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How Unequal Is Europe? Evidence from Distributional National Accounts, 1980-2017

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Abstract

This paper estimates the evolution of income inequality in 38 European countries from 1980 to 2017 by combining surveys, tax data and national accounts. We develop a harmonized methodology, using machine learning, nonlinear survey calibration and extreme value theory, in order to produce homogeneous pre-tax and post-tax income inequality estimates, comparable across countries and consistent with official national income growth rates. Inequalities have increased in a majority of European countries, both at the top and at the bottom of the distribution, especially between 1980 and 2000. The European top 1% grew more than two times faster than the bottom 50% and captured 17% of regional income growth. Relative poverty in Europe went through ups and downs, increasing from 20% in 1980 to 22% in 2017. Inequalities yet remain lower and have increased much less in Europe than in the US, despite the persistence of strong income differences between European countries and the weaker progressivity of European-wide income redistribution.

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Contents

1 Introduction

Despite the relevance of Europe (and particularly the European Union) as an economic and political entity, it is remarkably hard to know how growth has been shared over the past few decades across its population. This difficulty is not the result of a lack of data *per se*. In fact, there is a fair amount of data available, at least since the 1980s. The problem is that these data are scattered across a variety of sources, taking several forms, using diverse concepts and different methodologies. In the end, we find ourselves with a disparate set of indicators that are not always comparable, are hard to aggregate, provide uneven coverage, and can tell conflicting stories.

As a result, the literature has struggled to answer simple questions such as: which income groups in which countries have benefited the most from European growth? How is European inequality affected by taxes and transfers? Is Europe as a whole more or less equal than the United States? [1]

This paper addresses this problem by constructing distributional national accounts for 38 European countries since 1980. While we still face considerable challenges in the construction of good estimates of the income distribution in some countries, we believe that our new series present major improvements over existing ones.

First, our estimates combine virtually all the existing data on the income distribution of European countries in a consistent way. That includes surveys, national accounts, and tax data. Our methodology exploits the strengths of each data source to correct for the weaknesses of the others. It avoids the kind of systematic errors that would arise from the comparison of different income concepts, different statistical units and different methodologies. As such, our estimates are meant to reflect the best of our current knowledge on what has been the evolution of inequality in Europe.

Second, in line with the logic of distributional national accounts (DINA), we distribute the entirety of national income. This includes money that never explicitly shows up on anyone's bank account, such as imputed rents or the retained earnings of corporations, yet can account for a significant share of the income recorded in national accounts and official publications of macroeconomic growth. Therefore, our results are consistent with macroeconomic totals, and can be directly discussed in terms of how much growth accrued to the different parts of the distribution.

[1] Among many studies, Atkinson (1996) found that inequalities were lower in the EU-15 than in the US in the late 1980s, and so did Beblo and Knaus (2001) when looking at the eurozone in the mid-1990s. Brandolini (2006) extended the analysis to the EU-25 and found a lower Gini coefficient than in the US when using purchasing power parities. Boix (2004) found the EU-28 to be more unequal than the United States, but not the EU-15 and the EU-25. Similarly, Dauderstädt (2008) and Dauderstädt and Keltek (2011) estimated that income disparities were larger in the EU-27 than in other world regions such as China, India, Russia or the US.

Third, rather than focusing on a handful of indicators, we cover the entire distribution from the bottom to the top 0.001%. Therefore, we can aggregate our distributions at different regional levels, and analyze the structure of inequality in great details. We can, furthermore, use our estimates to compute any set of synthetic indicators in a consistent way, such as top and bottom income shares, poverty rates or Gini coefficients.

Our approach builds on some of the latest advances in statistics, including machine learning (Chen and Guestrin, 2016), extreme value theory (Ferreira and Haan, 2006), and nonlinear survey calibration (Lesage, 2009). It obeys a handful of principles. To begin, national accounts are our benchmark for measuring inequality *between* countries. This does not mean that we consider them to be perfect (e.g. Zucman, 2013), but they do represent the most thorough attempt to define a concept of income harmonized at the international level, and in practice they are already routinely used to measure the average income of countries.

Then, surveys and tax data provide complementary information on the distribution of income *within* countries. Surveys cover the entire distribution. They are often — though not always — available as microdata, so they can be used with different income concepts and statistical units. But they tend to underrepresent the rich, which limits their ability to measure the income share of top groups. Tax data does not suffer from that problem. However, in several countries, it only covers the top of the distribution, and it uses income concepts and statistical units that depend on the legislation of each country. For that reason, surveys remain a core element of our method, but we correct them using the tax data to ensure their representativity in terms of income, in the same way that statistical institutes already correct them to ensure representativity in terms of age or gender.

We stress that our work should not be viewed as a substitute for what has been done, and is still being done, in country-specific studies on distributional national accounts (such as Piketty, Saez, and Zucman (2018) on the United States and Garbinti, Goupille-Lebret, and Piketty (2018) on France). In fact, we use such data in the few countries in which they are available. These comprehensive DINA studies typically involve a lot of work and assumptions to match estimates of the income distribution with the national accounts for every single component of national income. This results in series that are extremely detailed and extremely precise, but also very complex and time-consuming. It will take a long time until this type of work can be extended to all the countries covered in this paper. In the meantime, our approach has several advantages. It is simpler, faster, and requires less data. Yet it still represents a significant step forward compared to previous inequality series: unlike pure survey estimates, it does not suffer from the underrepresentation of the rich. Unlike raw tax data estimates, it covers the entire population, and it uses concepts and statistical units that are consistent across countries rather than dependent on the local legislation.

And it accounts for the main components of net national income that are traditionally missing from estimates of inequality. As such, our methodology captures the main improvements that come from the production of more comprehensive distributional national accounts, but can be implemented much faster and at a larger scale.

Our results are as follows. In terms of inequalities between countries, we do not observe a clear pattern of convergence in average income levels since the early 1980s. Per adult income in Eastern Europe was about 35% lower than the European average in 2017. This was the same value as in the early 1980s, before the fall of the USSR. In Southern European countries, per adult average incomes have been declining relatively to the continental average since the 1990s and were 10% below the average in 2017. Northern European countries were 25% richer than the average in the mid-1990s and ended up 50% richer.

Inequalities have been increasing in nearly all European countries, both at the bottom and at the top of the distribution. Nearly all European countries failed to reach the United Nations Sustainable Development Goals inequality target over the 1980-2017 period, which seeks to ensure that the bottom 40% of the population grows faster than the average. Since the 2000s, European countries have been relatively more successful at ensuring that bottom income groups secure a fair share of growth, but the majority of countries still failed to achieve the UN objective.

As a result of a limited convergence process and rising inequality within countries, Europeans are more unequal today than they were four decades ago. Between 1980 and 2017, the top 1% grew more than two times faster and captured as much growth as the bottom 50%. The share of national income captured by the richest 10% Europeans increased from 29% to 34% between 1980 and 2017. About 20% of citizens lived below the European poverty line in 1980, compared to 22% in 2017.

Despite rising inequality in Europe and in the European Union, European countries have been much more successful at promoting inclusive growth than the United States. This is largely because European countries succeeded in generating much higher growth rates for low-income groups. The average pre-tax income of the poorest half of the European adult population was 40% higher in 2017 than in 1980, while it was essentially the same as in 1980 for the poorest 50% of US citizens. Consequently, Europe was much less unequal than the US, despite higher inequalities between European countries than between US states. While European countries distribute pre-tax incomes much more equally than the US, the intensity of post-tax redistribution is stronger in the US. Top 10% US average pre-tax incomes were 20 times higher than that of the US bottom 50% in 2017. After taxes and transfers, this ratio fell to 12 (a 40% reduction of inequality). In Europe, taxes and transfers only reduced inequality by 25%. Nevertheless, post-tax inequality in Europe remains significantly lower than in the US.

In the online appendix, we provide detailed information on data sources, methodological steps and key results for all the countries and European regions covered in this paper. Detailed inequality series covering the distributions of pre-tax and post-tax incomes can be downloaded from the website of the World Inequality Database (`https://wid.world`), where incomes across European countries can also be compared on an online simulator (`https://wid.world/simulator`).

Section 2 presents the data sources and methodology used in this paper. Section 3 discusses the evolution of income inequality in Europe between 1980 and 2017. Section 4 concludes.

2 Data sources and methodology

2.1 Income concepts

We produce homogeneous income inequality estimates for thirty-eight European countries, spanning from Portugal to Cyprus and from Iceland to Malta, over the 1980-2017 period. Our geographical area of interest includes the twenty-eight members of the European Union, five candidate countries (Bosnia and Herzegovina, Serbia, Montenegro, Macedonia, Albania), and five countries which are not part of the EU but have maintained tight relationships with it (Iceland, Norway, Switzerland, Kosovo and Moldova).

Our benchmark measure to compare income levels between countries and over time is net national income. It is equal to gross domestic product (GDP) net of capital depreciation, plus net foreign income received from abroad. While GDP figures are most often discussed by both academics and the general public, we believe national income to be more meaningful, since capital depreciation is not earned by anyone, while foreign incomes are, on the contrary, effectively received (or paid) by residents of a given country. While GDP and national income usually follow each other, there are countries where they can diverge, such as Ireland and Luxembourg where a growing share of GDP growth has been captured by foreign corporations in recent years. Furthermore, as an indicator of *income* rather than *production*, national income is not sensitive to issues surrounding the localization of production that have become worrisome in recent years. For example, Ireland officially estimated its real GDP growth in 2015 to be +26%. This number stirred controversy, as it is believed to be the sole result of a few large multinational corporations relocating their intangible assets in Ireland for tax purposes.[2] National accountants are still debating whether it reflects the

[2] See `https://www.irishtimes.com/business/economy/handful-of-multinationals-behind-26-3-growth-in-gdp-1.2719047`

reality of the Irish GDP or a mere statistical artifact. Instead, using the concept of national income is much more straightforward: net foreign incomes compensate any change in GDP caused by different assumptions about the localization of production. Throughout this paper, we use national income series compiled by the World Inequality Database based on data from national statistical institutes and macroeconomic tables from the United Nations System of National Accounts (see Blanchet and Chancel, 2016).

Our work follows the guidelines for distributional national accounts that have been laid down by Alvaredo et al. (2017). It is therefore comparable to other works on distributional national accounts done in the United States (Piketty, Saez, and Zucman, 2018) and France (Garbinti, Goupille-Lebret, and Piketty, 2018). Our statistical unit is the adult individual (defined as being 20 or older), and we split income equally between adult household members. We focus on two concepts for the distribution of income: pre-tax and post-tax national income, both of which sum up to national income.

Pre-tax national income is our main concept. It is the sum of all personal income flows, before taking into account the operation of the tax and transfer system, but after taking into account the operation of the pension system. Contributions to pension and unemployment insurance schemes are therefore deducted, but the corresponding benefits are included. Pre-tax income is similar to the taxable income of many countries, but its definition is usually broader, and more comparable across countries. Because we include both pension and unemployment insurance, this corresponds to the "broad" definition of the DINA guidelines (Alvaredo et al., 2017).

Post-tax national income is equal to pre-tax income after subtracting all taxes and adding all forms of government transfers. In line with the DINA methodology, all forms of government spending are allocated to individuals, so that post-tax income adds up to the national income. Not doing so would make countries with a stronger provision of public goods appear mechanically poorer. Our benchmark post-tax income series allocate all government consumption is a neutral way, by making it proportional to income. This is the convention adopted by other DINA studies and makes the series more comparable to other estimates of post-tax income inequality. We experiment with alternative assumptions by distributing parts of government consumption as a lump sum rather than proportionally. This changes the levels of post-tax inequality, but not the trends.

2.2 Data sources

Our methodology relies on surveys, tax data and national accounts to produce our final estimates of the income distribution. We use additional information on social contribution schedules from

the OECD tax database when necessary to impute social contributions paid.[3] We provide extensive documentation of the availability of these sources country by country in the extended appendix of the paper.

2.2.1 Survey data

We bring together survey microdata from three sources and survey tabulations from two sources. The Luxembourg Income Study (LIS) provides access to harmonized survey microdata covering twenty-six countries over the 1975–2014 period. Most Western European countries are covered from 1985 until today, and several nations from Eastern Europe have been surveyed since the 1990s. Our second most important source of survey data is the European Union Statistics on Income and Living Conditions (EU-SILC), which have been conducted on a yearly basis since 2004 in thirty-two countries. We complemented that survey by its predecessor, the European Community Household Panel, which covers the 1994-2001 period for thirteen countries in Western Europe.

We complete our database by compiling survey tabulations available from the World Bank's PovcalNet portal and from the World Income Inequality Database. PovcalNet provides pre-calculated survey distributions by percentile of post-tax income or consumption per capita. The World Income Inequality Database (WIID) gathers inequality estimates obtained from various studies, and gives information on the share of income received by each decile or quintile of the population. We use generalized Pareto interpolation (Blanchet, Fournier, and Piketty, 2017) to recover complete distributions based on the tabulations. These estimates cover very different notions, which motivates our method for correcting conceptual discrepancies (see section 2.3.1 below). We observe three types of income/consumption definitions and five types of population units, amounting to fifteen potential types of inequality series. We may observe either pre-tax income, post-tax income or consumption. Population units can be households, adults, individuals, the OECD modified equivalence scale or the square root scale.[4]

Historically, surveys have mostly been used to produce estimates of the distribution of post-tax income. The situation has evolved in the latest decade, with measures of income before taxes and transfers being recorded consistently across the continent as part of EU-SILC. The Luxembourg Income Study also produces some historical data on pre-tax income, in many cases by imputing taxes and contributions as part of their harmonization effort. As a result, we have

[3] See `https://www.oecd.org/tax/tax-policy/tax-database.htm`.

[4] When computing inequality estimates with the OECD modified equivalence scale, the first adult in the household is given a weight of 1, other adults are given a weight of 0.5, and children are given a weight of 0.3 each. The square root scale divides total income by the square root of the size of the household.

data on pre-tax income in almost all countries since 2007, and for over a longer time period for some Western European countries (Germany, United Kingdom, Switzerland, and Nordic countries). Otherwise, we mostly observe the distribution of post-tax income. Cases in which we only observe consumption are limited to a handful of Eastern European countries (Moldova, Kosovo, Montenegro).

Our survey estimates for pre-tax income are limited to cases in which we have access to the microdata, given the need to properly match the DINA definition of pre-tax income.[5] That definition involves dividing social contributions between a contributory part and a non-contributory part. The contributory part finances pension and unemployment benefits that are included in pre-tax income, while the non-contributory part finances universal and social assistance benefits that should only be included in post-tax income. We only remove contributory contributions from pre-tax income. We rely on the national accounts to determine the share of contributory social contributions. We only distribute a fraction of social contributions, equal to the ratio of social insurance benefits (items D621 + D622 in the system of national accounts) to social insurance contributions (D63). However, the national accounts of countries do not usually provide enough details to separate social insurance benefits (D621 + D622) from social assistance benefits in cash (D623). They only record their sum as social benefits other than social transfers in kind (D62). To make the distinction, we rely on the OECD social expenditure database, which breaks down social benefits by function in great detail since 1980. In general, the ratio of social benefits to social contributions is below one because contributions finance benefits other than pensions and unemployment insurance. Yet the opposite is true in some countries. Denmark, for example, derives virtually no revenue from social contributions. In such cases we assume that benefits in excess of contributions are financed by income and wealth taxes, so we deduct the corresponding part of taxes from pre-tax income.

Even when we have access to microdata with information on income before taxes and transfers, we have to sometimes perform additional imputations. In EU-SILC, both employer and employee social contributions are recorded, but employee contributions are combined with income and wealth taxes. Therefore, we impute employee contributions separately using social contribution schedules published in the OECD Tax Database. Before 2007, employer contributions may also not be recorded despite having information on income before taxes and employee contributions. In such cases, we also impute employer contributions based on schedules from the OECD Tax Database.

[5] The only exceptions correspond to a handful of Eastern European countries at the beginning of the period (Bosnia and Herzegovina, Moldova, Montenegro) for which we have no other source available. In these cases we use the survey distribution of pre-tax income as a proxy for the "true" pre-tax income.

We also use additional information from surveys to include imputed rents and the retained earnings of corporations in our measures of income (see section 2.2.3). Imputed rents are recorded in EU-SILC (though not included in the main income definition used by Eurostat). To estimate the distribution of retained earnings, we use the distribution of stock ownership (both held directly and indirectly, and for both public and private companies) in the Household Survey of Consumer Finance (HFCS), a European-wide wealth survey spearheaded by the ECB since 2014.

2.2.2 Tax data

Following contributions by Piketty (2001) for France and Piketty and Saez (2003) for the United States, several authors have been using tax data to study top income inequality in the long run. Most of these studies have been published in two collective volumes (Atkinson and Piketty, 2007; Atkinson and Piketty, 2010), and their results have been compiled in the World Inequality Database.[6] In general, tax data is only reliable for the top of the distribution, and this is why these series do not cover anything below the top 10%. Researchers estimate the share of top income groups by dividing their income in the tax data by a corresponding measure of total income in the national accounts. At the time of writing, data series were available for nineteen European countries, providing information on the share of income received over time by various groups within the top 10%.

We complete this database by collecting additional tabulated tax returns for Austria (2008–2015), East Germany (1970–1988), Estonia (2002–2017), Greece (2004–2011), Iceland (1990–2016), Italy (2009–2016), Luxembourg (2010, 2012) and Portugal (2005–2016). We use these tabulations to directly add new top income shares to our database. We provide a detailed account of the computations for each country in our technical appendix. In most cases, we directly correct the surveys with the tax data using the method of Blanchet, Flores, and Morgan (2018) rather than using a total income estimate from the national accounts. Direct correction of survey data is more a flexible and practical approach, at least for the recent period, and is now being preferred in the latest work on inequality (e.g. Piketty, Yang, and Zucman, 2017; Morgan, 2017; Bukowski and Novokmet, 2017). When extending existing series using that method, as in Italy or Portugal, our results are consistent with the work that was done previously, thus confirming the consistency and reliability of both approaches.

Top income series based on tax data have advantages and disadvantages. On the one hand, they generally provide a more accurate picture of the evolution of top incomes and are often available on

[6] See `http://wid.world`.

a yearly basis for long periods of time. On the other hand, because estimates of top income shares are measured from tabulated tax returns, they have to rely on definitions of taxable income and tax units which depend upon country-specific legislation. In Sweden, for instance, all individuals file tax returns separately and taxable income includes a significant share of social contributions (Roine and Waldenström, 2010). In Portugal, by contrast, married couples file jointly and taxable income excludes social contributions (Alvaredo, 2009). Therefore, while estimates based on tabulated tax data may portray accurately the evolution of top income inequality, they limit considerably the possibility to compare levels of inequality between countries.

2.2.3 National accounts

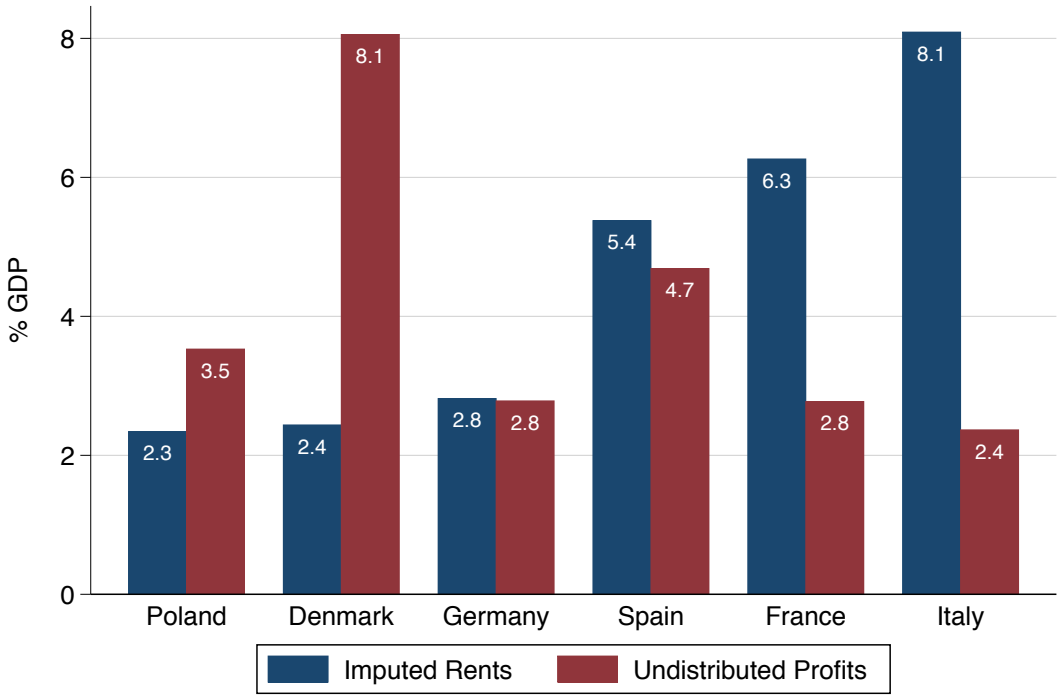
We rely on national accounts for several purposes. We use them to allocate the proper fraction of social contributions to individuals, as explained in section 2.2.1. We use net national income as our measure of income inequality between countries. And we use them to for certain types of income that are included in macroeconomic growth but excluded from many survey or tax-based estimates of inequality. For the simplified methodology presented in this paper, we focus on the two most important types of income that are traditionally excluded from estimates of the distribution of income: imputed rents and the retained earnings of corporations.[7] These components can represent a significant share of national income as defined in the national accounts. Both of them are classified as capital income, therefore their absence from the traditional estimates of income inequality partly explains why both survey and tax data both miss a large fraction of the capital income in the economy (Flores, 2018). Our estimates of net national income come from the World Inequality Database (see Blanchet and Chancel, 2016). For the rest, we use data from the standard sources: the United Nations Statistics Division, the OECD and Eurostat. We provide a detailed account of which sources are available in any given year for all countries in the extended appendix.[8]

Imputed rents correspond to the rental value of housing that homeowners pay to themselves when they live in their property instead of renting it to a third party. Their inclusion in the definition of income ensures that national income does not mechanically go up or down when the rate of home ownership changes. In advanced economies, they constitute a very significant part of capital income (Rognlie, 2015). In the national accounts, imputed rents correspond to the net operating

[7] Imputed rents are actually included in some survey estimates, and are also part of the tax base in some countries. Our methodology accounts and corrects for these discrepancies.

[8] When data are missing between two years, we linearly interpolate series expressed as a share of GDP. When data are missing at the beginning or at the end of the period, we extrapolate the series as a share of GDP using single exponential smoothing. Compared to carrying value forward or backward, single exponential smoothing avoid excessive reliance on potential outliers at the end or the beginning of the series.

Figure 1: Imputed rents and undistributed profits in six European countries



Source: Authors' elaboration based on tables from the United Nations' National Accounts Statistics.

surplus of the household sector (B2N).

The retained earnings of corporations correspond to profits that are kept within the company rather than distributed to shareholders as dividends. This income ultimately increases the wealth of shareholders and therefore represents a source of income to them. Several papers have documented the impact of including retained earnings in the United States (Piketty, Saez, and Zucman, 2018), Canada (Wolfson, Veall, and Brooks, 2016), and Chile (Fairfield and Jorratt De Luis, 2016; Atria et al., 2018). In Norway, Alstadsæter et al. (2017) showed that the choice to keep profits within a company or to distribute them is highly dependent on tax incentives, and therefore that failing to include them in estimates of inequality makes top income shares and their composition artificially volatile. Previous work would sometimes include capital gains in their income definition, which indirectly accounts for this type of income. Yet this constitutes a poor proxy, because capital gains are recorded upon realization, rather than when they accrue to individuals. And whether capital gains are realized or not depends on their value and on tax incentives. Therefore, attributing retained earnings to individuals directly is more reliable, more meaningful, more consistent with

macroeconomic measures of income, and more comparable across countries.

In the national accounts, retained earnings correspond to the net primary income of corporations (B5N). In line with our focus on *net* national income, this quantity is net of capital depreciation. We do not, however, distribute the entirety of that income to households, because some of it belongs to the government or to foreigners. To that end, we rely on the financial balance sheets of countries: we divide the equity assets of the government and of the rest of the world by the equity liability of the domestic corporate sector. We exclude that fraction of retained earnings from the amount that is allocated to households.[9]

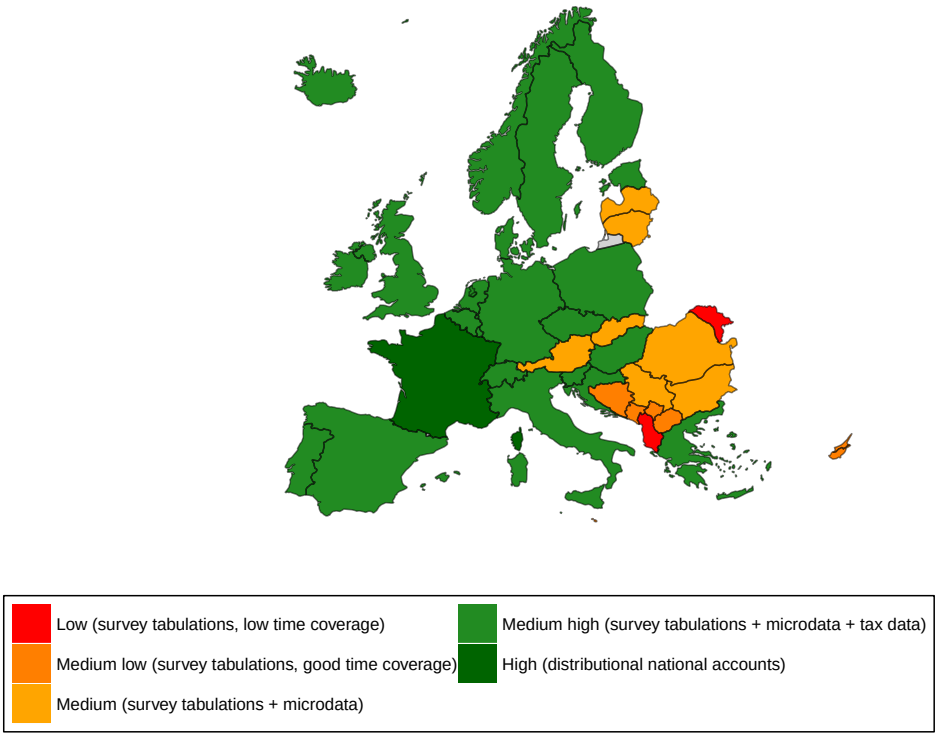
Figure 1 presents the share in GDP of both retained earnings and imputed rents for six selected countries of the EU. While imputed rents represent 2 to 3% of GDP in Poland and Germany today, they make up more than 6% of GDP in France and Italy. The total value of undistributed profits also varies quite significantly from a country to the other, from less than 3% of GDP in France and Italy to more than 8% in Denmark. The importance of imputed rents and undistributed profits in GDP also varies over time. The undistributed profits rose significantly in Italy or Poland since the 1980s, whereas they decreased in Spain and the United Kingdom.

2.2.4 Quality of data sources

Figure 2 maps the overall quality of data sources by country. For France, high-quality distributional national accounts were already estimated by Garbinti, Goupille-Lebret, and Piketty (2018) by combining surveys, micro-level tax data and national accounts. Top income shares, microdata and survey tabulations covering the entire 1980-2016 period are available for most Western European countries. In Eastern Europe, by contrast, survey microdata generally cover the twenty-first century and survey tabulations are available for earlier years. For ex-Yugoslavian nations and several small countries, existing sources are more limited. In Cyprus and Malta, surveys from EU-SILC are available for recent years but no information exists prior to the 2000s. In Albania and Moldova, only survey tabulations with limited time coverage were available. Detailed information on time coverage by country, types of data sources available as well as original studies from which fiscal

[9] This calculation assumes that the public sector only owns domestic corporations. While this is a roughly true for most countries, Norway is a notable exception. Through its Oil Fund, its own over 1% of global shares (see `https://www.economist.com/finance-and-economics/2017/09/23/norways-sovereign-wealth-fund-passes-the-1trn-mark`). For the purposes of this computation, we therefore remove the value of this fund from government assets. A second issue relates to the treatment of foreign-owned corporations. In the system of national accounts, profits from corporations that are owned by foreigners are subtracted from the net primary income of corporations only if foreign ownership takes the form of foreign direct investment, and not portfolio investment (Alvaredo et al., 2017). The latter has become more important over the past decades. Our computation is therefore conservative because it treats all foreign ownership as portfolio investment.

Figure 2: Quality of data sources



data series originate are available in appendix (table A.1).

2.3 Methodology

The issues that affect the validity and the comparability of existing income inequality estimates may be divided into three categories: conceptual discrepancies, nonsampling error, and sampling error.

Conceptual discrepancies are not errors in themselves but refer to differences as to what, precisely, is being measured. Existing estimates of income inequality may be concerned with different types of income and different populations units. While there may be a case for measuring inequality using any of these concepts and units, the existence of such a wide range of definitions makes it hard to compare inequality estimates both over time and between countries. As we have seen, both survey tabulations and fiscal data suffer from important conceptual discrepancies, as they

are measured on different groups of individuals and using different income concepts. One of the contributions of this paper is to provide a new method to harmonize these different distributions.[10]

Sampling and non-sampling errors apply to surveys. Sampling error refers to problems that arise purely out of the limited sample size of survey data. Low sample sizes affect the variance of estimates, which means they may vary a lot around their expected value. But low sample sizes may also create biases, especially when measuring inequality at the top of the distribution (Taleb and Douady, 2015). Estimates based on raw survey data do not account for any of these biases and therefore tend to underestimate incomes at the top end. Non-sampling error refers to the systematic biases that affect survey estimates in a way that is not directly affected by the sample size. These mostly include people refusing to answer surveys and misreporting their income in ways that are not observed, and therefore not corrected, by the survey producers.

The general methodology we introduce in this paper aims at correcting all three biases. We correct conceptual discrepancies by training a machine learning algorithm (Chen and Guestrin, 2016) that systematically analyzes how they affect estimates of the income distribution. We correct for non-sampling error in survey data by combining them with harmonized top income shares using a nonlinear survey calibration method (Deville and Särndal, 1992; Lesage, 2009). And we correct for sampling error by modeling the top tail of the income distribution based on extreme value theory (Ferreira and Haan, 2006). We view this methodology as a consistent and straightforward framework to exploit all published survey and tax information, while correcting for the weaknesses of these different sources. We feed to our methodology virtually all the data available and obtain estimates of inequality in Europe that reflect latest data and methodological developments.

2.3.1 How we correct conceptual discrepancies between survey data

The first step of our methodology consists in harmonizing surveys for which we are unable to recover directly the distribution of pre-tax and post-tax incomes among equal-split adults. This is the case of all survey tabulations, as well as some surveys for which we have microdata but for which pre-tax income or post-tax income was not measured. For these data sources, we have to develop a strategy to transform the distribution of the observed "source concept" (such as consumption per capita or pre-tax income among households, for instance) into an imputed distribution measured in a "target concept" (pre-tax or post-tax income per adult).

The distributions for the different income concepts across country-years are correlated: therefore,

[10] Previous studies on European or global income distributions typically relied on a combination of non-harmonized income and consumption sources, see for instance Lakner and Milanovic (2016).

we can use the distribution for one income concept to impute the distribution for another whenever the former is observed but not the latter. To do so, we use all the cases where the income distribution is simultaneously observed for two different concepts to learn how one tends to relate to another. In practice, we use survey microdata (EU-SILC, LIS and ECHP) to compute distributions for all equivalence scales and all income concepts available in a given country-year. We then use these estimates — as well as survey tabulations observed in similar country-years but measured using different concepts — to model how different income concepts and population units relate to one another at different points of the distribution.

To clarify this idea, we can first consider a straightforward, but naive approach. We can observe the p-th quantile of both the source and the target distributions for a variety of countries i and a variety of years t: write them $Q_{it}^{\text{target}}(p)$ and $Q_{it}^{\text{source}}(p)$. Therefore, we can estimate the average ratio between the two distributions for each percentile as $\alpha(p) = \mathbb{E}[Q_{it}^{\text{target}}(p)/Q_{it}^{\text{source}}(p)]$. Say that for a country j in year s, we only observe the source concept $Q_{js}^{\text{source}}(p)$. Then we can approximate the target concept as $Q_{js}^{\text{target}}(p) = \alpha(p)Q_{js}^{\text{source}}(p)$. While this remains an approximation, it at least corrects for some systematic discrepancies that we can observe in the data.

That approach has the merit of simplicity. When we tried it with our data, it gave passable results. But there are several problems with it, both in theory and in practice. The main issue is that it makes a very restrictive assumption about the way different income concepts may relate to one another: it considers that the sole predictor of, say, the 25th percentile of income for equal-split adults is the 25th percentile of income for households. Furthermore, it assumes that the relationship is entirely linear. There is no good theoretical reason for any of that to be true: a better, more general model would allow that 25th percentile of the target distribution to depend on any percentile of the source distribution, including but not limited to the 25th. It would also allow these relationships to be nonlinear and potentially with interactions. That relationship could also depend on auxiliary variables Z_{it} capturing demographic, political and institutional factors. The simple approach also cannot ensure that the estimated distribution for the target concept will be increasing, which creates problems that have to be dealt with in an *ad hoc* way (e.g. by re-ranking percentiles) and imply inefficient use of information. This in particularly true for the bottom of the distribution for which incomes can be close to zero and the ratios may therefore be very unstable.

Therefore, to construct the best mappings between the different concepts, we consider a much more general model. In that model, each percentile of the target distribution is an arbitrary function of every percentile of the source distribution, and of additional covariates. We write:

$$\mathbb{E}[Q_{it}^{\text{target}}(p)] = \varphi(Q_{it}^{\text{source}}(p_1), \ldots, Q_{it}^{\text{source}}(p_m), p, t, Z_{it})$$

for a grid $0 \leq p_1 < \cdots < p_m < 1$ of fractiles. Estimating such a model raises some challenges. Linear regression will not be flexible enough due to its parametric assumptions and will tend to overfit the data if m is large due to the number of covariates.

To estimate this model, we therefore rely on more recent advances in high-dimensional, nonparametric regression, also known as *machine learning* methods. The algorithm we use is known as *boosted regression trees*, a powerful and commonly used method introduced by Friedman (2001). We rely on an implementation known as XGBoost (Chen and Guestrin, 2016), which has enjoyed great success due to its speed and performance, to the point that is has earned a reputation for "winning every machine learning competition" (Nielsen, 2016). On top of their performance, boosted regression makes it easy to deal with missing values, or to impose certain constraints, such as the fact that the quantile function $Q(p)$ must be increasing with p.

The algorithm starts from regression trees, a fast and simple nonlinear prediction method that successively cuts the space of predictors into two subspaces in which the predicted variable has lower variance. This leads to a "tree" of simple decision rules based on the value of the predictors. Following these rules the algorithm places any observation into a subspace where the predictor should have a relatively low variance, and the predicted value for that observation is the average of the predictor within that subspace.

Regression trees provide predictions that are simple, but rough. "Boosting" is a method that combines many of these simple but low accuracy prediction methods into a high-accuracy one. It starts by estimating a regression tree. It then runs a second regression tree to predict the residual from the previous regression: this is called a "boosting round." The process is repeated several times: each round of boosting forces the algorithm to concentrate on the part of the data where the previous predictions failed. In the end, all the regression trees are combined into a single prediction.

The appropriate number of boosting rounds is determined by cross-validation: the sample is divided into K subsamples. For each subsample, we train the algorithm on the data excluding the subsample, and we test the prediction on the excluded subsample: we use the number of boosting rounds for which the cross-validation prediction error is lowest. By excluding the sample on which we perform the prediction, we make sure to avoid overfitting to the data on which we estimate the model.

Since our dataset is made up of countries that we follow over the years, it has a panel dimension, which we take into account as follows. We assume that the country-specific prediction error is independent conditional on all observed variables (i.e. that it is a *random* rather than a *fixed* effect.) Under that assumption, the imputation method remains valid because the error term remains

exogenous. However, there is a risk of over-fitting if we do not make sure that the different subsamples used in the cross-validation are not independent, because then we would force the algorithm to try to predict the country random effect. To avoid that problem, we perform the cross-validation by making sure that all the observations for one country are in the same cross-validation subsample, which is known as leave-one-cluster-out cross validation (Fang, 2011). When possible, we also estimate and include the country random effect into our imputation. The random effect is estimated as a function of the percentile using the mean prediction error by country and percentile.

In the end, for any target concept of interest, we get as many predictions as there are sources available. Let $\boldsymbol{y} = (\hat{Q}_{it}^{\text{target,1}}, \ldots, \hat{Q}_{it}^{\text{target,n}})'$ the n different predictions. Using the cross-validation estimation of the prediction error, we can estimate the variance-covariance matrix $\boldsymbol{\Sigma}$ between the different predictions. Following the logic of generalized least squares, the optimal way of combining the n predictions into one is to average them, weighted by the row or column sums of the symmetric matrix $\boldsymbol{\Sigma}$. This yields our harmonized estimate of the distribution, taking into account observed regularities across concepts and percentile groups.

In appendix, we provide detailed information on the performance of the method for imputing the different concepts.[11] As table A.10 shows, the mean (cross-validation) prediction error for the value of the average of a percentile is between 2% and 11% depending on the concept that was used for the prediction. Adjusting for the statistical unit while keeping the income concept identical creates the least difficulties. Consumption, on the other hand, is a rather poor predictor of income. Moving from post-tax to pre-tax income is a somewhat intermediary situation. The auxiliary variables that we use to improve the performance of the prediction are the average national income, the share of households with different sizes, the population structure by age and gender, the top tax rates and social expenditures. While the inclusion of these variables has only second-order effects on our harmonized series, they do improve the prediction error by about 15–20%.

2.3.2 How we correct for non-sampling error

We correct survey data for non-sampling error using known top income shares estimated from administrative tax data. We do so by adjusting the survey weights using survey calibration methods (Deville and Särndal, 1992). Statistical institutes already routinely use these methods to ensure

[11] Before training the model, we transform the data using the transform $y \mapsto \text{asinh}(y)$ for the value of the quantiles and $x \mapsto -\log(1-x)$ for the corresponding rank. This stabilizes the mode without changing the nature of the data. The use of asinh rather than the logarithm avoid issues with having zero or near-zero incomes at the bottom of the distribution. All distributions are normalized by their average since we are only concerned with the distribution of income. When we report prediction errors, these are computed for distributions that have been properly transformed back to their original value.

these methods to ensure that their surveys are representative, typically in terms of age and gender. Our approach is a natural extension of theirs, in the sense that we enforce representativity in terms of taxable income in addition to age and gender.

Let $d_1, \ldots, d_n$ be the original survey weights, and let $w_1, \ldots, w_n$ be the corrected survey weights. The objective of survey calibration is to minimize the distortion between the original survey weights and the corrected survey weights:

$$\min_{w_1,\ldots,w_n} \sum_{i=1}^{n} \frac{(d_i - w_i)^2}{d_i}$$

under the constraint that the top shares in the corrected survey are equal to their value in the tax data. However, traditional survey calibration methods only work with constraints that can be written as a linear function of the data (such as a mean or a frequency), which is not the case with top shares.

Lesage (2009) suggested two methods to solve such problems. The first one involves linearizing the top shares using their *influence function*. Informally, the influence measures the marginal contribution of the weight of each observation to the overall statistic. For the case of the top $(1-\alpha) \times 100\%$ share, we show in the technical appendix that it is equal to:

$$z_i = y_i H\left(\frac{\alpha N - W_{i-1}}{w_i}\right) + (\alpha - \mathbb{1}_{y_i < \hat{Q}_\alpha})\hat{Q}_\alpha$$

where y_i is the income of observation i, w_i is the weight of observation i, $\hat{Q}_\alpha$ is the α-quantile of income in the survey, and H is a function such that $H(x) = 0$ if $x < 0$, $H(x) = x$ if $0 \leq x < 1$ and $H(x) = 1$ if $x \geq 1$. As Lesage (2009) explains, it then suffices to impose the linear constraint $\sum_{i=1}^{n} w_i z_i = 0$ in standard calibration methods to approximately enforce, up to a first order approximation, the value of the top income share. Intuitively, the survey calibration performs a trade-off between spreading the adjustment of the weights over as many observations as possible (hence minimizing overall distortion) and concentrating the adjustment on the observations with the largest impact on the top share (hence satisfying the constraint with fewer distortions). The optimum is attained when the marginal penalty of adjusting each observation is equal to their marginal contribution to the constraint, which is given by the influence function. The first-order approximation comes from the fact that the influence of each observation is assumed to be constant.

The second solution of Lesage (2009) involves the introduction of a *nuisance parameter*. For the top $(1-\alpha) \times 100\%$ share, the nuisance parameter is the true value of the α-quantile of income. Given that value, one can apply standard calibration methods to impose the proper number of people and their proper amount of income on both sides of the quantile. The advantage is that this leads

to the constraint being exactly satisfied. But for that method to give acceptable results, we need a good guess for the value of the nuisance parameter. Lesage (2009) suggests using its value in the original survey.

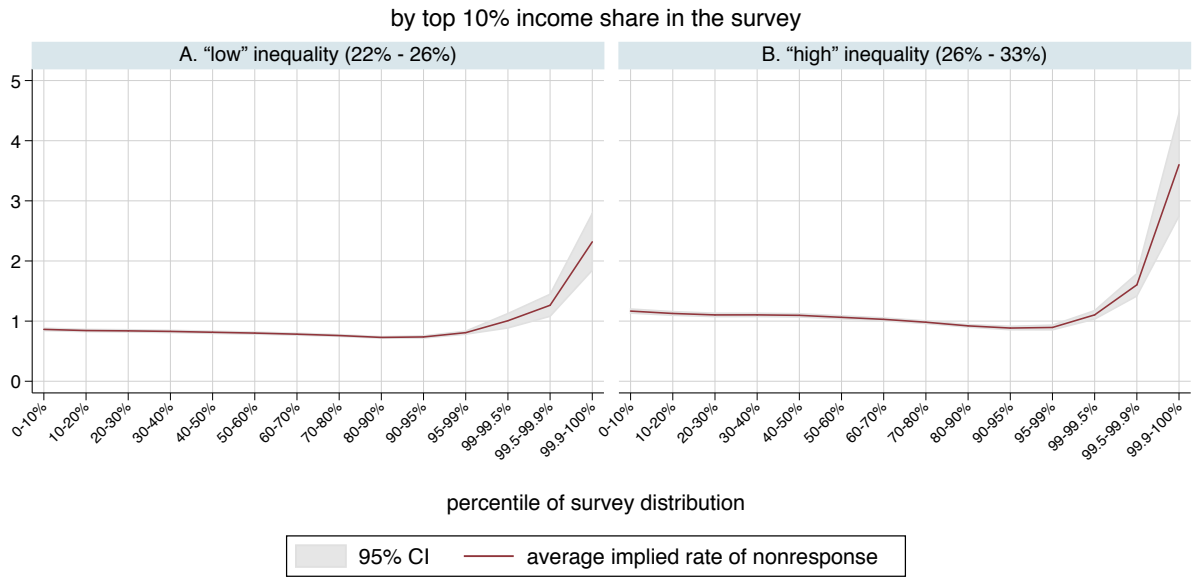
We obtained the best results by combining both methods. In the first step, we use the influence function method. This performs the majority of the required adjustment, but still leaves a small discrepancy between the survey and the tax data. In the second step, we get rid of the remaining discrepancy by applying the second approach, with the nuisance parameter estimated in the survey corrected through the first step.

Statistically, survey calibration can be interpreted as the estimation of a non-response function, in which non-response depends on the variables introduced in the constraints. In that interpretation, we are assuming that nonresponse has the same shape as the influence function for top shares. This shape is that of a continuous, piecewise linear function with a kink at the threshold corresponding to the top share. It is almost flat below that threshold, meaning that the bottom 90% of the distribution is virtually unchanged. Above the threshold, nonresponse increases linearly with income — though we can capture non-linearity of nonresponse at the top by including several top income groups in the calibration, for example top 10%, 5% and 1%. That shape is what we expect if the richest households refuse to answer surveys at a higher rate, and also corresponds to the share of the nonresponse that we observe with access to richer data (Blanchet, Flores, and Morgan, 2018). Because the nonresponse function is continuous, our correction method preserves the continuity of the density function of income.

Figure 3 shows the average estimated nonresponse profile over all the survey and tax data at our disposal. It is mostly flat for most of the distribution, meaning that survey distribution is mostly preserved. But observations in the top 0.1% are underrepresented by a factor of 3 on average. We may also notice certain regularities: nonresponse is higher at the top when there is more inequality in the survey. This is the result of having more wealthy households that are less likely to answer surveys, a fact partially captured by the level of inequality before correction. Given that high-inequality countries have experienced more nonresponse, surveys have a tendency not just to underestimate inequality, but to compress them in cross-country comparisons.

When we do not directly observe tax data in a country, we still perform a correction based on the profile of nonresponse that we observe in other countries. To capture statistical regularities such as the one describe above, we estimate the nonresponse profile as a function of the distribution of income in the uncorrected survey using the same machine learning algorithm as in section 2.3.1. We stress that this remains a rough approximation and that in our view the proper estimation of top income inequality requires access to tax data. Fortunately, our tax data covers a large majority

Figure 3: Average nonresponse profile in survey data



of the European population and an even larger majority of European income, so that the impact of these corrections on our results remain limited.

2.3.3 How we correct for sampling error

The sample size of surveys varies a lot and can sometimes be quite low: this, in itself, can seriously affect estimates of inequality at the top and, in general, will underestimate it (Taleb and Douady, 2015). Correcting sampling error requires some sort of statistical modeling. We chose to use methods coming from extreme value theory, which is routinely used in actuarial sciences to estimate the probability of occurrence of very rare events, but can similarly be used to estimate the distribution of income at the very top.

The main tenet of extreme value theory can be understood in analogy to the central limit theorem. According to the central limit theorem, under some regularity assumptions, but regardless of the exact distribution of iid. variables $X_1, \ldots, X_n$, the distribution of the sum $\sum_{i=1}^{n} X_i$ as n goes to infinity will belong to a tightly parametrized family of distributions (a Gaussian one). Similarly, under mild regularity assumptions, the distribution of the largest value of the sample $\max(X_1, \ldots, X_n)$ as n goes to infinity will belong to a certain parametric family. The same holds for the second-largest value, the third-largest value, and so on. As a result, the top k largest values will approximately

follow a distribution known as the generalized Pareto distribution, which has the cumulative distribution function:

$$F(x) = 1 - \left\{1 + \xi\left(\frac{x-\mu}{\sigma}\right)\right\}^{-1/\xi}$$

That result is known as the Pickands–Balkema–de Haan theorem (e.g. Ferreira and Haan, 2006). The generalized Pareto distribution therefore more or less provides a universal approximation of the distribution of the tails of distributions. It includes the Pareto or the exponential distribution as a special case. We use it to model the top 10% of income distributions. Because the likelihood surface of the generalized Pareto distribution is very flat, maximum likelihood estimation often gives poor results unless the sample size is very large. The standard method of moments also fails if the distribution has infinite variance, which can often occur with income distributions. We use a simple and robust alternative known as probability-weighted moments (Hosking and Wallis, 1987). For X following a generalized Pareto distribution, define $a = \mathbb{E}[X]$ and $b = \mathbb{E}[X(1 - F(x))]$. Then we have $\xi = (a - 4b)/(a - 2b)$ and $\sigma = 2ab/(a - 2b)$, while μ is determined a priori from the threshold from which we start to use the model. We obtain the complete distribution by combining the empirical distribution for the bottom 90% with the generalized Pareto model for the top 10%.

2.3.4 How we harmonize the tax data

As we previously explained, the top income shares based on tax data are not directly comparable due to differences in the income definitions and the unit of analysis (individuals or households). We address that problem by combining the survey with the tax data.

We start by matching the income concept in the survey to the income concept in the tax data as closely as possible: we take into account share of social contributions that are excluded from the tax base, which social insurance benefits are included in the tax base in each country, etc. We perform the survey calibration (see section 2.3.2) using the proper income concept and the proper statistical unit. We therefore make the survey representative of the true population in terms of taxable income. Once we have this corrected survey, we compute the income distributions in the survey for our concepts of interest (pre and post-tax income for equal-split adults).

That correction of the tax data affects the inequality levels, but broadly preserves the trends. Before we have access to microdata in a given country, we therefore extrapolate the correction into the past by carrying backward coefficients of correction by percentile between the raw and the corrected tax data.

2.3.5 How we account for additional sources of income

As explained in section 2.2.3, our estimates account for the two main sources of tax-exempt capital income in the economy: imputed rents and the retained earnings of corporations.

The retained earnings of corporations belong to the owners of corporate stock. To distribute them, we therefore assume that the distribution of retained earnings is the same as that of the stock holdings of households. This includes both private and public stocks that are held directly or indirectly through mutual funds and private pension plans. However, we exclude sole proprietorship, since in the national accounts they are not an entity separate from the household to which they belong.

The distribution of stock ownership comes from the Household Finance and Consumption Survey (HFCS), the pan-European wealth survey of the European Central Bank. We calibrate that survey on the top income shares as we do for other surveys to make it representative in terms of income and get consistent results. The HFCS only started around 2013, so before that year we keep the distribution of retained earnings constant and only change the amount of retained earnings to be distributed: this constitutes a reasonable approximation because stock ownership is always already highly concentrated, so that the main impact of retained earnings on inequality comes from changes in their average amount rather than changes in the inequality of stock ownership. After 2013, we use the wave that is closest to the year under consideration. For imputed rents, we use their distribution as recorded in EU-SILC surveys, which we also calibrate on the top income shares. We take the total amount of imputed rents to be distributed from the national accounts. For countries in which the distribution of one of those two components in not observable due to lack of data, we use the average European distribution. Again, this assumption is relatively innocuous because the first-order effect of the impact of these incomes on the distribution comes from their average amount rather than from changes in their distributions.

Then, we distribute both types of income to individuals. In doing so, we aim to preserve the marginal distribution of retained earnings and imputed rents. We also preserve the marginal distributions of pre and post-tax income (excluding retained earnings and imputed rents) previously calculated by combing survey and tax data. And finally we preserve the copula (i.e. the dependency) between pre-tax income (excluding retained earnings and imputed rents) and the additional sources of income. We achieve those goals using the following procedure: we sort all the datasets according to their pre-tax income (excluding retained earnings and imputed rents). When using microdata, we match observations one by one from the lowest to the highest level of pre-tax income. Because the microdata are weighted, the observations must be matched partially with one another. Therefore, when matching a dataset of size n with a dataset of size m, we end up with a dataset of at most

$n + m - 1$ observations. When matching microdata to a distribution that comes from a tabulation, we attribute to each observation the income that corresponds to the average income of the part of the distribution that is represented by the observation in the microdata.

Table A.9 in appendix shows how these incomes are distributed in the different countries. On the one hand, the top 10% of the distribution of income (before imputed rents and retained earnings) owns generally between 15% and 20% of imputed rents. This is generally less than their corresponding share of income, therefore imputed rents have a somewhat equalizing impact on the distribution if income. One the other hand, between 40% and 60% of the retained earnings of corporations accrues to the same group of people. That is usually more than their corresponding share of income, therefore accounting for the retained earnings of corporations increases inequality.

3 Results

Combining surveys, tax data and national accounts with our harmonized methodology gives rise to a new dataset on pre-tax and post-tax income inequalities in Europe from 1980 to 2017. Distributional national accounts, in particular, allow us to adopt EU-wide or European-wide perspectives, decomposing the relative roles played by between-country and within-country inequalities. In this section, we present some stylized facts on the evolution of European income inequality. Section 3.1 briefly reassesses the question of convergence in per adult national incomes in Europe. We then turn to the description of inequality trends within countries (section 3.2), before looking at the evolution of income inequality in Europe as a whole (section 3.3). Section 3.4 studies how taxes and transfers reduce inequalities in Europe. Section 3.5 compares the evolution of income inequality in Europe to that observed in the United States since 1980.

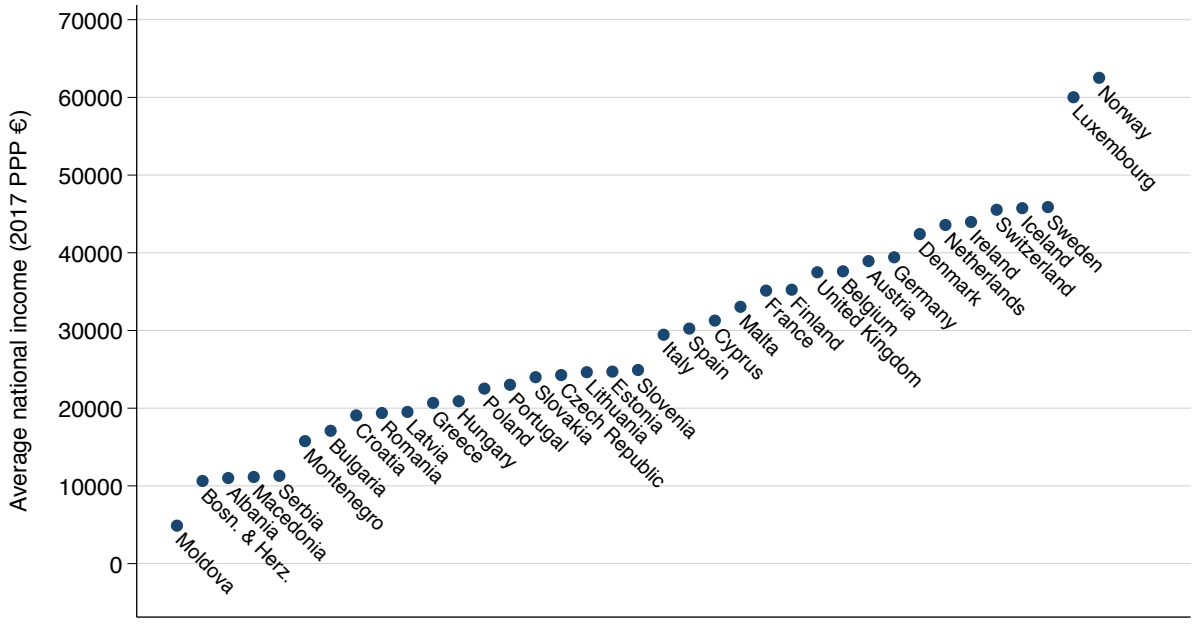
3.1 Inequalities between European countries

Before looking at inequalities within European countries and within wider regional entities (such as the European Union), it is worth having in mind how differences in countries' average national incomes have evolved between 1980 and 2017. As new countries joined the EU and further political integration was enhanced by policy makers in the 1990s and 2000s, convergence in standards of living gradually became part of the European Union agenda, along with the harmonization of economic policies. One of the explicit objectives of European integration, in particular, was to reduce average income gaps between EU Member States. The Lisbon Treaty, one of the legal basis of the EU, states that "the EU shall promote economic, social and territorial cohesion, and solidarity among Member States."[12]

In 2017, important differences in standards of living between European countries were visible, but relatively homogeneous levels among the largest member states of the European Union (figure 4). In most of the Balkan countries, per adult national incomes were below €15,000, while Southern and other Eastern European countries earned between €15,000 and €30,000. In most other EU countries, incomes ranged between €30,000 and €45,000. Luxembourg and Norway, finally, stood out with average national incomes higher than €60,000. Based on these differences as well as geographical proximities, we propose to divide Europe into four broad regions in the rest of this

[12] Article 3 of the Lisbon Treaty. Inequality reduction between Member States is also made clear in the Treaty on the Functioning of the European Union. Article 174, for instance, states that "the Union shall aim at reducing disparities between the levels of development of the various regions and the backwardness of the least favored regions."

Figure 4: Average national incomes of European countries, 2017

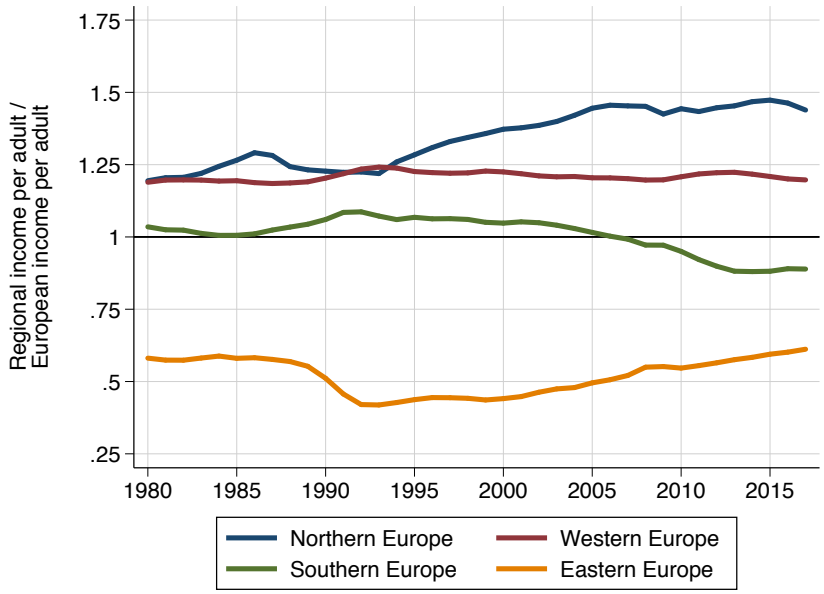


Source: World Inequality Database.

paper: Northern Europe, Western Europe, Southern Europe and Eastern Europe. Northern Europe includes Nordic countries spanning from Denmark to Iceland. Southern Europe includes Italy, Spain, Portugal, Greece, Cyprus and Malta. Eastern Europe includes other countries located east from Austria, and Western Europe encompasses the remaining countries (see table A.2 for a full list of these countries and the evolution of their national incomes per adult).

Regional growth trajectories in the past forty years do not show a rapid equalization of absolute income levels (figure 5). In Eastern Europe, sustained economic growth since the early 2000s has succeeded in bringing back the income levels that existed during the communist era and which dramatically fell after the dislocation of the USSR, but Eastern European citizens still earn about 40% less than the average European. Meanwhile, the financial and debt crises which strongly hit Portugal, Italy, Greece and Spain contributed to reducing the income levels of residents of Southern Europe in relative terms. Finally, while Western European nations have steadily been characterized by national incomes higher by 25% on average, Scandinavian countries have consolidated their positions at the top of the European distribution, experiencing high growth rates since the mid-1990s.

Figure 5: Average national incomes of European regions relative to average, 1980-2017



Source: authors' computations using data from the World Inequality Database. *Interpretation*: between 1980 and 2017, the average income of a Western European citizen remained about 20% higher than that of an average European.

Looking more precisely at country-specific trajectories reveals a relatively complex picture, with no sign of long-run monotonic convergence. Between 1980 and 1989, national income growth was slightly higher in countries with standards of living closer to the European average – such as Finland, the United Kingdom, Slovenia and Sweden –, while the rest of Europe saw annual growth rates of about 1% throughout the decade (table A.4). Following the disintegration of the Soviet Union, former communist countries characterized by lower standards of living than Western European nations experienced strong recessions, mirrored by negative growth rates (-1.7% per year on average) for the poorest 10% countries of the old continent. The 2000-2007 period, on the other hand, came with restored stability and revived economic growth for Central and Eastern European countries, which led to a moderate reduction in between-country inequalities. Finally, the fact that Spain, Italy, Portugal and Greece were strongly affected by the 2007-2008 crisis translated into negative growth rates at the middle of the European distribution during this period.

The analysis of income inequalities between countries therefore points to the importance of both macro-historical events and country-specific trajectories. The economic downturns in Eastern Europe which followed the collapse of the USSR, as well as macroeconomic imbalances exacerbated

in Western Europe since 2008 have strongly affected national and regional growth trajectories. Yet, because European countries have been affected very differently by these crises, their overall effect on income differences between nations has remained unclear.

Did European integration contribute to decreasing inequality between member States? Unsurprisingly, European integration in itself has been associated with a gradual *widening* of income differences between EU members. This is the mechanical consequence of an integration process in which new member States have increasingly more diverse income levels. The integration of Spain and Portugal in 1986, both slightly poorer than EU-10 members, as well as the inclusion of Sweden and Finland in 1995 led to a slight increase in between-country inequalities at the EU level. As former communist countries joined the European community in 2004, 2007 and 2013, these differences became even wider. Thanks to new access to the common market, technological catch-up, economic reforms and EU cohesion policies, however, it is expected that new Member States catch up with the rest of the EU. Figure 6 shows that income growth rates of Eastern European countries which joined the EU after 2004 grew at a much faster rate than EU-15 countries.

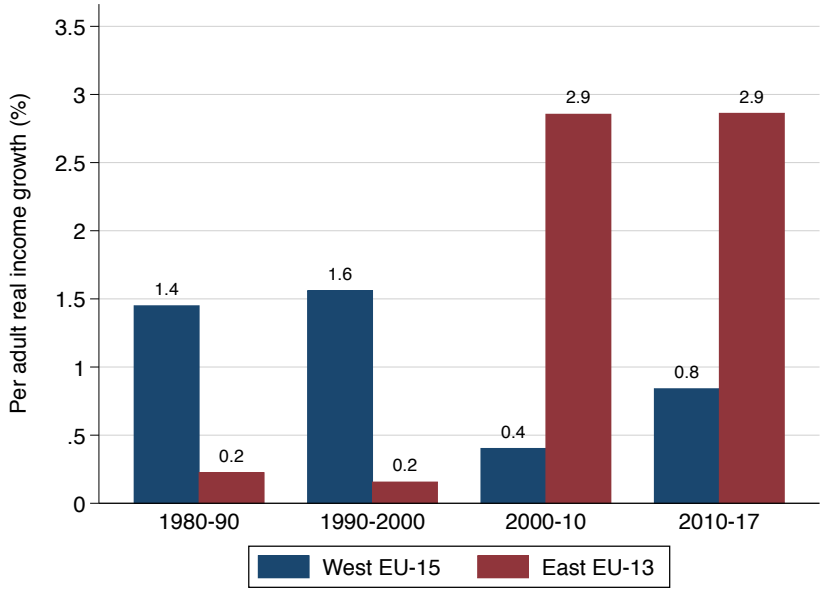
This picture should, however, be interpreted cautiously. First, despite significantly higher growth rates, income levels in Eastern European countries remain significantly below that of EU-15 countries and at a relatively similar level to that of the early 1980s, before the collapse of Eastern European economies (see figure A.2).[13] Second, since 2008, the growth differential between EU-15 and Eastern European Union countries is partly due to sluggish post-crisis growth in the EU-15. A large part of the high Eastern European growth is also related to economic recovery after the collapse of Eastern European economies in the early 1990s (up to the late 2000s, non-EU Eastern countries also caught up rapidly with EU-15 members).

On the issue of budget transfers between rich and poor EU countries, we observe that contributions to the EU budget are unsurprisingly favorable to new Member States (see figure A.1): Lithuania, Latvia or Bulgaria receive as much as 2-3% of their GDP in EU transfers, while rich countries can give up to 0.2-0.3% (France, Austria or Germany for instance) of their GDP to the EU budget. Such transfers, however, need to be analyzed in the broader context of foreign income transfers between EU countries. EU integration made it easier for Western European investors to buy assets in poorer, Eastern European countries. Such investments contribute to Eastern European development but they also generate income flows remunerating the ownership of capital by richer countries. Our new dataset can help better assess the distributional impacts of such investments.

To what extent do these outflows counterbalance EU transfers directed towards Eastern European

[13] In 2017, the average income of Eastern European Union countries was equal to 62% of EU-15 average income. This value was 54% in 1980.

Figure 6: Average annual income growth rate,
EU-15 vs. Eastern enlargement, 1980-2017

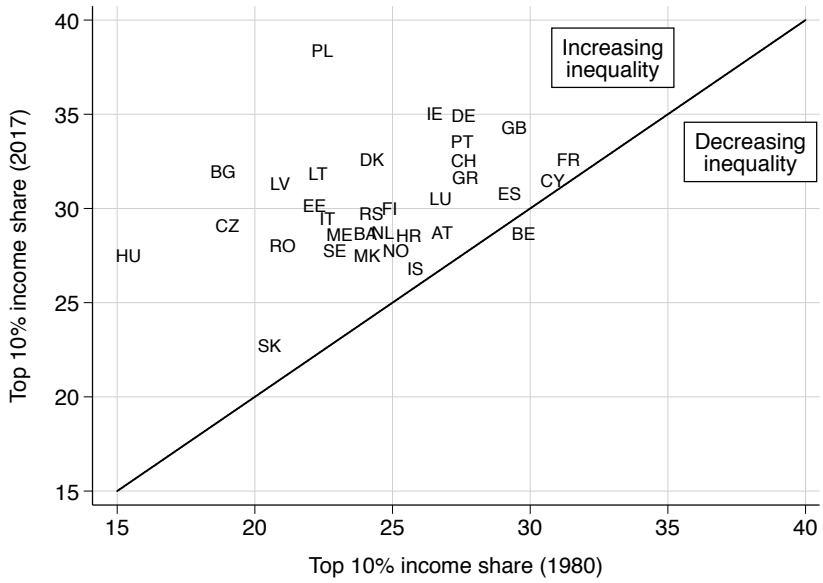


Source: authors' computations using data from the World Inequality Database.

countries? To answer this question, one would ideally rely on bilateral foreign income flows, but such information is not available. Net foreign income flows between countries and the rest of the world yet show interesting patterns. While most net EU budget beneficiaries have negative net foreign incomes (on the order of 3 to 6% of their GDP), net contributors to the EU budget are characterized by consistently positive NFIs (on the order of 2-3% of their GDP). Over the past decade, foreign income positions in most Eastern European have deteriorated, in line with growing foreign capital ownership in these countries. Given the high share of foreign direct investments in Eastern European countries coming from other EU members, it is likely that a relatively important part of outflows from Eastern European countries accrue to Western European nations. If only half of these flows accrued to Western European countries, this would be sufficient to match richer nations' net contributions to the EU budget.[14] Foreign capital flows, such as capital investments from Germany to Poland, are, of course, likely to have contributed to raising general productivity in Eastern Europe. On the other hand, different wage levels and wage-setting institutions could have significant impacts on the level of profits and foreign income flows in these countries.

[14]See EU Commission data for 2010 FDIs within Europe: `https://tinyurl.com/yanz62hl`.

Figure 7: Income inequality dynamics in European countries:
Top 10% national income shares, 1980 versus 2017



Source: authors' computations combining surveys, tax data and national accounts.

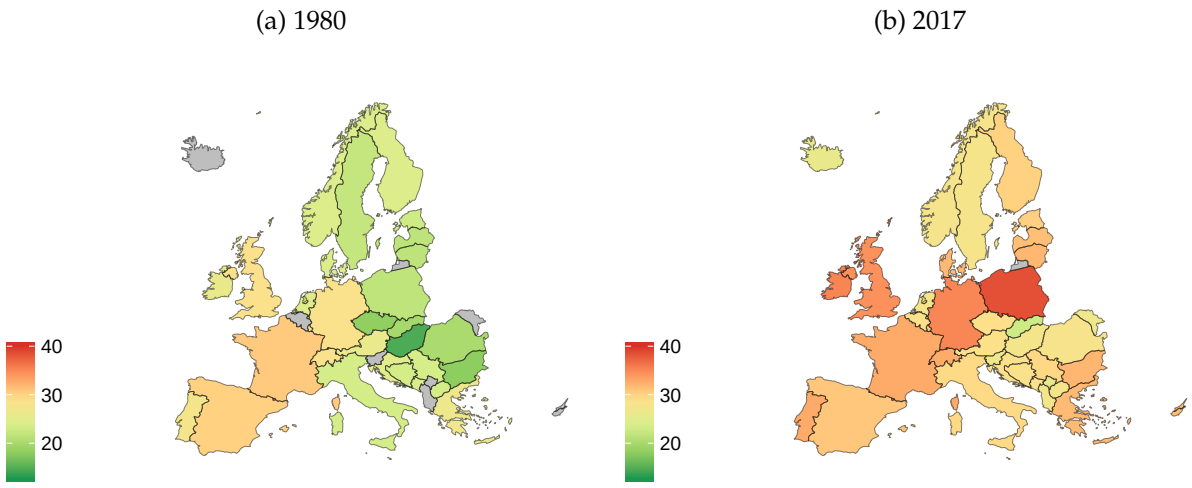
3.2 Inequalities within European countries

We now turn to the analysis of income inequalities within European countries. How did European countries perform in curbing inequality and promoting inclusive growth over the past decades? Beyond country-specific trajectories and short-run dynamics, it is possible to identify a set of stylized facts.

3.2.1 Top income inequality

First, in a large majority countries where data is available since 1980, top earners have captured an increasing share of national income. Figure 7 plots changes in top 10% shares between 1980 (x-axis) and 2017 (y-axis). Nearly all points lie to the left of the 45-degree line, implying that in all countries (except Belgium), top 10% shares have increased over the period. The figure yet also reveals significant differences in national trajectories. In countries closer to the 45-degree line such as France, Iceland or Spain, inequalities have only increased moderately. In Bulgaria, Poland or Ireland, on the other hand, top 10% income shares have increased much more.

Figure 8: Top 10% income shares in European countries, 1980-2017



Source: authors' computations combining surveys, tax data and national accounts.

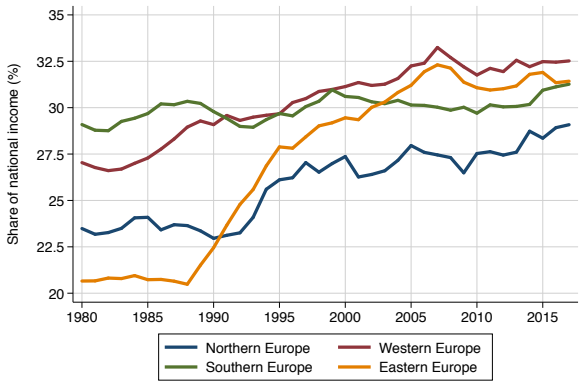
Figure 8 maps these evolutions. In 1980, income disparities were generally higher in Western Europe than in Scandinavia and Eastern Europe. This gap increased between 1980 and 1990 as inequalities rose in Spain, Portugal, Germany and the United Kingdom. The 1990-2000 period, by contrast, coincides with rapidly increasing top income inequality in Norway, Sweden, Finland and in Eastern European countries following the disintegration of the Soviet bloc.

If one looks more precisely at average inequality levels among European regions, differences in trajectories between our four regions of interest are identifiable (figures 9a and 9b). Top 10% income shares in Southern Europe were slightly higher than in other regions in the 1980s, but increased less – income gaps widened in Portugal and Italy, for instance, but remained stable in Spain. In Northern Europe and Western Europe, on the other hand, inequalities have increased more linearly. Eastern Europe is finally the area where inequalities have risen the most, especially at the top of the distribution during the 1990s and the early 2000s, as Eastern European countries transitioned from communism to capitalism.[15] Today, pre-tax income inequality remains, on average, slightly lower in Northern Europe than in other regions of the continent, even if these differences should not be exaggerated.

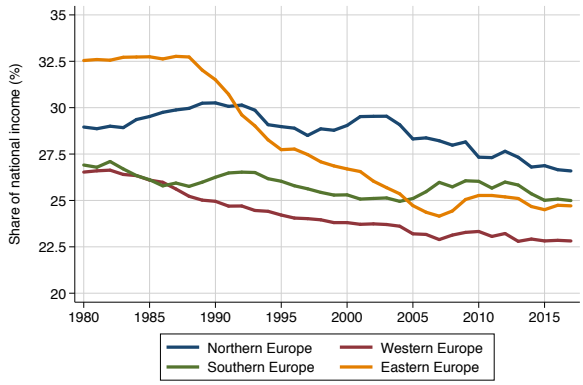
[15]It is important to stress here that we focus solely on monetary income inequality, which was unusually low in Russia and Eastern Europe under communism. Other forms of inequality prevalent at the time, in terms of access to public services or consumption of other forms of in-kind benefits, may have enabled local elites to enjoy much higher standards of living than what their income levels suggest.

Figure 9: Income inequality in European regions, 1980-2017:
top 10% versus bottom 50% average income shares

(a) Top 10% average income share



(b) Bottom 50% average income share



Source: authors' computations combining surveys, tax data and national accounts. Figures correspond to population-weighed country averages in the regions considered.

The growth trajectories of different income groups reveal that inequalities in European regions have mainly risen at the top of the distribution (table 1). Top 0.001% earners in Southern and Western European countries experienced annual growth rates above 3% on average, while the economies of these two regions grew by about 1% every year. In Eastern European countries, top earners captured an even greater share of national income growth: the average income of the top 0.001% rose on average more than ten times faster than that of the bottom 50%.

While common trends are visible in broad European regions, there are also country-specific trajectories (figure 10). Germany, France and the United Kingdom, who together represent 80% of the adult population of Western Europe in 2017, all witnessed increasing inequalities at the top of the distribution. In the United Kingdom, the top 10% share increased from 1980 to the 2007-2008 crisis, while it mainly rose in Germany in the 2000s and remained more stable in France over the period. Variations are also visible in Southern Europe and Scandinavia. Differences in standards of living between residents grew rapidly in Portugal and Italy, while they remained approximately stable in Spain. In Northern Europe, income inequality increased mainly during the 1990s, except in Denmark where inequality rose after the 2007-2008 crisis.

Eastern Europe, finally, is clearly the region where inequalities within countries have risen most. Poland, the Czech Republic, Hungary, Romania and Bulgaria all went through important political and structural economic changes in the 1990s as they transitioned to market economies. At the beginning of the 1980s, Eastern European countries were among the least unequal of the continent;

Table 1: Income growth and inequality in European regions, 1980-2017

	Average annual income growth rate, 1980-2017 (%)			
	Western Europe	Southern Europe	Northern Europe	Eastern Europe
Bottom 50%	0.6 %	0.9 %	1.4 %	0.6 %
Middle 40%	0.9 %	1.1 %	1.4 %	1.1 %
Top 10%	1.4 %	1.3 %	2.2 %	2.5 %
incl. Top 1%	2.0 %	1.7 %	3.1 %	3.8 %
incl. Top 0.1%	2.4 %	2.2 %	4.0 %	5.0 %
incl. Top 0.01%	2.7 %	2.7 %	4.8 %	6.2 %
incl. Top 0.001%	3.0 %	3.2 %	5.5 %	7.5 %
Full population	1.0 %	1.1 %	1.6 %	1.3 %

Source: authors' computations combining surveys, tax data and national accounts. Figures correspond to population-weighted averages of growth rates in the regions considered.

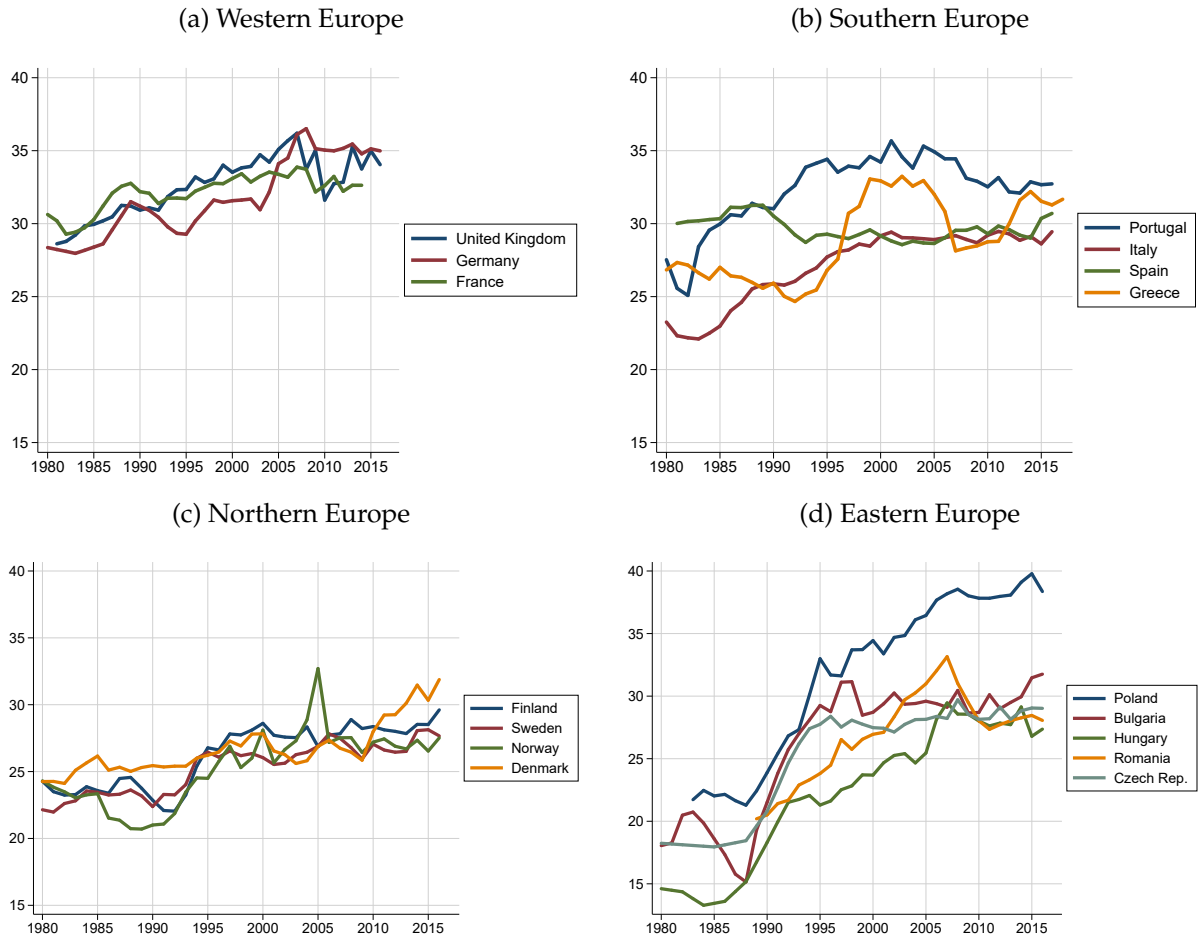
by 2000, they had caught up with Southern European inequality levels. Poland is the country where income disparities rose most, in part because they continued to rise in the 2000s and 2010s while they more or less stabilized in the rest of the region. In 2017, top 10% Polish earners received 40% of national income, more than any of their counterparts in other European countries.

3.2.2 Poverty

Our dataset does not only allow us to look at broad groups of the income distribution; it also provides detailed information on low-income individuals. Since the beginning of the 2000s and the implementation of the European Statistics on Income and Living Conditions (EU-SILC), the evolution of poverty in the European Union has been regularly documented and analyzed. Based on EU-SILC data, in particular, Eurostat provides yearly information on poverty in EU countries, focusing on the at-risk-of-poverty rate – the share of individuals living with below 60% of the national median equivalised disposable income.[16] One of the contributions of this paper is to provide detailed data going back further in time: by harmonizing survey tabulations and microdata for all European countries since 1980, it becomes possible to look at how poverty has evolved in the long-run. The low quality of data sources covering the bottom of the distribution in some countries prevents us from studying short-run trends with great precision, but we are still able to identify

[16]See for instance `https://ec.europa.eu/eurostat/statistics-explained/index.php/Income_poverty_statistics#At-risk-of-poverty_rate_and_threshold`. Notice that the poverty rates we obtain are slightly different from the official rates provided by Eurostat since the latter uses the OECD modified equivalence scale. By contrast, we divide income equally among adult members of the household.

Figure 10: Top 10% income shares in selected European countries, 1980-2017

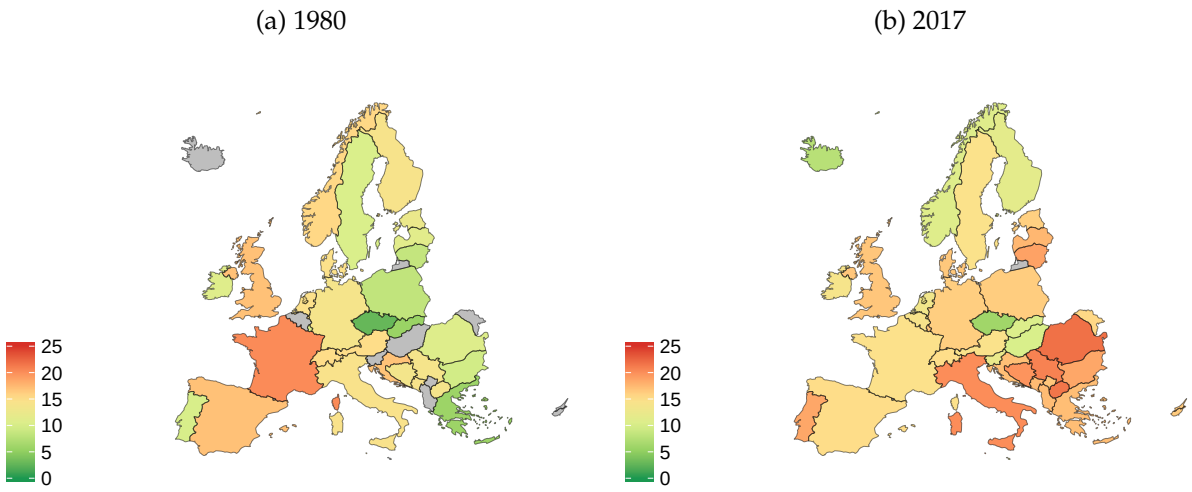


Source: authors' computations combining surveys, tax data and national accounts.

key evolutions.

Between 1980 and 2017, poverty has remained stable or risen in a majority of European countries (figure 11). In 1980, more than 10% of citizens in most Western European countries lived with less than 60% of the national median income. By contrast, Baltic countries and other Eastern European nations were characterized by very low relative poverty. Thirty-seven years later, these differences have almost been completely reversed: Romania, Bulgaria and Balkan countries now stand out as the countries with highest poverty rates. There are exceptions to this pattern: the at-risk-of-poverty rate decreased significantly in France and rose only moderately in the Czech Republic, making the latter the European nation with the lowest share of poor adults in 2017.

Figure 11: At-risk-of-poverty rates in European countries, 1980-2017



Source: authors' computations combining surveys, tax data and national accounts.

To what extent are poverty and top income inequality linked? Theoretically, there is no mechanical relationship between the poverty rate and top income shares: multiplying the average income of the top 1% or the top 10% leaves relative poverty unchanged since the shares of national income accruing to median earners and individuals at risk of poverty decrease proportionally. Comparing figures 8 and 11 suggests a weakly positive relationship between top 10% income shares and relative poverty. Scandinavian countries have both low poverty and low inequality, while the United Kingdom, Germany, Bulgaria or Greece rank high in both indicators. There are however interesting exceptions. Poverty in France is among the lowest across the continent but top income inequality remains high. On the contrary, top incomes remain relatively low in Italy but poverty was the highest among Southern and Western European countries in 2017. Understanding these specificities is beyond the objective of this paper. They are likely to reflect, among other things, divergent historical trajectories in education systems, taxation regimes and the construction of the welfare state, which we hope our dataset can contribute to apprehending in future work.

3.2.3 Inclusive growth

We conclude this section by looking at countries' relative performances in promoting inclusive growth since 1980. We use two simple indicators. First, our aim is to shed light on countries' performances in reaching the United Nations' Sustainable Development Goal 10.1, adopted in 2015, which aims to "progressively achieve and sustain income growth of the bottom 40 percent of

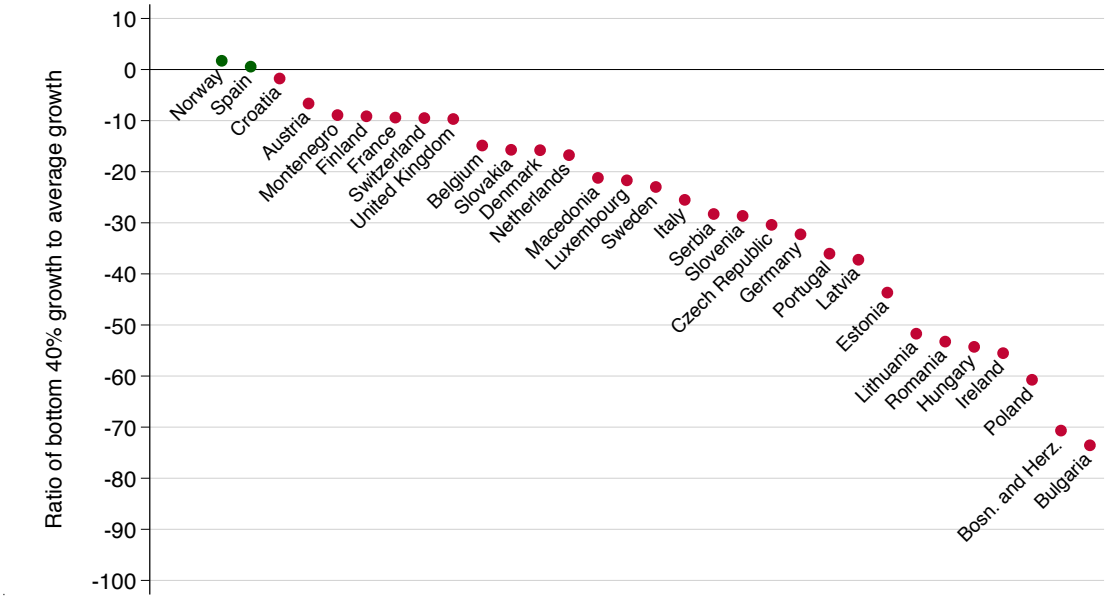
the population at a rate higher than the national average".[17] A simple statistic which adequately measures whether a country met this target is the difference between bottom 40% earners' total income growth and the total growth of the average national income per adult over a given period of time. One limit of this indicator, however, is that it tends to focus on the bottom of the distribution. In particular, it could potentially disguise rising inequalities at the top of the distribution or a squeezed middle class. Looking at another indicator, such as the difference between the growth rates of the top 10% and the bottom 50%, can therefore provide a complementary picture to the official UN inequality target.

Our main finding is that most European countries have failed to reduce inequalities at the bottom of the distribution in the past forty years. Figure 12 ranks countries by our first indicator of interest, measured over the 1980-2017 period. In a majority of European nations for which data is available, the average income of bottom 40% earners grew at a significantly lower rate than the average national income. Norway and Spain stand out as the only countries in which the target was achieved: the bottom 40% experienced very slightly higher growth rates than the rest of the economy. In all other European nations, especially in Eastern Europe, poorer individuals benefited less from growth than richer citizens did.

Tables A.5 and A.6 in appendix provide more detailed information on our two indicators of interest for five time periods. Two main results are visible. First, there have been no major changes in countries' performances in distributing growth to the bottom of the distribution. In all decades of the late twentieth and early twenty-first centuries, in a majority of European nations, economic growth benefited more top earners than poorest citizens. The second key fact which appears from these figures is that European countries tend to perform better when looking at the UN's indicator than when accounting for rising inequalities at the top of the distribution. This is a direct corollary to our previous findings: because inequality dynamics in Europe are largely driven by higher income concentration at the very top of the distribution, looking exclusively at poorer individuals can lead to misrepresent countries' performances. If one assesses countries' trajectories by comparing the top 10% to the bottom 50%, in particular, no country appears to have truly achieved inclusive growth. Our results therefore point to the need to complement the UN income inequality target with additional metrics, informing on the evolution of growth in other parts of the distribution.

[17] See `https://www.un.org/sustainabledevelopment/inequality/`.

Figure 12: Difference between bottom 40% growth and average national income growth per adult in European countries, 1980-2017



Source: authors' computations combining surveys, tax data and national accounts.

3.3 Inequalities between European citizens

Having discussed the evolution of income inequality between and within European countries, we now look at income inequality in Europe as a whole. The level and evolution of inequality between European citizens depend upon three factors: the evolution of income inequalities between European countries, the evolution of inequalities within countries, and the relative weights of countries' populations. In this section, we measure European-wide income inequalities at purchasing power parities to account for differences in average costs of living between European countries. When comparing Europe to the US, however, we will adopt market exchange rates estimates to make results between the two regions more comparable – since PPP conversion factors exist for European countries but not for US states.

Income differences between European residents have increased in the past forty years (figure 13). Top 10% earners in Europe received 29% of total regional income in 1980, while the bottom 50% received 24%. In 2017, by contrast, the top 10% share had risen to 34%, while 20% total income accrued to the poorest half of the population. In line with our previous findings, it appears that

Figure 13: Income inequality in Europe, 1980-2017:
Top 10% vs. bottom 50% income shares

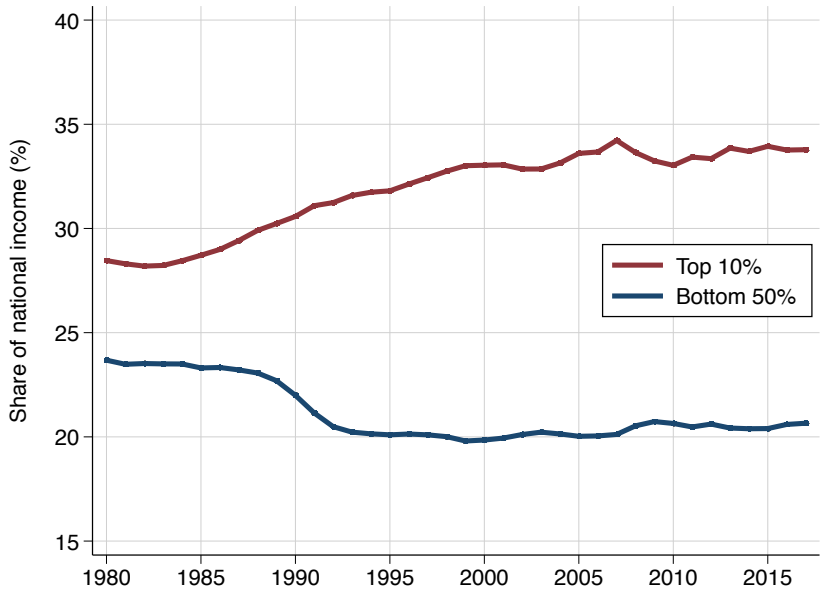
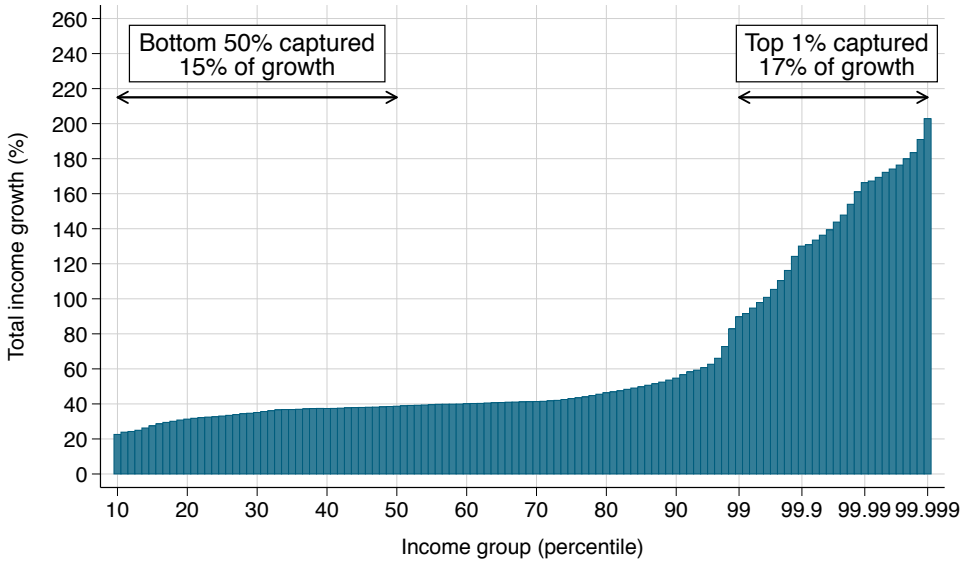


Figure 14: Income inequality in Europe, 1980-2017:
Growth incidence curve



Source: authors' computations combining surveys, tax data and national accounts.

Table 2: Income growth and inequality in Europe, 1980-2017

	Average annual income growth rate (%)				
	1980-2017	1980-1990	1990-2000	2000-2007	2007-2017
Bottom 50%	0.8 %	0.5 %	0.3 %	1.8 %	0.6 %
Middle 40%	1.0 %	1.2 %	1.3 %	1.2 %	0.4 %
Top 10%	1.6 %	2.0 %	2.1 %	2.2 %	0.3 %
incl. Top 1%	2.2 %	2.8 %	2.9 %	3.2 %	0.1 %
incl. Top 0.1%	2.6 %	3.7 %	3.4 %	4.0 %	-0.2 %
incl. Top 0.01%	2.9 %	4.9 %	3.2 %	4.6 %	-0.5 %
incl. Top 0.001%	3.0 %	5.6 %	2.8 %	5.5 %	-0.9 %
Full population	1.1 %	1.3 %	1.4 %	1.6 %	0.4 %

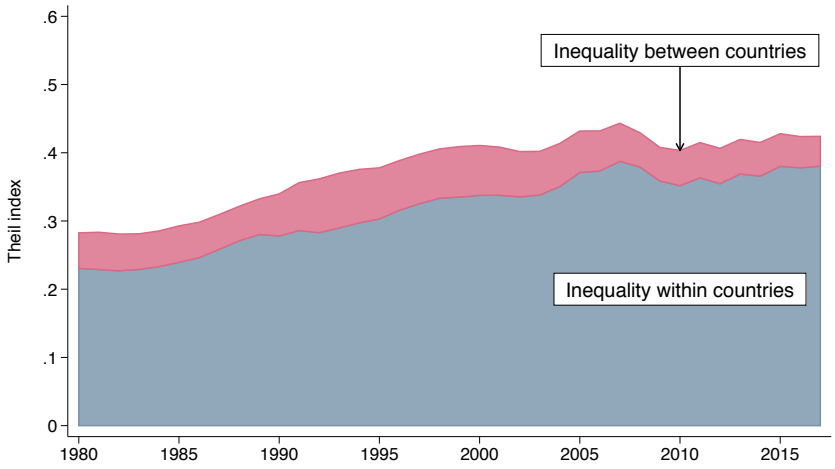
Source: authors' computations combining surveys, tax data and national accounts.

changes in the income distribution mostly occurred during the last two decades of the twentieth century. As top income inequality increased in most countries of Western Europe and Scandinavia between 1980 and 2000, the richest decile captured an increasing share of the continent's growth, before more of less stagnating since then. By contrast, the bottom 50% share decreased more suddenly in the early 1990s due to the combination of strong recessions and rising inequalities at the top in Eastern Europe. These two movements have driven most of variations in income inequality in Europe. Perhaps surprisingly, the 2008 crisis has not led to major changes in the distribution of pre-tax incomes: even if the top 10% share decreased very slightly between 2007 and 2010, it remained remarkably stable in all following years.

Long-run trends in Europe reveal that inequalities have mainly increased at the very top of the income distribution. Figure 14 plots the total growth rates of different income groups over the 1980-2017 period. In the past thirty-seven years, the poorest half of European residents saw their incomes increase by 30 to 40%. The "European middle class" only benefited slightly more from growth than these poorer groups: income earners between percentiles 50 and 90 saw their incomes increase by 40 to 50%. As soon as one looks at groups within the top 10%, however, total growth rates are markedly higher. All income groups among top 0.1% earners saw their earnings grow by more than 100% during our period of interest, and top 0.001% European earners now enjoy standards of living which are about three times higher than what they used to be.

A more careful examination of short-run evolutions reveal important differences between periods. Table 2 provides information on the average annual growth rates of different income groups between 1980 and 2017. Between 1980 and 1990, the average income of bottom 50% earners grew

Figure 15: Income inequality dynamics in Europe, 1980-2017: Theil decomposition



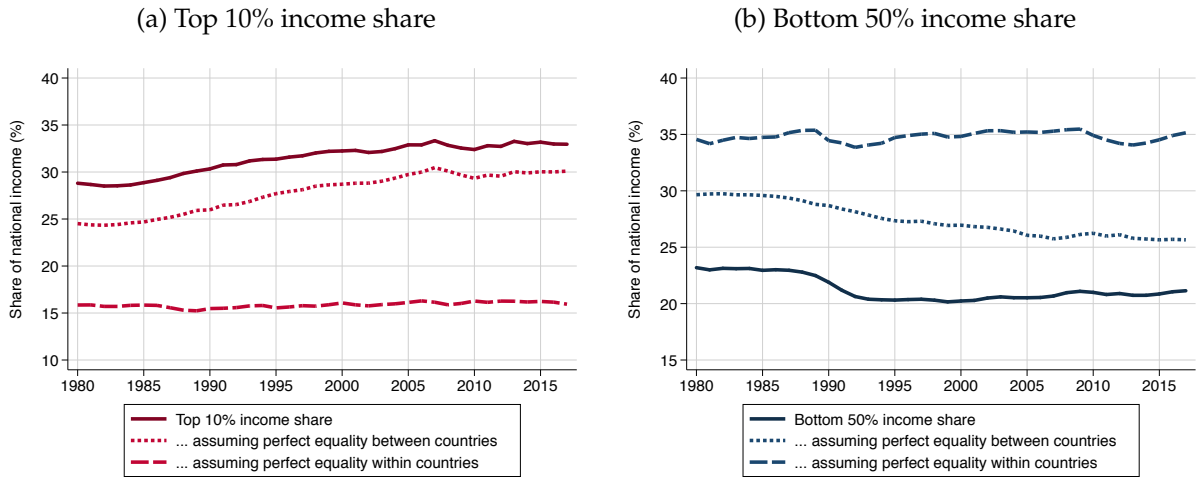
Source: authors' computations combining surveys, tax data and national accounts.

significantly slower than the average income of the top 10%. Similar dynamics were visible in the 1990s. The 2000-2007 and 2007-2017 periods, on the other hand, were associated with stagnating or moderately declining income inequality. Between 2000 and 2007, economic growth was more or less distributionally neutral, except at the very top of the distribution where growth was slightly higher. The 2007-2017 period, finally, benefited significantly more to poorer Europeans: top 1% earners saw their incomes decrease, while the bottom 50% experienced positive average annual growth rates. Yet, very rich groups benefited much more from the last decades of the twentieth century than they were hurt by the 2007-2008 financial crisis. As a result, the income of the top 0.001% rose much faster than that of the poorest half of the population over the entire period.

How important are between-country inequalities compared to within-country income differences in explaining these trends? Figure 15 decomposes the Theil index additively into a between-group and a within-group components. It appears clearly that income inequality within countries explains the largest share of European inequalities over the period. Furthermore, the long-run increase in the Theil index has been entirely driven by rising inequalities within countries: the within-group component rose approximately from 0.3 to 0.4, while the between-group component decreased slightly. Accordingly, the share of overall European inequality explained by inequalities within countries grew significantly.

Another way to decompose between-group and within-group inequalities is to compute counterfactual income shares. Figure 16 shows the potential levels and dynamics of top 10% and bottom

Figure 16: Between- versus within-country inequality decomposition in Europe, 1980-2017: counterfactual income shares



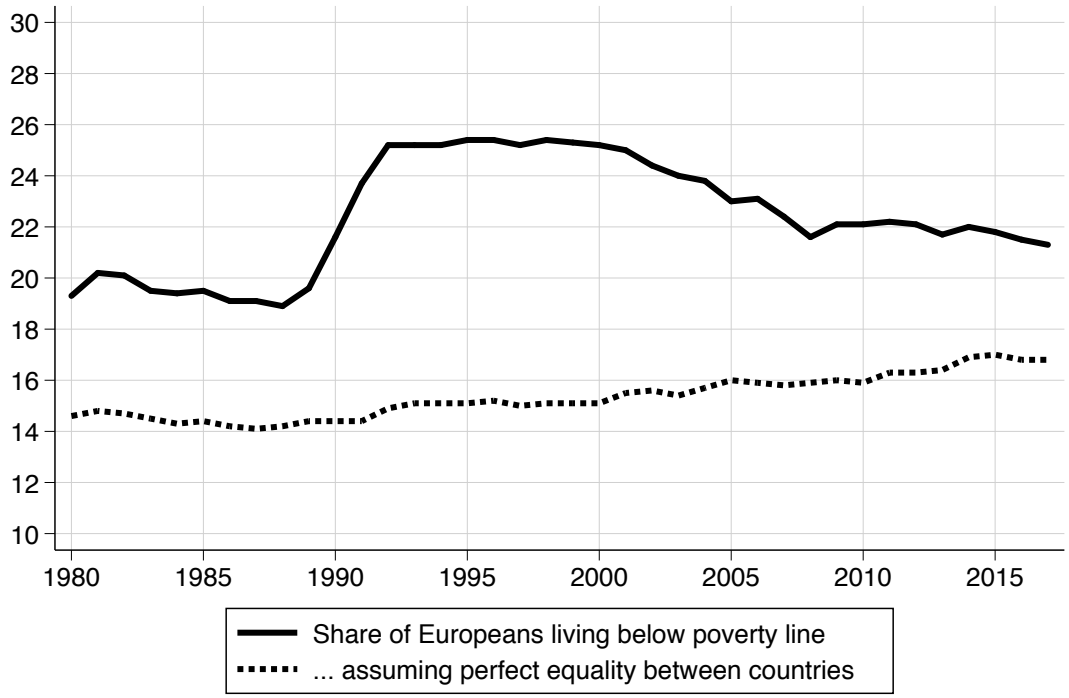
Source: authors' computations combining surveys, tax data and national accounts.

50% income shares under different scenarios. Solid lines represent the true series, dotted lines correspond to the income disparities that would exist if there was no inequality between countries, and dashed lines correspond to those that would prevail if there were no inequalities within countries. Eradicating differences in countries' average national incomes would have a moderate effect on European inequalities: both the top 10% and the bottom 50% shares would change by a few percentage points in all years considered. If all Europeans were to earn the average national income of their country of residence, by contrast, differences in standards of living would be dramatically reduced. The top 10% share would have stagnated at about 15%, while bottom 50% earners would receive more than one third of total income in all years considered.

Figure 17 plots the evolution of the at-risk-of-poverty rate in Europe as a whole between 1980 and 2017, as well as the poverty rate that would prevail if there were no differences in national incomes between European countries.[18] Four periods can be identified. Between 1980 and 1990, about a fifth of the European population lived with less than 60% of the European-wide median income. The Eastern European transitions to capitalism at the beginning of the 1990s, associated with both macroeconomic recessions and higher income inequality, moved six percent of the European population into relative poverty. Between 2000 and 2007, Eastern convergence and the stabilization of inequality levels in a number of European countries led to a progressive reduction of the poverty

[18]The poverty rate "assuming equality within countries" is excluded since it is sensitive to marginal changes in countries moving below or above the continental median income.

Figure 17: At-risk-of-poverty rate in Europe, 1980-2017



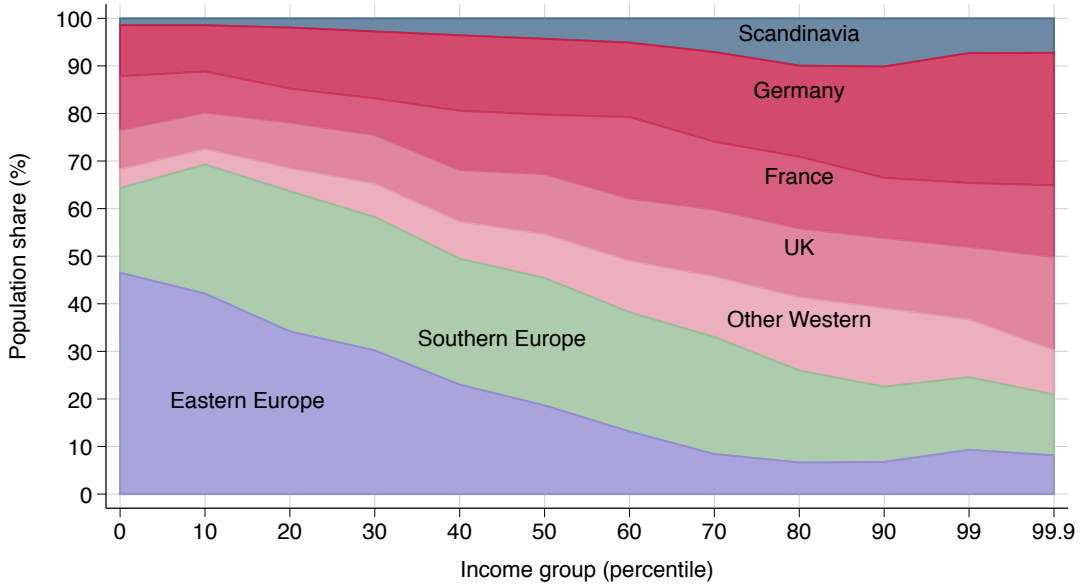
Source: authors' computations combining surveys, tax data and national accounts. The at-risk-of-poverty rate is defined as the share of adults earning less than 60% of the European-wide median post-tax income. Income is split equally among adult members of the household.

rate. Finally, the post-2007 economic crises in Southern Europe and sluggish growth in other European countries have put an end to this short period of poverty reduction, and relative poverty remained stable at about 22% between 2007 and 2017.

Even though inequalities between East and West explain a non-negligible share of short-run trends, macroeconomic convergence has become increasingly insufficient at reducing European poverty. If there were no differences in national incomes between countries, the poverty rate would have increased by about two percentage points, due in particular to rising relative poverty in Eastern European countries and in Southern Europe since the 2007-2008 crisis. In 2017, perfect macroeconomic convergence would have moved only 4% of the European population out of poverty.

Our results thus show that policies based on average income convergence have been insufficient to reduce inequalities between European citizens and will be insufficient in the future. If policy-makers

Figure 18: Geography of European income inequality, 2017

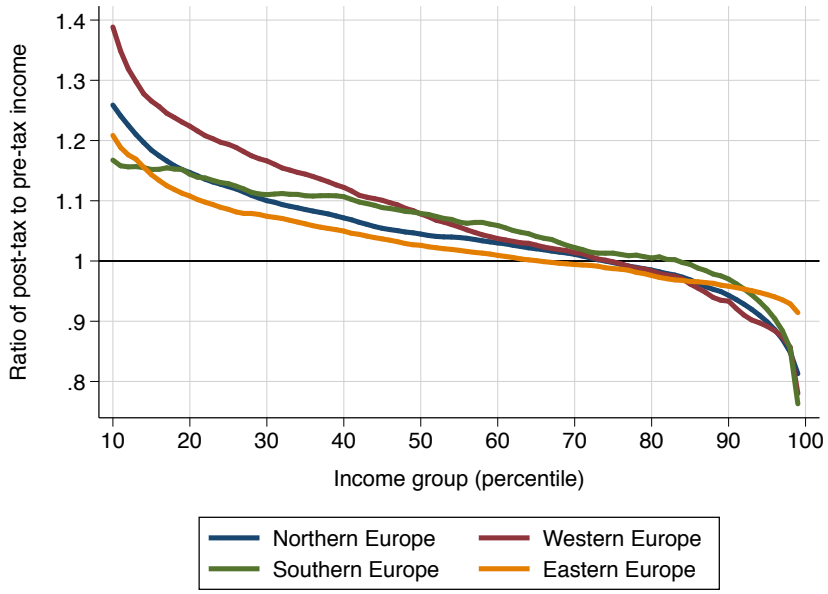


Source: authors' computations combining surveys, tax data and national accounts. *Interpretation*: in 2017, about 40% of individuals belonging to the European bottom 10% lived in Eastern Europe.

in Europe and the European Union aim at fostering equitable growth, there is more potential in reducing inequalities within countries than between countries. Regional programs dedicated to help poorer nations to "catch up", are unlikely to tackle overall inequalities between European residents if they do not take into consideration how growth is distributed at the level of the country. Shifting the relative focus from between-country convergence to within-country convergence is in line with the general objectives set out in the EU Pillar of Social Rights, adopted by the Commission and the European Parliament in 2017.

Our estimates also allow us to decompose geographically different European income groups. Figure 18 provides information on the contribution of main European regions to the overall income distribution in 2017 (see figure A.3 in appendix for other years). Residents of Eastern and Southern Europe have always been more likely to be located at the bottom of the scale, while Western Europeans and Scandinavians are more concentrated at the top. Rising inequalities within countries and diverging growth trajectories have, however, led to important changes. In Southern Europe, the 2007-2008 crisis and higher income inequality in Italy and Portugal have contributed to raising dramatically the number of individuals belonging to the bottom of the distribution. A relatively similar process occurred in Germany, where a significant number of poor individuals

Figure 19: Redistribution in European regions, 2017:
ratio of post-tax to pre-tax income by percentile



Source: authors' computations combining surveys, tax data and national accounts. Figures correspond to population-weighted averages over the countries belonging to the corresponding regions.

experienced lower growth rates than the rest of the country. As a result, the share of poorest 10% Europeans living in Germany increased substantially. Rising inequalities in Eastern Europe, on the contrary, have been associated with the emergence of an economic elite which can now compete with its Western European counterparts. Between 1980 and 2017, the share of top 10% Europeans earners living in Eastern Europe was multiplied by four and reached almost 10% in 2017.

The fact that European income disparities are partly geographically concentrated should not make us forget that inequalities within countries remain much more significant. While figure 18 shows that there are more poor Eastern Europeans than poor Western Europeans, it also reveals that no region can escape from being at least partly "spread out" through the entire European distribution. National incomes per adult are 25% to 75% lower than the continental average in most Eastern European countries; yet, a substantial share of inhabitants of this area belong to the European middle or even upper-middle classes. Accordingly, a non-negligible proportion of Europe's poorest families still live in some of Western Europe's wealthiest nations.

3.4 Curbing inequalities? From pre-tax to post-tax income

Until now, we have focused exclusively on the distribution of pre-tax income, that is the sum of all pre-tax personal income flows accruing to the owners of the production factors, before taking into account the operation of the tax and transfer system, but after taking into account the operation of the pension system. We will now look more precisely at the evolution of post-tax disposable income inequality in Europe and the extent of redistribution across European regions. Post-tax disposable income corresponds to the sum of primary incomes over all sectors, after taxes and transfers. It includes all in-kind transfers and public spending, which are attributed proportionally to all individuals, so that aggregate post-tax income is equal to aggregate national income.

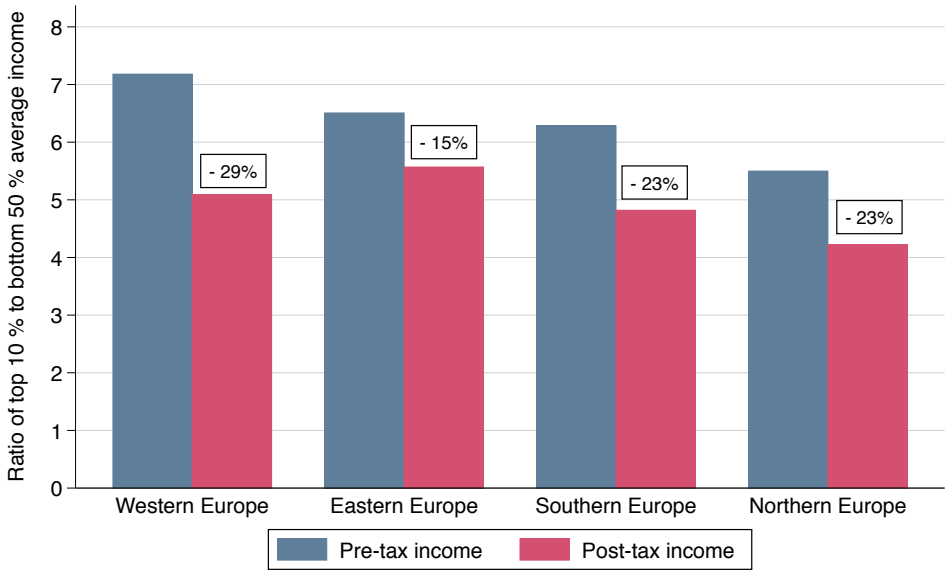
Since the tax data used to correct inequality at the top of the distribution are only available for pre-tax income, we assume that the underestimation profile of post-tax income inequality is similar to that observed for pre-tax income. Furthermore, given that pre-tax income and post-tax income are only available jointly in a limited number of surveys (essentially EU-SILC and a few surveys from the Luxembourg Income Study), we are not able to precisely document evolutions in the redistributive effects of taxes and transfers. Analyses of larger geographical areas and broad comparisons between countries can still reveal interesting information on redistribution in Europe. As more detailed studies become available, more precise comparisons between countries and across time will become possible.

We start by looking at the incidence of taxes and transfers in European regions. Figure 19 plots the population-weighted average ratio of post-tax to pre-tax income by percentile across European regions in 2017. Taxes and transfers appear to reduce income inequality in all regions: they increase the average income of bottom 50% earners by up to 40%, and reduce the earnings of top earners by up to 25%. Redistribution is lowest at the top end of the distribution in Eastern Europe, while Western Europe tends to redistribute more towards poorer individuals.

In order to synthesize this information with a simple indicator, we propose to follow Bozio et al. (2018) and look at the percent reduction in the ratio of the top 10% to bottom 50% average incomes. This ratio is a simple and straightforward measure of inequality, as it summarizes in a single number the gap between the earnings of the two sides of the income distribution. Looking at the extent to which fiscal systems reduce this gap can therefore inform directly on their redistributive effect.[19] Figure 20 compares average redistribution across European regions with this indicator. On average, taxes and transfers reduce the income gap between rich and poor about two times less in

[19] The results of this section are robust to the use of different groups for the top and the bottom of the distribution (e.g. top 1%/bottom 50%). See table A.8 in appendix.

Figure 20: Redistribution in European regions, 2017: pre-tax vs post-tax ratio of top 10% to bottom 50% average incomes



Source: authors' computations combining surveys, tax data and national accounts. Figures correspond to population-weighted averages over the countries belonging to the corresponding regions. *Interpretation*: in 2017, on average, taxes and transfers reduced the income gap between top 10% and bottom 50% earners by about 15% in Eastern European countries.

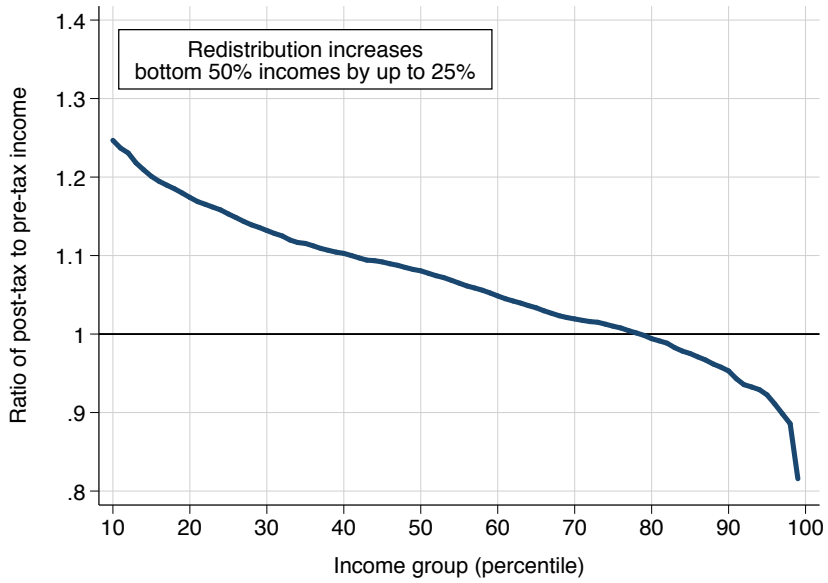
Eastern European countries than in Western European countries. Southern and Northern European countries tend to have intermediate levels of redistribution.

Given these diverse systems of taxes and transfers, how does Europe as a whole perform in curbing pre-tax income differences? Figure 21 plots the ratio of post-tax to pre-tax averages incomes by percentile in Europe in 2017. National fiscal systems appear to reduce overall inequalities between European citizens significantly: individuals at the bottom of the distribution see their incomes increase by up to 25%, while the average income of the top 1% is reduced by close to 20%.

Figure 22 plots the evolution of the gap between top 10% and bottom 50% European earners. Taxes and transfers play a significant role in reducing inequality. In 2017, the richest decile's average pre-tax income was about 8 times higher than that of the bottom 50%; after taxes and transfers, this gap was reduced to about 6.

The distribution of post-tax income also depends on how we choose to allocate government expenditure to individuals. Until now, we have followed the DINA convention of allocating government expenditures in a distribution-neutral way — i.e. proportionally to income. This

Figure 21: Redistribution in Europe, 2017: ratio of post-tax to pre-tax income by percentile

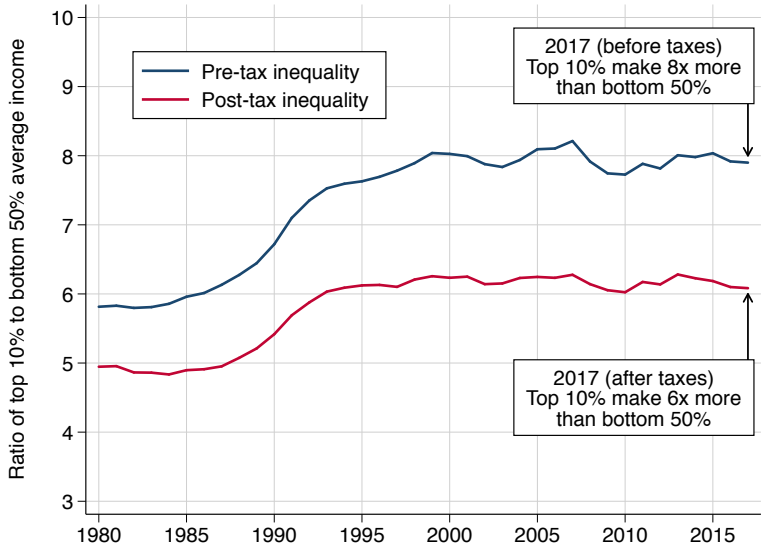


Source: authors' computations combining surveys, tax data and national accounts.

makes our results more comparable to other DINA studies (Piketty, Saez, and Zucman, 2018; Bozio et al., 2018), and also more comparable to other estimates of post-tax income inequality that ignore the role of government expenditure. We can, however, experiment with different ways of allocating public consumption. The two opposite scenarios are proportional allocation (our benchmark) and lump-sum allocation (everyone gets the same amount). We can also choose different strategies for individual expenditures (e.g. health or education) and collective expenditures (e.g. defense or general administration). Hence we get four scenarios: full proportional allocation, full lump-sum allocation, and two mixed approaches (proportional allocation of collective expenditures and lump-sum allocation of individual expenditures, and vice-versa).

The share of government expenditures represents about 20-25% of national income in European countries. As shown in figure 23, when we distribute it as a lump sum we naturally get a lower level of post-tax inequality. However, government expenditures have remained broadly stable over time, so that there is no discernible impact on the trends. The same is true of mixed scenarios for which we allocate different individual and collective consumption expenditures.

Figure 22: Redistribution in Europe, 1980-2017:
ratio of top 10% to bottom 50% average incomes



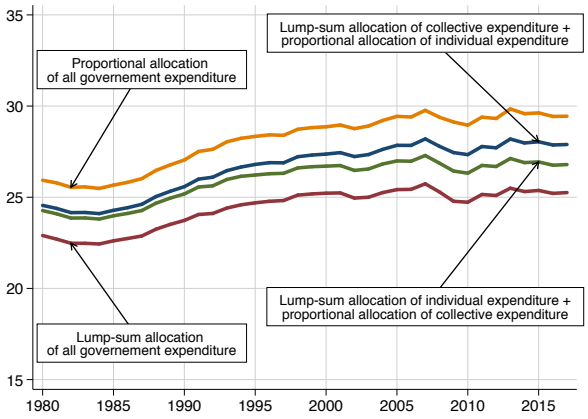
Source: authors' computations combining surveys, tax data and national accounts.

3.5 Is Europe more unequal than the United States?

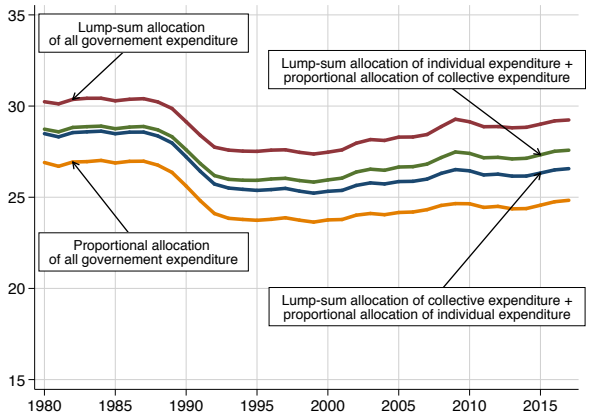
Income inequality in the US has increased dramatically in the past forty years, especially at the top of the distribution (Piketty, Saez, and Zucman, 2018). In this section, we seek to compare these dynamics to those observed in Europe. Europe and the United States are two large, integrated world regions, which share relatively high degrees of similarities in terms of levels of development, exposure to global markets or penetration of new technologies. Comparing the evolution of income inequality in these regions can thus provide insights into their different policy and economic trajectories since the 1980s. In particular, we will refine and expand on the recent work done in the World Inequality Report 2018 (Alvaredo et al., 2018) by focusing on two questions. Are income disparities in Europe larger than in the US? And what are the roles of between-country (between-states) and within-country (within-states) inequalities in explaining these differences? Our estimates for Europe are based on the work done in this paper. For the US, we collect data on total state domestic products from the Bureau of Economic Analysis, along with state adult populations series from the United States Census Bureau. In order to obtain comparable series on income inequalities within US states, we correct survey distributions obtained from the Current Population Surveys with top income shares estimated by Frank et al. (2015), using the same

Figure 23: Post-tax inequality using different allocations of government expenditure

(a) Top 10% income share



(b) Bottom 50% income share



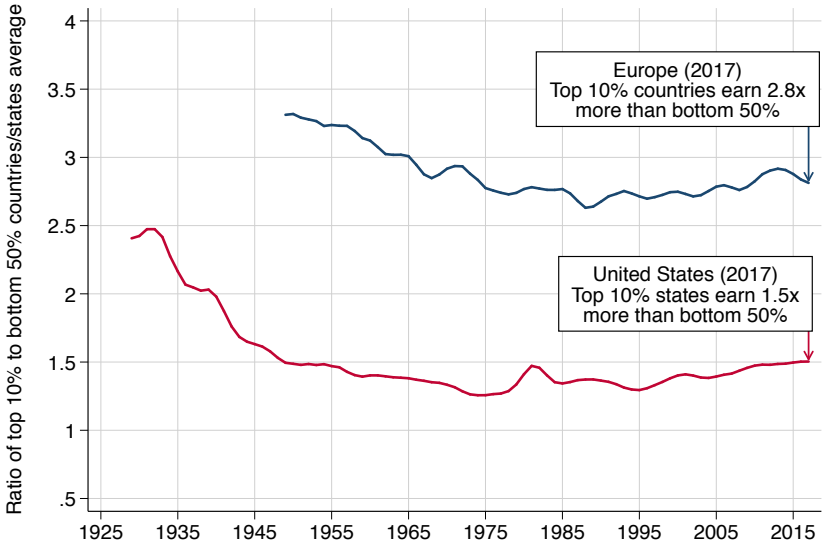
Source: authors' computations combining surveys, tax data and national accounts.

harmonized methodology as the one used for Europe. In what follows, when looking at inequality in Europe as a whole, we use market exchange rates estimates to measure differences in average income levels between European countries. This is to make the comparison between US states and European countries more meaningful. While purchasing power parity figures could be computed for European countries, there exist no conversion factor which would allow us to account for differences in average costs of living between US States.

Our first result is that spatial inequalities have always been much smaller in the US than in Europe, at least since the mid-twentieth century. Figure 24 plots the ratio of the average income of the population-weighed top 10% countries or states to the population-weighed poorest 50% countries or states of Europe and the US respectively.[20] This indicator is a simple measure of spatial inequality: it compares the average income of the "core" territories to that of the poorest states or countries gathering half of the total population. In Europe, inequalities between countries have decreased slightly from 1950 to the beginning of the 1980s and have remained broadly stable since then: in 2017, the national income of top 10% European countries was 2.8 times higher than that of the bottom 50%. Spatial heterogeneity has never reached such levels in the US, where the top 10% to bottom 50% ratio has decreased from 2.5 at the beginning of the 1930s to 1.5 in 2017.

[20]State domestic products provided by the Bureau of Economic Analysis go back as far as 1967. We extrapolate these series back to 1929 by using the growth rates in personal income per capita available from Barro and Sala-i-Martin (1992). The ratios of the top 10% to bottom 50% European states or US states adjust for population differences. That is, we split proportionally the population of states which are at the frontier between the top 10% and the bottom 90% of the continental population.

Figure 24: Spatial inequality in Europe and the US, 1980-2017



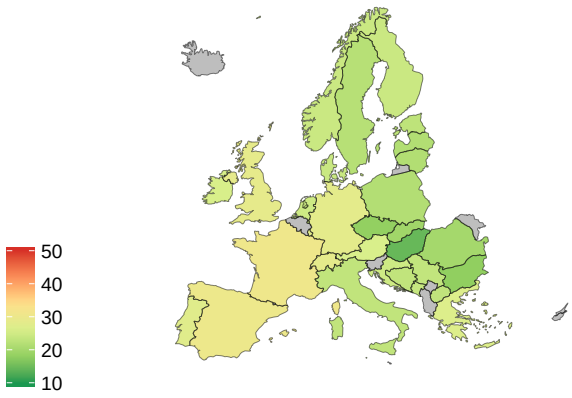
Source: authors' computations combining national accounts data from the World Inequality Database (Europe) and the United States Bureau of Economic Analysis (US). The ratios of the top 10% to bottom 50% European states or US states adjust for population differences. That is, we split proportionally the population of states which are at the frontier between the top 10% and the bottom 90% of the regional population.

These differences are apparent when comparing individual countries and states in recent years. The poorest European countries had national incomes per adult lower than the continental average by more than 50%, both in 1980 and in 2017 (figure A.4). There was no such equivalent in the US, neither today nor thirty years ago. In 1980, poorest US states were characterized by standards of living lower than the national average by no more than 25%, and this figure did not exceed 40% in 2017 (table A.7). Similarly, the wealthiest countries of Europe have steadily remained richer than the average European by about 75%, compared to only 25% in the US. There were, both in 1980 and 2017, small US states who were significantly richer than the rest of the country: in 1980, residents of Alaska and Washington D.C. earned more than 300% of US national income. Beyond these exceptions, however, a vast majority of states have always had standards of living located between 70% and 120% of the national average.

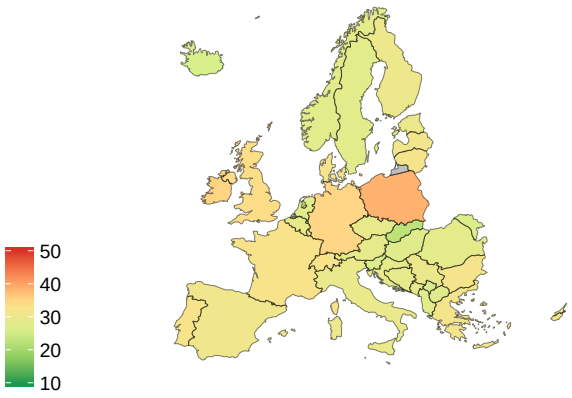
There are at least two potential explanations for these differences. First, the United States has reached a significantly higher degree of economic integration than Europe, and have remained politically and institutionally stable for a much longer time. In this context, US states rapidly

Figure 25: Top 10% income shares in European countries and US states, 1980-2017

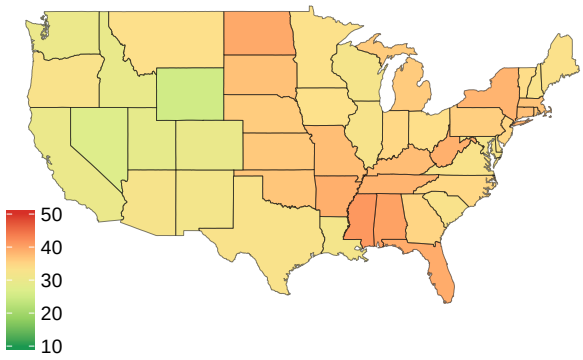
(a) Europe, 1980



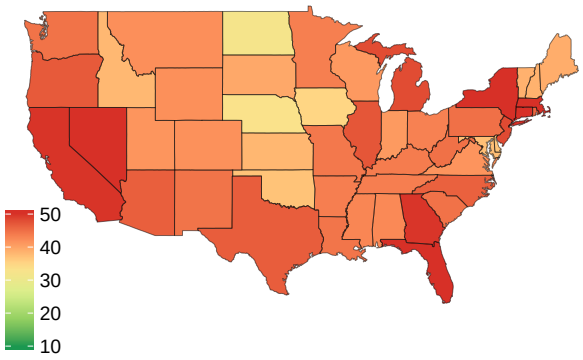
(b) Europe, 2017



(c) United States, 1980



(d) United States, 2017



Source: authors' computations combining surveys, tax data and national accounts.

converged in their levels of development, especially at the beginning of the twentieth century (Barro and Sala-i-Martin, 1991; Barro and Sala-i-Martin, 1992). Accordingly, the persistence of high between-country inequalities in Europe can partially be explained by the multiplication of strong asymmetric shocks since the 1980s which have delayed potential convergence processes. The 1990s crises in Eastern Europe badly affected the poorest economies of the continent, just as the 2008 crisis hit only moderately richer European nations but led to stronger recessions in Southern and Baltic countries. That heterogeneity also has to do with a lack of political integration and coordinated policy responses among European countries and within the European Union. While the EU has decided to encourage the adhesion of future members with financial aid funds, it has only dedicated moderate sums to these programs. Between 1991 and 2003, for instance, average transfers from West Germany to East Germany had amounted to some 4.5% of western GDP and 30% of eastern GDP, leading to rapid and significant regional convergence after reunification.[21] By contrast, the 2019 financial programming of the European Regional Development Fund, the main program for correcting imbalances between EU regions, is expected to amount to 31 billion euros, or less than 0.2% of total EU GDP.[22] And when looking at net contributions to the EU budget, countries benefiting most from EU transfers (such as Bulgaria, Hungary of Lithuania) do not receive net income flows higher than 3% of their GDP, while the most important contributors (such as Germany or Sweden) give up less than 0.4% of their total annual production (see figure A.1).

Our second key result is that while geographical disparities are higher in Europe than in the US, inequalities within territories are higher and have grown much faster in the US. Figure 25 maps the long-run evolution of top income inequality in European and US regions. In 1980, US states were, on average, only slightly more unequal than Western European countries. Between 1980 and 2017, however, this gap grew significantly: while inequalities within European countries increased only moderately, they skyrocketed in most US states, reaching up to 60% in New York and Florida. The fact that inequalities increased only moderately in Europe, and mainly in Eastern European countries who "caught up" with their Western neighbors, announced a clear disconnection between the US and Europe. In 2017, top 10% shares in the most equal states of the US were close to those observed in the most unequal countries of Europe.

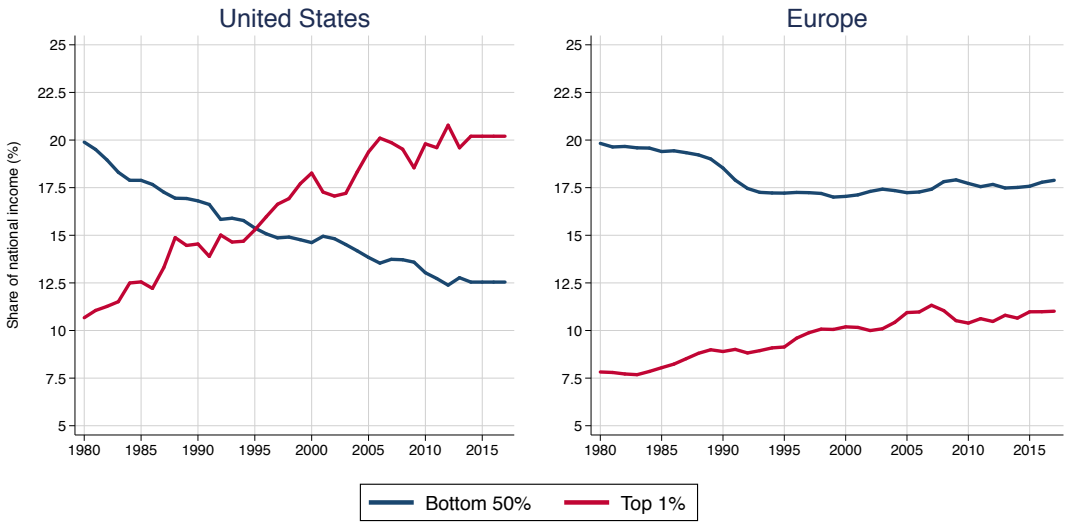
Another interesting fact is that top 10% income shares were generally more similar across US states than they were across European countries in 1980, where communist countries were characterized by significantly lower income disparities than Western European nations. Just as in the case of between-region inequalities, this can be partly explained by differences in degrees of political

[21] See for example `http://ec.europa.eu/economy_finance/publications/pages/publication1437_en.pdf`.

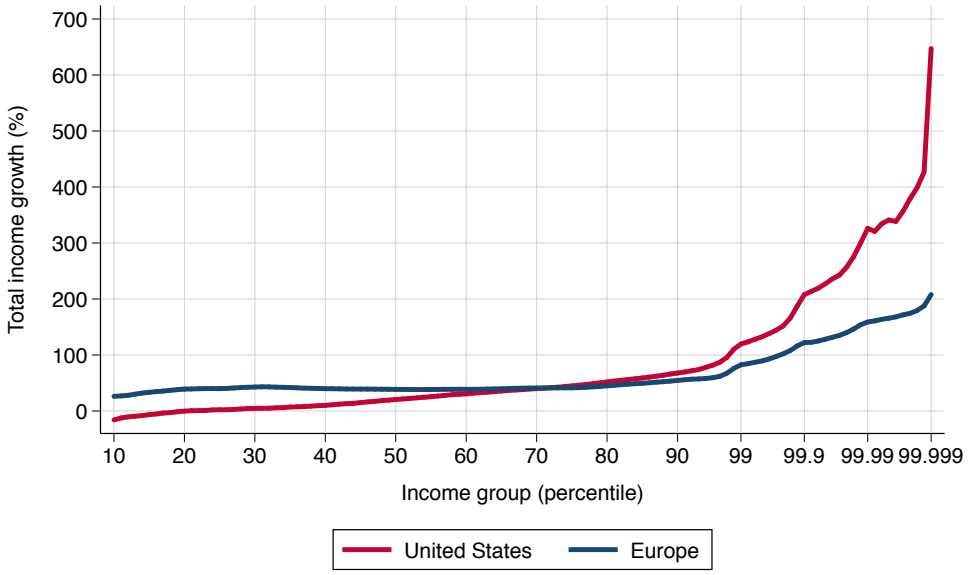
[22] See `https://ec.europa.eu/budget/library/biblio/documents/2019/Programmes_performance_overview.pdf`.

Figure 26: Income inequality trends in Europe and the US, 1980-2017

(a) Bottom 50% vs. Top 1% income shares

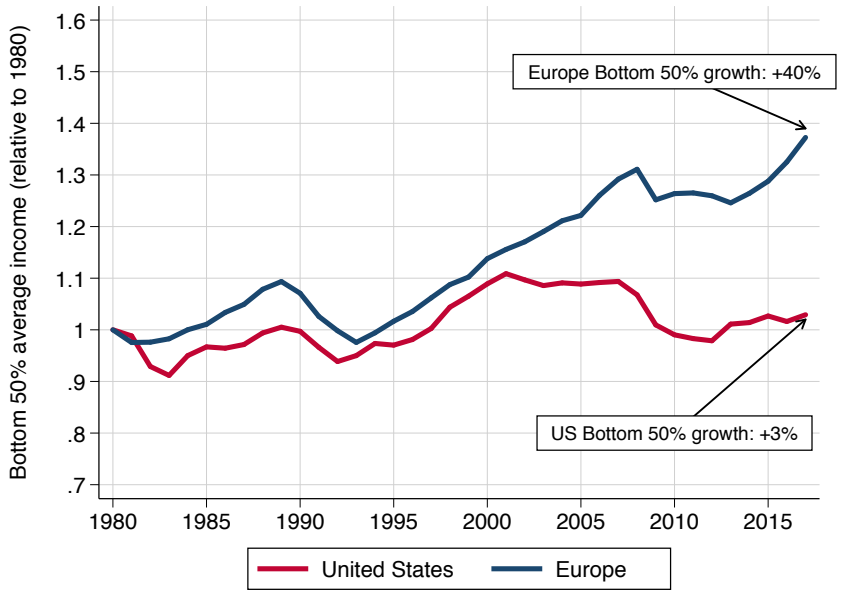


(b) Growth Incidence Curves



Source: authors' computations combining surveys, tax data and national accounts for Europe; Piketty, Saez, and Zucman (2018) for the United States.

Figure 27: Income inequalities in Europe and the United States: bottom 50% income growth, 1980-2017

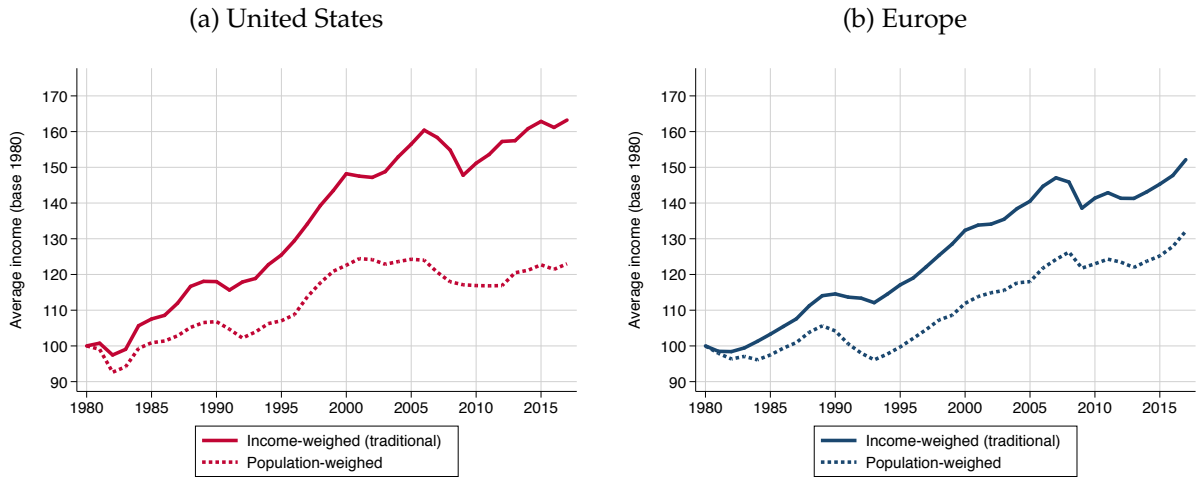


Source: authors' computations combining surveys, tax data and national accounts for Europe; Piketty, Saez, and Zucman (2018) for the United States.

integration. In the US, even if states did collect and redistribute fiscal resources, the federal government played a key role in alleviating poverty and reducing income inequalities at the top thanks to high income and wealth tax rates or to the federal minimum wage. No such mechanism existed in Europe, where the key actor of economic redistribution remained the Nation State. In 2017, however, the situation had changed: differences in inequality levels between US states have increased, while the progressive integration of Eastern European countries to market economies and rising inequalities in Scandinavian countries led to lower differences between European countries.

Spatial inequalities are therefore lower in the US than in Europe, while inequalities within European countries are lower than inequalities within US states. Adding up these two effects, are overall income differences wider in the US than in Europe as a whole? The answer is unequivocal: income inequality is substantially higher in the US than in Europe. In 2017, the top 1% in the US captured a share of national income twice as large as the poorest half of the population. In Europe, by contrast, the bottom 50% share was significantly larger than that of top 1% earners (figure 26a). This was not always the case: in 1980, bottom 50% shares were actually very similar between the two regions, amounting to about a fifth of national income. While income inequalities have increased in both

Figure 28: National income growth in the United States and Europe: Income-weighed vs population-weighed estimates



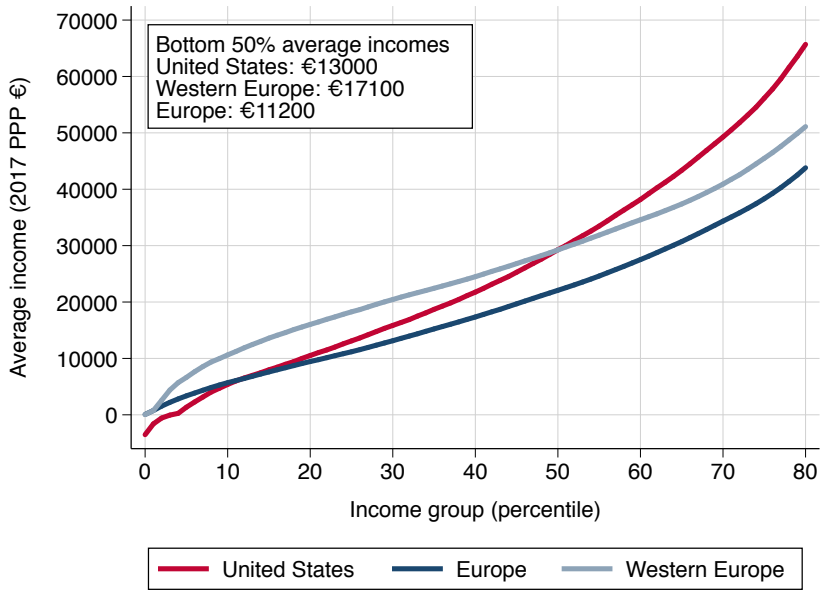
Source: authors' computations combining surveys, tax data and national accounts for Europe; Piketty, Saez, and Zucman (2018) for the United States.

Europe and the US, the trend has therefore been much steeper in the latter. In Europe, economic crises and rising income disparities in Eastern Europe contributed to moderately compressing the bottom 50% share at the beginning of the 1990s, while top income inequality increased slightly from the 1980s to the 2000s. Inequality dynamics in the US have been much more linear: in the past forty years, the top 1% share steadily surged from 11% to 20% and the bottom 50% share was nearly divided by two.

These differences appear even more striking if one compares the growth trajectories of different income groups in the two regions (figure 26b). Between 1980 and 2017, top earners in Europe experienced growth rates lower than 200%; during the same period, the richest 0.001% US citizens saw their standards of living multiplied by seven. And while poorer Europeans' earnings grew by 40%, bottom 50% earners in the US did not experience any improvements in their income levels (figure 27). Our estimates reveal that despite the fact that the average national income grew faster in the US than in Europe by 40% during this period, the poorest 70% European residents saw their incomes grow faster than the poorest 70% US citizens (the two growth incidence curves cross at the seventieth percentile).

Figure 28 formalizes the gap between average national income growth and the growth felt by "typical" individuals. Solid lines represent the evolution of the average income per adult in Europe and the US, measured directly from national accounts, relative to its value in 1980. This standard

Figure 29: Income inequalities in Europe and the United States: Average incomes by income group, 2017



Source: authors' computations combining surveys, tax data and national accounts for Europe; Piketty, Saez, and Zucman (2018) for the United States.

figure, by definition, corresponds to what one could call "income-weighed" growth, since the aggregate rate of the economy can be computed as the average growth rate of each percentile, weighed by the corresponding shares of national income they earned: at the limit, if the top 1% were to own all of national income, that growth would only be determined by that group, so that the fate of the bottom 99% would no at all be reflected by macroeconomic growth. By contrast, it is possible to compute a alternative "population-weighed" growth rate, obtained by averaging growth across income groups, weighed by their share in the national population. This figure is much closer to the growth rate experienced by the average person in the economy.[23] The wide gaps visible between income-weighed and population-weighed growth rates, both in Europe and the US, are suggestive of how increasing inequalities have led to a rising disconnection between average national income growth and what "typical" individuals experienced. In the US, the total income growth across the 1980-2017 period is reduced from 60% to 20%; in Europe, it decreases from 50% to 30%.

[23]This figure remains different from the growth rate experienced by a person sampled at random. Computing such an estimate would require individual-level panel data. But it gets a lot closer conceptually.

Table 3: Theil index decomposition of between-region and within-region inequalities in Europe and the US

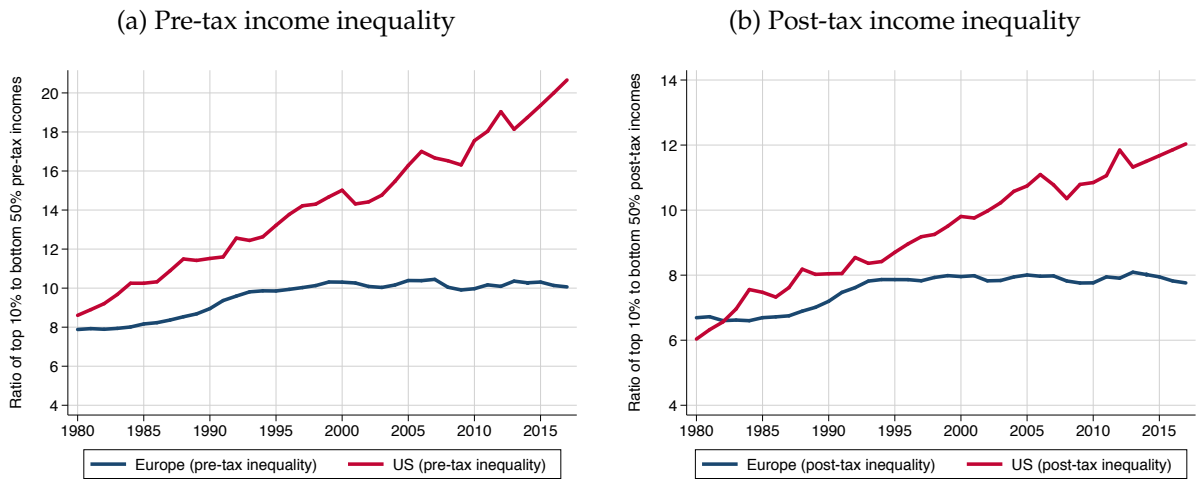
	Theil index	Within-group		Between-group	
		Value	% of total	Value	% of total
Europe					
1980	0.37	0.24	65.0 %	0.13	35.0 %
1990	0.43	0.29	67.4 %	0.14	32.6 %
2000	0.49	0.34	69.6 %	0.15	30.4 %
2007	0.52	0.39	74.8 %	0.13	25.2 %
2017	0.50	0.38	76.6 %	0.12	23.4 %
United States					
1980	0.45	0.44	96.7 %	0.01	3.3 %
1990	0.63	0.61	98.0 %	0.01	2.0 %
2000	0.85	0.84	98.5 %	0.01	1.5 %
2007	0.94	0.93	98.5 %	0.01	1.5 %
2017	1.00	0.98	98.3 %	0.02	1.7 %

Source: authors' computations combining surveys tax data and national accounts.

Differences in income inequality in Europe and the US are also a powerful illustration of how standard macroeconomic aggregates can fail to measure true standards of living. Figure 29 plots the average income of poorer income groups in the US, Europe and Western Europe. In 2017, according to national accounts, US citizens were on average significantly wealthier than Europeans: their national income per adult reached about €54,000, compared to only €37,000 in Western Europe and €31,000 in Europe as a whole (in 2017 PPP euros). Median income in Western Europe, however, was approximately equal to US median income, and all groups below median were richer in Western Europe than corresponding individuals in the US. In Europe as a whole, a significantly larger fraction of individuals were poorer than their counterparts in the US. Yet, the poorest fifth of the adult population was characterized by comparable standards of living in both regions (between €0 and €10,000). Traditional indicators therefore disguise how important income differences between residents can be: while the United States' production is among the highest in the world, a majority of US inhabitants still earn very little in comparison to what figures from national accounts suggest.

Table 3 provides Theil decomposition of income inequality in Europe and the US between 1980 and 2017. In 1980, inequalities were slightly higher in the US than in Europe, if one considers the Theil index to be a broad measure of income concentration. This gap had widened considerably in 2017: the Theil index reached 1 in the US, compared to only 0.5 in Europe. Furthermore, decomposition

Figure 30: Redistribution in Europe and the United States:
Ratio top 10% to bottom 50% average incomes



Source: authors' computations combining surveys, tax data and national accounts for Europe; Piketty, Saez, and Zucman (2018) for the United States.

reveals that inequalities between countries explain a much larger share of income disparities in Europe than inequalities between states do in the US. At the beginning of our period of interest, about two thirds of income inequalities in Europe were explained by inequalities within countries. Due to rising income disparities in European nations, the share of income concentration explained by within-group inequalities increased to more than 75% in 2017. In the US, on the other hand, higher geographical integration and larger differences in standards of living within States have led between-group inequalities to remain of minor importance. Between 1980 and 2017, the share of overall US inequalities explained by within-state income differences remained above 95%.

We conclude by bringing together pre-tax income inequality and post-tax inequality estimates for both regions. Since our European data series do not able us to attribute in-kind transfers to individuals (such as Medicaid in the US), our concept of post-tax income is closest to that of post-tax disposable income used by Piketty, Saez, and Zucman (2018). This corresponds to all sources of incomes, net of taxes, received by individuals and which can be individualized (excluding social transfers in kind, collective consumption expenditure and government deficits).

Figure 30 plots the ratio of top 10% to bottom 50% average incomes before and after redistribution. As our previous analysis showed, pre-tax income inequality rose much faster in the US than in Europe. In the US, the average income of the top 10% was 8 times higher than that of the bottom

50% in 1980 and 20 times higher in 2017. In Europe, this figure rose much more moderately, from about 8 to 10. However, redistribution in the US appears to be substantially higher than in the old continent: after accounting for taxes and transfers, the top 10% to bottom 50% ratio grew from 6 to 12 in the US, while it rose from 7 to 8 in Europe.[24] The pre-tax income gap between rich and poor was therefore twice as large in the US than in Europe in 2017, while the post-tax income gap was about 50% wider. Taxes and transfers are therefore much more progressive in the US than in Europe, but they have still been insufficient to curb rising pre-tax inequalities in either region.

4 Conclusion

We have developed a novel methodology combining surveys, tax data and national accounts in a consistent manner to produce pre-tax and post-tax income inequality statistics for all European countries covering the 1980-2017 period. Based on this methodology, we have documented the following results.

First, we do not observe a clear pattern of convergence in average income levels between countries since the early 1980s. Per adult income in Eastern Europe is about 35% lower than European average today. This is the same value as in the early 1980s, before the fall of the USSR. In Southern European countries, per adult average incomes have been declining relatively to the continental average since the 1990s and are now 10% below the average. Northern European countries were 25% richer than the average in the mid-1990s and are now 50% richer.

Personal income inequalities have been increasing in nearly all countries. Nearly all European countries failed to reach the United Nations Sustainable Development Goals inequality target over the 1980-2017 period, which seeks to ensure that the bottom 40% of the population grows faster than the average. Since the 2000s, European countries have been relatively more successful at ensuring that bottom income groups secure a fair share of growth, but the majority of countries still failed to achieve the UN objective.

As a result of a limited convergence process and rising inequality within countries, Europeans are more unequal today than four decades ago. Between 1980 and 2017, per adult average annual pre-tax income growth was below 1% for bottom 50% earners, while the top 0.1% grew at a rate higher than 2% per year. The top 1% captured about as much growth as the bottom 50% of the population. The share of national income captured by the top 1% Europeans increased from less

[24] We get more similar levels of redistribution when looking at the ratio between the middle and the bottom of the distribution, except in Eastern Europe. See table A.8 in appendix for details.

than 8% of national income to nearly 11% between 1980 and 2017.

Despite a rise of inequality in Europe and within the EU, European countries have been much more successful at containing rising inequalities than the US. This is largely because European countries succeeded in generating higher income growth rates for bottom earners than did the US. Average income of the poorest half of Europeans was 40% higher in 2017 than in 1980, while it was essentially the same as in 1980 (+3%) for the poorest 50% Americans. Consequently, Europe is much less unequal than the US, despite higher spatial inequalities in Europe than between US states.

While European countries distribute pre-tax incomes much more equally than the US, the intensity of post-tax redistribution is stronger in the US. Top 10% average pre-tax incomes in 2017 were 20 times higher than bottom 50% average income in the US. After taxes and transfers, this ratio fell to 12 (a 40% reduction of inequality). In Europe, taxes and transfers reduce inequality by 20%. Nevertheless, Europe is significantly more equal after taxes and transfers than the US given the extreme level of pre-tax inequality in the US.

To what extent did observed and perceived inequality dynamics in Europe contribute to current levels of resentment against national and European institutions? Which structural changes and set of policies enabled European countries to contain the surge of inequalities observed in the USA since 1980? This paper opens up many questions to which our inequality series will hopefully contribute to answering in future comparative research.

References

Aaberge, R. and A. B. Atkinson (2010). "Top incomes in Norway". In: *Top incomes: a global perspective*. Ed. by A. B. Atkinson and Thomas Piketty. Oxford University Press. Chap. 9, pp. 448–481.

Alstadsæter, Annette, Martin Jacob, Wojciech Kopczuk, and Kjetil Telle (2017). "Accounting for Business Income in Measuring Top Income Shares: Integrated Accrual Approach Using Individual and Firm Data from Norway". URL: http://www.nber.org/papers/w22888.

Alvaredo, Facundo (2009). "Top incomes and earnings in Portugal 1936-2005". In: *Explorations in Economic History* 46.1, pp. 404–417.

Alvaredo, Facundo and Elena Pisano (2010). "Top incomes in Italy, 1974-2004". In: *Top incomes: a global perspective*. Ed. by A. B. Atkinson and Thomas Piketty. Oxford University Press. Chap. 12, pp. 625–663.

Alvaredo, Facundo and Emmanuel Saez (2010). "Income and wealth concentration in Spain in a historical and fiscal perspective". In: *Top incomes: a global perspective*. Ed. by A. B. Atkinson and Thomas Piketty. Oxford University Press. Chap. 10, pp. 482–559.

Alvaredo, Facundo, A. B. Atkinson, Lucas Chancel, Thomas Piketty, Emmanuel Saez, and Gabriel Zucman (2017). "Distributional National Accounts (DINA) Guidelines: Concepts and Methods used in WID.world".

Alvaredo, Facundo, Lucas Chancel, Thomas Piketty, Emmanuel Saez, and Gabriel Zucman (2018). *World Inequality Report*. Tech. rep. World Inequality Lab. URL: http://wir2018.wid.world/files/download/wir2018-full-report-english.pdf.

Atkinson, A. B. and Thomas Piketty (2007). *Top incomes over the twentieth century: a contrast between continental European and English-speaking countries*. Oxford University Press, p. 585. ISBN: 9780199286881. URL: https://global.oup.com/academic/product/top-incomes-over-the-twentieth-century-9780199286881?lang=en&cc=fr.

— (2010). *Top incomes: a global perspective*. Oxford University Press, p. 776. ISBN: 9780199286898. URL: https://global.oup.com/academic/product/top-incomes-9780199286898?cc=fr&lang=en&#.

Atkinson, A.B. and J.E. Søgaard (2013). "The long-run history of income inequality in Denmark: Top incomes from 1870 to 2010". In: *EPRU Working Paper Series 2013-01*.

Atkinson, Anthony B. (1996). "Income distribution in Europe and the United States". In: *Oxford Review of Economic Policy* 12.1.

Atria, Jorge, Ignacio Flores, Ricardo Mayer, and Claudia Sanhueza (2018). "Top incomes in Chile: A Historical Perspective of Income Inequality (1964-2015)". URL: http://ignacioflores.com/pdf/top-incomes-chile.pdf.

Barro, Robert and Xavier Sala-i-Martin (1991). "Convergence across States and Regions". In: *Center Discussion Paper No. 629*.

— (1992). "Convergence". In: *Journal of Political Economy* 100.2, pp. 223–251.

Bartels, Charlotte (2017). "Top incomes in Germany, 1871-2013". In: *WID.world Working Paper Series 2017/18*.

Beblo, Miriam and Thomas Knaus (2001). "Measuring income inequality in Euroland". In: *Review of Income and Wealth* 47.3.

Blanchet, Thomas and Lucas Chancel (2016). "National Accounts Series Methodology". URL: http://wid.world/document/1676/.

Blanchet, Thomas, Ignacio Flores, and Marc Morgan (2018). "The Weight of the Rich: Improving Surveys Using Tax Data".

Blanchet, Thomas, Juliette Fournier, and Thomas Piketty (2017). "Generalized Pareto Curves: Theory and Applications".

Boix, Carles (2004). "The institutional accomodation of an enlarged Europe". In: *Friedrich Ebert Stiftung, Europäische Politik* 6.1, pp. 1–9.

Bozio, Antoine, Bertrand Garbinti, Jonathan Goupille-Lebret, Malka Guillot, and Thomas Piketty (2018). "Inequality and Redistribution in France, 1990-2018: Evidence from Post-Tax Distributional National Accounts (DINA)". In: *WID.world Working Paper 2018/10*.

Brandolini, Andrea (2006). "Measurement of income distribution in supranational entities: The case of the European Union". In: *LIS Working Paper Series, No. 452*.

Bukowski, Pawel and Filip Novokmet (2017). "Top incomes during wars, communism and capitalism: Poland 1892-2015". In: *WID.world Working Paper Series 2017/22*.

Chen, Tianqi and Carlos Guestrin (2016). "XGBoost: A Scalable Tree Boosting System". URL: http://dx.doi.org/10.1145/2939672.2939785.

Chrissis, Kostas and Franciscos Koutentakis (2017). "From dictatorship to crisis: the evolution of top income shares in Greece (1967-2013)". In: *Working Paper*.

Dauderstädt, Michael (2008). "Ungleichheit und sozialer Ausgleich in der erweiterten Europäischen Union". In: *Wirtschaftsdienst* 88.4, pp. 261–269.

Dauderstädt, Michael and Cem Keltek (2011). "Immeasurable Inequality in the European Union". In: *Intereconomics* 46.1, pp. 44–51.

Decoster, André, Koen Dobbeleer, and Sebastiaan Maes (2017). "Using fiscal data to estimate the evolution of top income shares in Belgium from 1990 to 2013". In: *Ku Leuven Discussion Paper Series DPS17.18*.

Deville, Jean-Claude and Carl-Erik Särndal (1992). "Calibration Estimators in Survey Sampling". In: *Journal of the American Statistical Association* 87.418, pp. 376–382. DOI: 10.1080/01621459.1992.10475217.

Fairfield, Tasha and Michel Jorratt De Luis (2016). "Top Income Shares, Business Profits, and Effective Tax Rates in Contemporary Chile". In: *Review of Income and Wealth* 62.August, S120–S144. ISSN: 14754991. DOI: 10.1111/roiw.12196.

Fang, Yixin (2011). "Asymptotic Equivalence between Cross-Validations and Akaike Information Criteria in Mixed-Effects Models". In: *Journal of Data Science* 9, pp. 15–21.

Ferreira, Ana and Laurens de Haan (2006). *Extreme Value Theory: An Introduction*. Springer Series in Operations Research. Springer.

Flores, Ignacio (2018). "Income Under the Carpet: What Gets Lost Between the Measure of Capital Shares and Inequality". URL: http://ignacioflores.com/pdf/Income_under_the_Carpet.pdf.

Foellmi, Reto and Isabel Z. Martínez (2017). "Volatile top income shares in Switzerland? Reassessing the evolution between 1981 and 2010". In: *Review of Economics and Statistics* 99.5, pp. 793–809.

Frank, Mark, Estelle Sommeiller, Mark Price, and Emmanuel Saez (2015). "Frank-Sommeiller-Price Series for Top Income Shares by US States since 1917". In: *WID.world Technical Note Series 2015/7*.

Friedman, Jerome H. (2001). "Greedy Function Approximation: A Gradient Boosting Machine". In: *The Annals of Statistics* 29.5, pp. 1189–1232. URL: http://www.jstor.org/stable/2699986.

Garbinti, B, J Goupille-Lebret, and T Piketty (2018). "Income inequality in France, 1900–2014: Evidence from Distributional National Accounts (DINA)". In: *Journal of Public Economics* 162.1, pp. 63–77.

Hosking, J R M and J R Wallis (1987). "Parameter and Quantile Estimation for the Generalized Pareto Distribution". In: *Technometrics* 29.3, pp. 339–349. ISSN: 0040-1706. DOI: 10.1080/00401706.1987.10488243. URL: https://www.tandfonline.com/doi/abs/10.1080/00401706.1987.10488243.

Jäntti, M., M. Riihelä, R. Sullström, and M. Tuomala (2007). "Long-term trends in top income shares in Ireland". In: *Top incomes over the 20th century*. Ed. by A. B. Atkinson and Thomas Piketty. Oxford University Press. Chap. 12, pp. 501–530.

— (2010). "Trends in top income shares in Finland". In: *Top incomes: a global perspective*. Ed. by A.B. Atkinson and Thomas Piketty. Oxford University Press. Chap. 8, pp. 371–447.

Kump, Nataša and Filip Novokmet (2018). "Top incomes in Croatia and Slovenia, from 1960s until today". In: *WID.world Working Paper Series 2018/8*.

Lakner, Christoph and Branko Milanovic (2016). "Global Income Distribution: From the Fall of the Berlin Wall to the Great Recession". In: *The World Bank Economic Review* 30.2, pp. 203–232. ISSN: 0258-6770. DOI: 10.1093/wber/lhv039. URL: https://academic.oup.com/wber/article-lookup/doi/10.1093/wber/lhv039.

Lesage, Éric (2009). "Calage non linéaire".

Mavridis, Dimitris and Pálma Mosberger (2017). "Income inequality and incentives: the quasi-natural experiment of Hungary, 1914-2008". In: *WID.world Working Paper Series 2017/17*.

Morgan, Marc (2017). "Extreme and Persistent Inequality: New Evidence for Brazil Combining National Accounts , Surveys and Fiscal Data, 2001-2015". URL: http://wid.world/wp-content/uploads/2017/09/Morgan2017BrazilDINA.pdf.

Nielsen, Didrik (2016). *Tree Boosting With XGBoost Why Does XGBoost Win "Every" Machine Learning Competition?* Tech. rep. December, p. 2016. URL: https://brage.bibsys.no/xmlui/bitstream/handle/11250/2433761/16128_FULLTEXT.pdf?sequence=1&isAllowed=y.

Novokmet, Filip (2018). "The long-run evolution of inequality in the Czech lands, 1898-2015". In: *WID.world Working Paper Series 2018/6*.

Piketty, Thomas (2001). *Les hauts revenus en France au XXe siècle*. Seuil.

Piketty, Thomas and Emmanuel Saez (2003). "Income Inequality in the United States, 1913–1998". In: *Quarterly Journal of Economics* CXVIII.1.

Piketty, Thomas, Emmanuel Saez, and Gabriel Zucman (2018). "Distributional National Accounts: Methods and Estimates for the United States". In: *Quarterly Journal of Economics* 133.2, pp. 553–609.

Piketty, Thomas, Li Yang, and Gabriel Zucman (2017). "Capital Accumulation, Private Property and Rising Inequality in China, 1978-2015". URL: http://www.nber.org/papers/w23368.pdf.

Rognlie, Matthew (2015). "Deciphering the Fall and Rise in the Net Capital Share". In: *Brookings Papers on Economic Activity* 46.1, pp. 1–69. URL: https://ideas.repec.org/a/bin/bpeajo/v46y2015i2015-01p1-69.html.

Roine, Jesper and Daniel Waldenström (2010). "Top incomes in Sweden over the twentieth century". In: *Top incomes: a global perspective*. Ed. by A. B. Atkinson and Thomas Piketty. Oxford University Press. Chap. 7, pp. 299–370.

Salverda, W. and A. B. Atkinson (2007). "Top incomes in the Netherlands over the twentieth century". In: *Top incomes over the 20th century*. Ed. by A. B. Atkinson and Thomas Piketty. Oxford University Press. Chap. 10, pp. 426–471.

Taleb, Nassim Nicholas and Raphael Douady (2015). "On the super-additivity and estimation biases of quantile contributions". In: *Physica A: Statistical Mechanics and its Applications* 429, pp. 252–260. ISSN: 03784371. DOI: 10.1016/j.physa.2015.02.038. URL: http://dx.doi.org/10.1016/j.physa.2015.02.038.

Wolfson, Michael, Mike Veall, and Neil Brooks (2016). "Piercing the Veil – Private Corporations and the Income of the Affluent". In: *Canadian Tax Journal* 64.1, pp. 1–25.

Zucman, Gabriel (2013). "The Missing Wealth of Nations, Are Europe and the U.S. net Debtors or net Creditors?" In: *Quarterly Journal of Economics* 128.3, pp. 1321–1364. DOI: 10.1093/qje/qjt012.Advance.

Appendix

Table A.1: Coverage of data sources

Country	Surveys	Tax data	Undistrib. prof.	Imp. rents	Tax data source	Quality score
Western Europe						
Austria	1987-2016		1995-2017	1995-2017		Medium
Belgium	1985-2016	1990-2016	1994-2017	1985-2017	Decoster, Dobbeleer, and Maes (2017)	High
France	1989-2015	1980-2014	1995-2017	1980-2017	Garbinti, Goupille-Lebret, and Piketty (2018)	Very high
Germany	1981-2016	1980-2013	1991-2017	1991-2017	Bartels (2017)	High
Ireland	1980-2016	1980-2015	2001-2017	1995-2017	Jäntti et al. (2007)	High
Luxembourg	1985-2016	2011	1999-2016	1995-2017	Authors	High
Netherlands	1983-2016	1981-2012	1990-2017		Salverda and Atkinson (2007)	High
Switzerland	1982-2016	1981-2014			Foellmi and Martínez (2017)	High
United Kingdom	1986-2016	1981-2014	1990-2017	1990-2017	Atkinson and Piketty (2007)	High
Northern Europe						
Denmark	1981-2016	1980-2010	1994-2017	1990-2017	Atkinson and Søgaard (2013)	High
Finland	1981-2016	1980-2009	1995-2017	1980-2017	Jäntti et al. (2010)	High
Iceland	2004-2015	1990-2016		2005-2014	Authors	High
Norway	1986-2016	1981-2011	1995-2017	1980-2017	Aaberge and Atkinson (2010)	High
Sweden	1981-2016	1980-2013	1995-2017	1980-2017	Roine and Waldenström (2010)	High
Southern Europe						
Cyprus	1990-2016			1995-2017		Medium Low
Greece	1995-2016	2004-2011	1995-2016	1995-2016	Chrissis and Koutentakis (2017)	High
Italy	1981-2016	1980-2009	1995-2017	1980-2017	Alvaredo and Pisano (2010)	High
Malta	2007-2016			2000-2017		Medium Low
Portugal	1980-2016	1980-2005	1995-2017	1995-2017	Alvaredo (2009)	High
Spain	1980-2016	1981-2012	1995-2017	1995-2017	Alvaredo and Saez (2010)	High
Eastern Europe						
Albania	1996-2012					Low
Bosn. & Herz.	1983-2011					Medium Low
Bulgaria	1980-2016					Medium
Croatia	1983-2016	1983-2013		2002-2012	Kump and Novokmet (2018)	High
Czech Republic	1980-2016	1980-2015	1993-2017	1993-2017	Novokmet (2018)	High
East Germany		1980-1988			Authors	Medium High
Estonia	1988-2016		1994-2017			High
Hungary	1982-2016	1980-2008	1995-2017	1995-2017	Mavridis and Mosberger (2017)	High
Kosovo	2003-2013					Medium Low
Latvia	1988-2016		1994-2017	1995-2017		Medium
Lithuania	1988-2016		1995-2017	1995-2017		Medium
Macedonia	1983-2014					Medium Low
Moldova	1993-2015					Low
Montenegro	1983-2014					Medium Low
Poland	1983-2016	1983-2015	1995-2016	1995-2016	Bukowski and Novokmet (2017)	High
Romania	1989-2016			2004-2013		Medium
Serbia	1983-2016			1997-2011		Medium
Slovakia	1980-2016		1995-2017	1995-2017		Medium
Slovenia	1987-2016	1991-2012	1995-2017	1995-2017	Kump and Novokmet (2018)	High

Table A.2: Average national incomes in Europe, 1980-2017

	Average national income per adult					% of European average income				
	1980	1990	2000	2007	2017	1980	1990	2000	2007	2017
European regions										
Europe	21160	24120	27600	30910	32130	100	100	100	100	100
EU-15 (West)	24010	27810	31930	34950	35250	113	116	116	113	110
EU-13 (East)	12940	13230	13440	17720	21690	61	55	49	57	68
Other West	35050	40960	48610	51900	51700	165	170	177	168	161
Other East	9100	8110	6460	8700	10080	43	34	23	28	31
Eastern Europe										
Albania	6630	5720	6670	9340	11000	31	24	24	30	34
Bosnia and Herzegovina	2540	2070	7750	9110	10630	12	9	28	30	33
Bulgaria	8450	10440	8760	12500	17080	40	43	32	41	53
Croatia	18370	16190	13680	18910	19070	87	67	50	61	59
Czech Republic	17660	20280	17100	21980	24260	83	84	62	71	76
Estonia	13130	15120	14320	23010	24700	62	63	52	75	77
Hungary	14200	15070	14710	18690	20890	67	63	53	61	65
Latvia	13180	15280	8920	17350	19510	62	64	32	56	61
Lithuania	14760	15560	11380	20390	24620	70	65	41	66	77
Macedonia	11160	9630	8680	9110	11140	53	40	32	30	35
Moldova	6010	6530	2350	3570	4880	28	27	9	12	15
Montenegro	19710	15160	10720	13560	15750	93	63	39	44	49
Poland	11550	10480	14630	17200	22510	55	44	53	56	70
Romania	11400	11920	10120	14830	19370	54	50	37	48	60
Serbia	12690	11520	6520	9950	11290	60	48	24	32	35
Slovakia	14180	15260	13710	20140	23980	67	63	50	65	75
Slovenia	22150	18020	19840	25170	24910	105	75	72	82	78
Southern Europe										
Cyprus	16950	26320	30890	37000	31270	80	110	112	120	98
Greece	21690	22180	24610	30110	20670	102	92	89	98	64
Italy	25280	28660	31820	32950	29450	119	119	116	107	92
Malta	14300	18310	23680	25660	33050	67	76	86	83	103
Portugal	14370	18670	22670	23070	23010	68	78	82	75	72
Spain	18770	23300	27230	29340	30230	89	97	99	95	94
Western Europe										
Austria	25400	29640	34700	38960	38930	120	123	126	126	121
Belgium	24850	29130	34380	37010	37610	117	121	125	120	117
France	24690	28480	32980	34930	35130	117	118	120	113	110
Germany	26740	29820	32520	35920	39420	126	124	118	116	123
Ireland	15590	20730	37870	42740	43960	74	86	138	139	137
Luxembourg	31040	54900	75660	89090	60010	146	228	275	289	187
Netherlands	32030	31590	39890	43840	43580	151	131	145	142	136
Switzerland	36070	42640	44940	45220	45530	170	177	163	147	142
United Kingdom	21070	25850	32300	37010	37490	99	108	117	120	117
Northern Europe										
Denmark	25740	29010	36040	41430	42410	121	121	131	134	132
Finland	20970	25420	31410	37760	35240	99	106	114	122	110
Iceland	27510	30430	35330	42800	45740	130	127	128	139	143
Norway	33810	38800	55480	63880	62510	160	161	202	207	195
Sweden	23470	27670	33860	41530	45880	111	115	123	135	143

Source: authors' computations. Serbia includes Kosovo. *Interpretation*: in 1980, Albania's average national income per adult was 31% of the European average (69% lower).

Table A.3: Shares of total European income received by rich versus poor countries in Europe, 1980-2017

Country groups	National income share (%)				
(deciles)	1980	1989	2000	2007	2017
1	4.6 %	4.4 %	3.0 %	3.9 %	4.8 %
2	5.9 %	5.6 %	5.2 %	5.8 %	6.8 %
3	7.8 %	8.0 %	7.7 %	8.2 %	7.9 %
4	9.4 %	9.6 %	10.5 %	10.0 %	9.2 %
5	10.0 %	10.8 %	11.6 %	10.8 %	9.9 %
6	11.2 %	11.4 %	11.7 %	11.3 %	11.0 %
7	11.7 %	11.7 %	11.8 %	11.6 %	11.7 %
8	11.9 %	11.9 %	11.9 %	11.8 %	12.1 %
9	13.0 %	12.7 %	12.1 %	12.0 %	12.3 %
10	14.5 %	13.9 %	14.5 %	14.5 %	14.3 %

Source: authors' computations. *Interpretation*: the poorest 10% countries in Europe (mainly Bosnia and Herzegovina, Albania, Moldova, Macedonia and Bulgaria) received 2.2% of European national income in 1980.

Table A.4: Annual income growth rates of rich versus poor countries in Europe, 1980-2017

Country groups	Average annual income growth (%)			
(deciles)	1980-1989	1989-2000	2000-2007	2007-2017
1	1.0 %	-2.2 %	5.6 %	2.4 %
2	1.0 %	0.4 %	3.2 %	2.1 %
3	1.7 %	0.8 %	2.5 %	0.1 %
4	1.7 %	2.0 %	0.9 %	-0.4 %
5	2.2 %	1.9 %	0.6 %	-0.5 %
6	1.7 %	1.5 %	1.1 %	0.1 %
7	1.4 %	1.3 %	1.4 %	0.4 %
8	1.4 %	1.2 %	1.5 %	0.6 %
9	1.2 %	0.8 %	1.6 %	0.6 %
10	0.9 %	1.7 %	1.6 %	0.2 %

Source: authors' computations based on data from the World Inequality Database. *Interpretation*: the average incomes of the poorest 10% countries in Europe (weighed by their adult population) grew by 1% per year on average between 1980 and 1989.

Table A.5: Performances of European countries in reducing inequalities, 1980-2017: bottom 40% versus average growth rates

	Difference between bottom 40% growth and average growth				
	1980-2017	1980-1990	1990-2000	2000-2007	2007-2017
Eastern Europe					
Albania				0.6	6.3
Bosnia and Herzegovina	-70.7	-0.4	-47.8	-3.0	-2.0
Bulgaria	-73.6	-0.5	-20.2	-13.4	-9.7
Croatia	-1.8	-7.6	3.9	-2.8	4.9
Czech Republic	-30.4	-4.4	-10.4	-6.0	-3.5
Estonia	-43.7	-17.0	-16.0	1.7	7.8
Hungary	-54.3	-7.5	-13.1	-24.0	-3.7
Kosovo				-1.5	15.2
Latvia	-37.2	-2.6	-11.6	-13.4	2.8
Lithuania	-51.7	-7.1	-11.3	-7.9	-10.2
Macedonia	-21.2	-0.8	-26.8	1.6	14.0
Moldova			-6.5	10.8	33.7
Montenegro	-8.9	-0.3	-5.7	-6.9	3.2
Poland	-60.7	-3.0	-28.8	-12.0	-0.1
Romania	-53.3	-0.3	-15.4	-38.2	18.1
Serbia	-28.3	-2.8	-10.6	-14.6	-4.6
Slovakia	-15.7	2.5	-12.2	-2.1	4.7
Slovenia	-28.7	0.0	-20.1	-3.0	-6.6
Southern Europe					
Cyprus			4.8	1.2	-10.1
Greece				34.8	-12.0
Italy	-25.5	-7.9	-11.9	0.9	-6.1
Malta				2.6	-16.8
Portugal	-36.1	-13.9	-16.0	0.0	-0.1
Spain	0.6	-2.9	7.7	-2.1	-1.8
Western Europe					
Austria	-6.7	0.2	2.4	-0.0	-6.3
Belgium	-14.9	-1.7	-6.1	-1.1	-2.5
East Germany		4.1			
France	-9.4	-11.8	-1.0	3.1	1.9
Germany	-32.3	-5.9	-4.5	-13.7	-3.2
Ireland	-55.5	-0.9	-17.7	-5.3	-6.3
Luxembourg	-21.7	-1.0	-5.8	-6.5	-0.9
Netherlands	-16.8	-3.9	10.3	-13.1	-4.1
Switzerland	-9.5	-3.4	-1.0	-0.9	-3.0
United Kingdom	-9.7	-15.0	-1.0	-1.0	9.6
Northern Europe					
Denmark	-15.8	-3.0	-1.1	4.3	-9.9
Finland	-9.2	7.9	-2.4	-1.1	-8.1
Iceland				-6.5	11.3
Norway	1.7	20.2	-17.6	-2.9	0.4
Sweden	-23.0	5.6	-0.3	-10.9	-8.1

Source: authors' computations.

Table A.6: Performances of European countries in reducing inequalities, 1980-2017: top 10% versus bottom 50% growth rates

	Difference between bottom 50% growth and top 10% growth				
	1980-2017	1980-1990	1990-2000	2000-2007	2007-2017
Eastern Europe					
Albania				2.8	12.0
Bosnia and Herzegovina	-162.3	1.1	-127.5	-6.2	-1.3
Bulgaria	-220.6	-24.9	-45.2	-12.2	-23.1
Croatia	-17.0	-16.3	-2.6	-3.3	8.4
Czech Republic	-110.1	-20.4	-37.1	-8.0	-6.6
Estonia	-100.2	-49.2	-39.8	10.8	23.3
Hungary	-176.7	-33.7	-40.3	-52.5	7.0
Kosovo				-6.0	24.0
Latvia	-100.8	-10.0	-33.6	2.5	-3.8
Lithuania	-125.5	-22.9	-23.9	-15.4	-11.5
Macedonia	-35.0	0.9	-36.1	-4.4	11.3
Moldova			-13.9	16.9	46.3
Montenegro	-24.2	1.3	-15.9	-11.6	0.1
Poland	-206.1	-12.1	-88.8	-23.3	-0.7
Romania	-111.3	-2.2	-40.5	-66.7	38.2
Serbia	-47.8	-3.6	-17.9	-20.5	-5.9
Slovakia	-37.7	3.1	-31.3	-4.1	13.5
Slovenia	-68.7	0.0	-49.1	-4.4	-11.8
Southern Europe					
Cyprus			13.9	4.5	-23.8
Greece				45.3	-18.1
Italy	-53.2	-20.2	-24.0	0.4	-5.5
Malta				11.5	-53.2
Portugal	-60.6	-26.6	-26.2	-2.1	5.5
Spain	-4.0	-4.5	11.4	-2.7	-6.3
Western Europe					
Austria	-22.2	-3.7	1.4	-4.2	-8.4
Belgium	-13.0	-4.5	-2.2	1.5	-4.6
East Germany		-6.6			
France	-15.1	-15.7	-2.8	-0.6	6.3
Germany	-62.3	-17.2	-5.5	-28.1	1.0
Ireland	-154.7	0.7	-49.4	-10.2	-18.3
Luxembourg	-37.7	-3.7	-11.2	-16.7	3.0
Netherlands	-32.4	-2.2	7.5	-26.1	-3.6
Switzerland	-28.5	-3.0	-9.0	-4.3	-6.8
United Kingdom	-47.3	-22.3	-12.9	-11.5	13.4
Northern Europe					
Denmark	-68.4	-7.6	-14.0	7.9	-29.2
Finland	-52.6	12.9	-34.3	2.2	-15.4
Iceland				-31.6	29.7
Norway	-27.1	32.3	-65.1	1.0	-1.1
Sweden	-71.9	3.0	-22.6	-16.0	-7.3

Source: authors' computations.

Figure A.1: Contributions to EU budget vs. net foreign incomes in the EU, 2017

(a) Contributions to EU budget (% GDP), 2017 (b) Net Foreign incomes in the EU (% GDP), 2017

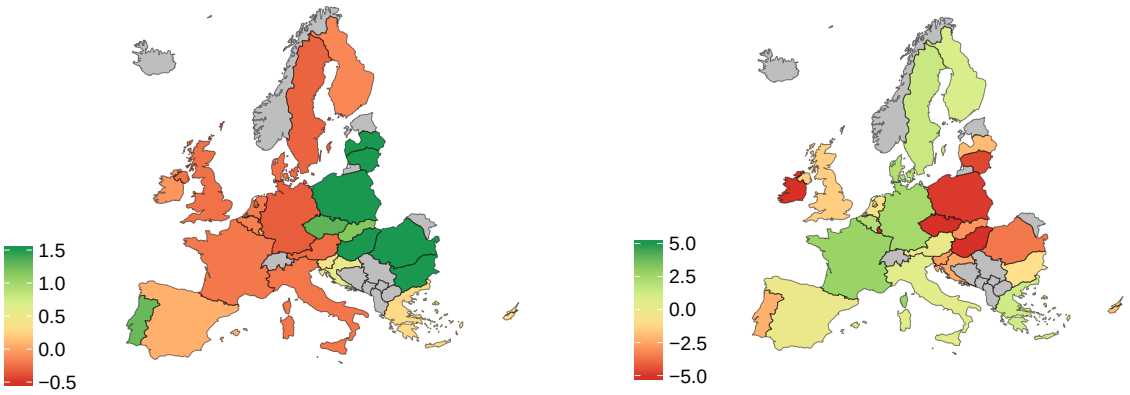


Figure A.2: Average incomes in Europe, 1980-2017: East vs. West

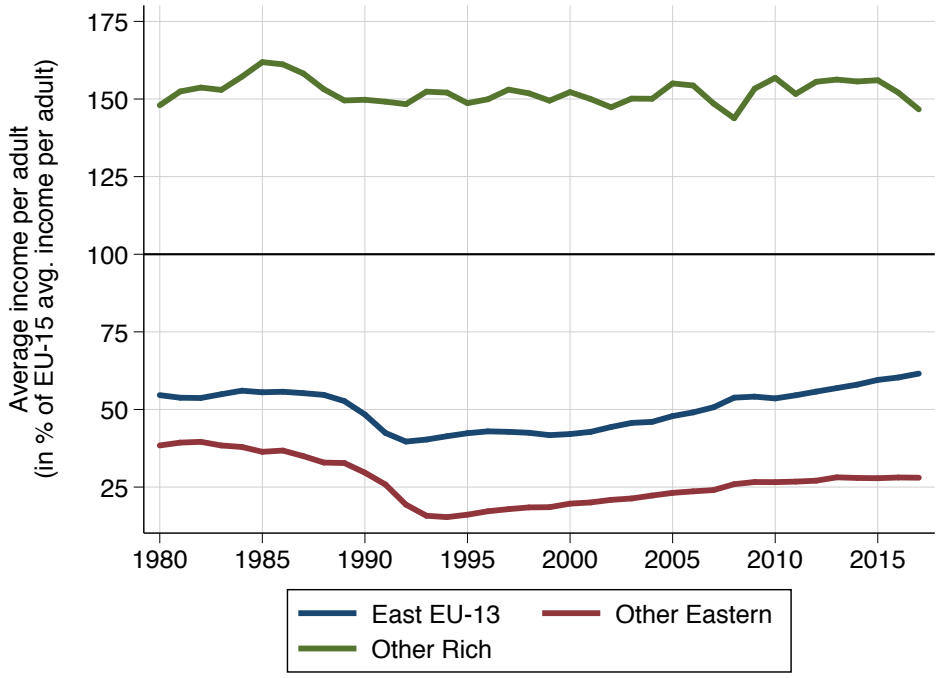
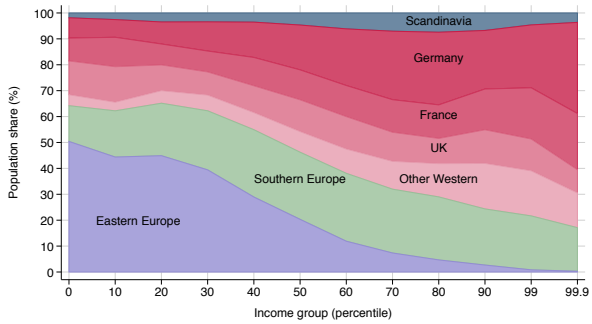
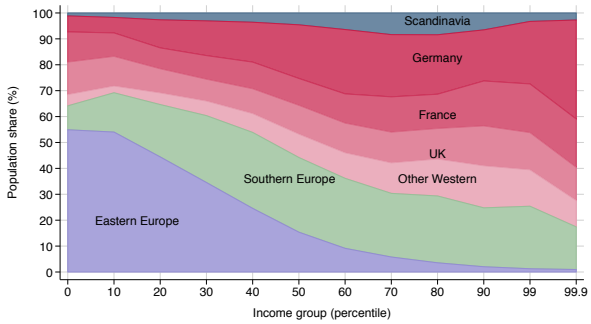


Figure A.3: Geography of European income inequality, 1980-2017

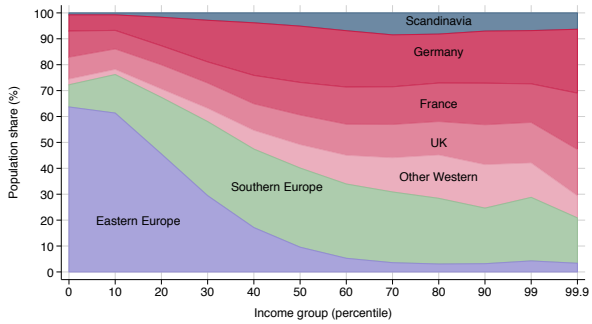
(a) 1980



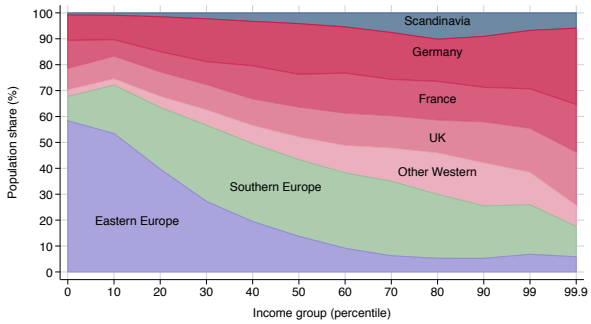
(b) 1990



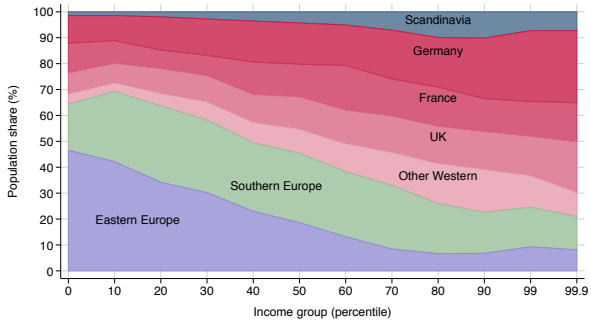
(c) 2000



(d) 2007



(e) 2017



Note: authors' computations. *Interpretation*: in 2017, 50% of individuals belonging to the European bottom 10% lived in Eastern Europe.

Table A.7: Average state incomes in the US, 1980-2017

	Average state income per adult					% of US average income				
	1980	1990	2000	2007	2017	1980	1990	2000	2007	2017
Alabama	25360	29540	34630	38170	38080	80	79	74	76	74
Alaska	106640	82770	60140	79880	78540	336	221	128	159	152
Arizona	30210	32330	42220	45480	40300	95	86	90	90	78
Arkansas	24130	27640	33540	36240	38540	76	74	71	72	74
California	35850	43060	53090	57590	58390	113	115	113	115	113
Colorado	35050	38240	54440	53960	54560	110	102	116	107	105
Connecticut	33710	48070	62880	69310	63620	106	128	134	138	123
Delaware	35300	48520	73120	67740	66300	111	130	155	135	128
District of Columbia	76470	99010	127110	157240	157160	241	264	270	313	303
Florida	24780	31070	38410	42310	38300	78	83	82	84	74
Georgia	28300	36610	49210	48320	46480	89	98	105	96	90
Hawaii	37000	47530	43280	50520	50510	117	127	92	101	98
Idaho	30030	32120	40420	40070	38920	95	86	86	80	75
Illinois	33800	40210	51610	53780	55690	107	107	110	107	108
Indiana	29130	33230	44130	45110	47870	92	89	94	90	92
Iowa	31830	33620	42110	48380	53390	100	90	90	96	103
Kansas	31760	35290	42920	47390	50530	100	94	91	94	98
Kentucky	27660	30890	36470	38230	40310	87	82	78	76	78
Louisiana	42720	39080	39890	50950	50580	135	104	85	101	98
Maine	24330	30920	36560	37610	37850	77	83	78	75	73
Maryland	29570	38050	46700	52900	55550	93	102	99	105	107
Massachusetts	31150	41830	57180	60100	62940	98	112	122	120	122
Michigan	30600	34660	46120	42310	42470	96	93	98	84	82

Table A.7: Average state incomes in the US, 1980-2017

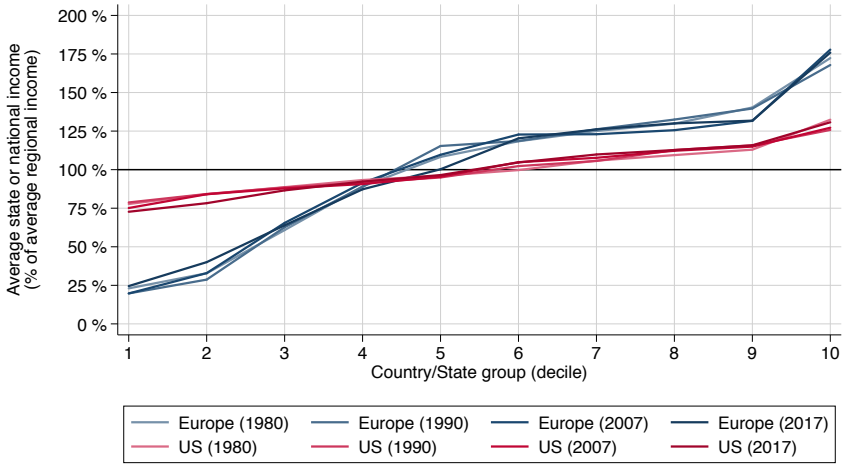
	Average state income per adult					% of US average income				
	1980	1990	2000	2007	2017	1980	1990	2000	2007	2017
Minnesota	33080	39250	50820	52470	55920	104	105	108	104	108
Mississippi	24310	26340	31230	33900	34290	77	70	66	67	66
Missouri	28220	33450	43790	42990	44500	89	89	93	86	86
Montana	31170	28580	31980	38940	41930	98	76	68	77	81
Nebraska	31410	36320	44350	49390	58960	99	97	94	98	114
Nevada	37430	41800	49140	53480	44630	118	112	104	106	86
New Hampshire	26590	34930	47160	48090	49260	84	93	100	96	95
New Jersey	31030	43910	54670	57450	57200	98	117	116	114	110
New Mexico	34180	30770	40940	43550	44000	108	82	87	87	85
New York	34690	43880	55880	59870	65620	109	117	119	119	127
North Carolina	26670	34250	43750	45690	45590	84	91	93	91	88
North Dakota	32270	30840	37000	46480	78220	102	82	79	92	151
Ohio	29970	34540	44950	44840	48690	94	92	96	89	94
Oklahoma	33190	31030	34800	42630	50080	105	83	74	85	97
Oregon	29760	32670	43900	47280	47460	94	87	93	94	92
Pennsylvania	27600	32970	41950	45620	49770	87	88	89	91	96
Rhode Island	26010	34170	41760	46520	47040	82	91	89	93	91
South Carolina	24320	31270	37260	37700	37430	77	83	79	75	72
South Dakota	27370	32260	41090	48210	53380	86	86	87	96	103
Tennessee	26120	31610	40710	41090	43360	82	84	87	82	84
Texas	39010	38520	47860	54370	59850	123	103	102	108	116
Utah	32030	35380	45550	52260	51140	101	94	97	104	99
Vermont	25530	34320	38670	40760	43230	80	92	82	81	83

Table A.7: Average state incomes in the US, 1980-2017

	Average state income per adult					% of US average income				
	1980	1990	2000	2007	2017	1980	1990	2000	2007	2017
Virginia	28980	38120	48400	52800	52360	91	102	103	105	101
Washington	33320	40260	52050	55690	57120	105	107	111	111	110
West Virginia	25310	25360	29460	32440	36960	80	68	63	65	71
Wisconsin	30230	34190	44100	45410	48000	95	91	94	90	93
Wyoming	61790	49820	46660	71810	69150	195	133	99	143	133

Source: authors' computations. Average state incomes per adult are expressed in 2017 dollars. *Interpretation*: in 2017, the average national income per adult in the state of Wyoming was about 88,000 dollars, corresponding to 111% of the United States' average national income per adult.

Figure A.4: Distributions of national/states incomes in Europe and the US, 1980-2017



Source: authors' computations. *Interpretation*: between 1980 and 2017, the poorest 10% countries in Europe have always earned less than 40% of the average European income. Meanwhile, in the US, the poorest 10% states have always earned more than 75% of the average federal income.

Table A.8: Redistribution in different parts of the distribution, 2010–2017

	Relative decrease through taxes and social assistance				
	top 10%/bottom 50%	top 1%/bottom 50%	top 10%/middle 40%	top 1%/middle 40%	middle 40%/bottom 50%
Western Europe	29.9%	34.1%	13.8%	18.9%	18.7%
Eastern Europe	13.5%	13.8%	5.2%	5.5%	8.9%
Southern Europe	21.5%	31.5%	14.9%	25.7%	7.8%
Northern Europe	21.6%	24.9%	11.4%	15%	11.6%
United States	38.2%	39.1%	13.1%	14.4%	28.9%

Source: authors' computations. *Interpretation*: In Western Europe, taxes and social assistance benefits decrease the ratio of the mean income of the top 10% to the mean income of the bottom 50% by 29.9% on average.

Table A.9: Share of imputed rents and retained earnings that belong to the top 10% of income earners

country	imputed rents	retained earnings
Austria	16%	56%
Belgium	15%	25%
Cyprus	16%	39%
Estonia	19%	37%
Finland	19%	75%
France	19%	69%
Germany	18%	47%
Greece	16%	62%
Hungary	14%	62%
Ireland	15%	56%
Italy	15%	62%
Latvia	17%	68%
Luxembourg	17%	53%
Malta	11%	73%
Netherlands	22%	24%
Poland	19%	52%
Portugal	20%	57%
Slovak Republic	14%	49%
Slovenia	14%	34%
Spain	15%	48%

Source: authors' computations using calibrated HFCS and EU-SILC data. *Interpretation*: In Austria, the top 10% of pre-tax income earners excluding imputed rents and retained earnings earned 16% of the economy's imputed rents, and 56% of the economy's retained earnings of corporations.

Table A.10: Mean relative error on the average by percentile when imputing pre-tax and post-tax income by adults from a different concept using the machine learning algorithm

		mean relative prediction error	
income/consumption concept	statistical unit	pre-tax income	post-tax income
consumption	equal-split per adults	10.1%	10.6%
consumption	equal-split per capita	10.6%	10.7%
consumption	households	11.0%	9.4%
consumption	OECD equivalence scale	9.8%	10.4%
consumption	square root equivalence scale	9.8%	9.8%
pre-tax income	equal-split per adults	n/a	5.7%
pre-tax income	equal-split per capita	4.2%	6.1%
pre-tax income	households	3.9%	6.8%
pre-tax income	OECD equivalence scale	2.6%	6.1%
pre-tax income	square root equivalence scale	2.8%	6.2%
post-tax	equal-split per adults	5.8%	n/a
post-tax	equal-split per capita	7.0%	3.8%
post-tax	households	7.1%	4.1%
post-tax	OECD equivalence scale	6.1%	2.2%
post-tax	square root equivalence scale	6.0%	2.7%

Source: authors' computations. *Note*: Error calculated only for the top 90% of the distributions to avoid problems of denominator equal to zero. *Interpretation*: When trying to impute pre-tax income per equal-split adult from consumption per household, the mean relative error for the average income of a given percentile is 11%.