The long run history of income inequality in Denmark[1]

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Abstract

We use historical publications and micro data from the tax returns to construct internationally comparable estimates of the development in income inequality in Denmark over the last 140 years. The study shows that income inequality and top income shares have declined during several distinct phases in between periods of stability. Furthermore the quality of the Danish data allows us to analyse not only the development in top income shares but also broader inequality measures such as the Gini coefficient. These analyses show that top income shares are a good proxy for the overall level of inequality.

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1 Introduction

The long run history of income inequality in Denmark is of considerable interest. Denmark is often portrayed as a country that has successfully combined economic performance with social safety. Certainly, in today's terms, Denmark scores well in league tables of income inequality. In the OECD report, *Divided we stand*, Denmark has one of the lowest Gini coefficients, and in the World Top Incomes Database (WTID), the share of the top 1 per cent is among the lowest recorded. This leads naturally to the question whether this has always been so. Or has Denmark in the past brought about a significant reduction in inequality? If so, when did it take place and how was it achieved?

With the focus on long run income inequality the present paper contributes to the recent literature on top income shares that has emerged since the studies by Piketty (2003), Piketty and Saez (2003) and Atkinson (2004). These studies have been influential in highlighting the dramatic changes in income inequality across many different countries since the beginning of the 20th century. Studies of this type have already been conducted on Sweden (Roine and Waldenström, 2010) and Norway (Aaberge and Atkinson, 2010) and the present paper thus completes the set of the Scandinavian countries.

At the same time the focus on top income shares stems from the fact that historical sources on the income distribution in most countries primarily covered the top of the distribution, hence making the estimation of broader measures of inequality such as the Gini coefficient infeasible. In contrast, the data sources for Denmark extend well down into the income distribution from almost the beginning of the 20th century and this allows us to address two questions left unanswered in the literature so far: namely how well do top income shares work as proxies for the development in the overall income distribution? and what other parts of the income distribution were affected by the changes at the top?

The study on Denmark is aided by the fact that the income tax data provide a rich historical source, which can be coupled with micro data covering the entire universe of taxpayers in Denmark available from 1980. There has long been research based on these tax records. The 1928 textbook, *Den*

økonomiske fordeling, by Zeuthen contained analyses of the distribution in the 1920s. Bjerke (1957, 1965) examined the period 1939-64, while later studies included Egmose (1985) covering 1939-80, Pedersen and Smith (2000) covering 1981-96 and the series for top income shares constructed from micro data for 1980 to 2005 by Kleven and Schultz (forthcoming). Finally a long run perspective is taken by Sørensen (1989, 1993), whose study covers 1903-1986. This paper benefits from these earlier investigations, and seeks to join up the findings for the different sub-periods, while paying strict attention to the comparability of the data over time.

In this respect, the concept of "assessed income" used in many of these earlier Danish studies represents a obstacle (in effect, it deducts taxes paid in the previous year), and compared to these earlier studies a major contribution of the present paper is to make estimates of the distribution of taxable income – a concept similar to that employed in other countries. In doing so, we obtain internationally comparable estimates of income inequality in Denmark from 1870 to 2010 – 140 years spanning two world wars, and the Great Depression as well as the recent financial crisis. At the outset we should emphasise that, as normal when considering time series from more than a century, data have limitations. The income tax data used here arise from an administrative process and reflect both the tax legislation and the reactions of taxpayers in the forms of avoidance and evasion. They should be seen as providing an imperfect source of evidence about a long period for which no alternative source (such as household surveys) exists.

With this in mind our study shows firstly that there have been epochs when Denmark has seen significant reductions in income inequality: (possibly) in the last 30 years of the 19th century spanning the start of the industrialization in Denmark, and definitely over the Second World War and in the 1970s. As a consequence the decline is not simply a secular downward trend. Instead there have been periods in between where the top income shares have remained stable and, most notably, spiked during the First World War. This time path resembles to a large extent of that of Sweden, which adds to the

picture of strong co-movement in income inequality across countries until the 1970s and increasing divergence since then.

Secondly, these patterns are present both when we consider the top income shares and when we examine the Gini coefficient, indicating that the top income shares indeed are a good proxy for the overall level of income inequality. Likewise our study shows that the reduction in the top income shares over the past century in particular benefitted the part of the population with incomes below the 70th percentile, while in contrast the income shares of the population between the 70th and 95th percentile have remained remarkably stable. This has implications for the possible explanations behind the development.

2 Methodology and data[2]

In using income tax data we follow a line of research that began in the United Kingdom in the nineteenth century (e.g. Baxter, 1868), was taken up in the United States when the present income tax was established, developed further by Kuznets (1953), and which has recently been revived in a series of studies following Piketty (2001 and 2003). These later studies combine administrative income tax data with external sources for total income and total population (often referred to as control totals) that allow the tax data to be placed in context (see Atkinson and Piketty, 2007 and 2010). This implies that our estimate of e.g. the income share of the top 1 per cent refers to the richest per cent of the total population and their share of total income.

The great advantage of income tax data is that they provide a long run time series – in the present case more than a century. At the same time, it represents a challenge. Firstly, because the early income taxation schemes only levied taxes on the part of the population with relatively high income, parts of the income distribution were not included in the data and control totals for both income and the popu-

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[2] More detailed information is provided about the data and methods in the working paper version of the paper, Atkinson and Søgaard (2013).

lation therefore have to be established on a consistent basis. Secondly, tax systems are over time subject to changes that affect the consistency of the statistics. However in tackling these challenges, the construction of the time series for Denmark benefits from a number of advantages.

Firstly there was a stable tax code over a long time span, with the tax code from the establishment of a permanent national income tax system in 1903 remaining the foundation of the income tax system until the end of the 1960s[3]. And secondly the income statistics that Statistics Denmark (DS) have collected since the beginning of the income taxation are very detailed and cover a large part of the population compared to that from other countries. This reduces the extent to which we have to rely on external income totals and the uncertainty associated with the calculation of the inequality measures.

At the same time, there are features of the Danish income tax system that differ from those in other countries and which have to be carefully treated. In what follows, we describe these features and the principal respects in which the tax system has changed over the period.

Definition of income

The income concepts applied in determining tax liability, and the income concepts reported in the statistics resemble – with one major exception – what is used in other studies of long run income inequality. The foundation of the income tax system was a comprehensive income concept, in which – in principle – all income streams were added along with deductions of all costs associated with "acquiring, securing and maintaining" the income. This meant that imputed rents, positive and negative interest payments, and income in kind all were included, while gifts, inheritances, lottery winnings etc. were exempt.

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[3] Since then, a number of tax reforms have been passed, notably the change from family to individual taxation in 1970 that is discussed below.

The income concept includes public transfers such as unemployment benefits, sickness benefits and public pensions as they were all taxable[4]. However before 1994 some other transfers (cash-benefits and supplement provisions for pensioners) were exempt. We deal with this data break by assuming that the grossing up of transfers (the increase in benefit rates needed to compensate for the new tax liability) only affects the income total (not the top income brackets) and add back an estimate of the size of the exemptions to years before 1994[5].

Until 1970, tax liability in year T was based on income accrued in year T-1. In 1970 this changed to a current year basis, which meant that 1969 was a tax free year, and no estimates are given for that year. In all cases the year refers to the year of receipt not the year of assessment.

Treatment of capital income

There have been two significant exceptions from a comprehensive definition of income. The first is that capital gains were only included if they were accrued on intent, i.e. if they were accrued in relation to a taxpayer's livelihood or speculation. In practice it was often difficult to determine whether an asset was bought with the intent of speculation, and so from 1922 it became legal practice to presume speculation if an asset was bought and sold within 2 years. It therefore seems reasonable to assume that capital gains for ordinary tax payers only rarely entered our income definition.

After 1960, the treatment and placement of capital gains in the tax system were changed a number of times, but the changes in general kept capital gains not related to a tax payer's livelihood outside the income concept used in the statistics and as a consequence we interpret the income series as excluding capital gains.

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[4] Even though most transfers were included in taxable income, individuals who had only these as income would historically not pay taxes due to high personal allowances.

[5] We do this by first regressing the growth rates of total taxable income on total labour and capital income (excluding 1994) and scale up the 1993 income total, so that the growth rate from 1993 to 1994 equals the predicted value (2.7 per cent) instead of the actual (7.9 per cent). The implied increase in the 1993 income total of 5.1 per cent is indexed to the development in the income transfers relative to GDP and applied to all years before 1993.

The second exception is that, from 1991, dividends were taxed under a separate scheme and not included in taxable income. However this only had a minor impact on the income distribution as we show in section 3.

"Assessed income"

Where the Danish data deviate from those in most other countries – the major exception referred to earlier – is that, until 1966, the tax was levied on so-called "assessed income", which was given by taxable income as defined above minus all paid personal taxes, cf. table 1. This procedure did not involve circularity, since the tax paid in year T was based on income and deductions in year T-1. The deductions included all personal taxes paid to state, municipalities and the church, so that in effect the tax base in year T was equal to the net-of-tax income in year T-1 (see Bjerke, 1957, p. 99).

Table 1
Overview of the income concepts available in the tax statistics

Period	Income concept	Definition
1903-66	Assessed income	= Taxable income – paid personal taxes[1]
1967-	Taxable income	= Gross income – deductions (interest payments, etc.)
1976-	Gross income	= Wage income[2] + interest received + net business income + transfers + dividends[3] + imputed rents[4]
1980-	Micro data allowing a variety of definitions in addition to the above.	

Notes: 1) Relating to assessed income in the previous year.
       2) Including compensation in the form of stock options etc.
       3) Until 1990.
       4) Until 1999.
Sources: The first three rows correspond to Sørensen (1989, p. 63).

The deductibility of paid personal taxes up to 1966 stands in the way of constructing a consistent series over time and complicates the comparison of inequality in Denmark with that in other countries. Further, correcting tabulated data for this deductibility is not trivial, as the individual size of the deduction depends on the assessed income the year before. Presumably this is why earlier studies have simply used the "raw" data. In this study we have treated it by adding back an estimate of paid personal taxes for each reported income bracket in the statistics, where the estimate are based on the bracket mean

income and information on the tax schedule in each year. We thereby create an income concept closer to taxable income used after 1966. As far as we know, this is the first time such an adjustment has been made.

The calculation is only approximate for a number of reasons. It is based on income in year T rather than year T-1. It excludes municipal taxes, church taxes and certain other taxes such as the state wealth taxation; this exclusion affects the income share to the extent that they were not levied proportionally[6]. Using the interval average as the tax base is likely to underestimate the average tax payment in a progressive tax system, and hence to understate the degree of inequality. However, operating in the opposite direction is the fact that the group at the top of the distribution in year T can be expected to have had a relatively higher income increase between T–1 and T compared to other income groups in the same year, thus giving them a relative higher income compared to the year before in which the actual tax payments were calculated. Not being able to control for income mobility presumably overestimates the size of the taxes paid at the top of the distribution and underestimates them at the bottom, giving a more unequal income distribution. Leaving out the wealth tax counters this to the extent that income and wealth are correlated.

The resulting totals for taxable income are shown in figure 1 below together with the totals for assessed income and for reported income (excluding the income of those not included in the income tax statistics). In each case, the totals are expressed as a percentage of Gross Factor Income. The switch from assessed income to taxable income between 1966 and 1967 creates a large jump in the total reported income, but, despite the limitations of our estimates of the paid personal taxes, the implemented correction is more or less able to remove the jump in the total income, which indicates that the net

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[6] Municipalities had especially in the beginning of the 20th century a large degree of autonomy in specifying their own tax system, resulting in progressive taxation in some and probably effectively regressive taxation in others. It is therefore difficult to say anything about the aggregate level of progressivity in municipal taxation.

effect of our correction is broadly correct[7]. The remaining gap is attributed to the deduction of munici-pal, wealth and other minor taxes, which we assume to be proportional and thus to not affect the calcu-lated inequality measures.

The totals relate to recorded household income and fall short of Gross Factor Income (100 per cent in figure 1) for two major reasons[8]. The first reason is that factor income accrues to other sectors of the economy (such as the corporate sector) and is not fully passed on to households (in the form, for example, of company dividends or interest payments). The second reason is that the valuation of income (for example, imputed rent) may differ in the national accounts. From figure 1, it may be seen that gross income was broadly stable as a percentage of Gross Factor Income from 1920 to the end of the 1960s. It increased in the 1970s and then fell by some 10 percentage points. A similar fall has been observed in other countries such as the United Kingdom (Atkinson, 2007a).

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[7] Unfortunately there are no years in which DS reports the income distribution both with and without the deductibility of paid personal taxes. However, when considering our series for the top income shares our correction appears to be correct, as we return to below. The same is true when we use the micro data for 1980-2010 to replicate our correction. More con-cretely we take the taxable income of each individual in the micro data in a given year and subtract the personal paid taxes calculated from last year's income and add the taxes calculated from the current year's income, and use this income defini-tion in the calculation of the income shares. This series deviate only marginally from the original series.
[8] Working in the opposite direction is the inclusion in household income of transfers and payments of interest by the gov-ernment.

Figure 1
Income totals as share of gross factor income
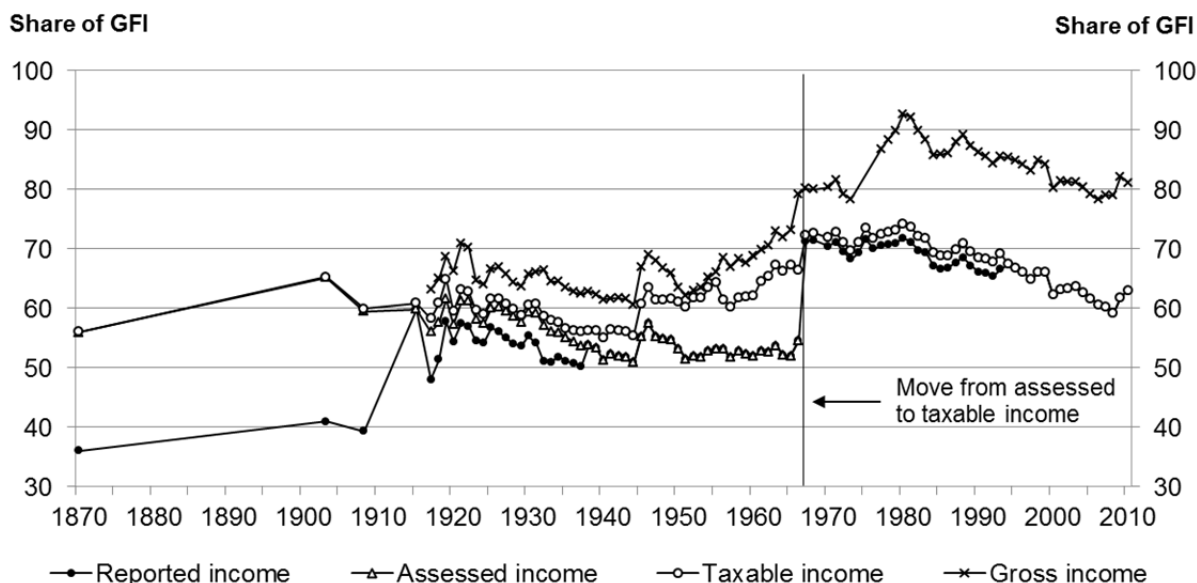
Notes: The income concepts refer to the following:
1) Reported income: The income total of the legal tax base from the DS tabulated income statistics and the micro data from 1980.
2) Assessed income: Reported income plus the DS estimates of the income of those who are not included in the income tax statistics. From 1917-1937 the excluded income has been estimated by Sørensen (1989).
3) Taxable income: Before 1966, assessed income plus our own estimates of the deductions for ordinary state income taxes (with effect from 1908). Before 1994 the taxable income series have further been adjusted for the grossing up of income transfers in 1994 as described in the text.
4) Gross income: Before 1970 gross income is given by the contemporary estimates from DS including the income of individuals not included in the income tax statistics and adding back all deductions. After 1970 it is given by the legal gross income, which is collected automatically by the tax authorities.
From 1980 the totals are taken from the micro data; the years 1980-82 overlap with tabulated totals.
All income totals are expressed as a percentage of Gross Factor Income given by Hansen (1974) (1870-1936) and DS (1937-2010).
Sources: Statistics Denmark (DS), Bjerke and Ussing (1957), Hansen (1974), Sørensen (1989) and own calculations.

With the above adjustments we obtain a comparable series on taxable income covering the whole century, which we take as our main series. This brings our estimates into line with studies of top income shares using a net income definition (see table 4 in Atkinson, Piketty and Saez, 2011). On the other hand they differ from estimates using gross income in that items such as interest payments, contributions to unions and unemployment insurance, travel to work costs, etc. are deducted. As may be seen from figure 1, there is a widening gap in recent decades between total gross income and total taxable income. However comparing our main series with estimates based on gross income for the years 1977-2010, where we have overlapping data, we find a very parallel development, as discussed below.

This gives us some confidence that the development measured by our series using taxable income is also historically a good proxy for the underlying development in gross income.

Finally it should be kept in mind that the income used here is reported for tax purposes, which implies that tax evasion is a potential problem. The presence of tax evasion of course gives rise to some caution in terms of interpreting the observed income distribution as the real distribution of economic resources, but it only constitutes a problem for our measures of inequality and of the top income shares, if the evasion is disproportional to reported income. As discussed in Atkinson and Søgaard (2013), there is some evidence that evasion is indeed relatively proportional to reported income.

Definition of population

Until 1969 the tax unit was the family with the incomes of husbands and wives being added together, and the required control total for the population for this period is therefore the total number of individuals aged 15+ minus the number of married women. Both of these numbers are available from the population censuses. In 1970 this changed to an individual based tax system so that relevant control total became individuals aged 15+[9]. From this point on we use the actual number of tax units as the population total, which corresponds closely to the population of age 15+. We do not attempt to bridge this break in the series, but we discuss the implications of using different population totals and the change between them in section 4.

Data sources

The sources for the period up to 1979 are tabulated data[10]. There are a number of gaps, but the series is particularly rich for the first part of the twentieth century: e.g. between 1903 and 1939 there are 26 observations. The Danish data are less strong for the 19th century, having only the one observation

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[9] Some individuals below 15 years also filed a tax return if they earned a sufficiently high income.
[10] As the tabulated income statistics in general do not correspond to the income percentiles of interest, it is necessary to derive an estimate of the income distribution within each interval in order to get the desired percentile cut-off. We use the split histogram as the interpolation method (see Atkinson, 2005). No extrapolation is made to obtain income shares in an open upper interval. The tabulated data do not include any intervals with negative incomes. Assessed income is assumed to be non-negative.

for 1870[11]. In what follows, we make use of the data for 1870, but it should be borne in mind that the long gap – a third of a century – means that the figures may be less comparable even though the principles in the tax code were the same.

A further strength of the tabulated data for Denmark is that the data from an early point in time covered a substantial part of the population, which is in contrast to many other countries, where the historical income tax data typically are limited to the very top of the income distribution. Prior to 1938, DS collected income assessments for families with an assessed income above 800 DKK, which meant that 26 per cent of the population was included in 1903. As is shown in figure 2 this number had increased to around 66 per cent by 1917 and remained around this level until 1937. From 1938 the statistics are assumed by DS to cover all potential tax payers and the overall coverage is therefore in principle 100 per cent from this point. Of these, a substantial proportion (86 per cent in 1938) had incomes above the bottom interval (this series is plotted in figure 2). This wide coverage together with the relatively high number of tabulated intervals (shown in figure 2) and close to micro data at the top of the income distribution (the numbers in the top interval are shown in figure 2) imply that from this point we can derive tighter bounds on both top income shares as well as broader inequality measures and that we have to rely less on external controls for total income.

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[11] As a reference the corresponding number of observations between 1903 and 1939 is much smaller for Sweden (10) and Norway (6), although for the 19th century Norway has 10 observations.

Figure 2
Assessing the quality of the data
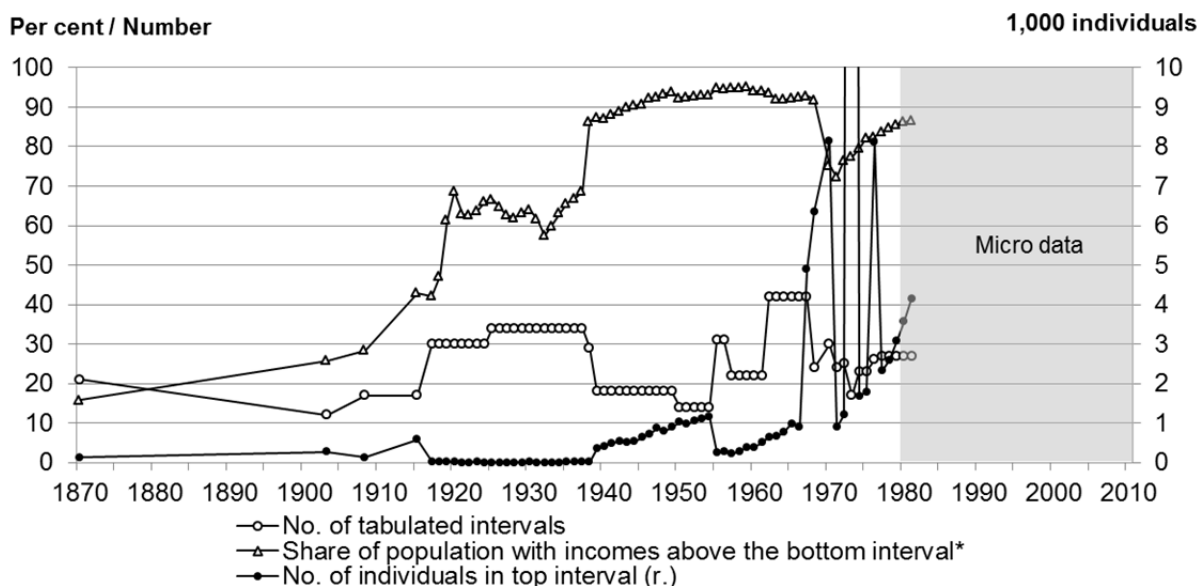
Notes: * For the years before 1938 the "residual" interval, with those who had an income below the threshold needed to be included in the income tax statistics, is treated as the bottom interval and counted in the number of intervals.
For the years 1921-1938 the number of individuals in the top interval is between 0-3. This is what we mean by saying that the data are "close to micro data". In 1973 the number of individuals in the top interval was 75,049.
Sources: Statistics Denmark and Sørensen (1989).

However despite of the wide coverage of the income statistics we still need estimates of the income of the families not included in the tabulated data for the period before 1938 and for this we rely on the contemporary estimates made by DS until 1915 and the estimates made by Sørensen (1989) for the years 1917-37. These estimates typically imply that an amount of around 400 DKK is added per excluded family, i.e. half of the income threshold required to be included in the statistics. In figure 1, the resulting estimated income of the families with an income below 800 DKK is given by the difference between reported and assessed income. It may be seen that the addition is substantial in the years before 1915.

From 1980 and onwards the income records of the entire universe of Danish tax payers are available as micro data. From this point we can therefore calculate income inequality using a variety of measures and income definitions, as well as at both an individual and a family level.

3 The development over time of the Danish income distribution

We now turn to the long run development in income inequality starting in figure 3a and 3b with the income share of the top income percentiles (P90-P100) as well as the income shares of the percentiles further down the income distribution. For the top income percentiles the quality of the Danish data implies that we can calculate the income shares (figure 3a) throughout the entire period from 1870 to 2010, while this is generally not the case before 1915 for the income shares of the lower percentiles (figure 3b).

Figure 3a
**The development in income shares in Denmark 1870-2010**
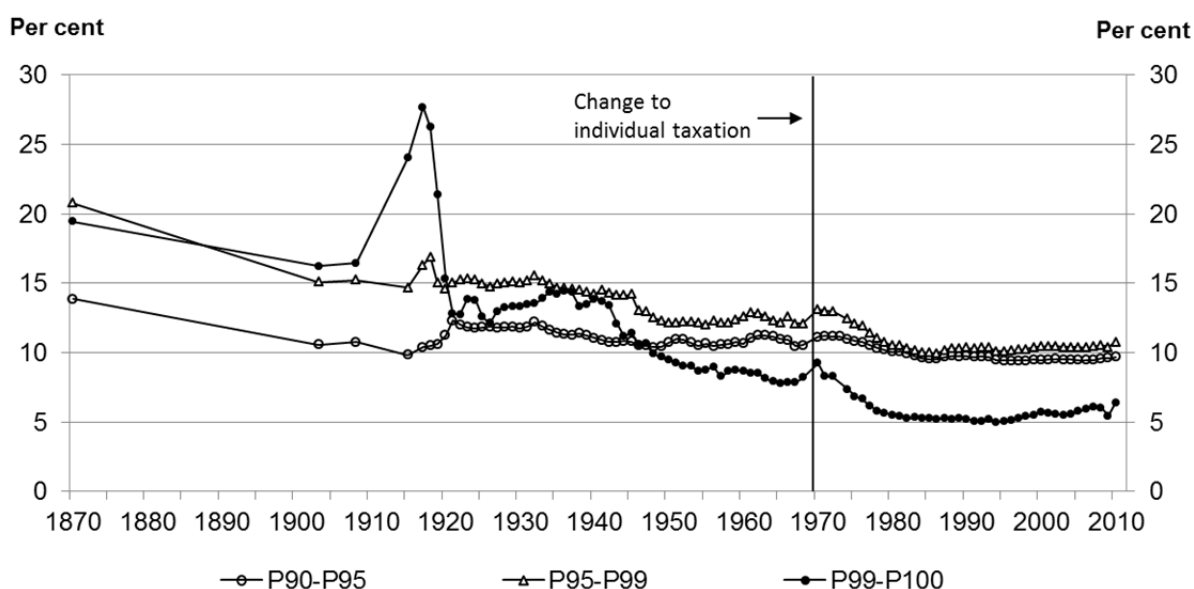
Notes: The income shares have been calculated using the definition of taxable income (gross income minus deduc-
tions), which we have adjusted for the grossing up of transfers in 1994 (with effect in the years prior to 1994)
and the deductibility of paid personal taxes (with effect in the years 1908-1966).
The vertical line in 1970 indicates the change from family to individual taxation.
Sources: Own calculations.

Figure 3b
The development in income shares in Denmark 1870-2010
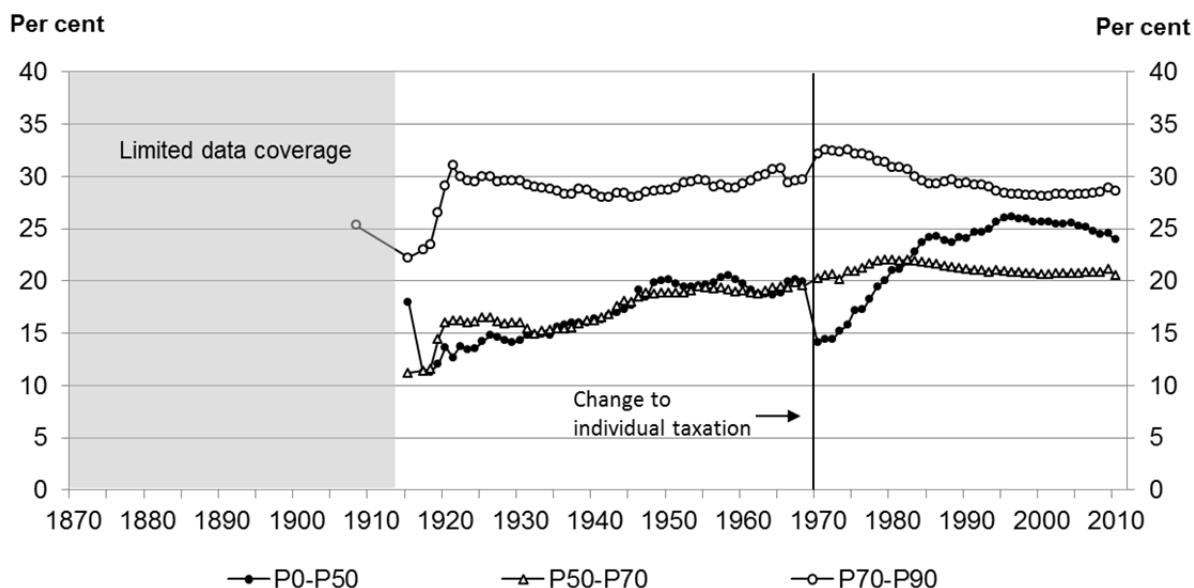
Notes: See figure 3a.
Sources: Own calculations.

Looking at the top income shares, we see that they first show a substantial decline between 1870 and 1903 of 12 percentage points distributed more or less equally among the 3 subgroups (the P90-P95, P95-P99 and the P99-P100). The facts that the 1870 figures were the result of a one-off tax and that we have no evidence about the intervening years, mean that the fall must be interpreted with caution. However the indication that income was much more unequally distributed before the 20th century is supported by Soltow (1979). He uses data from another one-off tax in 1789 to analyse the distribution of both income and wealth and arrive at a Gini coefficient at around 90 per cent. Applying the methodology used here to his numbers gives a lower bound on the top 1 per cent income share of around 30 per cent compared to our estimate of 19.4 per cent in 1870.

The indications of high inequality in 1789 and 1870 are interesting because they predate the 1890s that most historians set as the start of the industrialization in Denmark. The data thus speak against a standard Kuznets (1955) type of explanation for the development in inequality, where inequality follows an inverse-U shape: first increasing as only a few workers initially would be employed in

high productivity/high wage sectors in the beginning of the industrialization and then decreasing as more and more do so.

From 1903 – where we have a nearly continuous series – we first see a dramatic rise in top shares during the First World War, and then a decline that took place particularly in the 1940s and in the 1970s. Taken together, this means that the share of the top 1 per cent has fallen from around 16 per cent at the beginning of the twentieth century to around 6 per cent at the end of the century. Although the top income shares in the recent years have remained relatively low by historical standards, there has been a tendency to rising inequality at the very top. In 2010 the share of the top 1 per cent was 6.4 per cent, which was its highest level over the past 30 years, although only 1 percentage point higher than in 1980.

From figure 3a it is clear that most of the changes in the income shares of the top income groups have happened in the top 1 per cent, while the P90-P95 income share has been remarkably stable at around 10 per cent since the beginning of the 20th century. This pattern has been found in many other countries (see e.g. Piketty (2003) for France, Piketty and Saez (2003) for the USA and Roine and Waldenström (2010) for Sweden), and naturally leads to the question of which income groups were affected by the changes in the top income shares, i.e. as the income share of the top 1 per cent fell from 16.2 in 1903 to 5.5 in 1980, where did this income mass go?

The answer to this question can be seen in figure 3b, where we show the income shares of the bottom half of the population (P0-P50), as well as for the P50-P70 and the P70-P90. From this figure it is clear that the stability of the income shares of the P90-P95 can also be found for the P70-P90. In contrast the income shares of the P0-P50 and the P50-P70 grew almost in line from 11-12 per cent in 1917 to 19-20 per cent in 1968. At least for the case of Denmark the decrease in the top income shares since the beginning of the 20th therefore seems to have benefitted the income groups from the 70th percentile and below, but not the income groups between the 70th and the 95th percentile.

Top income shares and broader measures of inequality

The above description of the development in income shares of different groups throughout the income distribution raises the question as to how far the top income shares can serve as an indicator of the change in overall inequality, as measured for example by the Gini coefficient.

In considering measures of overall inequality, we have to take account of the incomplete coverage of the income tax data. This may be summarized in terms of three variables: (a) the proportion of the population, F, for whom we have effective income data (those above the income threshold for inclusion in the tabulation, shown in figure 2 earlier), (b) the share, Ω, of income attributable to this group, and (c) the starting value of income, y, for those covered, expressed as a fraction of the mean income. In 1903 the excluded group were essentially those with less than mean income, which means that any measure of overall inequality is likely to be surrounded by considerable uncertainty. We can however calculate bounds on this uncertainty.

A lower bound for the Gini coefficient is given by assuming that all individuals in the excluded group receive the same income, $(1-\Omega)/(1-F)$, expressed relative to the mean, and an upper bound is obtained by assuming that they were divided between two groups: one receiving zero and the other receiving the maximum, y. The difference between the two assumptions provides a measure of the maximum possible margin of error. For 1903, this is quite large – around 14.1 percentage points – but from 1915 the difference is generally below 2 percentage points. Using the same technique to calculate the upper and lower bounds for the contribution to the Gini coefficient from each tabulated interval, one can calculate the overall bounds on the Gini coefficient. In 1903 the difference between the two bounds is 14.2 percentage points, indicating that the bulk of the uncertainty comes from the excluded group.

Figure 4 shows the Gini coefficients (upper and lower bounds) for the entire period covered. The bounds are virtually indistinguishable from 1915 onwards. In considering these figures, it is important

to bear in mind the change in 1970 from a family to an individual basis and the grossing up of transfers in 1994 (marked by the vertical lines in figure 4), but allowing for the breaks, it is clear that the Gini coefficient has fallen substantially in Denmark over the past century. It also appears that, as with the top shares, the fall has been episodic rather than a constant downward trend.

Figure 4
The Gini coefficient and the top 1 per cent income share
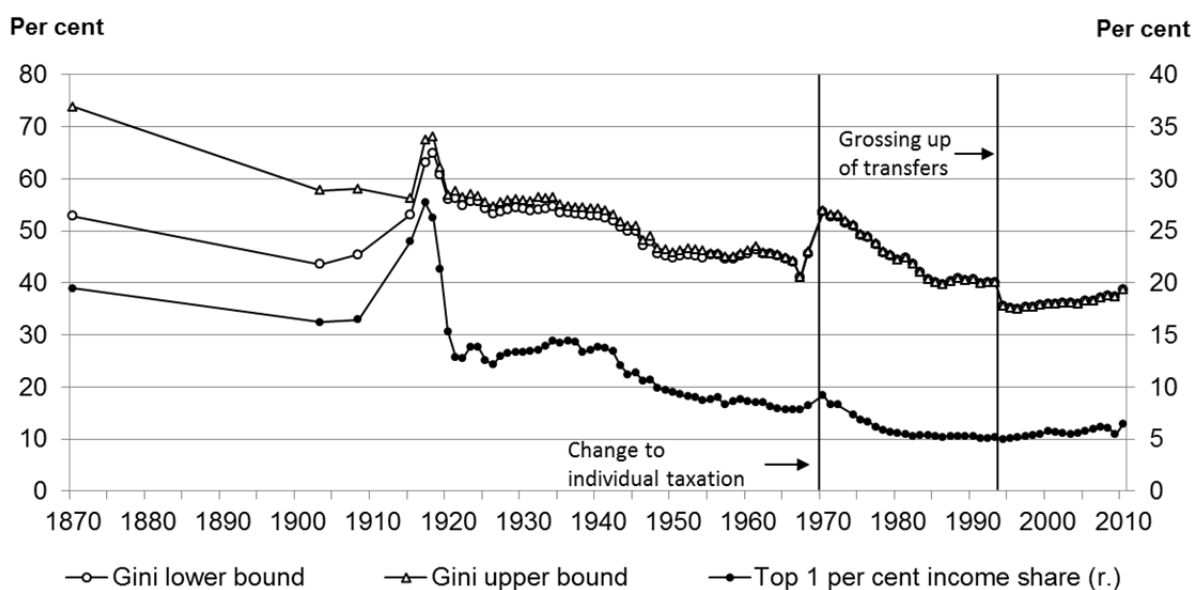
Notes: The first vertical line indicates the change from family to individual taxation in 1970, the second the grossing up of transfers in 1994. The top income series have been adjusted for the later data break by assuming that the grossing up only affected the income total as described above. Something similar is not possible for the Gini co-efficient.
Source: Own calculations.

From figure 4 it is evident that there qualitatively is a strong co-movement between the Gini co-efficient and the top 1 per cent income share. The next question is whether this is also the case quantitatively in the sense that there is a stable relationship between changes in the top 1 per cent income share and the Gini coefficient. If this is the case the relative sizes of different changes in the top income share is also informative about the relative sizes of the changes in the Gini coefficient.

In order to examine this question formally we run a basic co-integration analysis on the two variables over the time period 1915 to 2010, where we have relatively precise estimates of the Gini coefficient. From this analysis we learn that there is stable co-integration relationship in most of the sample

period with the exception of the years around the First World War (1915-1920) and the period after the change to individual taxation, which was dominated by entry of women into the labour market (1970-1983). Including dummies for these years in the co-integration relationship along with a dummy for the data break in 1994 yields the reduced form long run relationship presented in table 2.

Table 2
Estimated reduced form long run relationship between the Gini coefficient and the top 1 per cent income share

	Gini lower bound		Gini upper bound	
	Estimate	Standard error	Estimate	Standard error
Gini	-1.000		-1.000	
Top income share	1.877	0.176	2.096	0.168
Constant	27.470	1.717	26.157	1.638
No. of observations	94			
Rank of long-run matrix	1			

Notes: The table shows the reduced-form beta estimates from a co-integrated VAR of rank 1 with the Gini coefficient and the top 1 per cent income share as endogenous variables – both of which are included with two lags. The model further includes unrestricted year dummies for the years 1917-1920, 1969-1983 and 1994. Missing observations in 1916, 1969 and 1973 are imputed by linear interpolation.

Sources: Own calculations.

On this basis, a 1 percentage point fall in the share of the top 1 per cent is associated with a fall in the Gini coefficient around 2 percentage points. This relationship is as mentioned stable throughout most of the sample period, except under extreme increases in the top 1 per cent income share as experienced during the First World War or under the major change in the labour market structure represented by the entry of women into the labour market.

It is further interesting to note that the regression coefficients exceed the purely arithmetic contribution of changes in the top share, which can be approximated by $1-G^* \leq 1$, where G^* is the Gini coefficient for the bottom 99 per cent of the population (Alvaredo, 2011). This means that there must be co-movement between the top income share and inequality among the rest of the population. However this comes as no surprise, as we saw above that the decrease in the top 1 per cent income share primarily benefitted the income groups below the 70th percentile and therefore worked to reduce G^*. If the contribution of the changes in the top share should have equalled the purely arithmetic contribu-

tion, the changes should have been distributed to the income groups proportionally to their initial income.

Implications of different definitions of income and population unit

In section 2 we identified three different definitions of income – gross income, taxable income and assessed income – and distinguished between family and individual income. With the micro data from 1980 we can examine the robustness of the findings described above to the differences in definition. The first is that the series relates to taxable income, defined as gross income minus the deductions allowed in the tax code (such as interest payments). As we have seen, the overall importance of deductions has increased in recent years as the difference between total gross income and total taxable income has widened. Figure 5 shows the share of the top 1 per cent calculated on a gross income basis (where we also use tabulated data for 1977 to 1979). The gross share is initially higher, but the gap narrows over time and by 2000 there is little difference. As a result, the rate of decline in the top share is rather more marked for gross income.

In figure 5 we also show the effects of the omission of dividend income from 1991 onwards. It is not possible to add back this income source to our taxable income concept as dividends and realised capital gains are mixed together in the tax records after 1990, but removing dividends from taxable income before 1990 yields a drop of only around 0.1 percentage points in the income share of the top 1 per cent. This reflects the fact the level of dividends recorded by the tax authorities were close to zero in the beginning of the period, and as a result the removal of dividends from taxable income in 1991 did not create a visible break in the time series[12].

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[12] Including both dividends and capital gains in our income definition gives an income share of the top 1 per cent of 8.2 per cent in 2010. However we do not make this adjustment to our main series, as the total income of this type reported to DS increases from almost nothing in the beginning of the 1980s to around 2 per cent of taxable income from 2000 and onwards. This implies that, while the level of inequality using income including dividends and capital gains presumably is accurately measured at the end of the period, the increase over the period is likely to be exaggerated.

Figure 5
The top 1 per cent income share under different definition:
Gross versus taxable income and the effect of family-basis
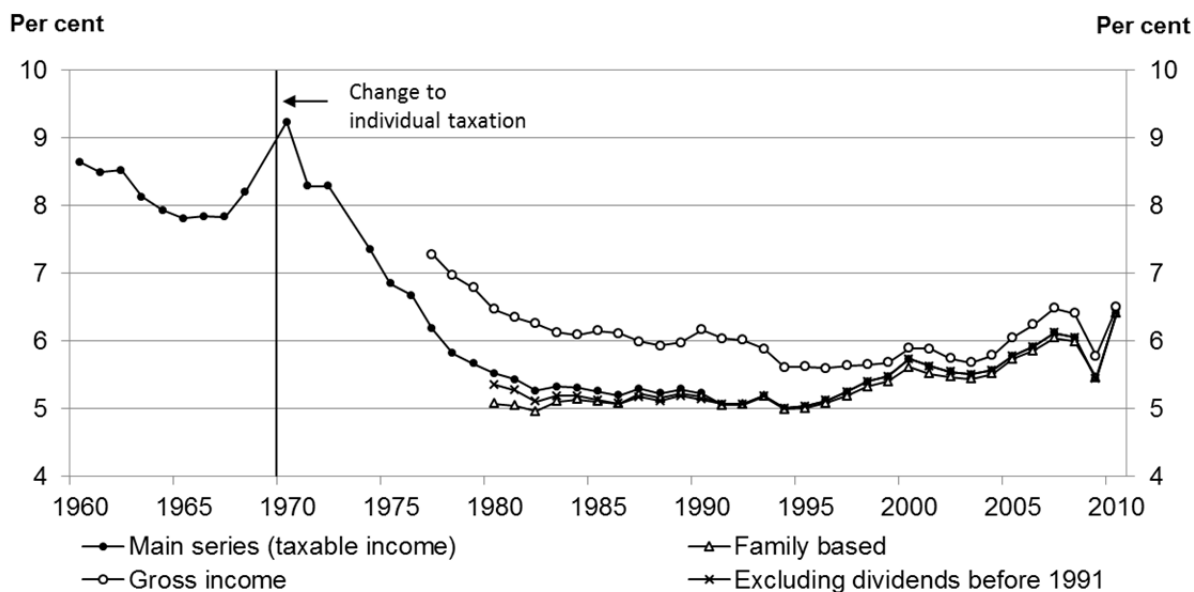

Notes: The income share on taxable income have been calculated using the definition of taxable income (gross income minus deductions), which we have adjusted for the grossing up of transfers in 1994 (with effect in the years prior to 1994) and the deductibility of paid personal taxes (with effect in the years 1908-1966).
The vertical line in 1970 indicates the change from family to individual taxation.
Sources: Own calculations.

In figure 6, we compare the series for taxable income with that for assessed income, where personal taxes have been deducted. It may be seen that the correction we have made effectively removes the jumps in the series between 1966 and 1967. From figure 6 it is further visible that the effect of taxation on the measured income shares was marginal before 1935 and builds up thereafter, where already from 1940 the effect on the top 1 per cent is stable at around 2 percentage points, while the effect on the top 10 per cent continues to increase to 4-5 percentage points. This is in line with evidence from other studies, see e.g. Egmose (1985, p. 53). In the figure we have also included estimates of the top income shares using assessed income constructed from the micro data. From these estimates we see that the difference between the income shares using the two income definitions are approximately the same in 1980 as in 1966. Since then the difference has narrowed so that the series for the top 10 per cent income share was 2.5 percentage points lower in 2010 using assessed income while the series for

the top 1 per cent was 1.1 percentage points lower. This implies that the overall level of progressivity in the tax system has been reduced over the period.

Figure 6
The top income shares using taxable and assessed income
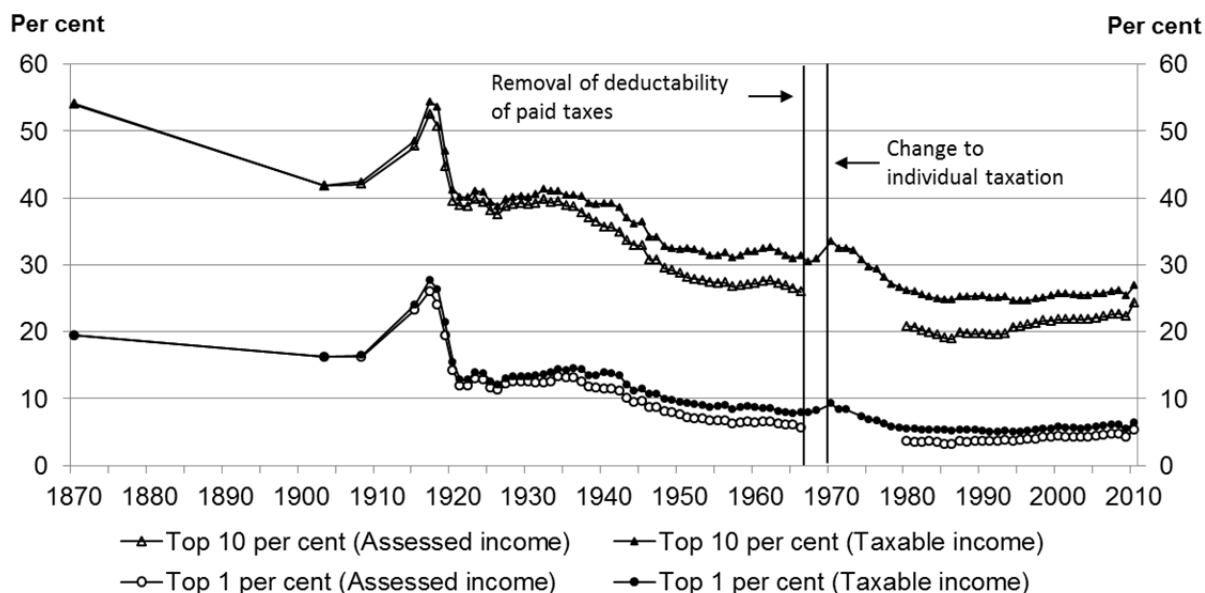
Notes: The pre-1967 taxable income is given by assessed income plus the estimated deduction for ordinary state in-come taxes (with effect from 1908). The vertical lines indicate the two data breaks of the removal of the deduct-ibility of paid personal taxes in 1967 and the change from family to individual taxation in 1970. Both series have been adjusted for the grossing up of transfers. Assessed income from 1980 and onwards has been constructed from the micro data as taxable income minus paid personal taxes.
Source: Own calculations.

Finally, the difference between the individual and the family as the population unit may be seen from figure 5. The change from family to individual taxation in 1970 resulted in a jump in the top in-come share (explored further below), but interestingly the results on a family basis from 1980 are very close to those on an individual basis when considering the top 1 per cent income share. This implies that the decline in the top income share between 1970 and 1980 is not just due to the changeover to individual taxation, but would also have been present without it[13].

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[13] The same conclusion emerges if we consider the top 0.1 per cent, but not for the top 5 per cent or top 10 per cent shares or broader measures such as the Gini coefficient.

### *The Danish development of top income shares in international perspective*

We began the paper by citing the good standing of Denmark in contemporary inequality league tables and asking how this had been reached. Before moving into these explanations, it is therefore interesting to compare the long-term development of top income shares in Denmark with that of other countries, both Scandinavian neighbours (Norway and Sweden) with relatively similar economic/fiscal systems and two countries (France and the US) where the differences are greater[14]. In making such a comparison, it is important to bear in mind the differences across countries in fiscal systems which compound those that arise from changes over time within countries. Nonetheless, figure 7 shows a striking similarity between Denmark, Sweden, Norway, France and USA up to around 1970. In 1965, for example, the top 1 per cent share was, in round numbers, 8 per cent in the US as well as Denmark, 6 per cent in Norway and Sweden and 10 per cent in France.

After 1970 there was a divergence. While the top 1 per cent income shares in USA and France remained constant between 1970 and 1980, Denmark alongside Sweden saw its top income share fall additionally and this has only been moderately reversed in the succeeding years. As a consequence Denmark in 2010 had a top income share of taxable income of 6.4 per cent, which is low by historical standards and was only 1 percentage point higher than in 1980. In contrast, the 1 per cent income share in the United States rose from 8.2 to 17.4 per cent over the same period[15].

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[14] The choice of France and USA reflect that previous studies have identified similar trends in income inequality among Continental European and Anglo Saxon countries respectively with France and USA being good representatives for the two groups (see e.g. Alvaredo et. al., 2013).

[15] As is discussed by Piketty and Saez (2003), part, but only part, of the increase is associated with the Tax Reform Act of 1986.

Figure 7
Top 1 per cent income share for Denmark 1870-2010 compared with other countries
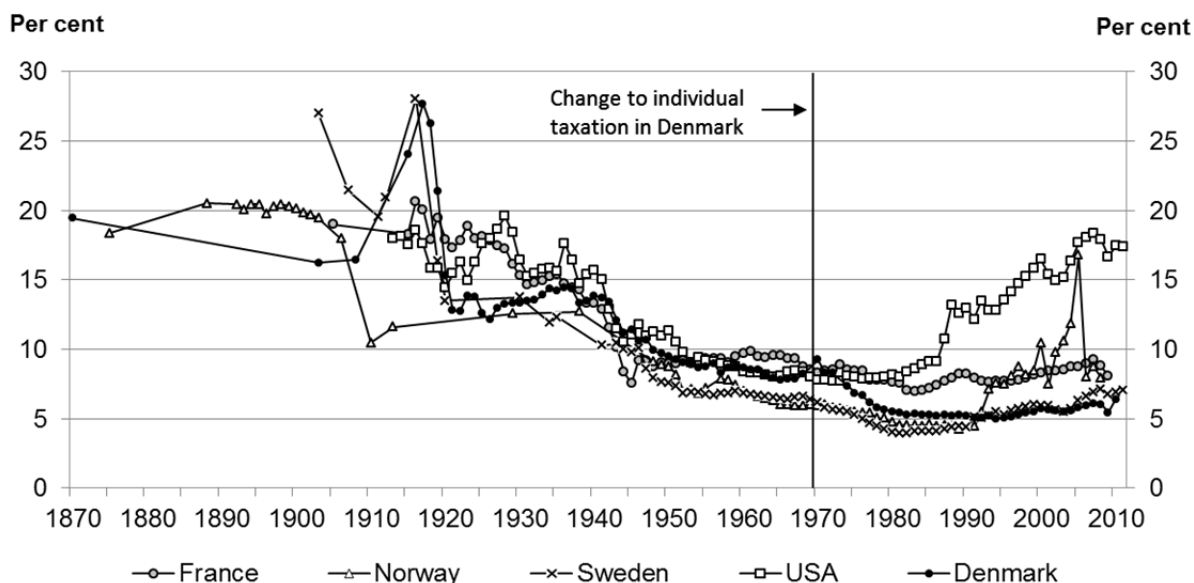
Notes: The income share for Denmark has been calculated using the definition of taxable income (gross income minus deductions), which we have adjusted for the grossing up of transfers in 1994 (with effect in the years prior to 1994) and the deductibility of paid personal taxes (with effect in the years 1908-1966). The series for other countries relate to gross income.
The vertical line in 1970 indicates the Danish change from family to individual taxation.
Sources: Own calculations and the World Top Incomes Database.

To find a share of more than 17 per cent in Denmark, one has to go back to the First World War and this highlights a second interesting feature: the sharp increase in income inequality during the First World War, which is present for both Denmark and Sweden, where the top 1 per cent income share reached a staggering 27-28 per cent in 1916-17. However, while the increase in one country might be dismissed as a statistical anomaly, the fact that the sharp rise is found independently in both countries suggests that something dramatic indeed happened during the First World War. Note also that the increase during the First World War is not a consequence of a collapse of the income total: the income total in Denmark increased on average 10 per cent annually (in nominal terms) from 1908 to 1918 compared to an average increase of 6 per cent from 1903 to 1960.

4 Explaining the evolution of income inequality in Denmark

The evidence presented in the previous section show that the level of income inequality in Denmark has changed dramatically over the past 140 years. Top income shares appear to have fallen be-

tween 1870 and the beginning of the twentieth century. There was a sharp rise and then fall in inequality associated with the First World War. Inequality then fell over the rest of the century in an episodic manner, not as a continuing trend, with marked falls in the Second World War and after 1970. In this section, we discuss some of the forces lying behind the observed evolution of income inequality.

World Wars

The sharp rise in inequality during the First World War, found also for top shares in Sweden, cannot, as we argued in the previous section, be dismissed as a statistical anomaly. The contrast between the dramatic increase in measured inequality during the First World War and the decrease (in both Denmark and Sweden) during the Second World War is therefore interesting. It is true that the two situations were different in that Denmark managed to stay neutral during the First World War and was occupied during the Second World War (the situations were less different in the case of Sweden). But during the occupation Denmark was able to maintain its own government with a high level of autonomy over internal affairs until 1943, and economically both episodes meant a large increase in aggregate demand in particular for agricultural products, while imports such as fuel and coal were in short supply.

The different development in inequality may instead lie in the fact that during the First World War the Danish government largely expected the war to be over quickly and was thus slow to adopt measures such as rationing and price/rent control. Furthermore, the unions and employer organizations had in 1911 settled on a 5 year collective agreement, which more or less dictated the nominal wage growth until 1916; this resulted in a large drop in real wages as documented by Lindberg (1921). In contrast, the potential economic consequences of the Second World War were much better foreseen by the Danish government, which therefore was quicker to implement rationing, price control etc. Also the unions reacted faster and demanded quarterly automatic wage adjustment to inflation in the collective agreement signed in March 1941. The two wars therefore point to the potential distributional consequences of increases in aggregate demand under sticky wages and prices. We recognise that the cir-

cumstances of wartime mean that money incomes may be a less reliable guide to living standards than in peacetime, but believe that there are grounds for exploring further the wartime experiences, in Denmark and in other countries.

The effect of population unit and women entering the labour market

The latest period of marked change in the level of income inequality in Denmark occurred during the 1970s and early 1980s. It has been suggested that this coincides with an increased proportion of Danish women entering the labour market.[16] However, the female employment rate had increased sharply from the beginning of the 1960s – see figure 8 – and it was only after the changeover to individual taxation in 1970 that there appeared to be an effect on income inequality.

Figure 8
The income share of the bottom 99 per cent and the female employment rate
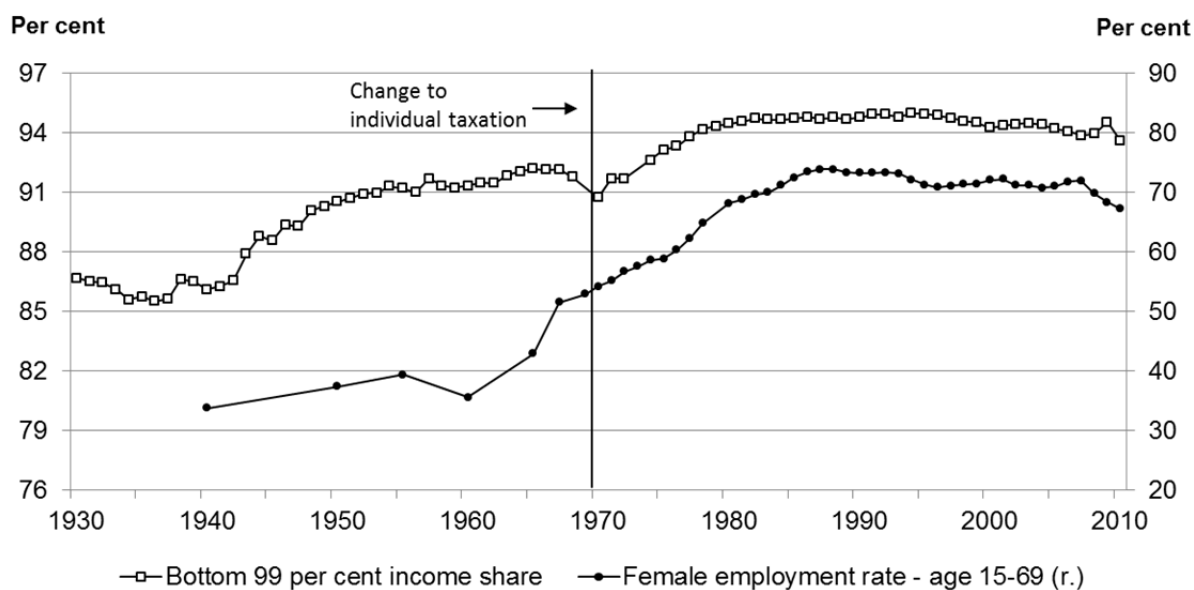
Notes: The vertical line in 1970 indicates the change from family to individual taxation. The participation rate is defined as total participation divided by the number of women between the ages of 15-69. For a description of the income definition, see figure 3a.
Sources: Own calculations and Statistics Denmark.

As explained in Atkinson (2007, p. 27), a move from a family to an individual unit could raise or lower top income shares, depending on the joint distribution of the incomes of husbands and wives. At

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[16] Related to this, Sørensen (1989, 1993) notes that the decline in inequality after 1970 is mainly is driven by a decline in inequality among secondary taxpayers (many of whom were outside the labour market at the beginning of the period), while inequality among primary earners is stable.

one extreme, assuming that all individuals in the top income groups are either unmarried or married to someone with zero income, the change only affects the top income shares through a change in the total population, in which case we can remove the break in the series by simply changing the population total to all individuals age 15. Doing this for the year 1968 yields an increase in the income share of 8.4 percentage points for the top 10 per cent and 2.0 percentage points for the top 1 per cent, cf. table 3, which can be compared to the actual increases from 1968 to 1970 of 2.7 and 1.0 percentage points respectively.

Table 3
The effect of the change from family to individual taxation

Per cent	Individual		Family	
	Top 10 per cent	Top 1 per cent	Top 10 per cent	Top 1 per cent
1967	38.7*	9.8*	30.4	7.8
1968	39.2*	10.2*	30.8	8.2
1970	33.5	9.2		
1971	32.5	8.3		

Notes: Families refer to age 15+ excluding married women. Individual refers to all individuals age 15+. 1969 was a "tax free year" and is thus excluded from the table. * Calculated based on the assumption that all taxpayers in the top income shares were either unmarried or married to someone with zero income.
Sources: Own calculations based on the series for taxable income.

The fact that this calculation greatly overestimates the effect of the change in tax units indicates that the families in the top income groups before 1970 had a non-negligible income from secondary earners. The change to individual taxation thereby resulted in a division of the family income between two individuals thus tending to reduce the top shares. With no information from the tabulated data on the income distribution within each family, there is no easy fix to join the series across the change in tax units. One cannot simply buckle the two series together by scaling, as the timing in the change from family to individual taxation can have a big impact on not just the recorded level, but also the development of inequality.

This highlights that the distributional impact of different factors such as increases in the female employment rate is likely to depend on whether incomes are measured on a family or individual basis.

On an individual basis, the impact of increased female employment depends on the incomes received by women in the absence of employment, but as this in most cases is likely to be zero, the impact will almost always tend to reduce inequality (except if women enter the labour market with very high wages). In contrast the impact on a family basis depends both on where in the income distribution the men of the entering women are positioned and the inequality measure used. If e.g. the entering women primarily came from middle and low income families the impact on the top income shares will be negative, while the effect on broader measures of income inequality will be ambiguous. This demonstrates that the difference in the definition of the tax unit cannot be treated as simply a fixed effect.

The role of taxation

In the recent studies of the long run development of top incomes one of the key elements has been the effect of taxes (see e.g. Piketty et. al., 2014 and Alvaredo et. al., 2013). These authors concluded that the rising marginal tax rates were one of the reasons why top income shares did not recover after the Second World War, as high marginal tax rates impaired the incentive (or capacity) to accumulate capital at the top. Similarly, the global divergence in top income shares since the 1970s might be explained by differences in the development of marginal tax rates.

The rise in tax progressivity in Denmark is shown in figure 9, which depicts the marginal tax rate at the income cut-off for the top 1 per cent together with the income share of the top 1 per cent. The marginal tax rate is shown both as the statutory rate, t, and the effective rate, where the latter takes into account that the tax prior to 1967 was levied on "assessed income" where personal taxes paid in the previous year had been deducted. At the time policy makers typically calculated the effective tax rates as a so-called "equilibrium tax rate", which was based on the fact that under the assumption of a constant income over time, the effective marginal tax rate converges to $t/(1+t)$[17]. A statutory marginal tax rate of

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[17] The formula can be derived by considering a one-year increase in a tax payer's income. The first year this increases his tax liability by t. The next year the extra tax paid decreases his tax liability by t^2, which the third year increases his tax liability by t^3 and so forth. Disregarding discounting this process can be shown to converge to $t/(1+t)$

50 per cent thus corresponded to an equilibrium marginal tax rate of 33.3 per cent. This implied that the statutory marginal tax rates could be higher than 100 per cent, which they indeed were in the 1950s and 1960s.

Our calculation of effective tax rates uses the same formula and, as may be seen from figure 9, before 1967 the deductibility of paid personal taxes created a marked difference between statutory and effective tax rates. It should further be noted that the marginal tax rate at the top 1 per cent cut-off was not necessarily the top marginal tax rate: a general feature of the Danish tax system at the beginning of the 20th century was the large number of tax brackets going high up in the income distribution. Figure 9 shows that the development of the effective marginal tax rates at the top of the income distribution have followed an inverted U since the beginning of the 20th century, which inversely mirrors the top 1 per cent income share.

Figure 9
The income share of the top 1 per cent and the marginal tax rate at the top 1 percent cut-off
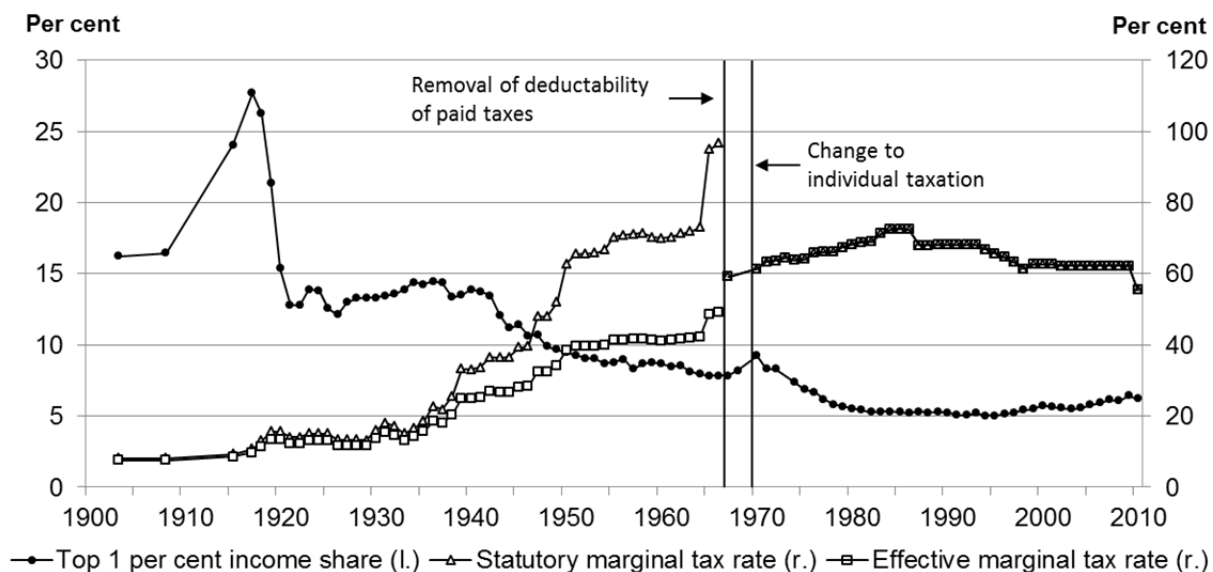
Notes: The marginal tax rate is measured at the income cut-off for the top 1 per cent and before 1970 it takes into account the ordinary state taxation, the common municipal fund law and average municipal taxation. The municipal average taxation (as per cent of the assessed income to the state) can be found in the statistical yearbook back to 1927. These rates have been adjusted by a factor 1.25 to take into account of the fact that the municipalities gave larger deductions before calculating the taxable income (in 1967 and 1968 the municipal income tax base was only 80 per cent of that of the state). Before 1927 the average municipal tax rate has been assumed constant at a level of 6.6 per cent. From 1970 the marginal tax rates are published by the Ministry of Taxation. The effective marginal tax takes into account the effect of the deductibility of paid personal taxes under the assumption of a constant income level. From 1967 the two tax rates are identical, since taxes paid could no longer be deducted. Until 1987 the marginal tax rate applies to almost all income types. After this point capital income is taxed at a lower rate. The vertical lines indicate the two data breaks of the removal of the deductibility of paid personal taxes in 1967 and the change from family to individual taxation in 1970.
Sources: Johansen (2007), Philip (1965), the Ministry of Taxation and own calculations.

Looking at the effective tax rates, we see that the first rise in the marginal tax rate (at this income level) came during the First World War. It then levelled off until the mid-1930s, after which it increased quite substantially until the beginning of the 1950s. The increase continued until the mid-1980s, where the marginal tax rate peaked at the same time as the top 1 per cent income share reached a historical low point. Since then marginal tax rates have decreased, while the top 1 per cent income share has increased slightly.

At a first glance the Danish case therefore seem to support the conclusions from the earlier studies that the development in (pre-tax) income inequality to some extent is driven by changes in tax rates. However, just as in these earlier studies, we have to question whether this effect can be interpreted as a

standard labour supply effect. The reason is that tax rates did not only increase at the top but also for the lower income groups, and interpreting the development in income shares as effects of changes in labour supply therefore require relatively large differences in labour supply elasticities across income groups.

To see this formally note that we can write the relative income shares (S) of two groups (i,j) as:

$$\frac{S_i}{S_j} = \frac{w_i N_i}{wN} \bigg/ \frac{w_j N_j}{wN} = \frac{w_i N_i}{w_j N_j} \tag{1}$$

where w_i is the average income in group i and N_i is the number of individuals in the group, while the same variables without the subscripts are the average income and number of individuals in the total population. Now, decomposing changes in w into effects of taxation given by the group specific marginal tax rate (τ) and other factors (z) and log differentiating with respect to time (t) yields the following:

$$\frac{\partial}{\partial t} \ln\left(\frac{S_i}{S_j}\right) = \varepsilon_i \frac{\partial \ln(1 - \tau_i)}{\partial t} - \varepsilon_j \frac{\partial \ln(1 - \tau_j)}{\partial t} + \frac{\partial \ln(w_i)}{\partial z_i} \frac{\partial z_i}{\partial t} - \frac{\partial \ln(w_j)}{\partial z_j} \frac{\partial z_j}{\partial t} \tag{2}$$

where we have used that $\Delta\ln(N_i)/\Delta t = \Delta\ln(N_j)/\Delta t$ by definition, when the considered income groups constitute a fixed faction of the total population and the definition of the labour supply elasticity (more correctly the elasticity of taxable income) $\varepsilon = \Delta\ln(w_i)/\Delta\ln(1-\tau_i)$[18]. In this setting, interpreting the changes in income shares over time as an effect solely driven by changes in taxation corresponds to assuming that the two last terms in equation (2) cancel out. The relationship between the two labour supply elasticities is thus given by:

$$\frac{\partial}{\partial t} \ln(S_i) - \frac{\partial}{\partial t} \ln(S_j) = \varepsilon_i \frac{\partial \ln(1 - \tau_i)}{\partial t} - \varepsilon_j \frac{\partial \ln(1 - \tau_j)}{\partial t} \tag{3}$$

Applying this formula to the Danish series of top income shares and assuming an elasticity of 0.2 for the P90-P95 income group (corresponding to the estimate obtained for Denmark by Kleven and

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[18] This is the average elasticity in the considered income group weighted by their individual incomes.

Schultz (forthcoming) for the period 1980-2005) implies an elasticity of 0.64 for the P95-P99 group and an elasticity of 1.49 for the top 1 per cent of the income distribution, when considering the period 1903 to 1965, cf. table 4.[19] Interpreting the changes in top income shares as solely an effect of changes in taxation thus requires that the underlying elasticities increase relatively quickly with income and to levels that seem to high compared with the consensus in the literature (see Saez et. al., 2013).

Table 4
Changes in income shares and marginal tax rates and implied elasticities

	Income share			Marginal net-of-tax rate[1]		
	P90-P95	**P95-P99**	**P99-P100**	**P90-P95**	**P95-P99**	**P99-P100**
1903	10.57	15.10	16.21	0.93	0.93	0.92
1965	10.94	12.13	7.79	0.54	0.53	0.51
Log change	0.03	-0.22	-0.73	-0.53	-0.56	-0.59
Implied elasticity[2]		0.64	1.49			

Notes: 1) Measured at the bottom income threshold for the group.
2) Assuming an elasticity of 0.2 for the P90-P95 group. If we instead assume an elasticity of 0.1 the elasticities for the P95-P99 and P99-P100 groups become 0.54 and 1.39 respectively.
Sources: Own calculations.

This analysis may be seen as the within-country version of the cross-country analysis conducted in Piketty et al. (2014).

5 Conclusions

This paper has been concerned with the long run development of income inequality in Denmark. To this end, we have constructed estimates of the top income shares in Denmark dating back 140 years. Compared to earlier studies of income inequality in Denmark these series are unique in that we pay strict attention to the comparability of the estimates over time and bring the methodology in line with that used in the recent studies of other countries. Using the constructed time series, it is possible to give some answers to the questions posed at the outset. There have been periods in the past when

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[19] The same calculations over the period from 1971 to 1985 yield elasticity estimates of 0.58 for the P95-P99 group and 1.21 for the P99-P100 when assuming an elasticity of 0.2 for the P90-P95. If we instead assumed 0.1 the estimates would drop to 0.48 and 0.11 respectively. Assuming that the elasticity is the same across income groups (as in a standard difference-in-difference analysis) yields an estimate of 19. After the introduction of the dual tax system in 1987 this analysis is complicated by the fact that the level of a single income definition such as taxable income is no longer sufficient to determine the marginal tax rate faced by an individual.

Denmark has seen significant reductions in inequality: (possibly) in the last 30 years of the 19th century spanning the start of the industrialization in Denmark, and definitely over the Second World War, and in the 1970s. Income inequality has thus declined during several distinct phases, and even though there has been an increase in inequality since the 1980s, inequality has by historical standards remained low. This time path follow relatively close the time path in Sweden, and the Danish case thus adds to the picture of global co-movement in inequality until the 1970s and thereafter divergences.

In contrast to the studies of other countries, the Danish tax records cover a relatively large proportion of the population almost from the beginning of our sample period, and this enables us to answer two important questions. Firstly we are able to assess to what extent the top income shares proxy the overall level of inequality and secondly we can address the question as to which groups of the income distribution benefitted from the decline in the top income shares. The answer to the first question is that there is a relatively stable relationship between the income share of the top 1 per cent and overall income inequality measured by the Gini coefficient, implying that top 1 per cent income share indeed is a good proxy for overall inequality, when the data quality restrict the calculation of such measures. Furthermore the development in the top 1 per cent income share seems to be relatively robust to the use of different income and population definitions, except during radical changes of the in structure of the economy, such as women entering the labour market.

The answer to the second question is that the decline in the top 1 per cent income shares primarily benefitted the part of the income distribution below the 70th percentile, while the income shares of the income groups between the 70th and 95th percentile have been remarkably stable over the past century. The fact that primarily the top 1 per cent share has fallen, while the income share of e.g. the group between the 90th and 95th income percentile has remained constant, seems to support the conclusions drawn by Piketty et. al., (2014) and Alvaredo et. al., (2013) that the long run trends do not merely reflect standard labour supply responses to increases in tax rates.

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