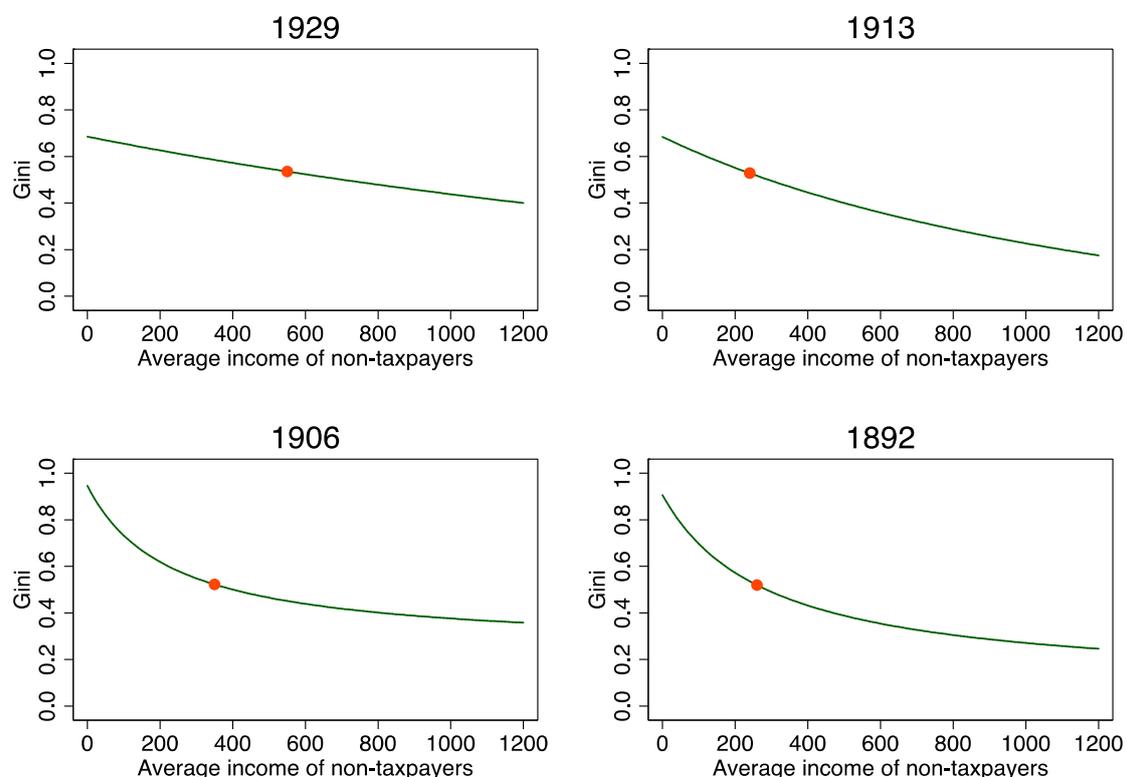
Table 7: The table shows the baseline parameters for the sensitivity analysis model of the Gini index. We will later analyse sensitivity by letting x , B , z and G^{**} vary.

7.2 Sensitivity analysis

7.2.1 Changing the average income of non-taxpayers

The most sensitive parameter is the average income of non-taxpayers. As we can see from Figure 26, the Gini is particularly sensitive in 1892 and 1906 where the taxpayer group only consists of those who paid state tax. For 1913 and 1929 the taxpayer group also consists of those who paid municipal tax.

Figure 26: Average income of non-taxpayers



Note: The Gini index for the complete income distribution plotted for different values of the average income of non-taxpayers. The baseline estimate is marked by a red dot.

According to Kiær (1910), the average income of non-taxpayers in 1892 was 259 NOK, which results in a Gini index of 52 percent. If we increase the average income by 100 NOK, the Gini index falls to 45 percent. This is significantly lower. If we decrease by 100 NOK, the Gini index rises to 61,55 percent. Interestingly, this is lower than the Aaberge *et al.* (2016) estimate of the lower bound on the Gini this year.

When considering what average income level would be reasonable, we should look at wage statistics and which part of the population belonged to the non-taxpayer group. Wage numbers will not be completely comparable to net incomes from the tax data, as the income definition used by the tax authorities is typically smaller than reported in the wage statistics. However, the wage statistics is the best available point of reference. Kiær assumed the difference between the tax data and wage statistics for low income earners to be 6 percent in cities and 19 percent in the countryside (1910).

In 1895, the average wage of a male farm assistant (Norwegian: *tjenestegutt*) in the countryside was 356 NOK, including the value of room and board (Statistics Norway, 1899). The average wage for a male assistant (Norwegian: *tjenestegutt*) in a city was even higher at 532 NOK. According to the 1894 wage survey (Den parlamentariske arbeiderkommission, 1899), male cottagers had an average income of 541 NOK. For rural labourers, the average wage was 481 NOK.

In 1892, 83 percent of income earning units are non-taxpayers. In other words, Kiær's estimate assumes that 83 percent of the relevant population on average earned less than a rural farm assistant and significantly less than a rural worker, even after adjusting the wage numbers down for comparability. Underemployment could lead to average incomes being lower than wage figures suggest. However, this should have been picked up by the income survey, where people were asked about their actual income. In our view, there could be reasons to believe that the average income that follows from Kiær are too low.

Table 8: Baseline estimate for non-taxpayers and wage statistics

	Share, non-taxpayers	Baseline av. wage	Male farm assistant av. wage	Assistant (cities)	Smallholder farm, family income
1892	83 %	259	356	532	
1906	91 %	349	430	600	
1913	37 %	242	660	-	2030
1929	37 %	550	519	-	

Note: The table compares our baseline average income for non-taxpayers with wage statistics for assistants and a smallholder farmer. We also show how large part of the adult population (excluding married women) belonged to the non-taxpayer group. All incomes in nominal NOK. Wage sources: Statistics Norway (1899; 1908; 1917; 1918; 1930).

For the following years, we find similar disparities between the baseline average wage and wage statistics on low income groups. By 1905, the average wage of a farm assistant in the countryside had increased to 430 NOK per year (Statistics Norway, 1908). In cities, it had increased to 600 NOK. Our baseline estimate from Kiær in 1906 is an average income of 349 NOK for non-taxpayers, yielding a Gini index of 52 percent.

In 1906, 91 percent of the units did not pay state tax. This means that we have a non-taxpayer population of about 1 million units. Again, it seems unreasonable to us to assume that the average income of this group is lower than the average wage of a rural farm assistant. If we increase the average income by 100 NOK, the Gini index falls to 48 percent. If we reduce it by 100 NOK, it increases to 58 percent.

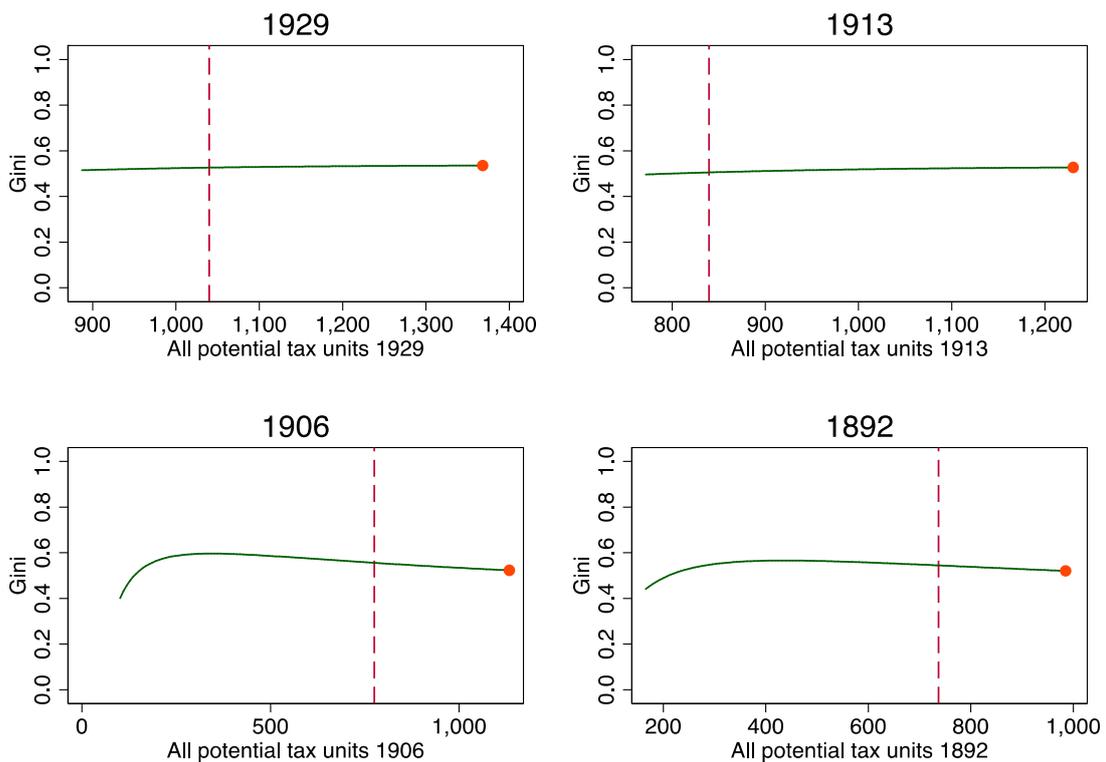
In 1913 and 1929, the tax data covers a much larger part of the population and more of the lower incomes, but the Gini index is still sensitive. Now, non-taxpayers only constitute 38 percent of the units. The average income baseline for 1913, based on Kiær (1915), is 240 NOK. This yields a Gini index of 54 percent. If we increase the average income by 100 NOK, then the Gini index falls to 47.5 percent. If we reduce the average income by the same amount, the Gini index increases to 59 percent. In 1929, we assume an average wage of non-taxpayers of 550 NOK. Non-taxpayers constitute 35 percent of the units. The baseline estimate yields a Gini index of 54 percent. If we increase the average income by 200 NOK, then the Gini index falls to 49 percent. If we reduce the average income by the same amount, the Gini index increases to 59 percent.

Altogether, we find that the Gini is highly sensitive for changes in the assumption about the average wage of non-taxpayers throughout the period. The baseline estimates we use could be too low. The sensitivity analysis shows large variation in the Gini index within a reasonable range of potential average incomes. Without more information on low-end incomes, it is unattainable to precisely identify the level of Gini index. More information on the incomes of non-taxpayers would help narrow in the possible range of the Gini index, and should be a priority for future research.

7.2.2 Changing the population

The Gini index is insensitive to the number of income earning units within reasonable bounds. The sensitivity analysis is shown in Figure 27. The number of non-taxpayers is a residual, which is determined by subtracting taxpayers from the estimated total number of income earning units. Our baseline is to subtract married women from all persons aged 15 or older. This would be an upper bound on the number of income earning units. As an ultimate lower bound, we use the number of employed heads of households. Using this employment figure instead would imply a 2 percentage points increase in the Gini in 1892 and 3 percentage point increase in 1906 and 1913. In 1929, it would imply a 3-percentage point reduction in the Gini. Note that the Gini index is insensitive within reasonable bounds, but not for the most extreme values. On its own, the Gini index of taxpayers is not a good approximation of the Gini index of the complete income distribution.

Figure 27: Estimate of income earning units

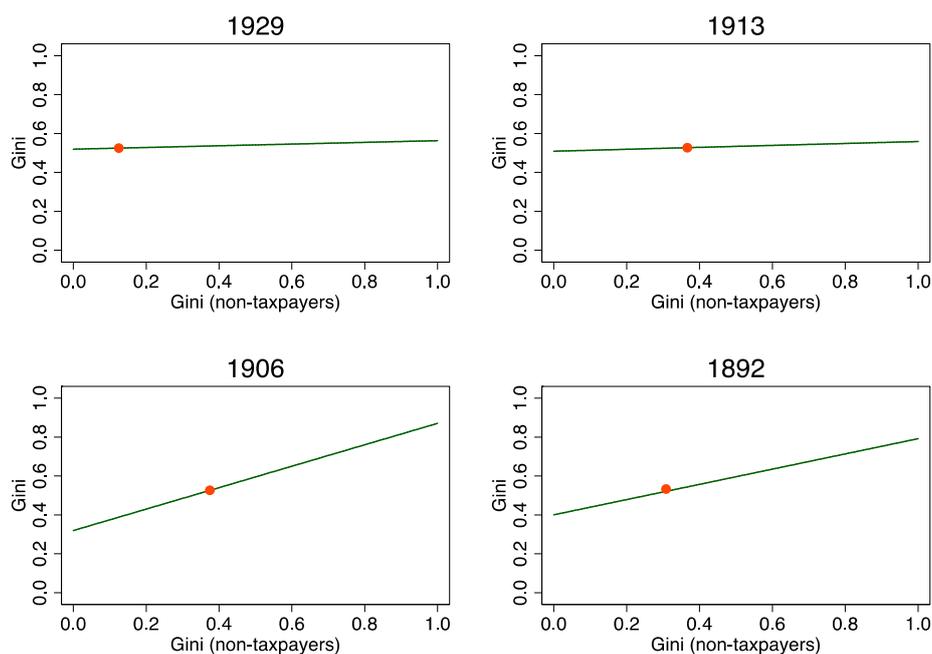


Note: The Gini index for the complete income distribution plotted for different values of all income earning units. Employment of head of households indicated by the lines. The baseline estimate is marked by a red dot.

7.2.3 Changing the Gini of non-taxpayers

The full Gini index is insensitive to the Gini index of non-taxpayers in 1913 and 1929, as shown in Figure 28. These years, a 10-percentage point change in the Gini of non-taxpayers changes the full Gini by less than 1 percentage point. When the taxpayers are the largest group by far, inequality between non-taxpayers matters little. The picture changes when taxpayers are a small minority in the data. This is the case the first two years. In 1906, a 10 percentage point change leads to a 5.5 percentage point change in the full Gini, while in 1892 it leads to a 3.9 percentage point change. These are significant effects. However, assuming that Kiær's estimate of the non-taxpayer income distribution is approximately right, the point estimate will be robust. It is likely that Kiær used tax data from the municipal tax, as well as the 1894 survey data, meaning that he had data on a large fraction of the population.

Figure 28: Gini index of non-taxpayers



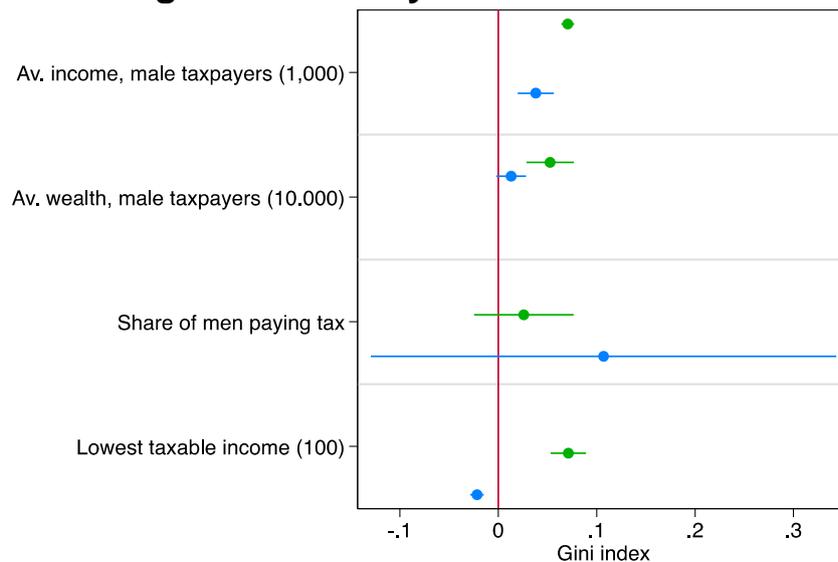
Note: The Gini index for the complete income distribution plotted for different values of the Gini index of non-taxpayers. The baseline estimate is marked by a red dot.

7.3 Local robustness

As an informal robustness check, we can see how the local Gini coefficients correlate with the tax data. If the correlations have other signs than we would expect, this would be cause for alarm. We see that higher average income of taxpayers is correlated with higher inequality, which is as expected. High-income individuals push up both average incomes among taxpayers and total inequality. Likewise, we should also expect higher average wealth to be correlated with higher income inequality. The share of men paying tax is not significant, as we should expect when the Gini is insensitive to the population definition.

As we use the lowest taxable income when estimating the income of non-taxpayers, a strong correlation could indicate that local variation was driven by our assumptions. We assume that the average income of non-taxpayers increases with the basic tax allowance. If the assumed increase is too low, this would bias the local Gini index upwards, and vice versa. The negative correlation in cities is driven by three outliers in northern Norway with very high basic tax allowances. If we remove the outliers, lowest taxable income is not statistically significant in cities. The positive correlation in the countryside could indicate that our rural Gini estimates are too high for municipalities with high basic tax allowances. However, correlation could also be due to other reasons, such as regions with social problems raising the tax allowance to help those with low incomes.

Figure 29: Tax system covariates



Note: Univariate regressions to the local Gini index. The units are either shares or 100, 1,000 or 10,000 NOK. The dots indicate point estimates, while the lines indicate 5% confidence intervals. **Blue:** Cities. **Green:** Rural

7.4 The sensitivity to dividends

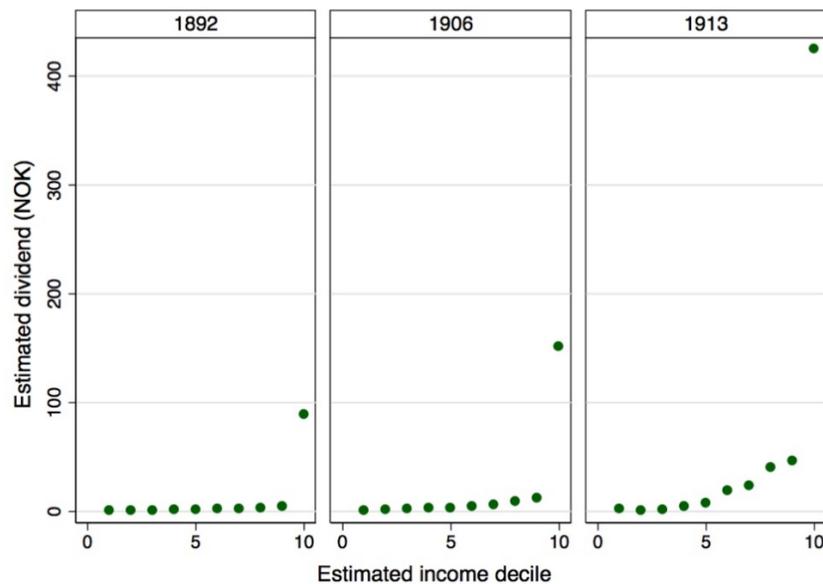
As stock dividends are not a part of registered income before 1921, we estimate dividend income for earlier years using the approach proposed by Kiær (1910). This estimation of dividends is sensitive to three factors.

1. The assumed total stock capital.
2. The assumed dividend pay-out ratio
3. The distribution of stock capital

The two first factors affect measured inequality in the exact same way. A 10 percent increase in the dividend pay-out ratio is equivalent to a 10 percent increase in total stock capital. We estimate the size of stock capital as being equal to the total wealth held by stock companies. Using this approach, stock capital increased by 94 percent from 1892 to 1906 and 136 percent from 1906 to 1913. Dividend pay-out is assumed to be 6 percent of stock capital for 1892 and 1906, and 8 percent for 1913.

We do a simple plot to check if the resulting estimates look reasonable over time and across income groups. Figure 30 plots average estimated dividend per income decile for 1892, 1906 and 1913. As we would expect, dividends increase over time as the number of stock companies increase. It is reassuring to see that the effect is by far largest for the top decile.

Figure 30: Mean estimated dividend per decile 1913



Note: We estimate mean dividend per decile for 1913. Estimated dividend is based on the method proposed by Kiær (1910). The income control totals used are our own, based on estimates from Kiær (1910; 1915)

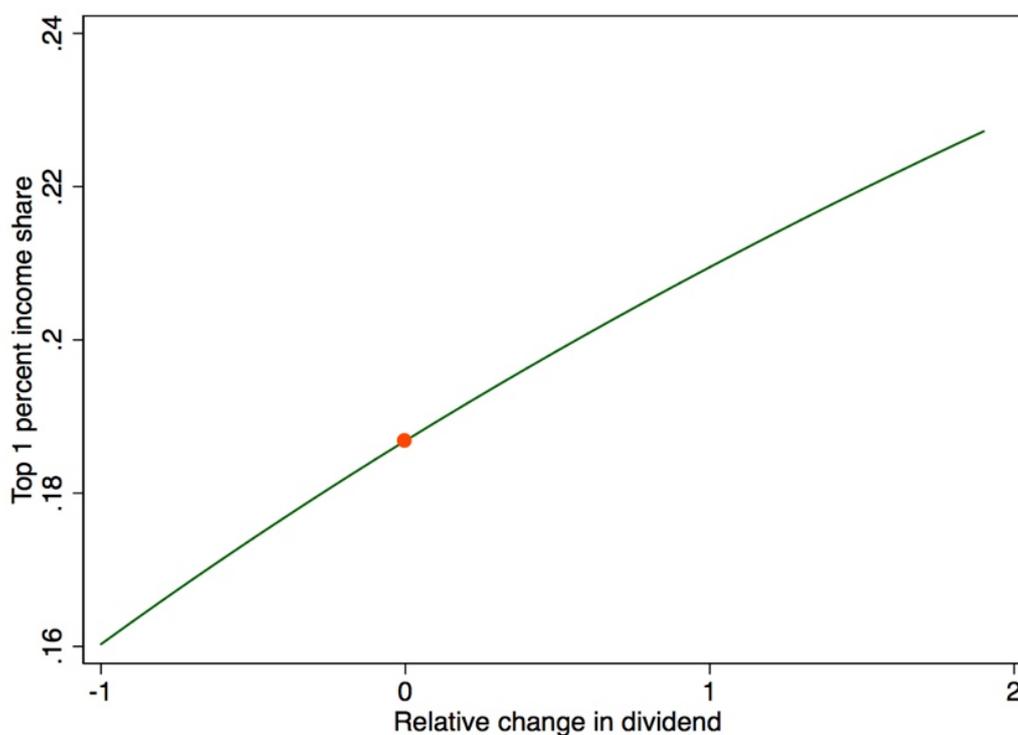
We will in the following section focus on top income shares, as they are more sensitive than the Gini index. We come back to the Gini index at the end of this chapter. 1913 is the year where stock dividends have the largest impact, and we therefore focus on this year.

First, we analyse the effect of changing the size of total dividend. X is the percentage change in dividends stemming from the change in the pay-out rate or total stock capital.

$$\text{Top income share} = \frac{(\text{top income, exc. dividends}) + \text{top dividende} \times (1 + X)}{(\text{total income, exc. dividends}) + \text{total dividende} \times (1 + X)}$$

In Figure 31, we see that the top 1 percent income share is sensitive only to large changes in total dividends. Changing total dividends with +/- 50 percent causes a +/- 1 percentage point change in the top 1 percent income share. Total stock capital and the dividend pay-out rate is retrieved from official statistics, which is not likely to deviate too much from the actual numbers. Kiær discusses this at length in the publication *Norske aktieselskaper 1892 og 1906* (Kiær 1910, p. 40-47).

Figure 31: Top income share sensitivity 1913



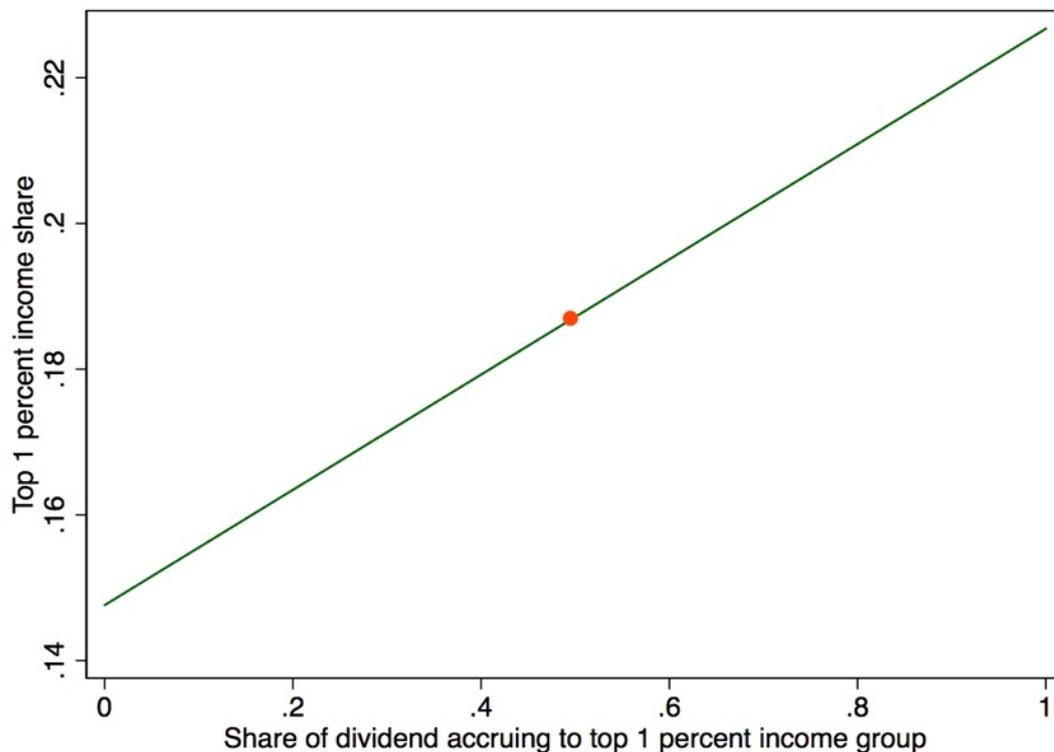
Note: Top 1 percent income share in 1913 for various changes in total dividends. -1 is a 100 percent reduction, while 2 is a 200 percent increase in total dividend. The income control total used is our own, based on estimates from Kiær (1910). The baseline estimate is marked by a red dot.

Next, we analyse the effect of changing the distribution of stock capital. Using Kiær's approach, stock capital is proportionally distributed with wealth (Kiær, 1910). In the formula below, Y is the share of dividend going to the top income group. As the variable Y is only in the numerator, the function is linear.

$$\text{Top income share} = \frac{(\text{top income, exc. dividends}) + \text{total dividende} \times Y}{(\text{total income, exc. dividends}) + \text{total dividende}}$$

Figure 32 reveals that the top 1 percent income share is sensitive to the distribution of dividends. The baseline estimate is marked by a red dot, representing what the income share would be if the distribution of stock wealth is proportional with wealth. The absolute upper bound would be to assume that all income accrued to the top 1 percent. In the case of 1913, this would lead to a top 1 percent income share of above 22 percent. We believe that the baseline assumption from Kiær is close to a lower bound. Therefore, top 1% incomes are probably somewhat underestimated before 1921.

Figure 32: Top income share sensitivity 1913



Note: Top 1 percent income share in 1913 for various changes in the share of dividends going to the top 1 percent. The income control total used is our own, based on estimates from Kiær (1910). The baseline estimate is marked by a red dot.

Lastly, we show the effect of including dividends on the Gini index. We calculate the Gini both before and after dividends for 1892, 1906 and 1913. As we would expect, the effect of dividends increases over time as the number of stock companies and dividend pay-out ratio increase. As discussed above, we believe that dividends are too equally distributed using Kiær's approach (1910). The implication is that these estimates could be a bit too low. The bias is likely to increase until 1921, when dividend tax is introduced.

Table 9: Gini index sensitivity

	1892	1906	1913
Including estimated dividends	52,0 %	52,3 %	54,2 %
Excluding estimated dividends	51,2 %	51,0 %	51,8 %
Difference	0,8 %	1,3 %	2,4 %

Note: The Gini index for all years where stock dividends are not included in the original data. Dividends are estimated using assumptions from Kiær (1910).

8. Concluding remarks

8.1 What we have learnt so far

Norway has been a large welfare state since the 1960s, something that many emphasize when explaining Norwegian income equality (Hodne & Grytten, 2002). However, is Norwegian equality a result of the post-war welfare state or did it exist earlier? The answer to these questions could have important implications as policymakers look for the best ways of reducing inequality. To understand the cause of Norwegian equality, we need to know when it first developed.

In this thesis, we estimate Norwegian income inequality in 1892, 1906, 1913 and 1929. We estimate pre-tax, pre-transfer Gini coefficients and top income shares for Norway using historical tax data and data on low incomes. We analyse how the level of inequality changed over time and decompose inequality for different segments of the population. For 1929, the data allows us to create local-level estimates for each municipality. Compared to previous research, we benefit from better data and more advanced estimation techniques. We identify several data weaknesses that have caused bias in previous studies. Much of the data previously used does not distinguish between individual taxpayers and impersonal entities such as stock companies and banks. Another weakness is that before 1921, dividends were not included in the income data. We correct for this, using only data on individual taxpayers and estimate dividend income where this is not already included.

We find that the pre-tax, pre-transfers Gini index is stable for the years we analyse, starting at 52 percent in 1892 and ending at 54 percent in 1929. The top 1% income share before taxes and transfers falls over time, falling from 19 percent in 1892 to 12 percent in 1929. We find that shocks to wealth might play a role in this development. Our results differ significantly from previous studies. First, we find a Gini index lower than Aaberge, Atkinson and Modalsli (2016). Second, we find lower top incomes and a different development over time than Aaberge, Atkinson and Modalsli (2013). In terms of income, our results suggest that Norway was already among the most equal countries in Western Europe between 1892 and 1929. However, our estimates are sensitive to the size of total income and to the estimation of stock dividends. Historical estimates from other countries are likely to be sensitive too, leaving a considerable risk of error when comparing. We nonetheless believe this thesis represents the best estimates available at this time.

8.2 Future research

We believe the best way forward to obtain precise estimates and open up more areas for research is to digitize existing microdata. The Norwegian censuses, military records, tax records and printed tax books contain microdata stretching back in time. The tax records would cover all taxpayers, and contain microdata on income and wealth. The tax books have the advantage of being printed, and typically included name, address, occupation, wealth and income, but are not available for all counties for all years. We would still lack income and wealth microdata on non-taxpayers, but since we would be able to observe individual characteristics in the censuses, we could use econometric methods to create much more precise estimates of their income. Together with the tax data, this would give much more precise estimates for a much larger number of years. The microdata would also have the advantage of being able to follow the same individual over time, estimating life cycle earnings, correct for family size and compute age-adjusted measures of inequality. We could also correct for regional price differences and look into intergenerational mobility, emigration and other life outcomes. Norway possibly has the best data in the world on this period. In this thesis, we have scratched the surface of a largely unexplored field. The potential for future research is vast.

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10. Appendices

10.1 Appendix A: New local unemployment data 1 December 1930

We have recovered new local-level data on unemployment, which we use in the covariate analysis. The data was located 7 February 2017 in the form of handwritten books in Statistics Norway's archives in Kongsvinger. The books were located in folders from the 1930 census. It is reasonable to assume from the location that the data is from the 1 December 1930 unemployment survey, which was conducted together with the census. To assess validity, we compare the data with the official aggregate numbers published from the unemployment survey. The official numbers were published in 1933, and had probably undergone some revisions. We will also document how unemployment was defined.

10.1.1 How unemployment was defined

Gunnar Jahn, then managing director of Statistics Norway, published an article on the definition of unemployment together with the 1930 unemployment figures (Statistics Norway, 1933). According to Jahn, the term *unemployed* did not have an agreed-upon definition in 1930. The term had started to change during World War 1. Before the war, unemployment was mainly understood as factory workers in cities being unable to find paid work within their profession. After the war, the term was gradually extended to other vocations. Statistics Norway (1933) asserts that the change was caused by government policy, such as the creation of local employment agencies and relief work. By 1930, workers in agriculture and fishing had started to seek relief for seasonal unemployment. The article notes that seasonal unemployment is high in December, which affects the numbers. Still, the term *unemployed* was interpreted differently, even within the same municipality. Statistics Norway received widely different answers when people were asked about their employment status. The 1933 article illustrates the problem by pointing to a district where all male inhabitants declared they were unemployed. In another bordering district, none declared themselves unemployed.

To make numbers more comparable, Statistics Norway (1933) excluded certain groups of people from the figures. Only people who were 15 years or older, who had earned a wage, and who declared themselves as unemployed at 1 December 1930 were included. Statistics

Norway also made some arbitrary exclusions, which are not fully explained in detail. Delimitations described are in the table:

Table A1: The unemployment definition

Included	Excluded
Wage earners	Small business owners
Liberal professions (e.g. doctors)	Self-employed fishermen
Young people who had not found a vocation	Young people employed at home
Self-employed craftsmen, artisan, drivers	

Note: Groups listed as included or excluded in the unemployment figures (Statistics Norway, 1933).

The statistics do not distinguish clearly between women who worked at home and women who were unemployed. According to Statistics Norway (1933), the unemployment figures for women should probably not be trusted.

In our view, it seems that the unemployment figures sometimes include seasonal unemployment, but not always. Statistics Norway has been able to exclude certain groups, but they could not correct for people who failed to declare themselves as unemployed. This means that there could be considerable inconsistency in the data, especially when comparing rural areas to cities.

10.1.2 Comparing the 1930 municipal data with official statistics

In total, the new municipal data has 1 635 more unemployed men than the official statistics. This amounts to 2 percent of 97 272 unemployed men reported in the official statistics. Aggregating the municipal data to the regions used in the official statistics and comparing, we see that the discrepancy varies from 8 unemployed men in Sør-Trøndelag (Trondheim) to 208 in Oslo. The largest regional discrepancy amounts to 5 percent. The percent-wise deviation is larger for the regions with the lowest number of unemployed. Six rural municipalities in Akershus are missing in the municipal data. These municipalities have a population of 8100 men 15 years or older. For rural Akershus, the official statistics register 420 more unemployed men than the municipal data. This discrepancy is likely due to the missing municipalities. For the rural regions, the discrepancies vary from -420 to +272 men (-5% to 8%).

The empirical standard deviation of discrepancy per region is 110 men (2.6%). Altogether, the discrepancies seem small. Even if we cannot directly evaluate the data on municipal level, the small differences on the regional level make it reasonable to assume that the municipal data does not differ much from the data on which the official statistics were based.

10.1.3 Summary statistics

Since we do not know the labour force in each municipality, we divide the number of unemployed men by the male population 15 years or older. Nationally, 10.4 percent of all adult men were unemployed, but with high local variation. Locally, the rate varies from zero to 42 percent. The data shows a wide belt of high unemployment stretching from Aust-Agder county through eastern Norway all the way up to Sør-Trøndelag county. In the belt, there is a high number of municipalities where the share of unemployed men is above 30 percent. The belt covers areas that were early industrialized and which were heavy on forestry and shipping. Large cities outside the belt also show up with higher shares of unemployment.

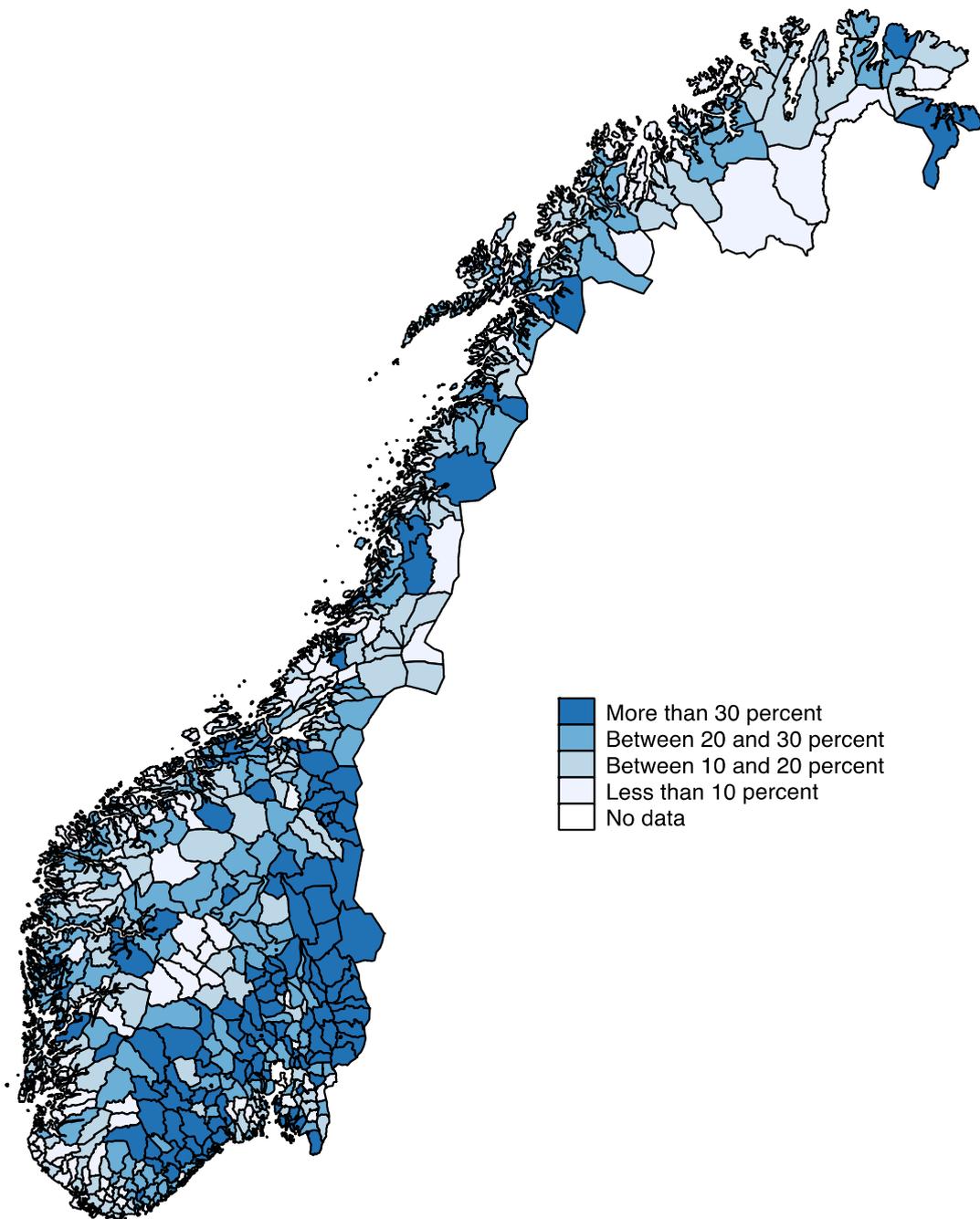
Decomposing unemployment into manufacturing, agriculture and other unemployment does not change the picture much. Unemployment in agriculture is concentrated in eastern Norway, and roughly matches the belt. Unemployment in manufacturing turns up as more concentrated spots inside the belt, probably due to industrial employment being concentrated around plants. Looking at non-farm, non-industrial unemployment, the Oslo fjord area and the western coast line light up with high unemployment. This group contains fishermen, craftsmen and tradesmen.

Table A2: Summary statistics: Unemployment 1930

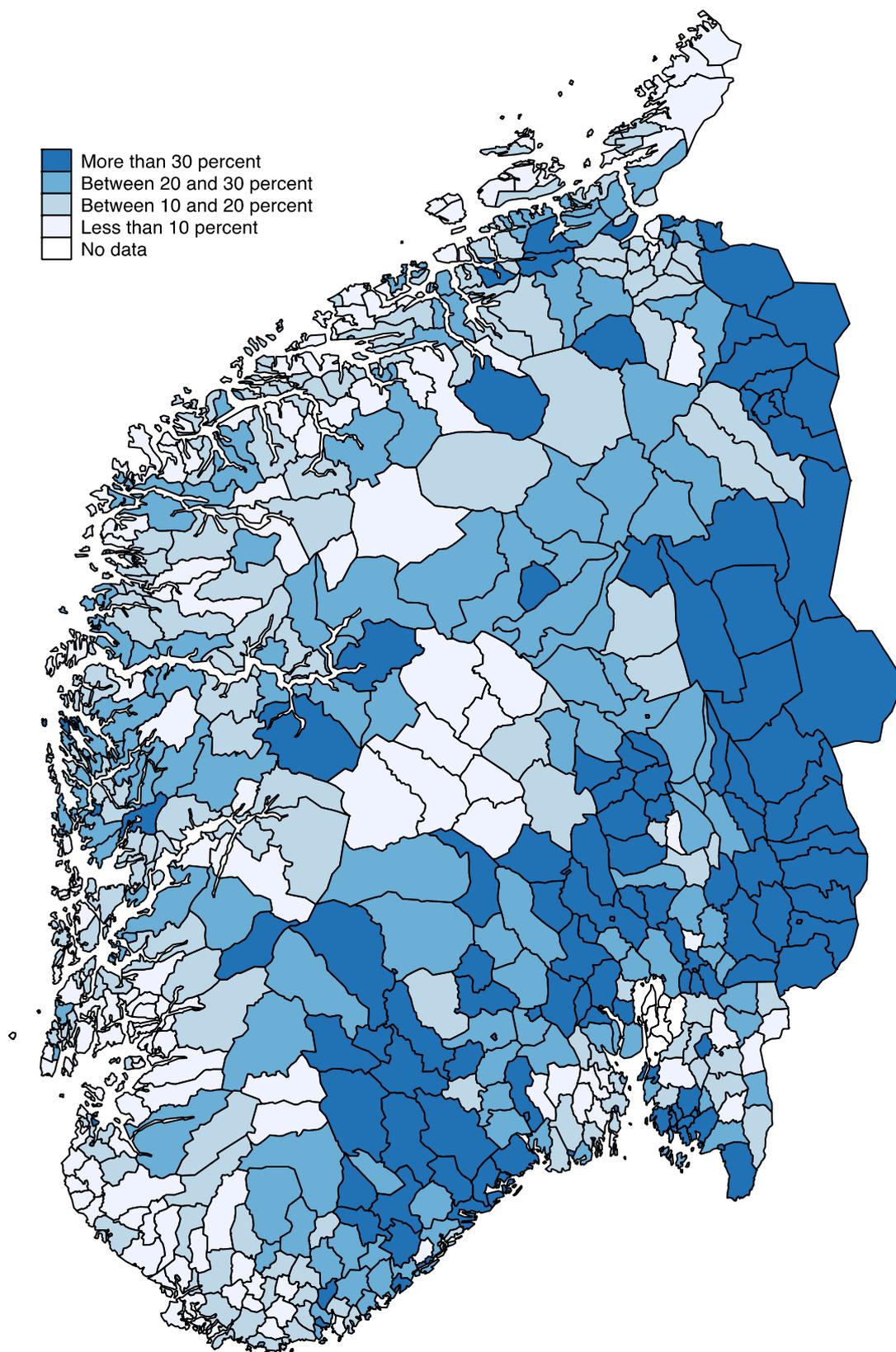
Variable	N	Mean	S.D.	P10	P90	Max	Min
Men							
Unemployed 1 dec. 1930	740	134	549	3	278	12669	0
As a share of adult men	740	7 %	7 %	1 %	17 %	42 %	0
of which, agriculture	675	3 %	5 %	0 %	7 %	39 %	0
of which, industry	740	3 %	3 %	0 %	7 %	20 %	0

Note: Summary statistics on local unemployment from the 1930 census data.

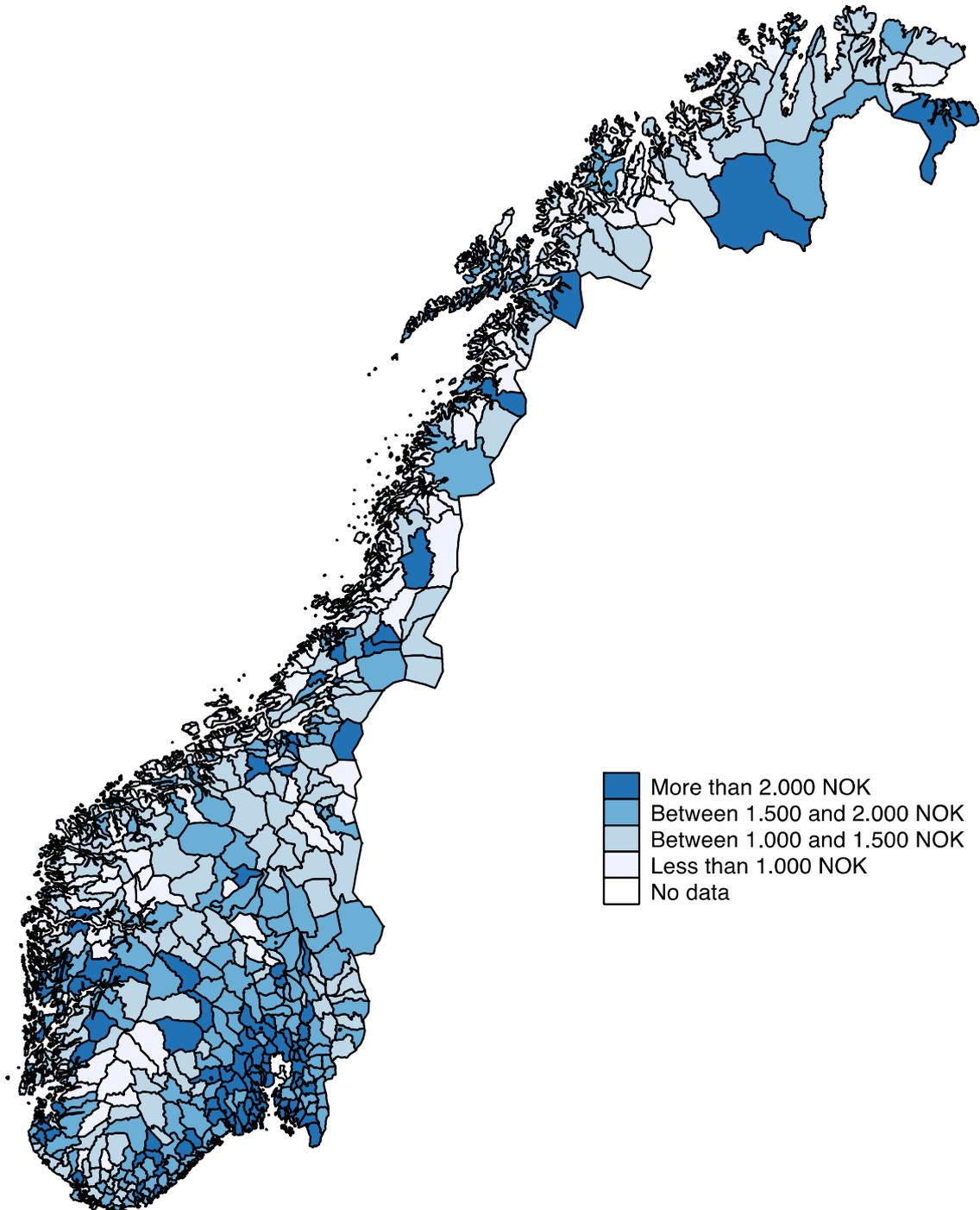
Map A: Unemployed men, 1 December 1930. Share of all adult men in the municipality.



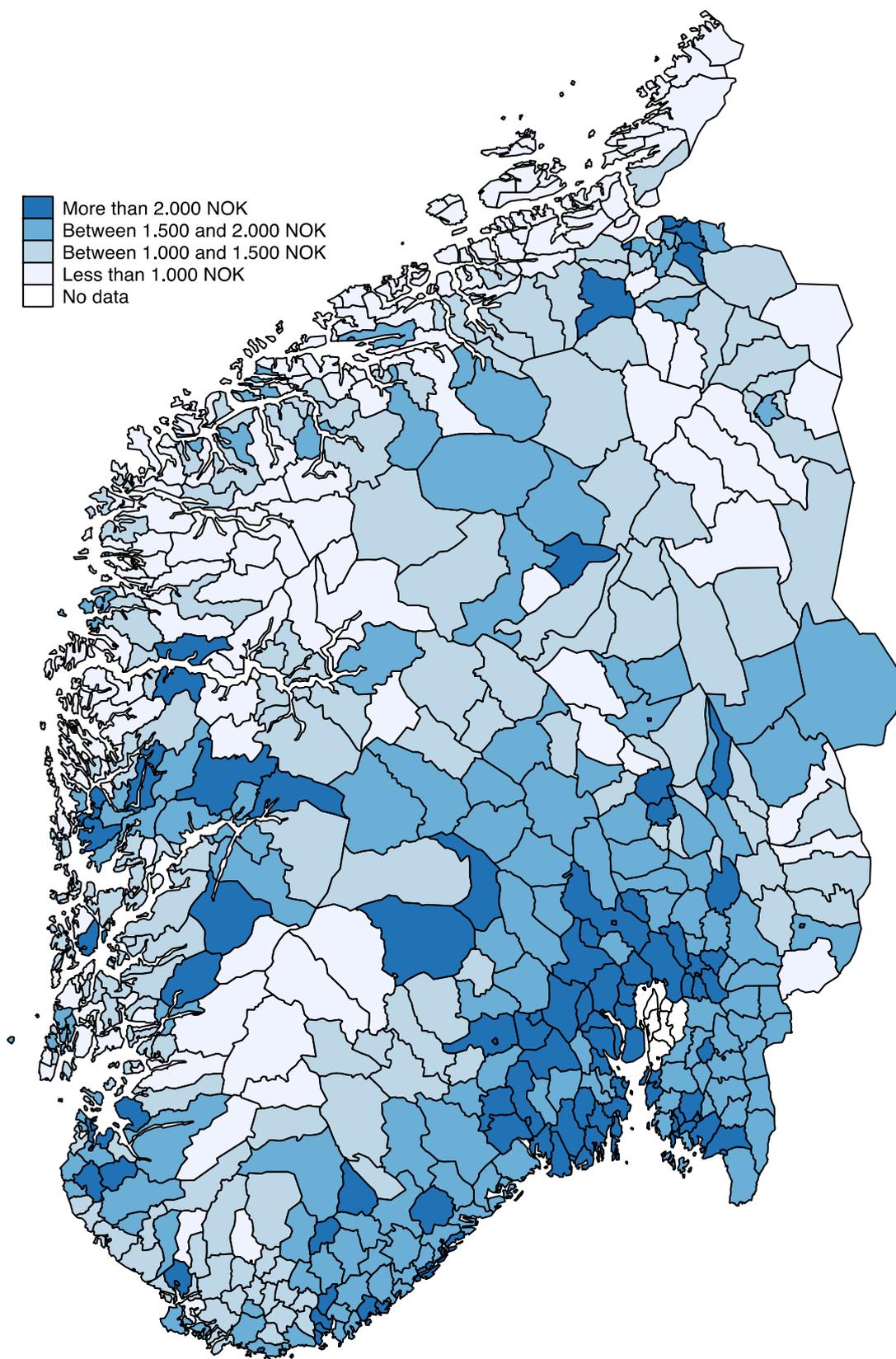
Map A.1: Unemployed men, 1 December 1930. Share of all adult men in the municipality (Southern Norway).



10.2 Appendix B: Average income for male taxpayers 1929

Map B: Average income for male taxpayers 1929.

Map B1: Average income for male taxpayers 1929 (Southern Norway).



10.3 Appendix C: Tax classes from 1927

1927 tax classes for rural municipalities

	Tax class							
	1	2	3	4	5	6	7	8
Tax-free amount	200	350	500	650	800	950	1100	1250
5/6 of	200-300	350-570	500-780	650-990	800-1200	950-1410	1100-1620	1250-1830
4/6 of	300-520	570-790	780-1060	990-1330	1200-1600	1410-1870	1620-2140	1830-2410
3/6 of	520-680	790-1010	1060-1340	1330-1670	1600-2000	1870-2330	2140-2660	2410-2990
2/6 of	680-840	1010-1230	1340-1620	1670-2010	2000-2400	2330-2790	2660-3180	2990-3570
1/6 of	840-1000	1230-1450	1620-1900	2010-2350	2400-2800	2790-3250	3180-3700	3570-4150
On income above the last limit, the total tax free amount is	600	900	1200	1500	1800	2100	2400	2700

Note: Tax classes describing standard tax-free net income for residents in rural areas (Thomle, 1930). Municipal councils could adjust the table within boundaries set by law. Currency in nominal NOK.

1927 tax classes for cities

	Tax class							
	1	2	3	4	5	6	7	8
Tax-free amount	400	700	1000	1300	1600	1900	2200	2500
5/6 of	400-640	700-1030	1000-1420	1300-1810	1600-2200	1900-2590	2200-2980	2500-3370
4/6 of	640-880	1030-1360	1420-1840	1810-2320	2200-2800	2590-3280	2980-3760	3370-4240
3/6 of	880-1120	1360-1690	1840-2260	2320-2830	2800-3400	3280-3970	3760-4540	4240-5110
2/6 of	1120-1360	1690-2020	2260-2680	2830-3340	3400-4000	3970-4660	4540-5320	5110-5980
1/6 of	1300-1600	2020-2350	2680-3010	3340-3850	4000-4600	4660-5350	5320-6100	5980-6850
On income above the last limit, the total tax free amount is	1000	1525	2050	2575	3100	3625	4150	4675

Note: Tax classes describing standard tax-free net income for residents in cities (Skattelov for byene, 1928). City councils could adjust the table within boundaries set by law. Currency in nominal NOK.

10.4 Appendix D: Derivation of the model for sensitivity analysis

The Gini index for the population:

$$G = 1 - 2 \left[\frac{1}{2} AB + (1 - B)A + \frac{1}{2} (1 - A)(1 - B) - \frac{1}{2} (1 - A)(1 - B)G^* - \frac{1}{2} ABG^{**} \right] + r$$

$$G = 1 - [AB + 2A(1 - B) + (1 - A)(1 - B) - (1 - A)(1 - B)G^* - ABG^{**}] + r$$

$$G = 1 - [AB - ABG^{**} + 2A(1 - B) + (1 - A)(1 - B) - (1 - A)(1 - B)G^*] + r$$

$$G = 1 - AB + ABG^{**} - 2A(1 - B) - (1 - A)(1 - B) + (1 - A)(1 - B)G^* + r$$

$$G = 1 - AB + ABG^{**} - 2A + 2AB - 1 + B + A - AB + (1 - A)(1 - B)G^* + r$$

$$G = 1 - 1 + 2AB - 2AB + ABG^{**} - 2A + B + A + (1 - A)(1 - B)G^* + r$$

$$G = AB \times G^{**} + (1 - A)(1 - B) \times G^* - A + B + r$$

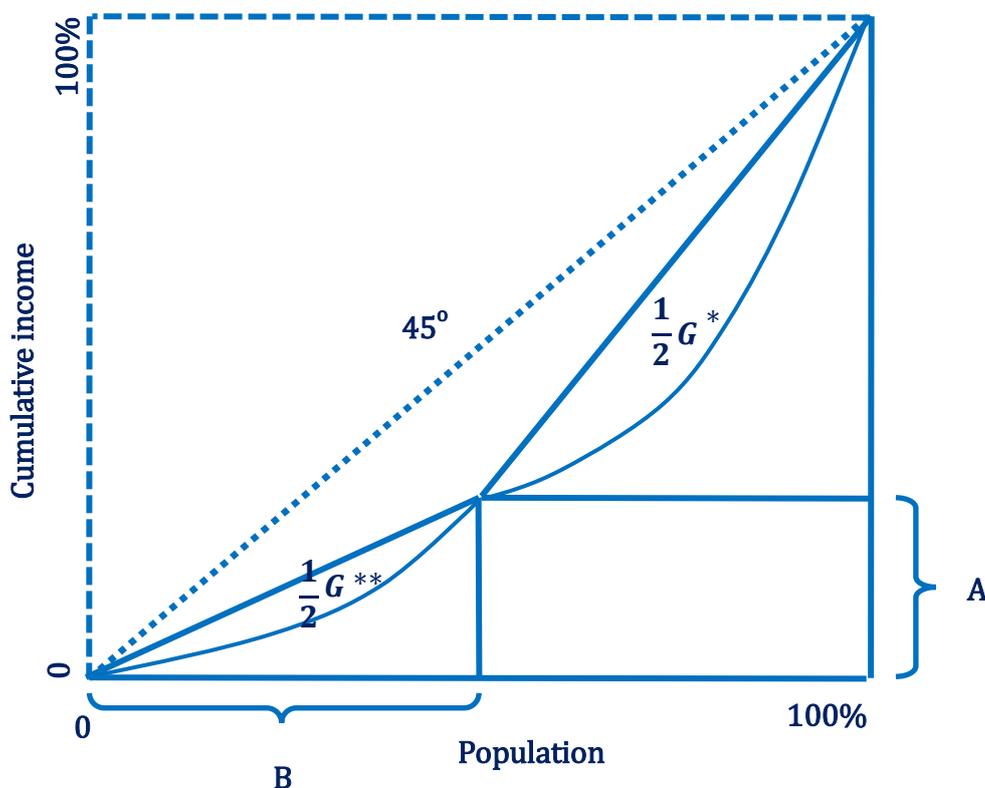


Figure 2: Illustration of the model for the Gini index, within the framework of the Lorenz curve. The model splices data on taxpayers with assumptions on the income of non-taxpayers.

10.5 Appendix E: Digitization and controls

In this appendix, we describe the data collection in detail including the digitalization process and assumptions made. We start by describing the process of extracting data from historic publications to structured data files. Then we describe methods used to validate the data and assumptions made to correct for errors.

10.5.1 Digitization

We use optical character recognition (OCR) software to digitalize data tables from historical publications. The output is exported to Excel with formatting and table structure mostly intact. This output is then carefully verified manually to make sure that it matches the original tables. This is done by implementing three checks:

- When a row or column total exist, we check if the sum of the numbers in a row or column is indeed equal to the total. Conditional formatting will signal with a red color if this test fail.
- When a cell is occupied by something that is identified as a number value, the conditional formatting function in Excel signals this with a green color. This makes it easy to identify values that are not correctly interpreted by the OCR software.
- Lastly, we check if the average income in an income group is inside the given income group. If this test fails it is an indication that something is wrong and it signals by making the cell orange.

When all errors have been checked with the original table, we declare a table okay. An example of how such a control file can look like after we have controlled all numbers can be seen in Figure D1. Remaining errors are handled in Stata. This is the subject of the next section.

10.5.2 Data verification

At this point we assume that our dataset is an exact representation of the table we want to digitalize. Unfortunately, this does not mean that all information is correct. These publications were all written before the invention of the digital computer. As a result, even simple summation can be wrong. Due to our lack of individual level data, we cannot ourselves control check these numbers. But we can check for internal inconsistencies in the data.

10.6 Appendix F: Using micro data to assess the impact of firms

We can test the effect of removing impersonal tax units in two counties using microdata. Using printed tax records for Kristiania (Oslo) in 1894 and for Romsdal county for 1900, we can create estimates without and without impersonal entities (P.T. Mallings Boghandels Forlag, 1894; Furø & Barmann, 1900).

The effect on top incomes in Romsdals amt is sizeable. Impersonal entities account for 11.8 percent of all top 1% income. In Kristiania 1894, firms account for 34.2 percent of top 1% income. The results suggest that large stock companies and banks are concentrated in large cities such as Kristiania, and that the error from the occurrence of impersonal unities will be larger there.

Companies in Romsdals 1900 account for 11 percent of all tax units earning more than 3,000 NOK. However, they have limited effect on the Gini coefficient for taxpayers. Once removed, the Gini index for taxpayers drops from 40,9 to 39,1 percent. The effect is larger in Kristiania 1894. There, 18 percent of the tax units with income above 3,000 NOK are firms. In Kristiania, the Gini drops from 54.3 to 43,1 percent.

Because of the more modest effect on the Gini index than the top income shares, we do not rule out the possibility that the data could be used to calculate the Gini index in the future. For rural municipalities, where the presence if banks and stock companies are small, the bias is likely to be mostly negligible

10.7 Appendix G: Assumptions from previous authors

Table G1: Average income of non-taxpayers

	Own baseline	Aaberge et al. (2016), before transfers	Aaberge et al. (2016), after transfers	Soltow (1965)
1892	259	72	88	126
1906	349	102	127	-
1913	242	122	156	-
1929	550	344	451	263

Note: Implied average incomes for non-taxpayers by Kiær (1910, 1915), Soltow (1965) and Aaberge et al. (2016).

Table G2: All income-earning units

	Adults excl. married women (Kiær)	Aaberge et al. (2016)	Employed head of households
1892	985,017	937,870	737,097
1906	1,133,197	1,077,000	774,849
1913	1,230,511	1,181,740	839,714
1929	-	1,416,542*	1,039,783

Note: Estimate of the total number of income earning units by Kiær (1910; 1915) and Aaberge et al. (2016). Interpolated values of employed head of households are also listed.

*: We have subtracted the population for 6 missing municipalities in Akershus. The numbers of employed head of households are listed for reference and not corrected.