Inequality within Generation: Evidence from France

Hippolyte d'Albis, Ikpidi Badji

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Ikpidi Badji

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Hippolyte d'ALBIS[1] **Ikpidi BADJI**[2]

Abstract. Intra-generational inequalities focus on the distributions within age groups. On the basis of French household income surveys carried out from 1996 to 2014, the Gini coefficient and D9/D1 inter-decile ratio were calculated so as to evaluate intra-generational income inequality before and after redistribution by the tax and welfare system. Age-Cohort-Period models were then estimated in order to disentangle age and generation effects. Over a life cycle, intra-generational inequality displays a hump-shaped curve peaking at age 55-59. This inequality is significantly lower among the youngest, whichever inequality indicator is used, and among the oldest, when measured by the inter-decile ratio. Comparison of pre- and post-redistribution income reveals that the tax and welfare system particularly reduces inequality among the young. Intra-generational inequality measured by the Gini coefficient increases significantly from one generation to the next. Measured by the inter-decile ratio, the increase is considerable for the gross income of those generations born from the 1970s on. However, the tax and welfare system has compensated for this increase, because analysis of the inter-decile ratio applied to disposable income shows no significant difference between generations.

Key words: income inequality; age groups; generations; Age-Cohort-Period model.

[1] Paris School of Economics and CNRS. Mail: 48 boulevard Jourdan, 75014 Paris, France. E-mail: hdalbis@psemail.eu. Corresponding author.
[2] Economix, Université Paris Nanterre. Mail: Bâtiment G - Maurice Allais, 200 avenue de la République, 92001 Nanterre cedex, France. E-mail: ikpidibadji@gmail.com

Introduction

In this article we examine developments in inequality from a generational perspective. We want to know whether young generations face greater inequality than their predecessors. Inequality can breed resentment and it is accepted that inequality, along with standard of living, is a major component of the well-being of population groups. Scholars are increasingly integrating this topic in composite indicators, for example Fleurbaey and Gaulier (2009) and Jones and Kleenow (2016). The novelty here is to consider that inequalities within age group -or generation- are those that matter for a given individual.

Generational analysis of inequality faces two difficulties. First, it is not possible simply to analyse the change over time of an indicator that gives a degree of inequality at a given date. It would be misleading to suppose that a given variation in inequality in recent years generates the same variation in inequality for recent generations, since the former is likely to affect all generations alive at the time. Similarly, no change in inequality does not necessarily imply that all generations are equal with respect to inequality. Our first challenge is therefore to attribute the relevant variations in inequality to each generation. Inequality that was now greater among the working population than the retired would not necessarily imply that the generation that is currently active will over its lifetime experience greater inequality that its predecessors. We need to track the inequality specific to each cohort over its life cycle. Where we have incomplete data, as is almost always the case, we have to use estimates.

These two difficulties are fairly standard in cohort analyses and can be found in estimates of changes in living standards from one generation to the next. The novel feature here is to apply these estimates to the topic of inequality. Our starting position is to use intra-generational inequality, i.e. the distribution of income within an age group. This demographic approach to inequality has been used in particular by Mather and Jarosz (2014) and Fisher et al. (2018). The main assumption in our article is that this is a most relevant inequality. This is based on the intuition that individuals compare themselves more with others of the same age than with those of other generations. Starting from this assumption, we can construct inequality indicators relating to certain parts of the life cycle of generations observed in surveys and thus distinguish cohort effects from age effects.

We have used the Tax Income Survey (Enquête Revenus Fiscaux – ERF) and Tax and Social Incomes Survey (Enquête Revenus Fiscaux et Sociaux – ERFS), conducted by the French

National Institute of Statistics and Economics Studies (Insee) to estimate annual income distribution before and after the redistribution induced by taxation and welfare transfers for five-year age groups from 1996 to 2014. Gross income (before redistribution) is not directly recorded in the surveys and we reconstructed for each household employer and employee contributions for pensions and unemployment. Intra-generational inequality was then estimated using the Gini coefficient and the inter-decile ratio. We also constructed for each inequality indicator a variable of the difference between income inequality before and after redistribution in order to measure the effect of the French tax and welfare system on intra-generational inequality. Like Piketty et al. (2018) and Bozio et al. (2018), we have thus estimated the effect of redistribution on inequality, but focusing in our case on intra-generational inequality and its variation from one generation to the next.

We estimated Age-Cohort-Period models to evaluate the effects of age and generation on intra-generational inequality. To our knowledge, this method has not often been applied to inequality. The exception is Deaton and Paxson (1994b), who use it to test the prediction of the permanent income hypothesis that income variance increases with age. We find that intra-generational inequality fluctuates considerably over a lifetime. It is very high at age 55-59 and much lower both at the start of working life and in retirement, when inequality is measured by the inter-decile ratio. The tax and welfare system plays a major role for those under 50 and a lesser role later. Over their lifetime, households thus see income inequality in their age group first increase then decrease. Allowing for this age profile, it is possible to compare generations and evaluate whether recent generations live in a more unequal environment than their predecessors. Taking the top and bottom deciles of the distribution, we find that inequality in gross income increased sharply beginning with the cohorts born in the 1970s; however, the tax and welfare system corrected this, because we find no significant differences between generations in inequality of disposable income. This redistribution effect of the tax and welfare system parallels the findings of Bozio et al. (2018) for the French population as a whole and of d'Albis et al. (2019) for inequality between generations. Recent researches have shown that living standards in France are not falling from one generation to the next, and that there is consequently no basis to the idea of a "sacrificed generation" (d'Albis and Badji, 2017). Economic growth benefits everyone and younger generations enjoy on average higher living standards than in the past. Subsequently, however, it has been shown that this improvement does not apply to all sections of the population: in particular, the living standards of men without the *baccalauréat* (secondary school leaving certificate) in recent generations are lower than for previous ones (d'Albis and Badji, 2020). We add to this line of research by directly analysing variations by generation in the traditional indicators of inequality such as the Gini coefficient and inter-decile ratio. In particular, we find that inequality as measured by the Gini coefficient increases steadily generation after generation and the tax and welfare system does not manage to counter that increase.

We present first the data used, the method for constructing our indicators of intra-generational inequality and some descriptive statistics. Then we describe in detail our econometric model and present the results of our estimates, before concluding.

Variables used and descriptive statistics

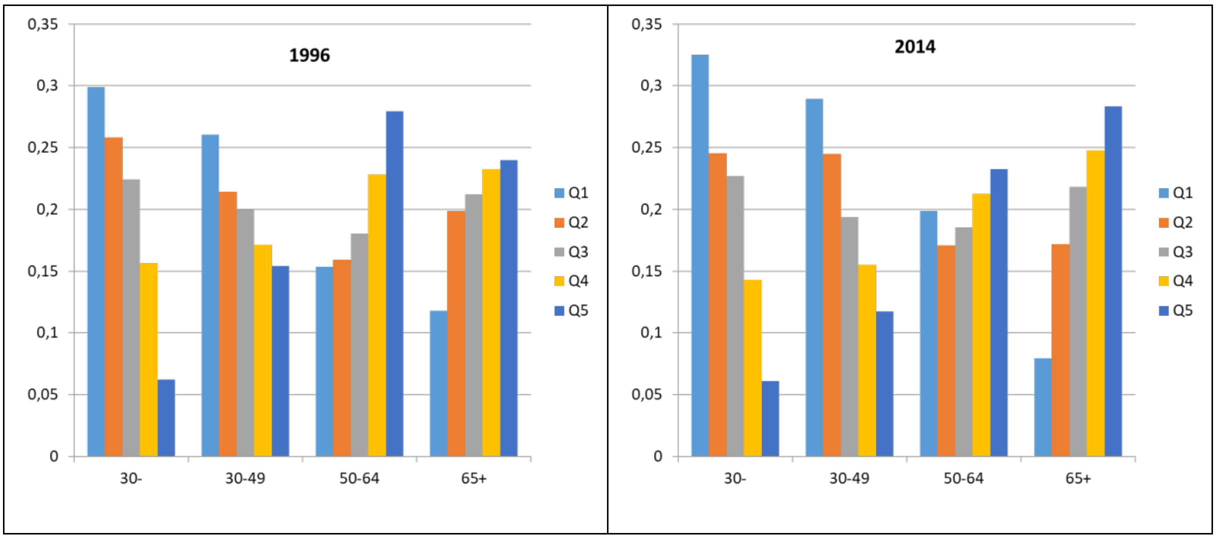
Two main variables are used in this article. One is gross income, called "pretax income" in Bozio et al. (2018), consisting of the sum of income from work net of unemployment and pension contributions, income from capital, pension and unemployment benefits and income from abroad. This gross income represents income before redistribution by the tax and welfare system. The other variable is disposable income, consisting of the sum of income from work net of all welfare contributions, income from capital, all welfare benefits and income from abroad, less direct taxes. Details of the construction of these variables may be found in Appendix A.

The extent and significance of age inequality may be seen by reproducing the figures in Fisher et al. (2018), but with our data. The aim is to determine from the entire sample the threshold values for the quintiles of income distribution. Then we define age groups (in this case, under 30, 30-49, 50-64 and 65 and over) and calculate the proportions of each age group in each income quintile. If there is no specific age effect, then the population of an age group will be evenly spread across the quintiles: the proportion in each quintile will be 20%. In that case, the population in the age group reflects the population as a whole (aged 25-84). Conversely, if these proportions differ from 20%, it means that the income distribution of the given age group diverges from that of the total population. The figure also shows whether incomes in that age group are higher or lower than those of the total population.

Figure 1 shows how the age groups divide between the quintiles for gross income in 1996 and 2014, the start and end of our observation period. It is noticeable that proportions decline from one quintile to the next in the youngest age groups (under 30 and 30-49), meaning that these groups are over-represented in the poorest quintiles. In 1996, nearly 30% of the under-30s were in the bottom quintile and 6% in the top. Conversely, in the oldest age groups, these proportions increase from one quintile to the next, meaning that they are over-represented in the richest quintiles. In 1996, of those aged 65 and over, just over 11% were in the bottom quintile and 24% in the top.

From 1996 to 2014, the divergence from total population distribution widened for all groups except the 50-64s. These divergences increased particularly for the 30-49 age group (the gap between proportions of the age group in bottom and top quintiles rose from 11 to 18 percentage points) and the over 65s (from 13 to 20 percentage points). Conversely, the divergence between the 50-64 distribution and that of the total population visibly diminished: by 2014 the one practically reflected the other.

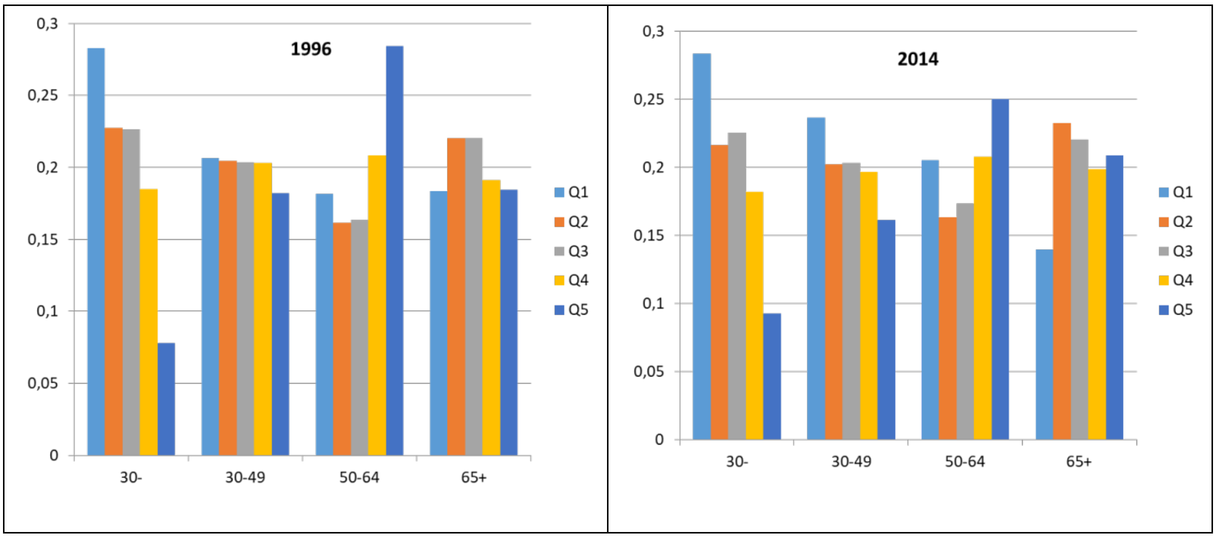
Figure 1. Gross income: distribution of age groups between the quintiles defined for the total population in 1996 and 2014.



Source: INSEE (ERF, ERFS), authors' calculations. Reading note: in 1996, 30% of the under-30s were in the bottom quintile of the distribution of gross income, calculated for the total population.

Introducing the effects of the tax and welfare system greatly changes estimated age inequality. Figure 2 is the counterpart of Figure 1 for disposable income. By comparing the two figures it can be seen that the distributions for disposable income are much closer to that of the total population, although some differences persist. In particular, the under-30s are still over-represented in the lower quintiles, although the absolute difference in proportions is lower than for gross income. Although the proportion of over-65s in the bottom quintile remains low (14% in 2014), the values for the other quintiles are close to 20%, a sharp contrast with the inequalities seen for gross income. The increase in divergence from the total population distribution seen for gross income is not seen for disposable income. The French tax and welfare system seems to contribute both to the reduction in age inequality and to its increase over time.

Figure 2: Disposable income: distribution of age groups between the quintiles defined for the total population in 1996 and 2014.



Source: INSEE (ERF, ERFS), authors' calculations. Reading note: in 1996, 28% of the under-30s were in the bottom quintile of the distribution of gross income, calculated for the total population.

Together, Figures 1 and 2 show that age groups matter for the understanding of inequality and that specific analysis based on age can be useful. We continue our exploration of intra-generational inequality by calculating for each age group the standard indicators of inequality, such as the Gini coefficient and the inter-decile ratio.

A number of indicators are used in the literature to measure income inequality. In this article we use two popular indicators: the Gini coefficient and the D9/D1 inter-decile ratio. The Gini coefficient satisfies key principles that make it reliable and has the advantage of covering the entire distribution (See Appendix B for more details). However, it does not focus on the extremes. To that end, we use the inter-decile ratio between the lowest income in the top decile and the highest in the bottom (D9/D1); this ratio reflects the extent of inequality between the richest and the poorest 10% of the population. Unlike the Gini coefficient, this inter-decile ratio does not satisfy the Pigou-Dalton transfer principle. Table 1 provide the Gini coefficient and the inter-decile ratio in 1996 and 2014. For both gross and disposable income, the inequality measures increased over the period.

Table 1. Inequality measures in 1996 and 2014

		1996	2014
Gross income	Gini	0.35	0.37
	D9/D1	5.08	5.50
Disposable income	Gini	0.27	0.29
	D9/D1	3.38	3.44

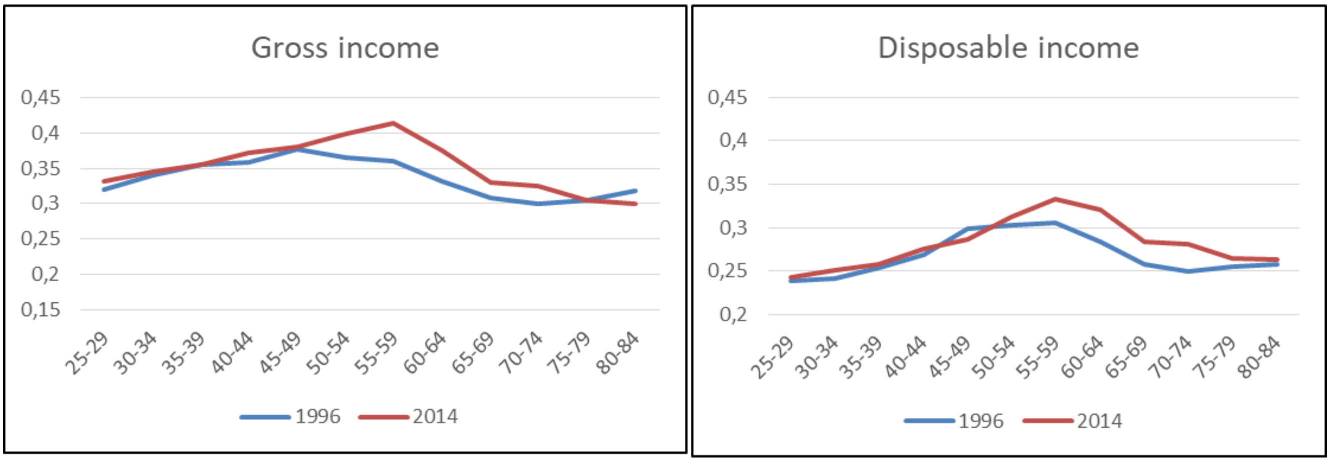
Source: INSEE (ERF, ERFS), authors' calculations.

We now turn to intra-generational inequalities. Figure 3 shows the Gini coefficients calculated for twelve five-year age groups from 25-29 to 80-84. We observe first that intra-generational inequality displays a hump-shaped curve by age. Inequality is greatest in the second part of working life (generally at age 55-59), and least for the outermost groups (25-29 and 80-84).

By comparing the curves of inequality of gross and disposable income, we see the effect of the tax and welfare system on inequality as a result of net transfers. Note that the French tax and welfare system comprises a wide variety of contributions and welfare transfers. Contributions include direct taxes (income tax, housing tax), indirect taxes (consumption, VAT), non-contributory social insurance contributions, taxes on capital. Transfers are both monetary and non-monetary but only the former are included here.

Descriptive statistics seem to confirm the redistributive effect of the tax and welfare system but seem to suggest that the system does not affect the differences observed between age-groups. Moreover, from 1996 to 2014, there is a sharp increase in intra-generational inequality between the ages of 50 and 70, and little change at other ages.

Figure 3: Gini coefficients for gross and disposable income by five-year age groups in 1996 and 2014



Source: INSEE (ERF, ERFS), authors' calculations. Reading note: in 1996, the Gini coefficient for the gross income of age group 25-29 was 0.32.

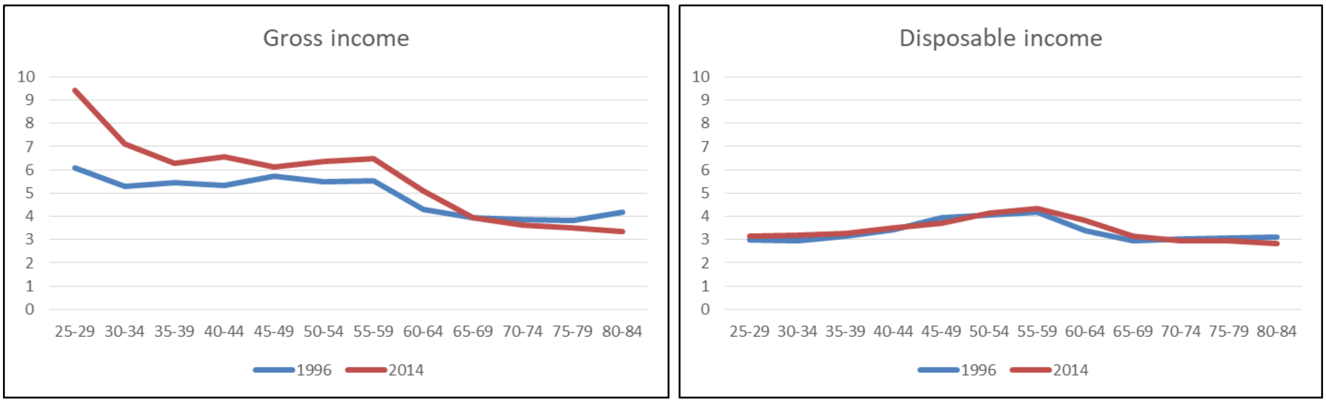
It is also instructive to examine the Gini coefficient values. As a basis for comparison, the coefficients calculated for the entire sample in 2014 are 0.37 for gross income and 0.29 for disposable income (Table 1). We may infer that at most ages, intra-generational inequality is lower than total inequality. However, the extent of variation between ages is striking. In 2014, the absolute variation between the 25-29 age-group coefficient (0.24) and the 55-59 one (0.33) is 0.09 for disposable incomes. This variation is close to that between France and the United States. In relative terms, the variation is even greater because between 25-29 and 55-59, intra-generational inequality increases by 36.8%, more than that between France and Togo. [3]

Figure 4 shows the inter-decile ratios calculated for twelve five-year age groups from 25-29 to 80-84. Note that this indicator does not reflect any transfers occurring between the other deciles (Atkinson and Brandolini, 2015; Villar, 2017). So comparing the gross income and disposable income indicators involves only analysing any transfers concerning the top and bottom deciles. Unlike what we saw with the Gini coefficients, the age inequality curves for gross and disposable income differ considerably. The former clearly decreases with age, as inequality is greater among the young. There is also a sharp increase in intra-generational

[3] According to the World Bank, the Gini coefficients for France, the United States and Togo are 0.32, 0.41 and 0.43 (https://donnees.banquemondiale.org/indicateur/SI.POV.GINI).

inequality during the study period, with the ratio reaching 9.5 in the 25-29 age group in 2014. For disposable incomes, the curve is much flatter—snaking between 3 and 4—and the hump-shaped curve re-emerges that we saw with the Gini coefficients. The relative variation between the 25-29 and 55-59 age groups is still very high, 38% in 2014. The tax and welfare system does seem to considerably reduce inequality between the ends of the distribution, particularly for the youngest. Furthermore, it seems to have completely eliminated the increase in inequality observed in gross incomes from 1996 to 2014.

Figure 4: Inter-decile ratios for gross and disposable income by five-year age groups in 1996 and 2014



Source: INSEE (ERF, ERFS), authors' calculations. Reading note: in 1996, the inter-decile ratio for the gross income of age group 25-29 was 6.1.

By way of comparison, the inter-decile ratios for the whole 2014 sample are 5.50 for gross income and 3.44 for disposable income. So for those under 50, intra-generational inequality in gross income is above this average. In disposable income, however, for most age groups, intra-generational inequality is lower than overall inequality.

These inter-decile ratios measure the outer ends of the distribution, and it is usual in addition to evaluate the relative income of the richest by comparing it with the median figure. In Appendix C we give the D9/D5 ratio (ninth to fifth decile), P95/D5 ratio (95th percentile to fifth decile) and P99/D5 ratio (99th percentile to fifth decile). The main difference with Figure 4 is that we do not find the extremely high inequalities observed for the gross income of the youngest individuals. Finally, the ratios computed with respect to the median income are ultimately fairly similar to those produced by the Gini coefficient, an observation also made by Bozio et al. (2018), which explain why we did not included them in the main analysis.

The curves shown on the above figures come from cross-sections of the population, implying that age groups are compared at a given date, and these are also involving different generations. We need to distinguish between age effects and cohort effects to gain a clear picture of changes in inequality over a life cycle and between generations. This can be done by estimating the contribution of age and cohort effects to the intra-generational indicators of inequality given above.

Below, we also use our two variables to estimate age effects and cohort effects in the impact of the tax and welfare system on intra-generational inequality. One is the difference between the Gini coefficient for gross income and disposable income, and the other the difference between the inter-decile ratio for gross and disposable income.

Estimation strategy

To disentangle age, cohort and period effects, we use the estimation method suggested by Deaton (1985). Since our data are cross-section data, we constructed pseudo-panels. The aim is to identify households in a single cohort and monitor for each of these cohorts the inequality they experience at each age. As Bodier (1999) points out, pseudo-panel results are not necessarily of poorer quality than those obtained from panel data. The reason is that the use of pseudo-panels has the advantage of avoiding selection biases due to attrition effects (which increase with each succeeding period) and learning biases.

We defined our cohorts by “year of birth” and constructed 76 of them. The first contains households born in 1913 and the last those born in 1988. Our pseudo-panel comprises only 1,138 cohort observations, because not every cohort is observed in every survey. The average size of a cohort observed at a given date is 739 individuals, and they range from 119 to 1,475.

The simultaneous introduction of “age”, “cohort” and “period” variables causes a collinearity problem because the year of the survey is the sum of the “age” and “cohort” variables. This problem has long been known and discussed (see Hall, 1971, and, for example, Kupper et al., 1985). Various solutions are suggested in the literature to remedy it. One is to measure the three variables using different units. For example, age in ten-year groups and the other two variables in five-year groups. This is not a robust solution because it evades the collinearity problem without really solving it. The results from this method have turned out to be unstable because they are highly dependent on the units chosen. Another solution is to replace one of the three variables with a variable that is not collinear with the other two (Fienberg and Mason, 1985). For example, Bodier (1999) estimates consumption by replacing the "survey date" variable with income, which reflects economic changes over time (and is also a key determining factor in consumption). However, this solution also has its limitations because income only partly reflects period effects. In d'Albis and Badji (2017) we proposed a new identification strategy, namely to replace the age variable with life expectancy at each age. Since life expectancy correlates with income, this strategy leads to an under-estimation of the effect that economic growth has on the estimated variable.

The most common identification strategy is to constrain the estimated parameters. Deaton and Paxson (1994s) suggest constraining period effects by assuming (a) that period effects sum to zero, and (b) that these effects are orthogonal to the long-term trend. The authors implicitly assume that macroeconomic change can be disaggregated into a trend and a cycle. The cycle is imputed entirely to the period effect, and the trend is captured by age and cohort effects. This strategy does, however, have some limitations. In particular, the age and cohort effects correspond to the long-term trend because of the assumption made about the period effect. This makes it hard to tease out the pure age and cohort effects. Moreover, the authors emphasise that this procedure is a risky one if the number of surveys is low, or if it is difficult to distinguish the trend from temporary shocks. For all its limitations, we consider that this method (Deaton and Paxson, 1994a) is the most appropriate for our purposes in this case.

We assume that the three effects (age, cohort and period) are additive. The model is

$$\bar{y}_{jt} = \mu + \sum\nolimits_{i} \alpha_i \, 1_{a_{jt}} + \sum\nolimits_{c} \beta_c \, 1_{j=c} + \sum\nolimits_{t} \gamma_t \, 1_{t=p} + \bar{\varepsilon}_{jt},$$

where $\bar{y}_{jt}$ is the dependent variable (log Gini coefficient, log inter-decile ratio, log variation between gross and disposable income Gini coefficients, and log variation between gross and disposable income inter-decile ratios) associated with cohort *j* = 1913, 1914,…,1988 and survey date *t* = 1996, 1997,…, 2014; $1_{a_{jt}}$ is the indicators of the five-year age groups *i* = 25-29, 30-34,…, 80-84 associated with cohorts *j* and dates *t*; $1_{j=c}$ represents the indicators of the cohorts, and $1_{t=p}$those of the survey dates. To attempt to eliminate collinearity, we follow Deaton and Paxson (1994a) and assume that period effects sum to zero and are orthogonal to the long-term trend.

In formal terms the constraints are expressed as follows:

$$\sum_t \gamma_t = 0 \text{ and } \sum_t (t \times \gamma_t) = 0.$$

In practice, the method introduces into the estimated equation not the period indicators but variables d^*_{ts}, obtained from the period indicators. This is achieved via the following relationship:

$$d^*_{ts} = d_{ts} - \frac{ts - t1}{t2 - t1} \times d_{t2} + \frac{ts - t2}{t2 - t1} \times d_{t1} \text{ with } s \geq 3 \; and \; d^*_{t1} = d^*_{t2} = 0,$$

where d_{ts} are the indicators for survey years *ts*. Then, to correct any heteroscedasticity that may be induced by the variation in size between cohorts, and from one date to another within cohorts, the variables are multiplied by the square root of cohort size.

We estimated our equation for each of the important variables. As can be seen in Table 2, in every case the tests for the presence of individual fixed effects (cohort effects in our pseudo-panels) are positive, leading us to choose a fixed-effects model. Specifically, we estimate a fixed-effects model of Least Square Dummy Variable type.

Table2. Test for fixed individual (i.e. cohort) effects and the Hausman test

	Individual effects test		Hausman test	
	F-statistic	P-value	F-statistic	P-value
Gini coefficient for gross income	8.68	0	93.32	0
Gini coefficient for disposable income	25.00	0	243.87	0
Variation between Gini coefficients for gross and disposable income	52.91	0	114.63	0
Inter-decile ratio for gross income	2.55	0	68.46	0
Inter-decile ratio for disposable income	2.90	0	588.88	0
Variation between inter-decile ratios for gross and disposable income	3.78	0	198.94	0

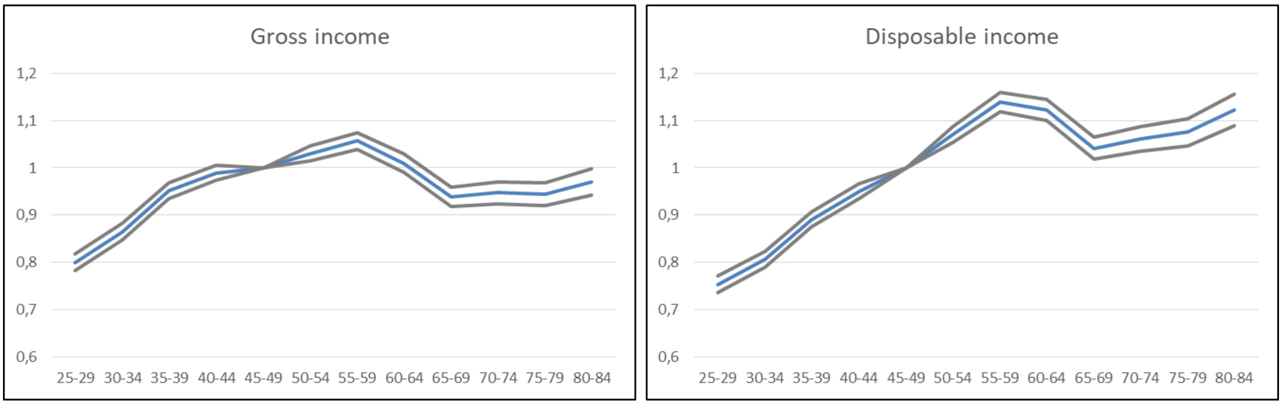
Reading note: the first two columns give the results of the test for individual (i.e. cohorts) effects. A P-value lower than 0.05 shows that the test for individual effects is positive at the 5% threshold. The next two columns give the results of the Hausman test. The fixed effects model is suitable for a P-value lower than 0.05.

Estimating age effects

Below we present our age effect estimates separately from cohort effects on intra-generational inequality. The estimates of period effects are not discussed here and are available on request.

Our estimates of intra-generational inequality as a function of the age of the household reference person are given in Figures 5 and 6, for Gini coefficients and inter-decile ratios. The results are expressed with respect to a reference age group, 45-49. They show the variations in the inequality indicator over a life cycle when controlled for cohort and period effects.

Figure 5: Gini coefficient as a function of the age group



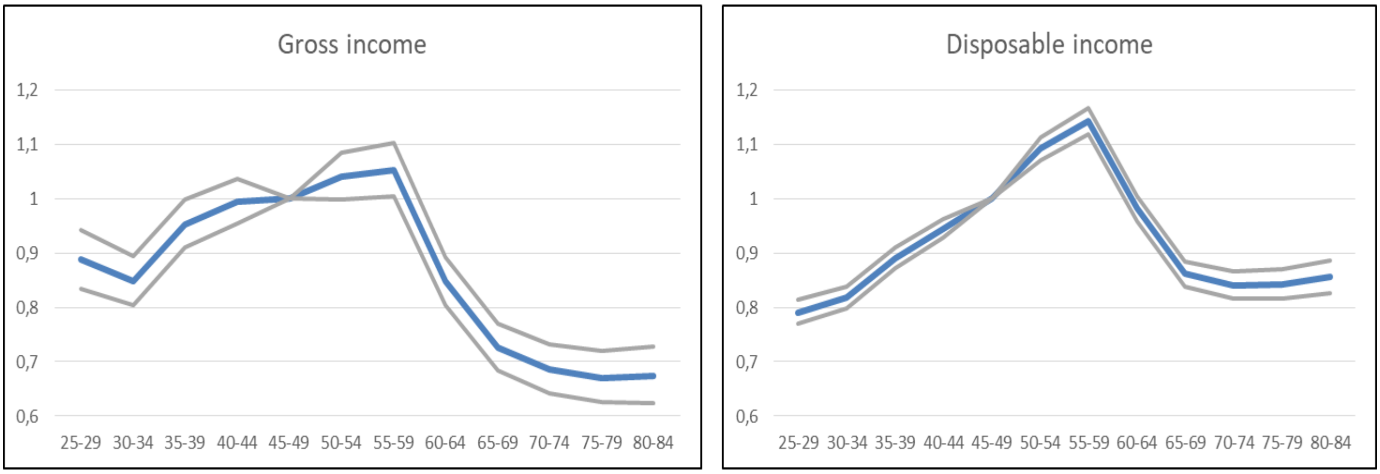
Note: the blue line joins the values given by the formula [exp(estimated coefficient α_i)–1]; the values are normalised to 1 for the 45-49 age group. The grey lines show the 95% confidence intervals

Figure 5 shows the estimates for the parameters associated with the age indicators in the equation that determines the Gini coefficient. Compared with the descriptive statistics in Figure 3, it can be seen that the hump-shaped curve persists up to the 65-69 age group, but then inequality stops decreasing: it flattens out or even increases at a level significantly higher than for the youngest groups. The variations (with respect to the lowest figure) between the Gini coefficients at the ages when it is highest (55-59) and lowest (25-29) are 32.1% for gross income and 51.2% for disposable income. However, the variations between the 55-59 and 80-84 age groups are much lower: 8.9% for gross income and 1.5% for disposable income. When one allows for cohort and period effects, therefore, the variations between age groups are much smaller.

Figure 6 shows the estimates for the age indicators in the equation for inter-decile ratios. For gross income, the curve by age differs considerable from the descriptive statistics in Figure 4.

The high inequality among the young disappears and seems more to reflect cohort or period effects. Once again there is the hump-shaped curve, as for the Gini coefficients, with a peak in inequality at age 55-59. But unlike with Gini, inequality sharply decreases towards the end of life. So the relative variations in inter-decile ratios between the 55-59 and 25-29 groups are 18.5% for gross income and 44.5% for disposable income. The variations between the 55-59 and 80-84 groups are higher for gross income (56.2%) but lower for disposable income (33.5%). Here too, age effects are particularly noticeable. The strong decline in the inter-decile ratio at older ages can be explain by the French safety net that allocates since 1956 an income to the poorest households after age 65 (*Allocation de solidarité aux personnes âgées*). If one considers a ratio computed with respect to the median income, like e.g. the D9/D5 ratio, the estimated age profiles are similar to those obtained with the Gini (See Appendix C for details).

Figure 6: Inter-decile ratio as a function of the age group

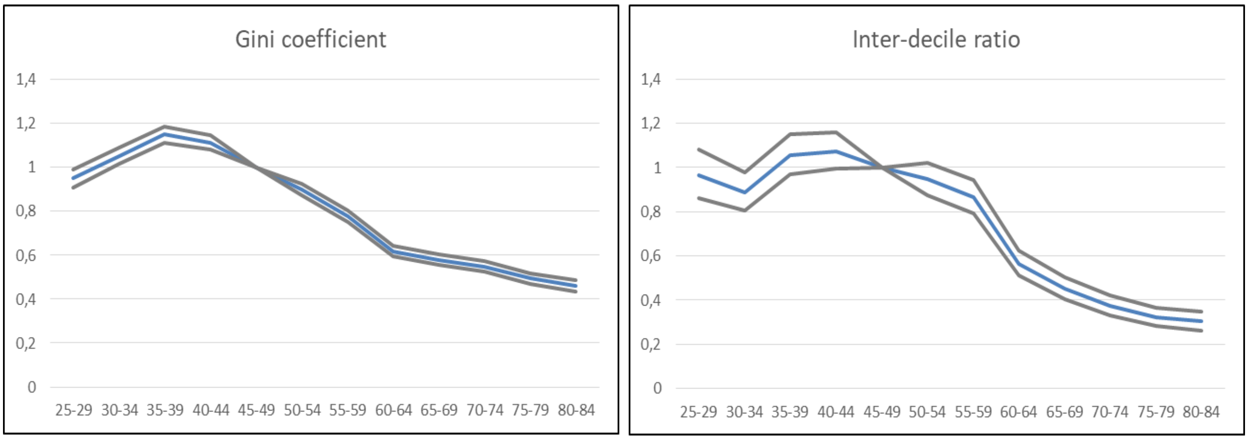


Note: See Figure 5.

Estimates of income by age differ slightly from those given by Deaton and Paxson (1994b) for Taiwan, United Kingdom and United States. Their curves increase more steeply and flatten out after age 60. This difference is most likely due to widely differing tax and welfare systems. It is also to the inequality indicator as Deaton and Paxson (1994b) use the variance in log income, which increases with the mean: the decline at retirement is thus less pronounced.

Figures 5 and 6 appear to indicate that the tax and welfare system has little impact on the variation in intra-generational inequality over the life cycle, because the curves by age are fairly similar. Indeed, Figure 7 shows the estimate of the effect of age on variations between intra-generational inequality for gross income and disposable income. Whether with the Gini coefficient or the inter-decile ratio, the estimate shows that it is those in their thirties who gain most from the tax and welfare system. The effect is similar for inequality measured by the Gini coefficient or the inter-decile ratio. This effect is consistent with the descriptive analysis in Figure 4 and is probably due to the large transfer payments made under French family policy. These start with the first child, on average when the mother is about 29 (Breton et al., 2019). The sum of welfare expenditure (in cash or kind) and tax expenditure (particularly via child tax relief, named *quotient familial*) is a significant transfer equivalent to nearly 5% of GDP (Pilorge et al., 2020).

Figure 7: Variations between intra-generational inequality in gross and disposable income, as a function of the age group



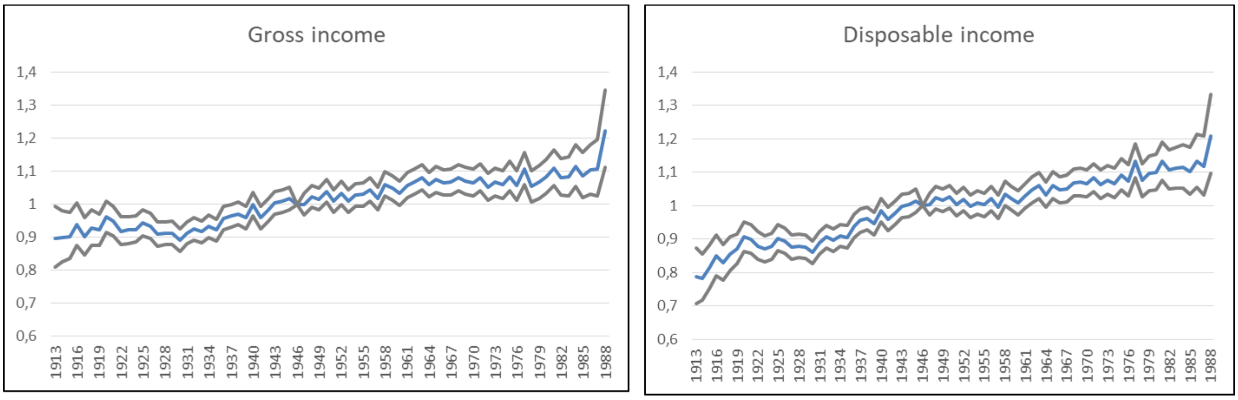
Note: See Figure 5.

Estimating cohort effects

Our estimates of intra-generational inequality as a function of the date of birth of the household reference person are shown in Figures 8 and 9 for the Gini coefficient and inter-decile ratio. The results are expressed with respect to the reference cohort born in 1946. They show the variations in the inequality indicator from one generation to the next, controlling for age and period effects.

Figure 8 shows the estimated parameters associated with the cohort indicators in the equation determining the Gini coefficient. It reveals a significant increase in inequality from generation to generation. For gross income, the Gini coefficient rose 7.1% from cohorts 1926 to 1946, 6.5% from cohorts 1946 to 1966 and 3.6% from cohorts 1966 to 1986. For disposable income, these increases are 11.8%, 4.8% and 8.2%. Intra-generational inequality is significantly higher than the reference cohort for all cohorts born after 1961 for gross income and for all those born after 1965 for disposable income. Visibly, it appears that the French tax and welfare system has had little effect on the inter-generational increase in this inequality.

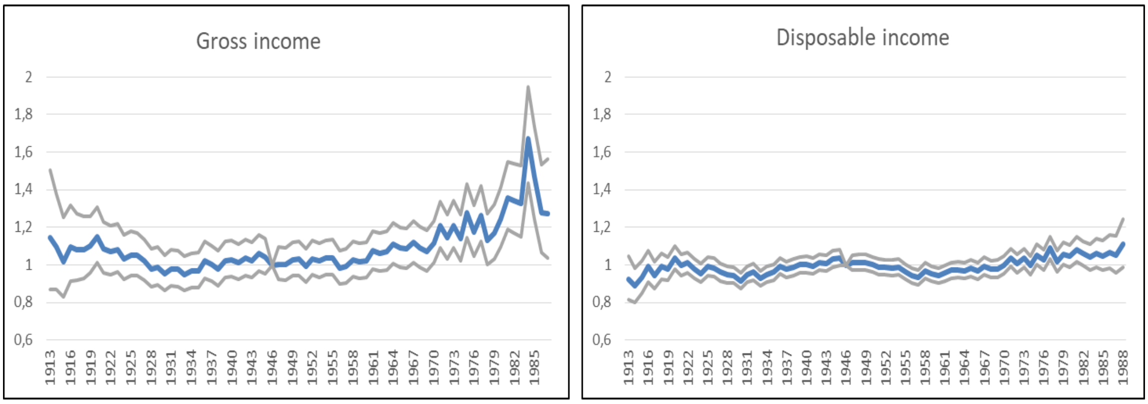
Figure 8: Gini coefficient as a function of the date of birth



Note: the blue line joins the values given by the formula [exp(estimated coefficient β_c)–1]; the values are normalised to 1 for the 45-49 age group. The grey lines show the 95% confidence intervals. Due to the smaller number of observations, estimates are less precise for the youngest and the oldest cohorts.

Figure 9 shows the estimated parameters associated with the cohort indicators in the equation determining the log inter-decile ratio. It differs considerably from the figure for the Gini coefficient. For gross income, there is no significant change between cohorts born from 1913 to 1969 and it is only from the cohorts born in the 1970s that inequality is seen to rise. But this later rise is a significant one, because after 8.4% between cohorts 1946 and 1966, the figure is 18.1% between cohorts 1966 and 1986. However, this increase is totally absent for disposable income. The change in inter-decile ratio is not significant for any of the cohorts studied. The tax and welfare system does therefore appear to greatly reduce the intergenerational unfairness cause by the greater inequality measured at the ends of the distribution. This is probably due to monetary transfers other than unemployment and pension benefits, which go mainly to people in the lowest income deciles. According to Bozo et al. (2018), the share of these transfers in the income of the first decile rose significantly after 1995 to 11% in 2018.

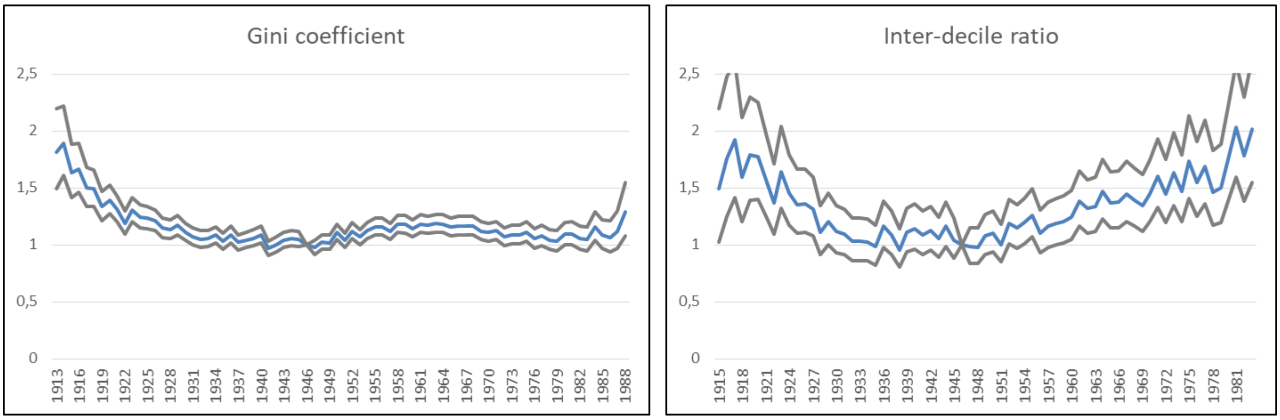
Figure 9: Inter-decile ratio as a function of the date of birth



Note: See Figure 8.

The effect of the tax and welfare system on changes in intra-generational inequality from one generation to the next is analysed in Figure 10, which shows the estimated effect of date of birth on the variations between intra-generational inequalities for gross and disposable income. It confirms that those born before the early 1930s gained more from the tax and welfare system in terms of reduced inequality that those born in the 1940s. By the Gini coefficient, it can be seen that those born in the 1950s and 1960s do better. By the inter-decile ratio, all cohorts born after 1958 do better and increasingly so over time.

Figure 10: Variations between intra-generational inequality in gross and disposable income, as a function of the date of birth



Note: See Figure 8.

Conclusion

In this article we have described intra-generational inequality in France, namely the inequality within a given age group. Using INSEE's ERF and ERFS surveys from 1996 to 2014, we evaluated the distribution of gross and disposable income within five-year age groups. To obtain gross income for each household examined it required some degree of construction of employer and employee pension and unemployment insurance contributions. Income distribution was summarised by the Gini coefficient and the inter-decile ratio, the latter emphasising the variation between the ends of the distribution. We also constructed for each inequality indicator a variable consisting of the variation between gross income inequality and disposable income inequality in order to measure the effect of the French tax and welfare system on intra-generational inequality. We also estimated Age-Cohort-Period models to evaluate age effects (controlling for cohort and period effects) and generation effects (controlling for age and period effects).

Our results are as follows. Intra-generational inequality by age displays a hump-shaped curve peaking at age 55-59. Inequality is most significantly lower among the youngest: from age 25-29 to age 55-59, disposable income inequality rises 51.2% by the Gini coefficient and 44.5% by the inter-decile ratio. Those aged under 50 gain most from the effect of the tax and welfare system on intra-generational inequality; those in their 30s see the largest variation in inequality between gross and disposable income. For the oldest groups, inequality only significantly decreases when measured by the inter-decile ratio: by the Gini coefficient the gap between disposable income for age 80-84 and 55-59 is only 1.5% but 33.5% by the inter-decile ratio.

The cohort curves for intra-generational inequality are, however, quite different. This implies that age inequality does not necessarily lead to inter-generational inequality. Disposable income inequality is seen to rise by the Gini coefficient; it increases 11.8% from the cohort born in 1926 to the 1946 one, 4.8% between the 1946 and 1966 cohorts, and 8.2% between the 1966 and 1986 cohorts. By the inter-decile ratio, gross income inequality rises sharply for all cohorts born from the 1970s on. However, disposable income inequality does not vary from generation to generation. We deduce that the tax and welfare system has managed to protect recent generations from a sharp increase in inequality between the ends of the distribution but not the average level of inequality.

The French tax and welfare system clearly operates in favour of the young by reducing inequality within their age group. But the system's inter-generational effect is more ambivalent: although it eliminates the increase in inter-decile ratio for gross income for those born after 1970, it fails to stop the increase in inequality measured by the Gini coefficient. Younger generations enjoy higher average living standards than previous generations (d'Albis and Badji, 2017), but the world they live in is more unequal. This may explain the dissatisfaction and sense of injustice some of them express.

Our results are rather descriptive and further research is needed is order to fully understand the main mechanisms at stake. It could be also useful to investigate whether the evolution we obtained for France are also observed in other countries.

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The authors equally contributed to the article.

The data that support the findings of this study are available from the corresponding author upon request.

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Appendix A. Surveys used and construction of income

We use the annual Tax Income Survey (Enquêtes Revenus Fiscaux–ERF) from 1996 to 2004 and Tax and Social Incomes Survey (Enquêtes Revenus Fiscaux et Sociaux–ERFS) 2005 to 2014. These INSEE surveys offer a comprehensive panorama of the income of French households. This involves matching the data from INSEE's employment surveys and the tax records of the Ministry of Finance. Changes introduced when the ERF was replaced by the ERFS improved the assessment of certain welfare benefits and financial income sources. Data from 1996-2004 were back-casted to ensure the continuity of the series (Blasco and labarthe, 2018). In 2011 and 2013, some methodological changes were introduced. For example, the ERFS imputes and corrects wealth incomes using models estimated on another wealth survey from the INSEE. Hence, the ERFS survey 2010 was produced in two versions: according to the 2009 methodology and according to the 2011 methodology. From 2013, the ERFS of year n includes the tax actually paid in n, therefore based on income received in n-1. Here again, the ERFS survey 2012 was calculated using the 2011 methodology and the 2013 methodology. The calculations carried out by Blasco and labarthe (2018) on the two versions (the one before and the one after the change) of the 2010 and 2012 databases, show that the inter decile ratio, and the D9-D5 ratio, which are the indicators we used in this paper, are stable. In particular, their values are equal for the two versions of the surveys 2010 and 2012.

We consider only those households where the reference person is aged between 25 and 84. Younger people are excluded because of the difficulty in assessing young adults' income in the ERF-ERFS, largely due to major variations in family transfers (Castell and Grobon, 2020). Older people are excluded mainly because they are poorly represented in the surveys, which do not cover people living in institutions. We correct income by household size, using the OECD scale, counting 1 for the first adult, 0.5 for any other person aged 14 and above, and 0.3 for any other person aged 13 and under. The sample characteristics are reported in Table A1.

Two main variables have been used in this article. One is gross income. It is the sum of (i) working income less pension and unemployment insurance contributions, (ii) income from capital, (iii) pension and unemployment benefits and (iv) income from abroad. The other is disposable income. This is the sum of (i) working income less all social security contributions, (ii) income from capital, (iii) all welfare benefits and (iv) income from abroad, less direct taxation.

Income after deduction of social security contributions and direct taxes is easily observable in the ERF and ERFS surveys. Disposable income is deduced from the figures recorded. Gross income is not directly observable and we recalculated it for each income from other sources of information. The general aim is to identify the amount of gross income from work and capital and then deduct certain social security contributions. We use the fact that ERF and ERFS record the amount of general social security contribution (CSG) paid by each household; we deduced the household's gross income from that by applying to observed income the annual rates of CSG (available on the website of the *Institut des Politiques Publiques*[4]) and the rate defining the tax base (namely 98.25%). Then we separated private sector employees, the self-employed and public sector employees, because their social security contributions are calculated differently. For each category, we calculated the contributions to pension and unemployment insurances, using the IPP website rates. By deducting these contributions from the gross working income calculated previously and adding other income sources, we obtain gross income. Note that we do not use the labor cost, which is a different concept (Bozio and al., 2020).

More precisely, for each worker we computed the gross salary using the amount of general social security contribution (CSG) paid by each worker available in the database; the rate of CSG and the rate defining the tax base (namely 98.25%), according to the following formula:

$$\text{Gross salary} = \left(\frac{\left(\frac{CSG\ amount}{CSG\ rate}\right)*100}{98.25}\right)*100$$

Concerning the calculation of the employers and employees contribution to the pension and unemployment insurances, we use the gross salary. We separated private sector employees, the self-employed and public sector employees. Private sector employees. Within this category of employees, we also distinguished executives from non-executives and the different income levels suggested by social security. Public sector employees. In the public sector, social security rates apply to the gross index-related salary, i.e. the gross salary before bonuses. According to Busch et al. (2017), it represents 78% of the gross salary in 2014. As we did not find information for years 1996 to 2013, we used this rate for all years, assuming it remained constant. It is worth noting that social security contribution rates differ depending on the type of public administration (local governments, hospital administration and central

[4] https://www.ipp.eu/baremes-ipp/.

government), but those distinctions are not specified in the database we use. Thereby, we averaged the social security contribution rate of local governments, hospital administration and that of central government.

Unfortunately, imputed rent is not included in the surveys. This would have made possible more accurate evaluations, but our earlier research has led us to conclude that its omission is unlikely to qualitatively bias our analysis of intergenerational inequality (see d'Albis and Badji, 2017).

Unlike d'Albis and Badji (2017), we did not need to realign individual variables with the National Accounts aggregates, because we are constructing inequality variables that are independent of the averages.

Table A1: Descriptive characteristics of the samples

Percentage (%)	1996	2000	2005	2010	2014
			Age Group		
25-29 yrs	7.11	6.74	6.36	5.95	4.84
30-34 yrs	9.63	9.23	8.40	7.21	6.86
35-39 yrs	10.89	10.35	9.50	8.77	7.69
40-44 yrs	10.86	10.28	10.31	9.64	9.50
45-49 yrs	11.20	10.47	10.37	10.41	10.03
50-54 yrs	8.95	10.91	10.38	10.28	10.37
55-59 yrs	7.36	8.15	10.67	10.07	10.31
60-64 yrs	7.75	7.02	7.08	10.54	10.57
65-69 yrs	8.54	7.83	6.89	7.34	9.95
70-74 yrs	7.86	7.71	7.69	6.89	6.98
75-79 yrs	6.15	6.98	6.74	7.02	6.74
80-84 yrs	3.68	4.32	5.62	5.88	6.16
			Gender		
Male	77.76	76.97	74.88	74.13	74.36
Female	22.24	23.03	25.12	25.87	25.64
			Type of household		
Living alone	24.82	26.21	28.20	29.44	30.01
Single parent family	6.78	7.21	8.16	8.90	8.9
Childless couple	27.86	29.39	28.46	29.52	29.61
Couple with children	38.70	35.57	32.71	29.95	29.18
Others	1.84	1.62	2.47	2.19	2.3
			County Size		
Rural area	27.63	28.93	21.90	21.72	25.76
Urban area less than 20000 inhabitants	16.77	17.44	16.11	16.65	18.13
Urban area from 20000 to - 200000 inhabitants	22.80	20.68	25.04	21.98	19.20
Urban area 200000 inhabitants +	19.53	19.68	23.85	25.09	25.06
Paris area	13.27	13.27	13.11	14.57	11.84
			Household head activity		
Workers	57.46	57.81	55.19	54.12	52.81
Unemployed	4.92	3.6	4.36	4.41	4.91
Inactive	37.61	38.59	40.45	41.47	42.28
Number of observations	21,075	64,240	32,617	49,914	45,952

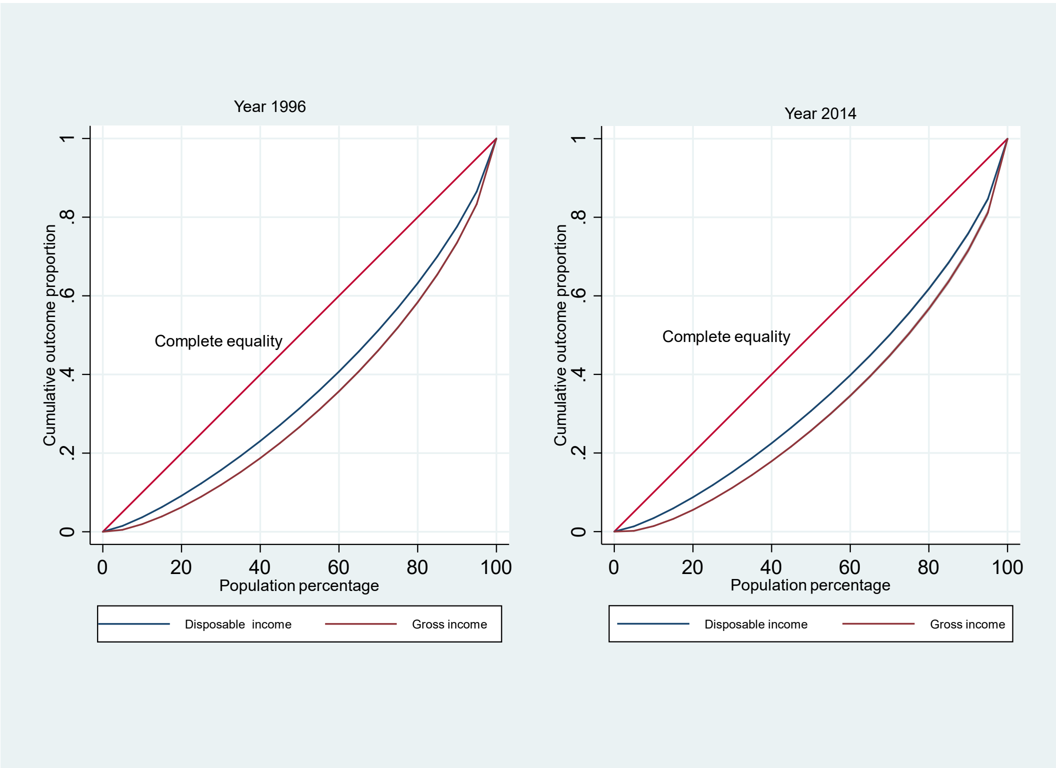
Source: *INSEE (ERF, ERFS), authors' calculations.*

Appendix B. Indicators of intra-generational inequality

The research literature on indicators of inequality is abundant (see, for example, Cowell, 2016, for a presentation). An inequality indicator is considered to be reliable if it satisfies the symmetry principle (invariance with change of ranking), Dalton principle (invariance with homogeneous population increase), Pigou-Dalton transfer principle (increase with transfer to a richer individual) and relative invariance principle (invariance with proportional increase in incomes).

The Gini coefficient is widely used in the literature because of its intuitive interpretation. It is based on the Lorenz famous curve, comparing the share of income received by households with their share of population. Figure B1 shows the Lorenz curves for the distribution of disposable and gross income in 1996 and 2014.

Figure B1: Lorenz curves for 1996 and 2014



Source: INSEE (ERF, ERFS), authors' calculations. Reading note: in 1996, 80% of the population received 63% of total disposable income of the total population.

These Lorenz curves represent the shares of disposable income and gross income ranked in ascending order. If income were equally distributed, the Lorenz curve would be a straight line rising at 45° from the origin and the share of income received by households would equal their share of total population. As inequality increases, so the Lorenz curve lies further from the "line of complete equality". The area between the straight line and a Lorenz curve gives the Gini indicator, defined as follows:

$$Gini = 1 - 2\int_0^1 L(y)dy\,,$$

where $L(y)$ is the Lorenz curve that applies to income distribution. The values of the Gini coefficient associated with the Lorenz curves in the figure are given in Table 1.

In theory, a Pigou-Dalton transfer is defined as a positive transfer of income from the richer to the poorer, such that their relative position in the income ranking does not change but the Gini coefficient is reduced. Starting from Gini formula proposed by A. Sen:

$$Gini^{5} = \frac{n+1}{n} - \frac{2}{n}\sum_{i=1}^{n}(n+1-i)\frac{y_i}{n\bar{y}},$$

where y_i is the income of household *i* in a population of *n* households whose average income is $\bar{y}$. Let *t* be the amount of the transfer of household *i* to a poorer household *j*. The impact of the transfer is

$$\Delta Gini\ (t) = Gini\left(y^{d'}\right) - \ Gini(y^{d}) = t\frac{2}{n^2\bar{y}}\ (j-i) < 0,$$

where $y^{d'}$ is the distribution obtained from distribution y^{d} after the Pigou-Dalton transfer. Our empirical observations made in Figure 3 are consistent with these predictions since the profile associated with disposable income differs from that derived from gross income by lower inequality at all age.

[5] Under this formulation, the Gini indicator is a linear function of a weighted sum of income shares, weighted by household rank. The weighting is *n* for the poorest and 1 for the richest. So this Gini indicator gives more weight to the poor.

Appendix C. Other income decile ratios

This appendix complement Figure 4, which focuses on the inter-decile ratio, by presenting three alternative ratios: D9-D5 between the 9th and the 5th decile (i.e. the median value), P95-D5 between the 95th percentile and the 5th decile and P99-D5 between the 99th percentile and the 5th decile. The source of Figure C1 are the same as those of Figure 4.

Figure C1: Alternative ratio for gross and disposable income by five-year age groups in 1996 and 2014

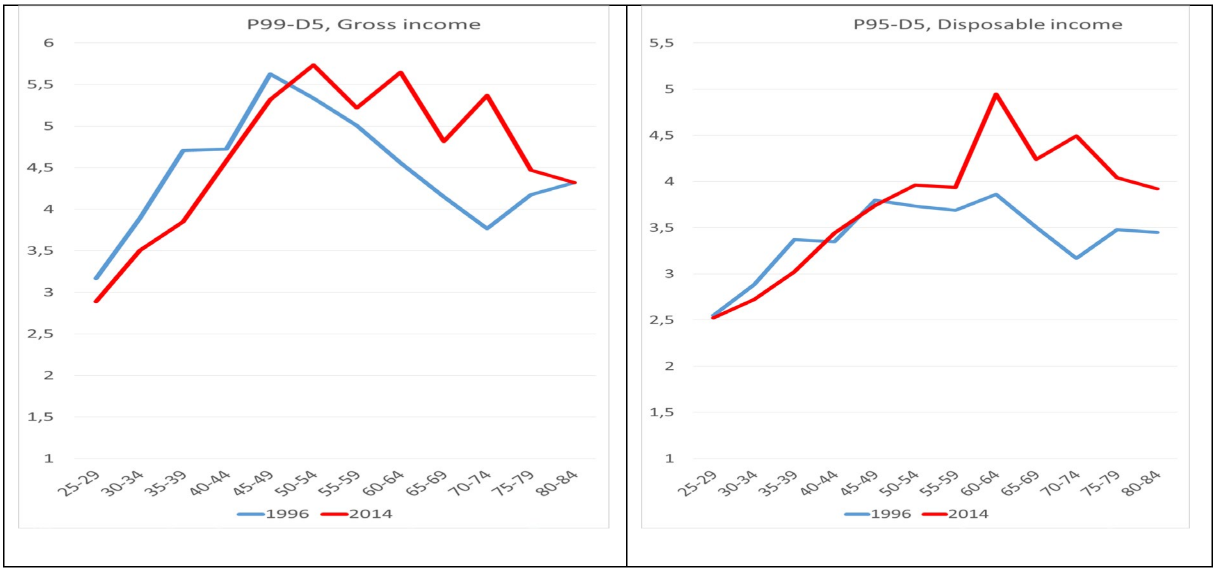


Figure C2 shows the estimates for the age indicators in the equation for D9-D5 ratios computed with the ACP method.

<u>Figure C2:</u> D9-D5 ratio as a function of the age group.