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Inequality in an Equal Society

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A society in which everybody is the same at the same stage of the life-cycle will exhibit substantial income and wealth inequality. We use this idea to empirically quantify natural inequality - the share of observed inequality attributable to life-cycle profiles of income and wealth. We document that recent increases in inequality in the United States and other developed countries are larger than observed rates would suggest. Extrapolating our measures forward suggests that natural inequalities will fluctuate over the next 20 years before settling to a new higher level.

JEL: D31, J10

Keywords: Income Inequality, Wealth Inequality, Demographic Structure

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The most equal society will exhibit a substantial degree of income and wealth inequality. Even in the absence of differences in talent, individuals approaching retirement will be substantially wealthier than those who are younger. Moreover, experience and seniority mean that older workers will have higher wages than their younger colleagues. Jointly, such life-cycle aspects of income and wealth give rise to a degree of inequality that is 'natural' in all societies – even if each individual over the course of the life-cycle is exactly the same as any other individual.

An early version of this argument was made by Atkinson (1971), who suggested that the distribution of wealth should be expected to be unequal solely due to differences in accumulated savings over the life-cycle. In a related contribution Paglin (1975) uses an argument similar to Atkinson's to suggest that popular measures of inequality such as the Gini coefficient should be corrected for the age structure inherent in income and wealth profiles. While Paglin's suggestion for a correction was not uncontroversial,[1] the core of his argument – that inequality measures should be adjusted for the underlying life-cycle structure – still holds.

A powerful new body of evidence (particularly Piketty (2003), Piketty and Saez (2003) and more recently, Atkinson et al. (2011), Piketty and Saez (2014) and Saez and Zucman (2016)) has transformed our understanding, and highlighted the societal implications, of long-term trends in inequality. However, following Atkinson (1971) and Paglin (1975) it is important to understand the extent to which these trends reflect changes in natural inequality due to changes in nations' demographics. This paper addresses this need by taking the life-cycle argument to the data.

[1]See the three rounds of comments and replies generated by his paper.

In doing so we document how much of the variation in income and wealth inequality is due solely to life-cycle effects and by implication how much reflects other factors. Using harmonised micro-data for the United States and other developed countries, we show that even in the absence of any inequality between individuals of the same age group, societies exhibit substantial degrees of income and wealth inequality. In particular, we show that the level due to life-cycle effects only (natural inequality) accounts for around one third of income inequality in the United States, with the remaining two-thirds attributable to differences between individuals, the effects of institutions, and so forth. Moreover, between the early 1970s and the early 1990s, the level of natural inequality increased by around 2 percentage points. The mid 1990s marks a turning point, natural inequality declined slightly, however this has been more than offset by large increases in excess inequality. This is in contrast to the other countries we study where the level of excess inequality is often lower and with a less pronounced upwards trend. Results for wealth show that natural wealth inequality has varied little over the last 20 years in the US as observed inequality has increased rapidly. However, life-cycle effects can explain a considerable amount of the cross-country variation in wealth inequality.

We utilise harmonised micro data from the Luxembourg Income Study (LIS) and the Luxembourg Wealth Study (LWS) for our analysis. Importantly for our purpose, these studies contain data which have harmonised variable definitions to allow meaningful comparison across countries as well as over time.

Our aim of quantifying the effect of changes in demography on inequality is similar to that of the early work of Mookherjee and Shorrocks (1982). Like them we will use the Formby and Seaks (1980) modification of the Paglin-Gini. Despite only very limited aggregated data they were nethertheless able to provide evidence that that rises in inequality in Great Britain over the period 1965-1980 could be almost entirely attributed to increasing 'natural' inequality. A key advantage of the much improved quality and coverage of harmonised data now available, is that we can see this trend in its proper historical context – as a temporary phenomenon soon to be reversed.[2]

There has been relatively little recent work looking at the role of demography in inequality. Thus, by documenting the relationship between the demographic structure and the natural rate of inequality we contribute to the important recent literature on trends in inequality. We assess the impact of the disproportionate size of the Baby Boom generation on natural inequality and study how natural inequality should be expected to change, *ceteris paribus* as the demographic structure converges to its long-run equilibrium. This exercise suggests that the bulge on the demographic pyramid generated by the Baby Boom is depressing natural inequality. Hence, in the future, as the demographic pyramid settles into its long-run equilibrium, wealth and income inequality will increase. Perhaps worryingly, this process will accelerate further the trend of increasing inequality documented by the seminal contributions of Piketty (2003), Piketty and Saez (2003), Atkinson et al. (2011), Piketty

[2]Related is the work of Brewer and Wren-Lewis (2016) who decompose trends in UK inequality by income source and demographic characteristics to show that increases in inequality amongst those in employment have been ameliorated by relatively low unemployment, and more generous pension provision.

and Saez (2014), Saez and Zucman (2016). In that sense, our paper contributes to the extant literature on inequality trends by highlighting that demographic forces will exacerbate the upward trends in inequality.

The paper proceeds as follows. The next section sketches the empirical argument for, and formalizes the notion of, natural inequality, and introduces the life-cycle adjusted Gini. Section II takes the notion of natural inequality to data. It focuses first on income inequality in the US, before considering a panel of countries. These results suggest, that particularly in the US, that ignoring changes in natural rates of inequality over the last 20 years may mean underestimating increases in inequality. The last part of Section II shows that comparatively little of wealth inequality is due to natural inequality. Section III turns to the future and simulates the evolution of natural inequality as countries return to their demographic steady states following the Baby Boom. The results suggest that in many countries there will be substantial increases in natural inequality over the next 20 years. We close with a brief conclusion. The Appendix summarises the data used and presents additional results.

I. Natural Rates of Inequality

Our focus on the level of inequality due solely to life-cycle factors is directly related to the prominent literature that studies the determinants of the distributions of earnings and wealth. For example, Huggett et al. (2011) consider how shocks received at different life stages affect lifetime income. The distribution of wealth is studied by Cagetti and De Nardi (2006) who study a quantitative model of occupational choice with the potential for entrepreneurship and study the role bequests and restrictions on investment play in determining wealth inequality. See also Neal and Rosen (2000) for a review and Huggett et al. (2006) for a more recent example attempting to match the extent to which more or less sophisticated life-cycle models can explain observed income-inequality. In this class of models life-cycle inequality is determined by the choice of parameters, often calibrated to US data, and the form of the model. As in Cagetti and De Nardi (2006), this approach allows for sophisticated analyses of the interaction of different features of an economy but any estimates depend on how well the model corresponds to reality and how precisely the parameters are chosen. Our approach is different, we use micro-data to study the empirical importance of life-cycle inequality for income and wealth without recourse to additional assumptions. One way we contribute to this literature is by providing empirical evidence as to the extent to which income and wealth inequality should be attributed to life-cycle effects in this type of model.

To fix ideas we follow Atkinson (1971) and start with a stylized exposition of the levels of income and wealth inequality that would prevail if the only difference between individuals is that they are at a different stage of their life cycle. Starting with income inequality, consider the following process of labour income:

$$W(v,t) = E(t-v)w(t), \tag{1}$$

where $W(v,t)$ is the income at time t of an individual born at time v, $w(t)$ is the economy wide wage rate and $E(t-v)$ is an individual scaling factor that creates a life-cycle pattern in labour income. $E(t-v)$ can be driven by many factors, which, for the sake of brevity we do not model separately.

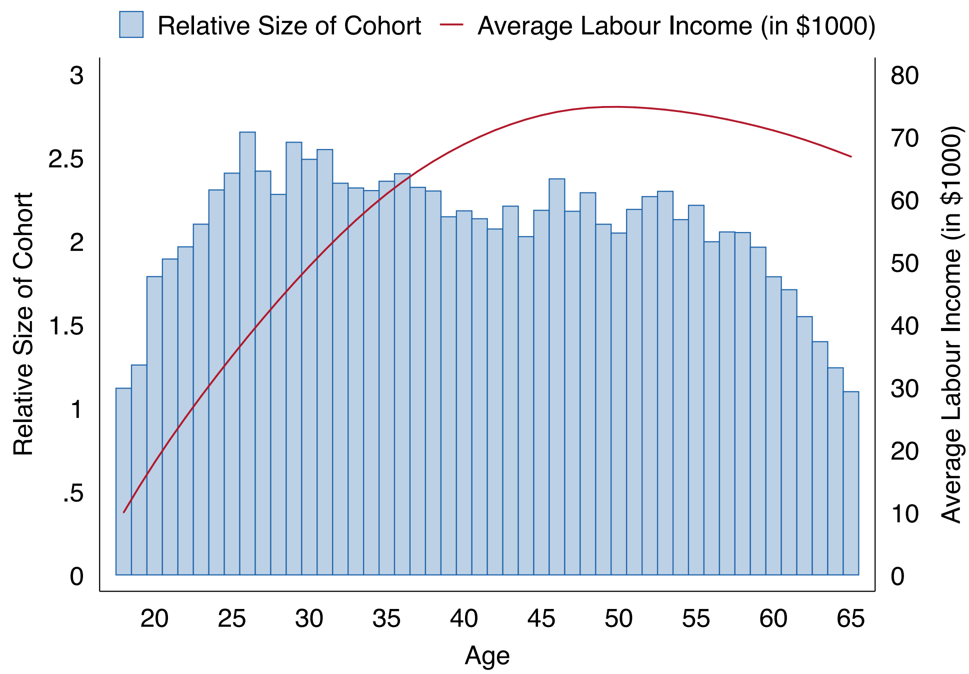
Indeed, for the current purpose it suffices to acknowledge that $E(t-v)$ can contain experience effects by which more senior workers earn more than junior workers but also institutional factors such as a social security system that redistributes income from workers to retirees.

This makes clear the argument of Atkinson (1971) and Paglin (1975) that the standard egalitarian view of complete income and wealth equality implies either substantial redistribution from old to young, or that there is no return to experience, etc. Indeed a society in which one never accumulates assets or develops is quite alien. This implies, as argued by Paglin (1975), that the correct benchmark is the level of inequality due only to life-cycle effects.[3] However, the degree of inequality is determined not only by how much richer the old are than the young, but their relative number. The demographic structure of the UK in 1969, as analysed by Atkinson (1971), is both quite different to that of today given

[3]The Paglin Gini differs from other modifications of the Gini in that it maintains the same egalitarian benchmark. Other approaches include that of Almås et al. (2011a) who provide an alternative adjustment of the inequality measures, focusing on *unfair* inequality. This approach replaces the assumption incarnate in the standard Gini index or Lorenz curve that fairness implies complete egalitarianism with a more general framework that better corresponds to intuitive and philosophical conceptions of a fair society. For example, *unfair* inequality may see as fair that those who work harder or who are better qualified earn more. In their empirical analysis Almås et al. (2011a) use rich micro-data to study departures from the *fair* income distribution for Norway. Generalizing standard approaches to other definitions of inequality extends in important ways our toolkit but is quite different to the approach of our paper, which maintains the standard egalitarian definition of inequality. It is also quite different in practical terms, as a key advantage of our measure is that it can be derived without having recourse to registry data with variables such as IQ, thereby enabling us to compare excess inequality internationally. We only need data on ages and income/wealth and not the detailed data used by Almås et al. (2011a). More similar to this paper is Almås et al. (2011b) who propose an alternative method of adjusting the Gini coefficient for life-cycle effects, that can better account for correlations between, say age and education levels. This is a substantial advantage, but again necessitates detailed microdata normally not available such as parental earnings, that the effects of age and other factors may be precisely estimated.

improvements in longevity but is also different to that elsewhere, then and now.

Figure 1 : Income and cohort size by age group United States, 2016



Source: Luxembourg Income Study (LIS), year 2016
Notes: The left y-axis corresponds to the relative size of each age cohort for men in 2016, represented by the light blue bars. The right y-axis in the average labour income in $1000 dollars for each group. Thus the red line maps the average earnings profile. The bulge in the relative population size around ages 45 to 60 is the impact of the Baby Boom generation distorting the standard demographic pyramid.

We develop the above intuition by sketching out the profile of income and cohort shares for the United States using data from the Luxembourg Income Study (LIS). The income profile, contained in the solid line of Figure 1, reflects the average income of men in each age group. There we see that income has the familiar hump-shaped profile. The bars in Figure 1 trace out the associated cohort sizes by age. This provides the relatively uniform demographic pyramid associated with high income countries. However, in contrast to a steady-state demographic structure, where we would expect a smooth decrease in cohort size as age increases, we notice the ragged structure of the triangle - due to, for instance, the Baby Boom. Importantly, we can combine the income profile and the size of the cohorts in Figure 1 to calculate a Gini coefficient. This simply involves using cohort averages, $\bar{x}_i$ and $\bar{x}_j$ in place of individual data, and weighting by cohort sizes p_i and p_j, in an otherwise standard expression for the Gini coefficient:

$$\theta^{NR} = \frac{\sum_{i \neq j} p_i p_j |\bar{x}_i - \bar{x}_j|}{2\bar{\bar{x}}}. \tag{2}$$

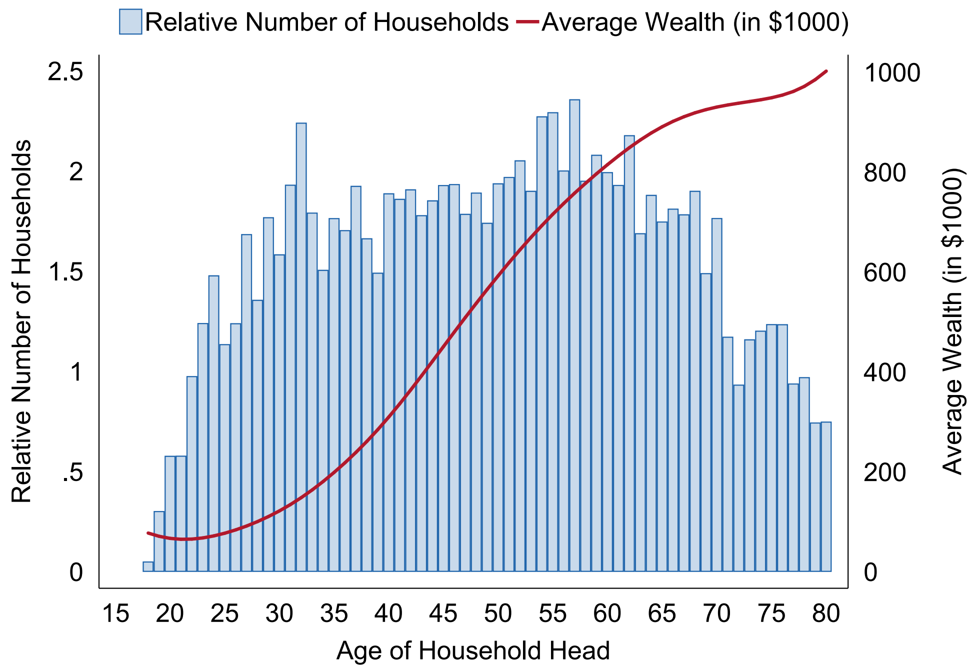
This provides a value of 0.16, thus attesting to the idea of a natural level of income inequality. For wealth we provide a similar analysis in Figure 2 where we sketch out the age profile of mean wealth for the United States using data from the Luxembourg Wealth Study. If anything, the wealth profile is more hump-shaped over the life-cycle. This translates into higher natural inequality with the Gini coefficient of wealth being 0.38.

For brevity, we formalize the reasoning developed above and summarize the main conclusions from the model in the following theorem.

Theorem 1. The Gini coefficient of income (wealth) is positive in the presence of a non-flat life-cycle income (wealth) profile.

Corollary 1.1. Perfect income (wealth) equality implies a flat income (wealth) profile over the life-cycle.

Figure 2 : Wealth and cohort size by age group United States, 2016



Source: Luxembourg Wealth Study (LWS), year 2016
Notes: The left y-axis corresponds to the relative number of households with a household head at a given age cohort, expressed by the blue bars. The right y-axis is the average wealth of each household in $1000. Hence, the red line maps the average wealth accumulation of households over the age profile of the household head. Results are produced using the household level weights.

The proof works by writing the Gini coefficient as a product of the standardised variation of income, and the correlation of income with its rank, following Milanovic (1997), and noting that both of these terms are only zero when income is constant for all ages. The proof itself is in Appendix A.

Considering that observed inequality is generated by a host of factors, it seems appropriate to view *natural* inequality as a benchmark, deviations from which are useful as indicators of life-cycle *adjusted* measures of inequality. Figure 3 reproduces the conventional graph defining the Gini coefficient, but with an additional Lorenz curve. The thick curved line is the life-cycle Lorenz curve – the Lorenz curve associated with the natural rate – and the dashed line is the actual Lorenz curve. A indicates the area between the line of equality and the life-cycle Lorenz curve and B and B' indicate the areas under the life-cycle and actual Lorenz curves, respectively. The natural rate Gini can be expressed as: $\theta^{NR} = 1-2B$, similarly the non-adjusted or conventional Gini coefficient can be expressed as: $\theta^{U} = 1-2B'$. Using the graph we can also define the life-cycle adjusted Gini as: $\theta^{LA} = \frac{B-B'}{B}$. Which can be derived from the above Ginis as:

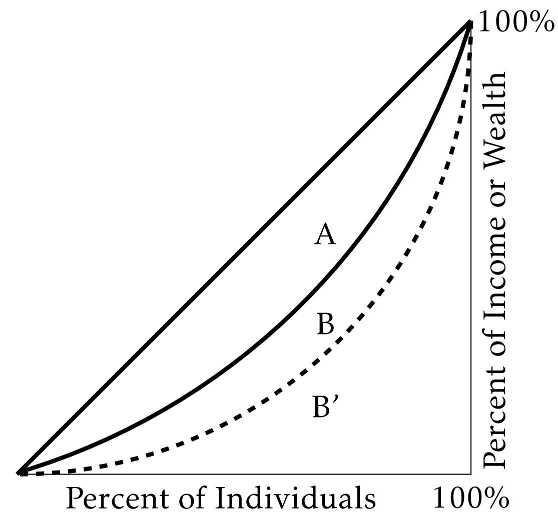
$$\theta^{LA} = \frac{\theta^{U} - \theta^{NR}}{1 - \theta^{NR}}. \tag{3}$$

Implying that a society with only natural inequality will have $\theta^{LA} = 0$, while a society exhibiting inequality in excess of natural inequality will take positive adjusted values.

Focusing on the Paglin (1975) debate about how to properly correct for age factors in inequality, we can observe that what we call the natural rate comes closest to what he calls the A(ge)-Gini, which was not the source of controversy. In fact, it is equivalent to the Modified-Paglin Gini suggested by Formby and Seaks (1980) and also employed by Formby et al. (1989) to analyse trends in inequality.[4] We seek to build on these earlier insights by exploiting vastly improved and harmonised data to obtain precise and

[4]Their modification of the Paglin (1975) measure amounts to redefining the denominator of θ^{LA} as B and not $A+B$.

Figure 3 : The Life-Cycle Adjusted Gini Coefficient



The solid diagonal line is the conventional line of perfect equality. The solid curve is the Lorenz curve associated with the natural rate. The dashed curve is the actual Lorenz curve. A is the area between the two solid lines, and B is the area under the natural rate Lorenz Curve. B' is the area under the actual Lorenz curve. The natural rate Gini can be expressed as: $\theta^{NR} = 1 - 2B$, similarly the non-adjusted or conventional Gini coefficient can be expressed as: $\theta^{U} = 1 - 2B'$.

comparable estimates of the inequality trends of multiple countries and, importantly, to predict the development of inequality into the future.

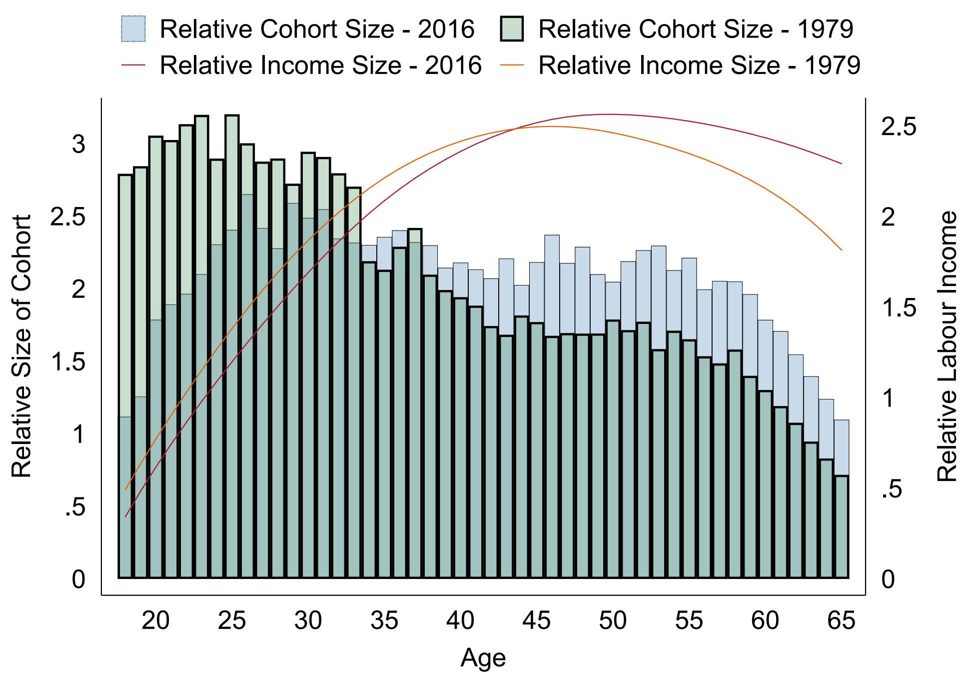
In taking this argument to the data one previously neglected, but important, subtlety in the computation of the Paglin Gini emerges. This is the choice of the relevant population, given both unemployment and endogenous labour market participation. If one includes the entire population as is implicit in the work of Paglin (1975) and Formby and Seaks (1980) then the income attributed to those unemployed, or not in the labour market becomes important. As is how the income from shared assets is attributed. This is true, a fortiori, for our purposes since we are making comparisons across countries and over a period in which dispersion in retirement ages has increased.

More concretely, the decision to retire embodies choices that are endogenous with respect to earning potentials as well as societal mores and institutions. For this reason we analyse the natural rate of inequality for men solely. We also restrict, as in Figure 1, our analysis to people aged 18-65 for the purposes of analysing labour income. This minimises concerns about endogenous selection in to full- or part-time employment once of retirement age. As per Figure 2 for wealth we consider the entire population, but to avoid having to split jointly held assets, choose households as the unit of analysis.

Our analysis will focus on natural inequality between men. This is because it is reasonable to assume, as an approximation, that all (or a constant fraction of) men aged 18-65 over the entire period, and all the countries we study, are in the labour market and thus that earnings of zero reflect unemployment. This is patently untrue for women, and female labour market participation rates still vary markedly across developed countries, and are changing within them, limiting what may be reasonably inferred. By focusing on this subpopulation of prime aged men we are able to abstract from the key labour market changes of the period.

The other key changes are the increase in the share of University Graduates and Skill-biased Technological Change. We note however that education is largely finished by the early to mid 20s for most people and that there doesn't seem to be substantial changes in the life-cycle earnings profile over the period. To see this consider Figure 4 below which reproduces Figure 1 but for comparison overlays the relative population size and income for 1979. The green bars with black outline are the relative cohort size in 1979 and we can see the larger population share of the young. Seeing this in contrast with 2016, the blue bars, it is evident that there has been a substantial demographic shift, whilst comparisons of the lifecycle earnings distributions suggests that these have remained similar.

Figure 4 : Income and cohort size by age group United States, 1979 & 2016



Source: Luxembourg Income Study (LIS), years 1979, 2016
Notes: The left y-axis corresponds to the relative size of each age cohort for men, the blue bars refer to 2016 and the green to 1979. The right y-axis in the relative labour income for each age group. Thus the red line maps the average earnings profile for 2016 and the orange for 1979. We can see that the earnings profile has remained similar over the time period, with the key changes being demographic.

In sum, taking inspiration from Atkinson (1971), Paglin (1975) and Formby and Seaks (1980) this section has sought to reinvigorate the argument that a stylized economy populated by individuals who are equal to each other at every stage of the life-cycle displays a substantial degree of income and wealth inequality. Moreover, we have seen that this measure can be used to calculate a life-cycle adjusted Gini coefficient.

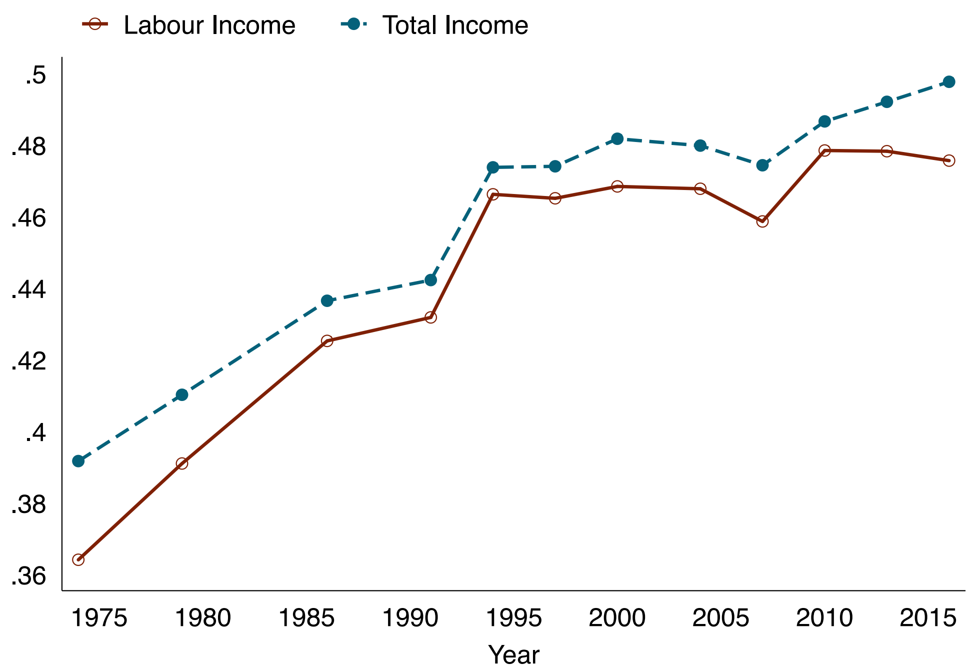
II. Inequality in an Equal Society

This section empirically assesses the quantitative importance of *natural* inequality. First for the United States and then for a cross-section of developed countries.

A. Inequality in the United States

For clarity, and in line with much of the focus of the literature, e.g. Piketty and Saez (2003), Saez and Zucman (2016), we begin our analysis by focusing on the United States, using the LIS data, the details of which may be found in Appendix B. We use these data in preference to the World Income Database Alvaredo et al. (2016) because they contain the necessary detailed microdata. Similarly, the register data used by Almås et al. (2011a) because we wish to study a range of countries for a sufficiently long period. Consider first the solid red line in Figure 5, this shows the Gini coefficient of labour income for the period 1974 to 2016 while the blue dashed line shows the Gini coefficient of total income for the same period. The most striking feature is the pronounced and consistent upwards trend over the period. The Gini was 0.36 for labour income and just above 0.39 for total income in 1974 and 0.48 and 0.50 respectively in 2016. Also clear, is that inequality in labour income has increased more than that of total income, with total income experiencing a less steep upward trend. For both series, it is apparent that the biggest growth in inequality was experienced in the period 1974 to 1995. While the trend is clear, there is also a substantial cyclical component, as as shown more generally by Milanovic (2016). Finally, we can note that the growth in inequality is faster from 2000 onwards for both series.

Figure 5 : Actual Gini Coefficients for Labour and Total Income



Source: Authors' calculations using Luxembourg Income Study (LIS)
Notes: The graph shows trends over time in unadjusted Gini. Labour Income (solid line) includes those aged 18-65 and total income (dashed line) includes those aged 18-78. For both time series we exclude individuals with a zero or negative income. Results are calculated using individual weights.

We now analyse the extent to which these changes in inequality reflect demographic changes. Figure 6 plots, for labour income, both actual (green circles) and natural inequality (blue diamonds), as well as our two measures of the difference: excess (red squares) and adjusted (purple triangles). As outlined in Section I, the natural inequality (from which excess and adjusted inequality are derived) is calculated by determining the Gini coefficient of average incomes by age. We can see that natural inequality increased from 1974 to the the mid 1990's by around 2 percentage points. Before falling, by almost 5 percentage points over the rest of the period to 2016.

Figure 6 : Actual, Natural, and Excess Gini Coefficients of Labour Income for the US 1974-2016

Source: Authors' calculations using Luxembourg Income Study (LIS) US 1974 - 2016.
Notes: Sample includes Men with positive income and are aged 18-65. Results are calculated using individual weights.

Figure 7 : Actual, Natural, and Excess Gini Coefficients of Total Income for the US 1974-2016

Source: Authors' calculations using Luxembourg Income Study (LIS) US 1974 -2016.
Notes: Sample includes Men aged 18-78. We exclude individuals with a zero or negative income. Results are calculated using individual weights.

Considering actual, natural, excess, and adjusted Ginis in Figure 6 together it is clear that while inequality increased only modestly from 1974 to 1990, this was in spite of a growth in natural inequality. In the late 1970s half on inequality was natural. On the other hand, the substantial increase in labour income inequality since the mid-1990s has been despite falling natural inequality. Excess inequality has rapidly increased. The difference between these two periods is important as it makes plain the quantitative importance of our argument. Ignoring the role of demographic change in generating variations in the natural rate of inequality can lead us to overstate the increase in inequality over the last 25 years. Equally, it leads us to understate it for the previous 25, and thus also to understate the difference between the two periods.

Comparison with Figure 7 shows that these results are robust to alternatively considering inequality in total income (calculated over those aged 18-78). In both cases excess inequality accounts for around three quarters of prevailing inequality in the US – the adjusted Gini is around 0.35 for labour income and 0.40 for total income. Moreover, trends in the two have been similar over the period with a substantial increase, particularly in the period since 1990. One interesting feature of the data is that the frequency with which natural and excess inequality vary are noticeably different. Changes in natural inequality are of lower frequency than changes in excess inequality which is known to be cyclical Milanovic (2016), perhaps as expected given the gradual nature of demographic change. Thus, changes in the natural rate are of most importance when analysing the evolution of inequality over substantial periods of time.

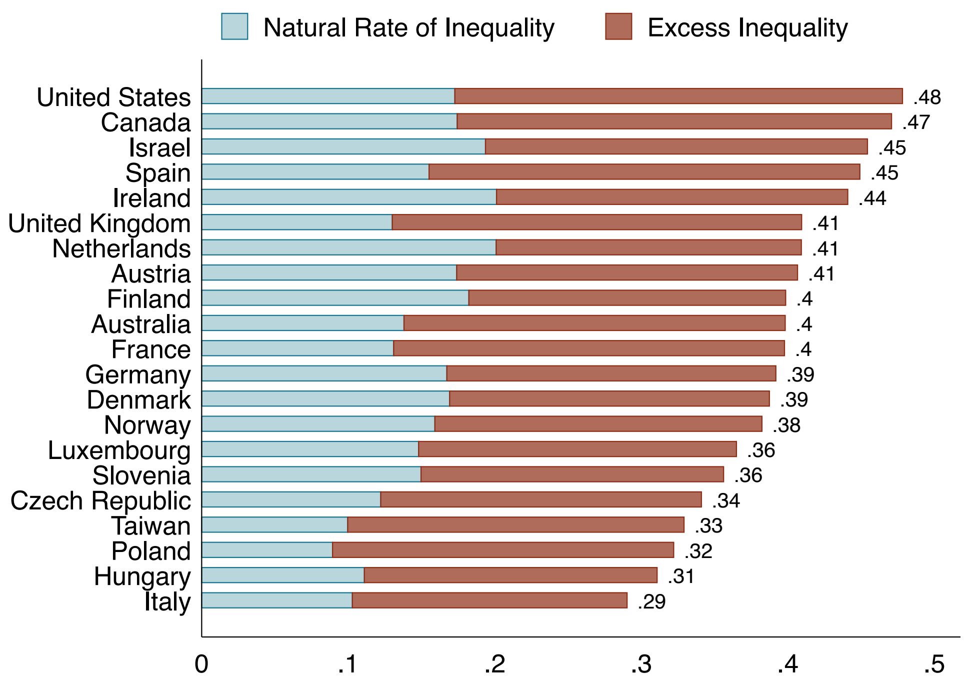
B. Cross Sectional Time Series Analysis

We now broaden the discussion to a sample of countries with sufficient time series available from LIS to conduct a meaningful study of trends over time. Figure 8 summarises the cross country variation in wave IX of the LIS for all of the countries we consider.

Natural inequality is blue, and excess inequality is red. The sum of these gives actual inequality in labour income, reported to the right of each bar. The most obvious feature of the data is the substantial variation in actual inequality, between 0.49 for the US or Canada and 0.30 for Hungary or Italy. This variation is continuous, meaning that there are no obvious 'groups' in the data. Secondly, we note that there is similarly large variation in excess inequality. For example, actual inequality in Spain or Germany is similar, but excess inequality is much higher in Spain. Alternatively, if Spain had the same demographics as the US, it would be nearly as unequal. Conversely, while natural inequality in Slovenia is similar to that in Spain, excess inequality is around 7 percentage points lower. Thus, cross-country comparisons of actual inequality may be misleading. France and Finland have the same actual Gini, but excess inequality in France is higher, and thus perhaps more amenable to policy. This emphasises that as well as being important in understanding variation over time, separating natural and excess inequality is crucial to a nuanced understanding of cross-country variation in income inequality.

In moving on to consider both cross sectional and time series variation we, initially, restrict our attention to a subset of the countries for which

Figure 8 : Cross Country Variation in Natural and Excess Inequality



Source: Authors' calculations using LIS Wave IX, (circa 2013)
Notes: The number to the right of the bars for each country denotes the *actual* Gini, and the total length of the bar. Thus this graph shows the decomposition of the level of *actual* inequality into its *natural* component (Blue) and *excess* inequality (red). All data are for gross incomes, apart from for Israel and Slovenia which are net, and Italy and France which are mixed. Individual level weights are used in all cases. Sample includes men ages 18-65 with positive labour incomes.

sufficient data are available in the LIS, as reported in Figure 8.[5] As well as focusing on those for which the data provide for a sufficient time series to look at the trends in inequality, we also limit our sample to a group of countries designed to be representative while ensuring clarity. To ensure comparability we prioritise countries for which gross income informa-

[5]Data are for wave IX of the LIS data, with the exception of France and Ireland where the data is for wave IIX. Mexico is excluded as the last wave available is wave VI.

tion is available. The countries which we discuss here are Canada, (West) Germany, Netherlands, Taiwan, United Kingdom and Spain.[6] The United States is presented again in order to make a comparison with other countries. We discuss regression analyses of the trends for the full set of countries below. Figures describing the other countries are available in the appendix.

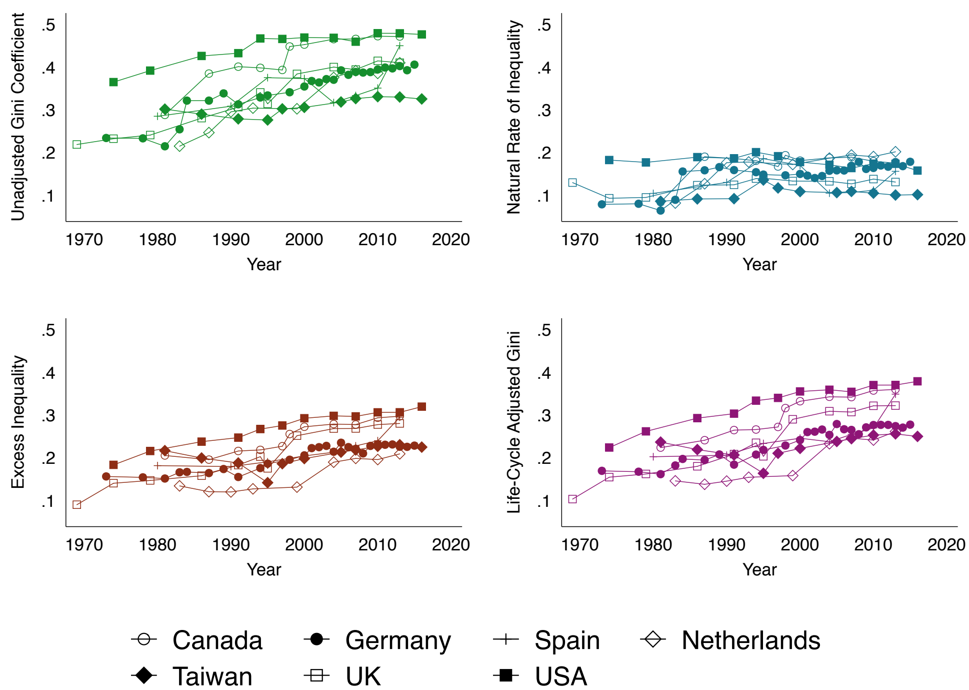
We begin by considering labour income. Looking at the top left (green) panel of Figure 9, we can see that the actual Gini coefficient in the US is high compared to the other countries we consider, particularly at the beginning of our sample period. However, the gap has narrowed and all countries have experienced rising inequality. Looking closer, it is clear that the biggest changes have been in Spain, the Netherlands, and Germany. In comparison, the US and Taiwan seem to have experienced relatively stable levels of inequality in labour income.

This finding is cast in new light when we consider the natural rates of inequality presented in the top-right (blue) panel of Figure 9. While natural inequality is stable on average, this masks comparatively notable increases for Spain, Germany and the Netherlands. This suggests that the similar trends in inequality have different sources in the US than elsewhere.

This difference is clearer when we consider adjusted inequality, displayed in Figure 9 in the bottom-right (purple) panel. Now we can see that the US has seen a substantial increase in adjusted inequality, both starting and finishing the period at a higher level of adjusted inequal-

[6]Results for Germany are for West Germany only throughout. Figures for Spain are for net incomes. Results for all other countries are for gross incomes. See Appendix B for more information.

Figure 9 : Adjusted and Unadjusted Gini of Labour Income: Selected Countries: 1969-2016



Source: Authors' calculations using LIS data.

Notes: All results are calculated using data on gross incomes with the exception of Spain which are net incomes (with exception of wave IX). We consider those aged between 18-65 and who have positive earnings. Results are calculated using individual level weights.

ity than elsewhere. Taiwan is notable in that adjusted inequality has remained relatively stable over the sample period. Other countries, such as the the UK and Canada, have seen rapid growth rates of adjusted inequality similar to those in the US, albeit from lower initial levels. In general, the rate of increase was relatively slow everywhere until the mid 1980s after which it accelerated. The similarities in these trends, allowing for different starting points, suggests that rises in excess inequality may be driven by technological and policy changes common across the developed nations.

To demonstrate that our results are not specific to the countries plotted, Table 1 reports the results of estimating a linear trend using a simple fixed-effects model.[7] We report results for both total income and labour income in the first and second rows respectively. Hence, the first column reports results for the actual Gini in a model in which the trends are assumed to be homogenous across countries: $y_{it} = \tau \times t + \mu_i + \epsilon_{it}$. For both income and labour income the slope is positive and precisely estimated, reflecting the secular upwards trend in inequality. The second column reports estimates from the mean-group estimator of Pesaran and Smith (1995) in which the reported coefficients are the averages of the coefficients from separate regressions for each country: $y_{it} = \tau_i \times t + \mu_i + \epsilon_{it}$. The results are qualitatively unchanged. Inspection of the individual slopes makes clear that virtually all countries exhibit positive and significant trends.[8] This provides broader support for the previous finding of consistent upwards trends. However, as above, there are differences between

[7]Given the small number of observations, these simple estimators are preferred to more sophisticated alternatives.

[8]These are reported in Table C.1 in the appendix.

Table 1: Time Trends in Inequality

	Actual		*Adjusted*	
	(1)	(2)	(3)	(4)
Labour Income	0.37***	0.39***	0.32***	0.32***
	(0.04)	(0.04)	(0.03)	(0.05)
Total Income	0.32***	0.34***	0.33***	0.32***
	(0.03)	(0.05)	(0.03)	(0.05)
Estimator	FE	MG	FE	MG
Countries	22	22	22	22
N	216	216	216	216

FE Estimator denotes the standard fixed-effects estimator with an homogenous time trend, with robust standard errors in parenthesis. MG denotes the mean-group estimator of Pesaran and Smith (1995) using the outlier-robust mean of coefficients, with standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

labour and total income. Using both estimators, the results using *adjusted* inequality as the dependent variable suggest that, for total income, it is increasing at the same rate as actual inequality. This again highlights that the increasing importance of adjusted inequality in the US is an outlier. However, for labour income it is clear that adjusted inequality cannot explain all of the increase in actual inequality. There is a gap of between 5 (FE estimates) and 7 percentage points (MG), which suggests that around a quarter of increases in inequality have been due to demographic change.

C. Wealth Inequality

As well as increases in income inequality, the prior literature has shown that increases in wealth inequality have tended to be even larger than those in income inequality. To understand the role of demographics in this pattern, we repeat our prior analysis for wealth using the Luxembourg Wealth Study (LWS).[9] These data, like the LIS, are harmonised cross country data. Although the LWS does not have the coverage of the LIS we are able to construct a limited time series for the United States and make cross-sectional comparisons for a number of other countries, which we have discussed with respect to income inequality and are available in the LWS data. The choice of data is a delicate one, the LWS data are top-coded, unfortunately the WID data (Alvaredo et al., 2016) which contain much better information on the very wealthy do not contain sufficient age data.

We choose disposable net worth (non-financial assets plus financial assets (excluding pensions) minus total liabilities) as our measure of wealth but this choice is not important for our results.[10] Wealth data are measured by the household rather at the individual level, because of this we use the head of the household's age as a proxy, in favour of attempting to divide assets within the household. Again, this assumption does not matter for our results.

Figure 10 shows the (actual) Gini coefficient of wealth inequality for the United States over the period 1995 – 2016. As expected wealth inequality is higher than income inequality over the same period. We can see that while inequality has been increasing, that the natural Gini increased only marginally, and that consequently excess and life-cycle adjusted Gini have risen more markedly. More precisely, the excess Gini of

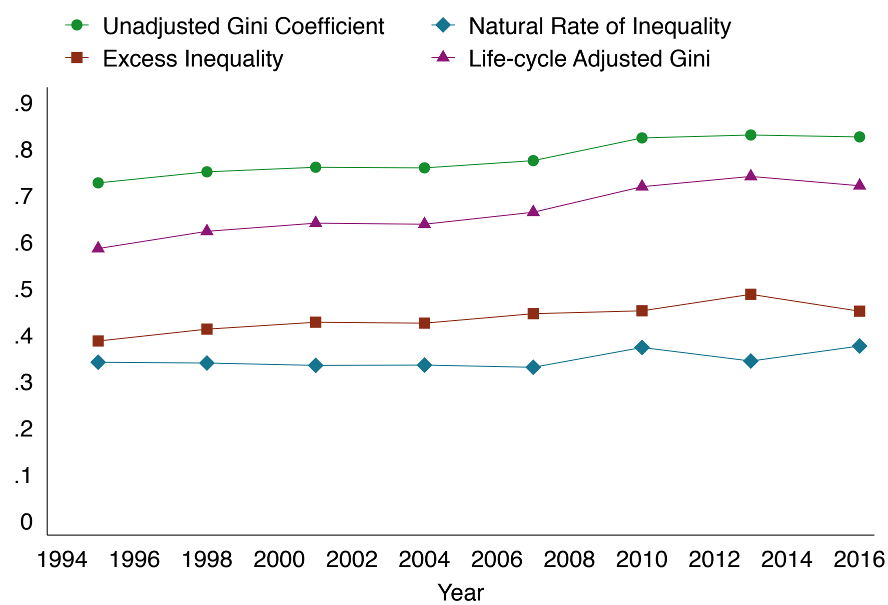
[9] Luxembourg Wealth Study (LWS) Database, http://www.lisdatacenter.org (multiple countries; 1995-2016). Luxembourg: LIS. Refer to appendix B for a data description.

[10] We drop the top 1% of the distribution to limit the effects of topcoding procedures in the original datasets. Similar results are obtained with the alternative of interpolating the true values of the topcoded observations assuming a Pareto distribution as in Heathcote et al. (2010).

wealth has increased by around ten percentage points over the 20 year period. Of course, our focus on the Gini coefficient is in contrast to much of the literature which uses concentration indices such as the share of the top 1%. Unlike those measures, our approach here will fail to capture much of the changes at the top end of the income distribution. But, importantly it is more sensitive to changes amongst the moderately wealthy. However, it is clear that while demographics can account for a substantial fraction of changes in income inequality they are comparatively unimportant for wealth. Changing demography cannot explain the stark increase in wealth inequality over the last few decades.

Table 2 shows results for the ten countries for which wealth data are available. We can see that the wealth inequality varies substantially, between 0.53 in Slovenia and 0.82 in the US. However, the second and third columns suggest that this variation is in part driven by variations in the natural rate. This is 0.38 in the US but only 0.14 in Slovenia, and excess inequality is relatively consistent compared to actual inequality varying between 0.35 in Australia for the US to 0.45 in the US. Comparing the US and Canada is instructive as while the actual Gini coefficients are quite different (0.82 and 0.68 respectively) the excess Ginis are very similar (0.45 and 0.44). Thus, abstracting from life-cycle effects both societies (at least on this basis) are similarly unequal, and the US appears less of an outlier. This highlights, again, that considering the actual Gini alone may be misleading.

Figure 10 : Wealth Inequality over Time (United States)



Source: Authors' calculations using Luxembourg Wealth Study (LWS)
Notes: Time series for United States, the underlying data are from the Survey of Consumer Finances and the wealth measure used is disposable net worth. The sample includes all households who have a head who is aged 18-78 including those who are recorded as having zero or negative net worth. Household level weights are used to produce results.

III. Inequality and the Baby Boom

We have seen that individual life-cycles have a central role in understanding inequality. An implication of this is that demographic dynamics will lead to changes in the distributions of income and wealth. Economists have paid considerable attention recently to long-run trends in inequality, prominent studies include Piketty (2003), Piketty and Saez (2003), Piketty (2011), Piketty and Saez (2014) and Roine and Waldenström (2015). In this section we ask: what is going to happen to natural rates of inequality, over the next forty years as the Baby Boom generation passes, and

Table 2: Wealth Inequality

	Actual	Natural	Excess	Adjusted
Austria	0.66	0.22	0.43	0.56
Australia	0.58	0.23	0.35	0.45
Canada	0.68	0.24	0.44	0.58
Germany	0.76	0.27	0.49	0.67
Finland	0.62	0.24	0.38	0.50
Italy	0.55	0.16	0.39	0.47
Norway	0.76	0.37	0.39	0.61
Slovenia	0.53	0.14	0.40	0.46
UK	0.58	0.23	0.35	0.45
US	0.82	0.38	0.45	0.72

Actual is the conventional Gini coefficient. Natural, Excess, and Adjusted are the alternative measures of inequality defined in Section I. Results are rounded to two decimal points. Results for Austria and Australia refer to 2014, Canada and Germany refer to 2012, Italy and Slovenia refer to 2014, Finland and Norway refer to 2013, the US refer to 2016, and the UK to 2011.

the demographic structure returns towards its long-run equilibrium? We find that this return *ceteris paribus* will increase the natural rate of inequality for most countries in our sample, and thus may lead to increases in overall inequality.

The Baby Boom generation, for the US commonly considered those born between 1946 and 1964, represented a temporary upwards deviation from developed countries' otherwise stable demographic trajectories. This can be seen in Figure 11 which reports long-run fertility data for a selection of countries. A first observation is that the Baby Boom was a common feature across many developed countries.[11] Although, there are variations in timing and magnitude these fail to mask the overall scale

[11] All data are from the Human Fertility Database (2013). Germany refers to West Germany only, France excludes the overseas territories. The 'Average' series is the annual arithmetic mean of available observations.

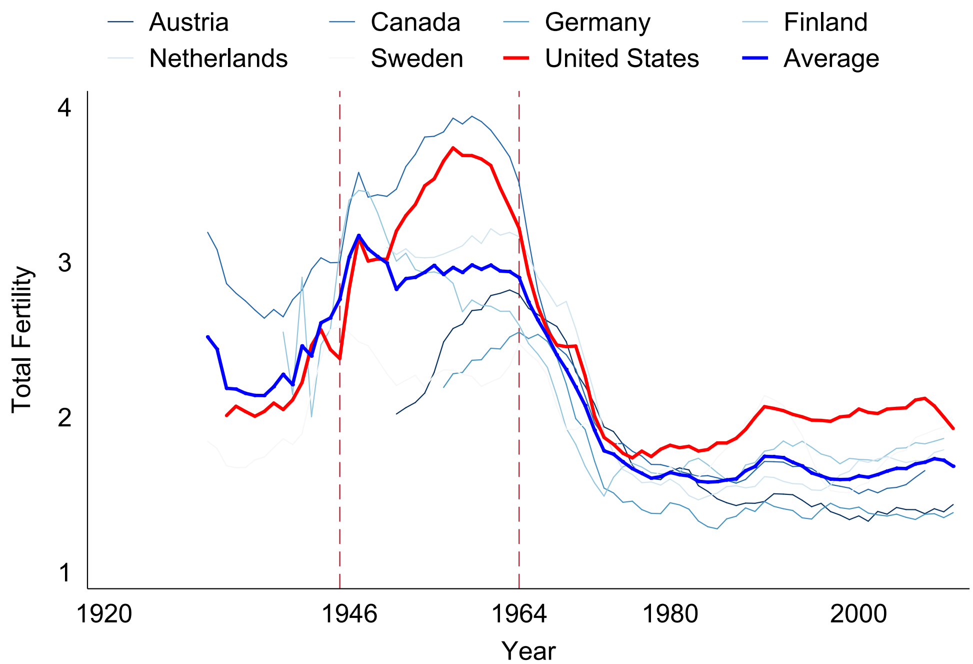
of the boom - nearly an extra child per woman for 18 years. Also, notable is the rapidity with which it began and ended. This large, sudden, and in demographic terms brief, rise in fertility has led to a one generation distortion in the demographic structure of the affected societies. This shock to the demographic pyramid provides an interesting natural experiment for us to study as the demographics return to their long run steady state following the departure of the Baby Boom generation. Our analysis suggests that recent increases in natural inequality will be permanent, and continue as the share of Baby Boomers in the labour market and overall population declines, with increases of up to 10 percent in inequality as societies return to the demographic steady-state.

Future Levels of Inequality

In order to study the impact of the Baby Boomers we simulate future population cohort sizes using age specific data on birth rates, death rates, and population cohort size. We do this using the standard Leslie matrix approach, in which the birth and death rates define a transition matrix that projects the cohort sizes next period given the current sizes. Then, because the natural rate of inequality only requires cohort or age-group specific income shares, we can then use the projected cohort sizes to scale these income shares, giving estimates of natural inequality under the new demographics. This process can be repeated to obtain projected demographics at any given time horizon.

We make two key assumptions for this exercise. Firstly, that the life-cycle earnings profile is be stationary. Secondly, we fix the relative size of the working cohort sizes. That is, we assume that the labour market

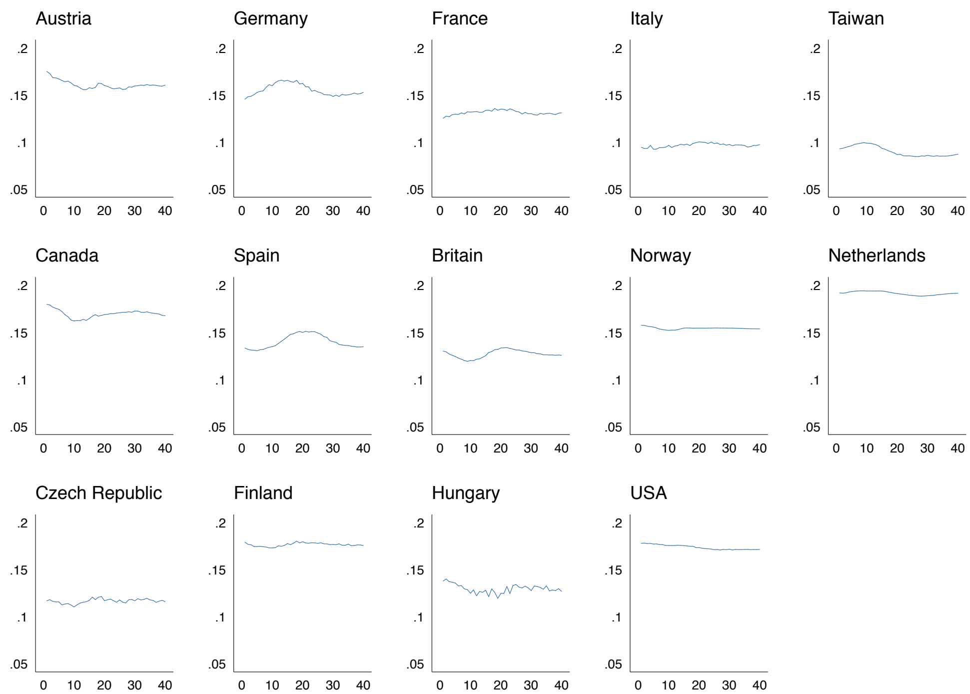
Figure 11 : The Baby Boom



Source: Authors' calculations using data are from the Human Fertility Database (HFD), 2013.
Notes: The y-axis reports the number of children born per woman in a given year. The blue line is the (unweighted) mean fertility rate across the six countries reported. The red line highlights the USA for clarity but is otherwise identical in construction to those for other countries. The dotted vertical lines indicate the beginning and end of the baby-boom.

participation and unemployment rates will remain fixed for each cohort over time. We are asking *ceteris paribus* what will happen to the level of natural rate inequality in a society in the future if all that is going to change is relative cohort sizes. In particular, we can expect to see the society returning to its normal demographic pyramid following the shock of the Baby Boom generation. This assumption entails also not making any inference regarding expected immigration. Thus we are assuming that this will be such that the relative size of the working cohort is fixed.

Figure 12 : Simulated Natural Rates of Income Inequality



Source: Simulations use data from the Human Mortality Database (2013) and Human Fertility Database (2013) and earnings profiles are taken from the most recent data available in the LIS database.
Notes: On the y-axis is the *Natural* Gini Coefficient and time (years in the future) is on the x-axis. We project the population distribution for up to 40 years in the future by which time all societies will be extremely close to their steady state.

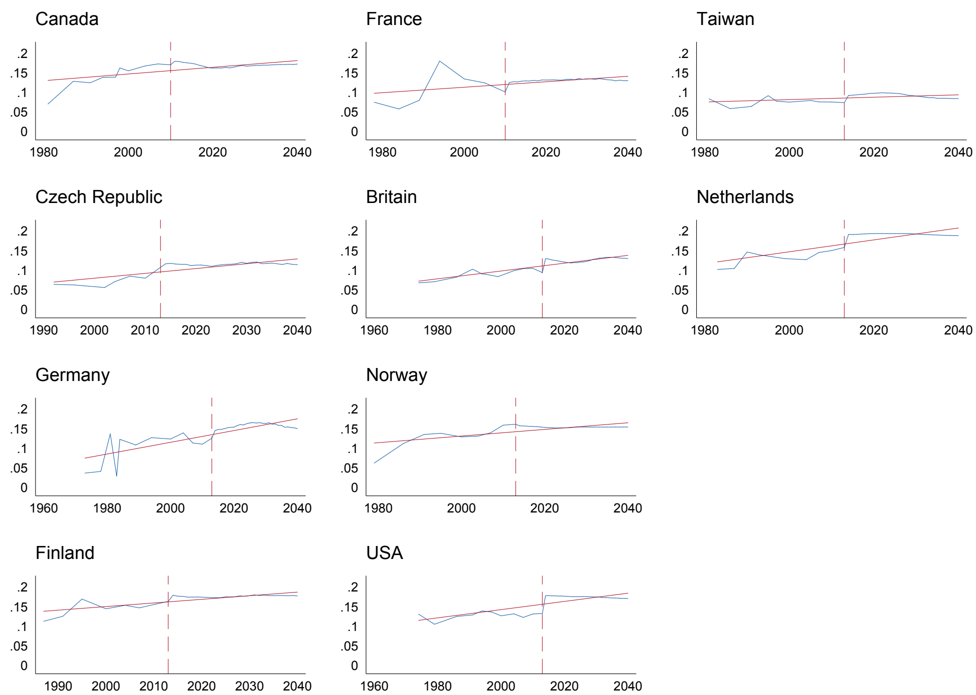
Thus, for the 15 countries for which suitable fertility and mortality data are available, and are part if the LIS data, we project expected levels of natural labour income inequality. Figure 12 plots projected natural inequality for the next forty years. We choose this horizon as by this point the children of the Baby Boomers have largely left the labour market and so the population will be approaching its steady-state. The key prediction is that in almost all countries natural inequality will remain at its current level or increase. A second prediction is that natural inequality will be much less volatile than in the past, although other than in the United States and Norway it will continue to fluctuate. Both of these results are consistent with our intuitions, as the Baby Boomers either have now retired or will do in the next few years. Seemingly, in the past the presence of the Baby Boomers reduced natural inequality, offsetting and thus masking increases in adjusted inequality. Any future rises in adjusted inequality will translate directly into increased overall inequality.

A second prediction concerns the timing of the fluctuations, which are expected to be largest around twenty years from now, when mortality rates for the Baby Boomers will be highest. This effect seems particularly pronounced for France, Germany, Spain and Britain. To further look at how these projections compare with the historical data, we plot them together in Figure 13 along with a line of best fit denoted by the red line.[12] The vertical red dashed line represents the point at which the simulation starts. To the left of this line are the historical results from LIS, and points to the right are the projected levels of inequality. Taken together it seems that future increases in natural inequality would represent a continuation of the historical trend. Historically, this presumably reflects the increased numbers of older people in the population due to improved health, and it is important to note that any continued improvements will likely increase natural inequality further. Most countries are forecast to experience a five to ten percentage points increase in the natural rate relative to the 1980's by the 2040's. This suggests that in the absence of

[12]The reduced set of countries reflects data availability.

more migration or changes in fertility patterns that there is unlikely to be any reduction in natural inequality, to offset trends in excess inequality, in the foreseeable future.

Figure 13 : Historical and Simulated Future Rates of Income Inequality



Source: Simulations use data from the Human Mortality Database (2013) and Human Fertility Database (2013). Historical data are taken from the LIS, the Earnings profiles for the projections are taken from the final wave of the LIS.
Notes: On the y-axis is the *Natural* Gini Coefficient and the x-axis plots the year. The dashed vertical red line signals the end of the historical LIS results and the beginning of the projected trend. The solid red vertical line is the line of best fit for the entire time period.

IV. Conclusion

Even a society in which everybody is the same at the same stage of the life-cycle will exhibit a substantial degree of income and wealth inequality. In this paper we take this notion to the data in order to quantify the share of observed income and wealth inequality that is attributable to life-cycle profiles of income and wealth. The data reveal that natural inequality is a substantial component of actual inequality. Treating the natural rate as the benchmark, and thus analysing excess or adjusted inequality suggests that recent increases in income inequality in the US are both larger than the actual rate would suggest, and represent a distinct change from the period pre-1990. It is also clear that natural inequality is of first-order importance in understanding variation in other developed countries and the variation between them. A similar analysis for wealth inequality suggests that natural inequality is less important a determinant than it is for income, and a much smaller component of actual wealth inequality. It similarly explains less of the cross country variation. To home in on the role of the demographic structure for inequality we close our analysis by focusing on the impact of the bulge on the demographic pyramid generated by the Baby Boom generation. This shows that the as cohort shares transition back into their long-run equilibrium levels, natural inequalities of income will fluctuate and reach a new higher level of steady state natural rate inequality.

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A. Proof of Proposition 1

Proof of Proposition 1. Focusing on income inequality and following Milanovic (1997) we can write the Gini Coefficient of Income as:

$$\theta(W) = \frac{1}{\sqrt{3}}\frac{\sigma_W}{\overline{W}}\rho(W,r_W)\frac{\sqrt{N^2-1}}{N} \approxeq \frac{1}{\sqrt{3}}\frac{\sigma_W}{\overline{W}}\rho(W,r_W),$$

where $\overline{W}$, σ_W are the mean and standard deviation of individual income W, r_W is the rank of a specific income level W and $\rho(W,r_W)$ is the correlation of W with its rank r_W. To proceed, observe that $\rho(W,r_W) \in [0,1]$ and that $\rho(W,r_W) = 0$ if and only if $W = \overline{W}\,\forall\, W$, otherwise $\rho(W,r_W) \in (0,1]$. In combination with the fact that $\sigma_W \geq 0$ but also $\sigma_W = 0$ if and only if $W = \overline{W}\,\forall\, W$, implies that as longs as the set $W \neq \overline{W}$ is non-empty $\theta(W) > 0$. Results for the Gini Coefficient of Wealth can be established with the same arguments. □

B. Data Appendix

Luxembourg Income Study Database (LIS)

The Luxembourg Income Study (LIS) provides a harmonised data set of microdata recording a broad range of economic and demographic characteristics drawn from various nationally representative surveys. Data are compiled at both the individual and household levels. For each wave, from each country, LIS takes data for the individual and the household level, with variables relating to socio-demographics, household characteristics, labour market and flow variables. The individual file is made up of the members of the households included in the household level files, where their individual observations regarding income and expenditure are summed to create the household aggregate information. For our purposes we use the individual level income data only.

The harmonisation procedure involves two main components. Firstly, ensuring the variables are comparable in terms of their definitions and in the coding convention applied, for example with respect to categorical variables. Secondly, missing values are processed to ensure both a consistent coding across countries and waves, but also given the differing questions asked by each national survey-wave where possible missing data are derived from the available data. For example, if the underlying survey does not contain information about unemployment but does contain sufficient employment data then unemployment data is derived appropriately.

The datasets produced by LIS are representative of the total population of that country for the given year. To this end the most appropriate weights provided by the original surveys are selected, and where necessary missing individual or household level weights are derived using the provided weighting data. The key criteria for the choice of weight variable, is that they deliver nationally representative results and in the cases where there is a choice of these priority is given to those which are designed to accurately capture the population income distribution.

We consider two main income variables from the LIS datasets taken from the individual level data files. These values are corrected for inflation by LIS using the Consumer Price Index (CPI).

Personal Monetary Income This is the total monetary income that an individual receives from labour and transfers. As such it is akin to the pre-tax total income in the CPS, and we will refer to it as Total Income.

Labour Monetary Income Labour income includes any monetary payments received from employment, in addition any profits or losses accruing from self employment.

We can additionally consider both the value monetary and non-monetary income however not all data sets are as good as reporting non-monetary income so this component maybe under reported in many cases. Regardless of this difference we can find similar results for both monetary and non-monetary incomes. We limit the age range consider to 18-78 when using personal monetary income, and to 18-65 for labour monetary income.

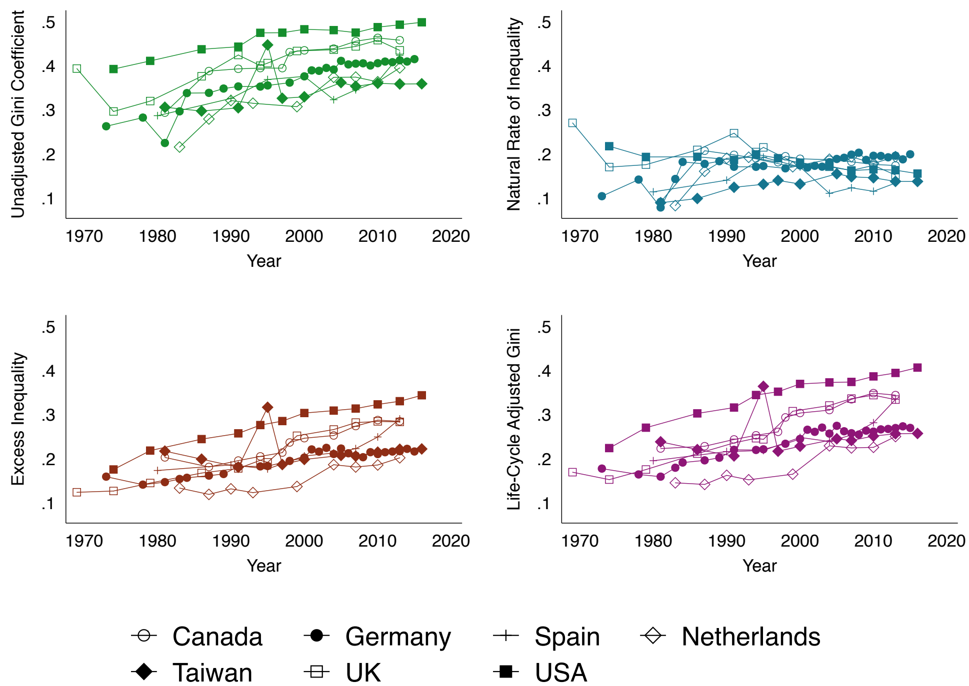
The LIS classifies each data set depending on the kind of income that the host data provider report. These groups are either *gross*, *net*, or *mixed*. A majority of the datasets are *gross*, that is the income amounts reported are gross of income taxes and social security employer contributions. This is contrasted to the *net* datasets which there is no information provided regarding taxes and other contributions. Finally, *mixed* datasets where that taxes and contribution data is not sufficiently available to be purely classified as either *gross* or *net*.

Luxembourg Wealth Study (LWS)

Our estimates of wealth inequality use data from the Luxembourg Wealth Study Database (LWS) . This combines representative national surveys on the basis of the same principles as the LIS, producing harmonised cross country data. A key difference is that wealth variables are measured at the level of the household unit. Therefore, we need to assign an 'age' to each household to calculate *natural* and *adjusted* inequality. To do so, we use the age of the head of household. This choice is unimportant for our results. All of our estimates are produced using the weights provided by LWS, and we allow net wealth to be negative. Wealth data are often top-coded and the wealthy are often oversampled due to higher rates of non-response. This can mean, given the small number of very wealth individuals, that results may not be truly representative. To address bias due to this we drop the top 1% of wealth observations in each country. Data for the United States are drawn from the Survey of Consumer Finances (SCF) and so we follow the approach of Heathcote et al. (2010) who trim the SCF so that the mean income is consistent across all their datasets.

C. Additional Results

Figure C.1 : Adjusted and Unadjusted Gini of Total Income: Selected Countries: 1969-2016



Source: Authors' calculations using LIS data.

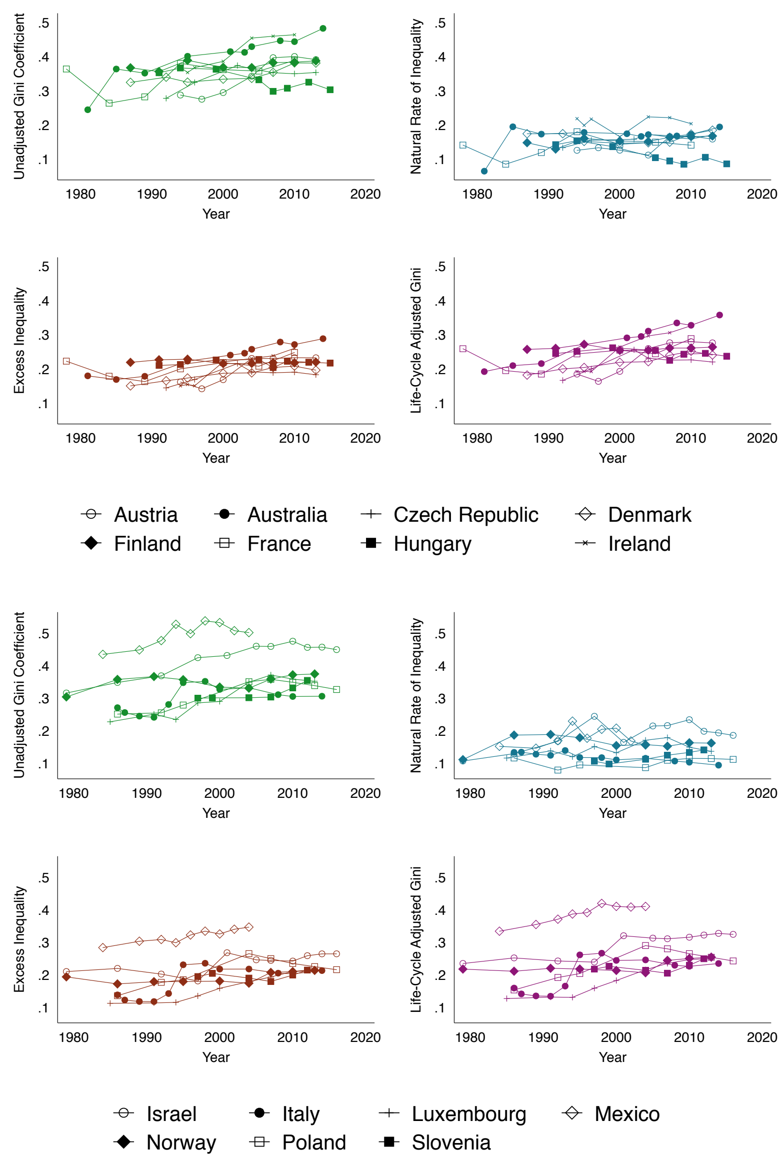
Notes: All results are calculated using data on gross incomes with the exception of Spain which are net incomes (with exception of wave IX). We consider ages 18-78 for total income and who have positive earnings. Results are calculated using individual level weights.

Table C.1: Country Specific Trend Estimates

	Actual		*Adjusted*		
Country	Total	Labour	Total	Labour	*N*
Austria	0.74***	0.80***	0.67***	0.75***	7
	(0.13)	(0.13)	(0.12)	(0.14)	
Australia	0.55***	0.41***	0.51***	0.35***	10
	(0.12)	(0.05)	(0.02)	(0.02)	
Canada	0.27***	0.52***	0.24***	0.48***	11
	(0.06)	(0.10)	(0.06)	(0.03)	
Czech Republic	0.31*	0.41 ***	0.23	0.22**	7
	(0.14)	(0.07)	(0.12)	(0.09)	
Germany	0.39**	0.44***	0.29***	0.32***	27
	(0.04)	(0.04)	(0.02)	(0.02)	
Denmark	0.06	0.23***	0.07**	0.20***	8
	(0.05)	(0.05)	(0.02)	(0.03)	
Spain	0.32**	0.31**	0.39***	0.34**	8
	(0.09)	(0.13)	(0.07)	(0.12)	
Finland	-0.01	0.05	-0.05***	-0.06	8
	(0.02)	(0.05)	(0.01)	(0.05)	
France	0.17	0.33**	0.10	0.24	7
	(0.19)	(0.13)	(0.14)	(0.15)	
Hungary	-0.27***	-0.39***	-0.06	-0.27***	8
	(0.06)	(0.07)	(0.03)	(0.06)	
Ireland	0.75***	0.70***	0.92***	0.83***	7
	(0.09)	(0.09)	(0.07)	(0.07)	
Israel	0.41***	0.43***	0.29***	0.26***	11
	(0.05)	(0.05)	(0.03)	(0.03)	
Italy	0.29***	0.29***	0.52***	0.27***	12
	(0.08)	(0.08)	(0.09)	(0.07)	
Luxembourg	0.51***	0.61***	0.53***	0.57***	9
	(0.09)	(0.07)	(0.04)	(0.06)	
Mexico	0.59***	0.40**	0.62***	0.40***	9
	(0.12)	(0.13)	(0.07)	(0.07)	
Netherlands	0.36***	0.62***	0.35***	0.45***	9
	(0.09)	(0.05)	(0.05)	(0.05)	
Norway	-0.15**	0.27***	-0.21**	0.19***	9
	(0.05)	(0.06)	(0.07)	(0.02)	
Poland	0.35***	0.36***	0.35**	0.30**	8
	(0.08)	(0.09)	(0.10)	(0.08)	
Slovenia	0.32**	0.30*	0.08	0.16	6
	(0.07)	(0.14)	0.10	0.10	
Taiwan	0.16**	0.14***	0.05	0.13*	11
	(0.07)	(0.04)	(0.07)	(0.07)	
United Kingdom	0.28**	0.50***	0.48***	0.51***	12
	(0.09)	(0.03)	(0.04)	(0.03)	
United States	0.24***	0.25***	0.40***	0.35***	12
	(0.02)	(0.04)	(0.04)	(0.04)	

Coefficients are country specific time trends obtained using the Mean Group estimator of Pesaran and Smith (1995). See Table 1 for further details.

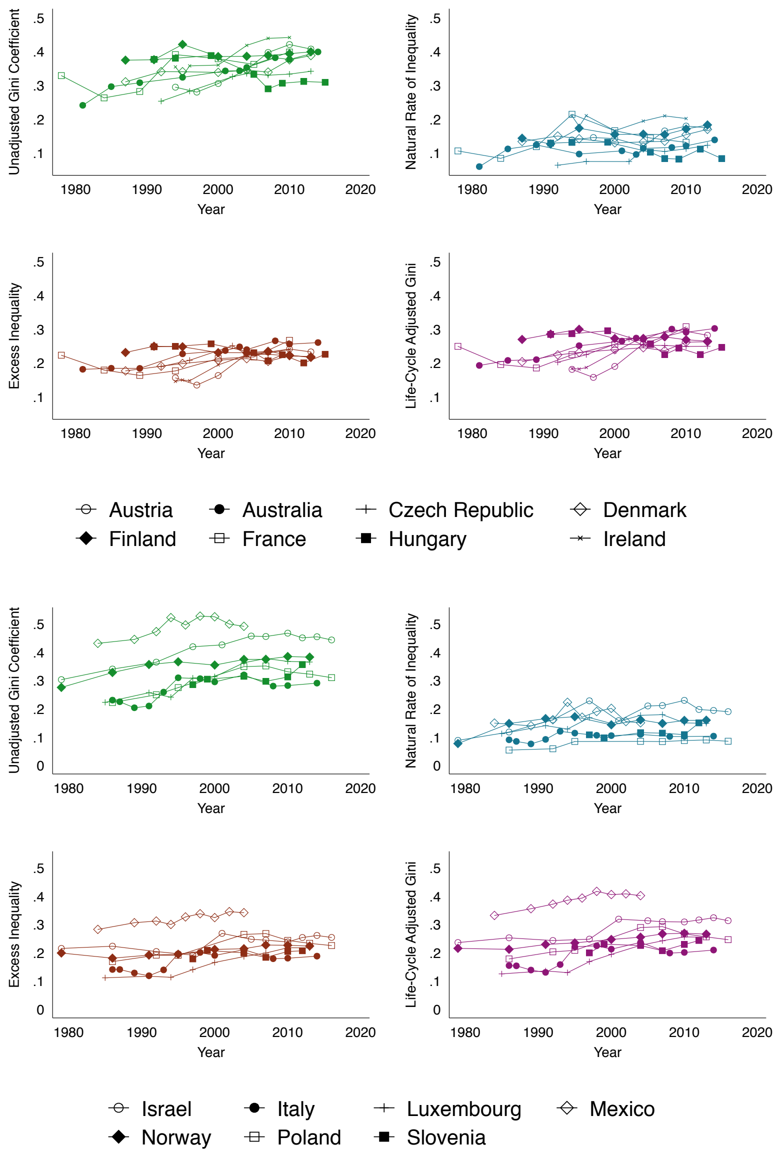
Figure C.2 : LIS Additional Countries, Total Income



Source: Authors' calculations using LIS data.

Notes: These are the countries for which a sufficient time series is available not reported in Figure 9. Note that, however, data for these other countries are not consistently classified as gross or net. Most datasets are classified as Gross. France is all classed as mixed and Slovenia is classed as Net. Austria, Belgium, Hungary, Israel, Italy, Luxembourg and Poland do not have a consistent classification over the time series. All others are for gross income. We consider Men aged between 18-78 and who have positive income. Results are calculated using individual level weights.

Figure C.3 : LIS Additional Countries, Labour Income



Source: Authors' calculations using LIS data.

Notes: These are the countries for which a sufficient time series is available not reported in Figure 9. Note that, however, data for these other countries are not consistently classified as gross or net. Most datasets are classified as Gross. France is all classed as mixed and Slovenia is classed as Net. Austria, Belgium, Hungary, Israel, Italy, Luxembourg and Poland do not have a consistent classification over the time series. All others are for gross income. We consider Men aged between 18-65 and who have positive income. Results are calculated using individual level weights.

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