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**Methodologies and Working papers**

# Inequality, growth and mobility: the inter-temporal distribution of income in European countries 2003-2007

**2010 edition**

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Eurostat is the Statistical Office of the European Union (EU). Its mission is to provide the EU with high-quality statistical information. To that end, it gathers and analyses data from the National Statistical Institutes (NSIs) across Europe and provides comparable and harmonised data for the EU to use in the definition, implementation and analysis of EU policies. Its statistical products and services are also of great value to Europe's business community, professional organisations, academics, librarians, NGOs, the media and citizens. In the social field, the EU Statistics on Income and Living Conditions (EU-SILC) instrument is the main source for statistics on income, poverty, social exclusion and living conditions.

Over the last years, important progress has been made in EU-SILC. This is the result of the coordinated work of Eurostat and the NSIs, *inter alia* in the context of the EU 'Living Conditions' Working Group and various thematic Task-Forces. Despite these significant achievements, EU-SILC data are still insufficiently analysed and used.

It is in this context that Eurostat launched in 2008 a call for applications with the following aims:

(1) develop methodology for advanced analysis of EU-SILC data;
(2) discuss analytical and methodological papers at an international conference;
(3) produce a number of publications presenting methodological and analytical results.

The 'Network for the Analysis of EU-SILC' (Net-SILC), an ambitious 18-partner Network bringing together expertise from both data producers and data users, was set up as in response to this call. The initial Net-SILC findings were presented at the international conference on 'Comparative EU Statistics on Income and Living Conditions' (Warsaw, 25-26 March 2010), which was organised jointly by Eurostat and the Net-SILC network and hosted by the Central Statistical Office of Poland. A major deliverable from Net-SILC is a book edited by Anthony B. Atkinson (Nuffield College and London School of Economics, United Kingdom) and Eric Marlier (CEPS/INSTEAD Research Institute, Luxembourg). It was published by the EU Publications Office (OPOCE) in December 2010 and can be downloaded free of charge from: (http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-31-10-555 )

The present methodological paper is also an outcome from Net-SILC. It has been prepared by Philippe Van Kerm (CEPS/INSTEAD, Luxembourg and ISER, University of Essex) and Marìa Noel Pi Alperin (CEPS/INSTEAD, Luxembourg and LAMETA, Université Montpellier I, France). Gara Rojas González was responsible at Eurostat for coordinating the publication of the methodological papers produced by Net-SILC members.

It should be stressed that this methodological paper does not in any way represent the views of Eurostat, the European Commission or the European Union. The authors have contributed in a strictly personal capacity and not as representatives of any Government or official body. Thus they have been free to express their own views and to take full responsibility both for the judgments made about past and current policy and for the recommendations for future policy.

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# Inequality, growth and mobility:
# the inter-temporal distribution of income in
# European countries 2003–2007[1]

Philippe Van Kerm
CEPS/INSTEAD, Luxembourg[2] & ISER, University of Essex, UK

Marìa Noel Pi Alperin
CEPS/INSTEAD, Luxembourg & LAMETA, Université Montpellier I, France

**Abstract:** This paper exploits longitudinal EU-SILC data 2003–2007 to describe the inter-temporal distribution of income in twenty-six European countries. We document levels, inequality and progressivity in the distribution of year-on-year income gains and losses and examine the consequences of these on inequality and poverty when, in contrast to the standard cross-section approach, incomes are aggregated over more than one year. The key observation is that new Member States have typically seen incomes grow faster than other countries, and inequality of gains has not necessarily been larger. However, on this last point, experiences have been diverse. Overall, over the short time span we are able to look at, income mobility makes little to reduce inequality of aggregated incomes. Furthermore potential issues about cross-country comparability of the data and the short period under consideration call for caution in interpreting our results.

**Keywords:** income mobility; income growth; inter-temporal inequality; EU-SILC

# 1. Introduction

Behind an 'economic growth' of $x$ percent hides a diversity of individual experiences. Some people see their income grow by a lot more than $x$ percent while others may be losing ground despite the economic growth. In contrast to some popular feelings, it is not necessarily the richest who are getting even richer (and the poorest poorer), at least if we look at annual flows of income. It has been well documented that there is 'income mobility' in modern societies with people moving up and down the income ladder over time, some escaping poverty while others are falling into deprivation. Understanding social benefits of economic growth requires detailed information about the diversity of individual experiences. This is what this paper provides on the basis of the European Union Statistics on Income and Living Conditions (EU-SILC). Who has gained and by how much? Who has lost? How unequally distributed have been gains (and losses) over time? Did they exacerbate social inequality or did growth and mobility had an equalizing impact, and by how much? This paper attempts to provide some answers to these questions, highlighting differences observable across twenty-six European countries, and between recent and older Member States in particular, in the period 2003–2007.

Our aim, more generally, is to show how EU-SILC longitudinal data can add to the cross-sectional picture on poverty and inequality in Europe. We provide a broad-brush picture of what can be learned empirically on these issues based on EU-SILC releases available to date, pointing out findings but also raising questions about the reliability of our observations.

We proceed by first documenting the distribution of individual income gains and losses in each of the twenty-six countries analyzed, emphasizing levels of income growth, but also aspects of inequality and progressivity. We then consider the impact of these income changes on poverty dynamics and assess how much income variations reduce inter-temporal inequality as compared to inequality of annual income. We find evidence of regression to the mean both across countries (with poorer countries showing higher average income growth) and within countries (with poorer individuals experiencing higher income growth). However, while inequality is reduced by extending the accounting period, over the duration covered by EU-SILC, this reduction is small and does not alter the relative position of countries. There is no evidence that countries with higher (cross-sectional) inequality compensate this with higher mobility. Similarly, in the short time frame and the countries considered, we find that indices of persistent poverty are closely related to cross-section poverty rates, so that higher poverty is not counteracted by more mobility. Caution is however required in interpreting our results as we find suggestive evidence that divergence in data collection methods across countries are influential; in particular estimates from countries using register data to collect income appear to differ in systematic ways from those relying on surveys.

The paper is organized as follows. Section 2 briefly describes the EU-SILC dataset, the sample we extracted therefrom, and details the income concept that we look at. Section 3 documents the distribution of income gains and losses. Section 4 focuses more specifically on the bottom of the distribution and describes some dynamic aspects of poverty. The impact of income mobility on medium-term inequality is considered in Section 5. Section 6 provides a discussion of our results and concludes the paper.

# 2. The longitudinal EU-SILC data, sample selection and the income concept

EU-SILC (European Union Statistics on Income and Living Conditions) is an instrument aiming at collecting comparable cross-sectional and longitudinal micro-data on income poverty and social exclusion. The micro-data on households and individuals available in EU-SILC are expected to be representative of the population living in private households in each of the participating countries. It has become the reference source for comparative statistics on income distribution and social exclusion in Europe. This instrument was developed to replace the European Community Household Panel (ECHP), supported and coordinated by Eurostat. EU-SILC has a legal basis making its implementation in EU Member States mandatory. The Council and European Parliament regulation 1177/2003 defines the scope of EU-SILC, provides definitions, time reference, data characteristics, sampling rules, sample sizes, etc.

It is important to note that while EU-SILC is based on a common framework with a common set of target variable definitions and rules, it is not a fully harmonized European-wide survey. Distinct data collection methods are being used in different countries within the framework provided by the regulations. Data sources of various types are being compiled, possibly differently for cross-sectional and longitudinal data. Target variables on income, for example, are collected from household surveys in some countries while they are extracted from administrative sources in other countries. Following pilot surveys in 2003, full-scale EU-SILC data collection was conducted in 15 countries in 2004, and in 25 countries in 2005. At the time of writing this paper, the data cover 26 countries (EU-27 minus Bulgaria and Romania, plus Norway and Iceland). The number is expected to reach around 30 countries, including all EU Member States.

The EU-SILC database contains a set of annual cross-section datasets since 2003 and a distinct set of longitudinal datasets covering overlapping periods of up to four years. The longitudinal datasets are based on a rotating panel sample. In the rotational design, the longitudinal sample is composed of several rotation groups, each of them similar in size and design and representative of the whole population. From one year to the next, one rotation group is dropped and replaced by a new one. The general rule for EU-SILC is a rotational design based on four replications, which implies that repeated, longitudinal observations on individuals are available for up to four years. The longitudinal components of EU-SILC are more limited in content and in sample size compared to the cross-section components. Details on the structure, content and design of the dataset are fully documented in Eurostat (2009*b*).

The analysis conducted in this paper exploits the three longitudinal datasets available to date, covering the periods 2003–2004–2005, 2003–2004–2005–2006 and 2004–2005–2006–2007. With the rotating design of EU-SILC we are able to analyze income changes from year $t-3$ to year $t$. Combining all three longitudinal datasets available, such an analysis over four years is possible for fourteen countries, among which only one of them is a new EU Member State (Estonia). Consequently, to provide a broader coverage of countries, we also analyze short-run income variations from one year to the next. This allows us to cover twenty-six countries: Austria (AT), Belgium (BE), the Czech Republic (CZ), Cyprus (CY), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (EL), Hungary (HU), Italy (IT), Iceland (IS), Ireland (IE), Latvia (LV), Lithuania (LT), Luxembourg (LU), the Netherlands (NL), Norway (NO), Poland (PL), Portugal (PT), the Slovak Republic (SK), Slovenia (SK), Spain (ES), Sweden (SE), and the United Kingdom (UK).

Our unit of analysis is primarily a *pair* of incomes for an individual measured at times $t-\tau$ and $t$ (income is defined shortly). To maximize sample sizes, we merged all three longitudinal datasets and pooled all $(t-\tau)$–to–$t$ income pairs available. With the rotational design of EU-SILC, each individual respondent can possibly provide up to three $(t-1)$–to–$t$ income transitions and one $(t-3)$–to–$t$ income transition.[3] Resulting sample sizes in each country are reported in Table 1. The table illustrates the substantial variations in sample sizes across countries, as well as the uneven distribution of the data over different time periods as not all countries provide data for all pairs of years.

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[3]By pooling data, we discard any potential effect of cyclical macroeconomic fluctuations in the time window considered.

**Table 1: Sample sizes: Number of ($t-\tau$)–to–$t$ individual income pairs by country and time period**

| | | ($t-1$)–to–$t$ | | | | | ($t-3$)–to–$t$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 03–04 | 04–05 | 05–06 | 06–07 | Total | 03–06 | 04–07 | Total |
| BE | (S) | | 6 533 | 7 444 | 9 212 | 23 189 | | 1 895 | 1 895 |
| CZ | (S) | | | 8 904 | 16 118 | 25 022 | | | |
| DK | (R) | 2 347 | 4 920 | 7 931 | | 15 198 | 2 290 | | 2 290 |
| DE | (S) | | | 21 647 | | 21 647 | | | |
| EE | (S) | | 9 020 | 10 177 | 9 487 | 28 684 | | 3 884 | 3 884 |
| IE | (S) | | 5 868 | 5 630 | | 11 498 | | | |
| EL | (S) | 7 948 | 10 188 | 9 783 | | 27 919 | 2 926 | | 2 926 |
| ES | (S) | | 20 242 | 21 251 | 21 190 | 62 683 | | 5 210 | 5 210 |
| FR | (S) | | 18 216 | 14 765 | 19 783 | 52 764 | | 11 576 | 11 576 |
| IT | (S) | | 38 347 | 36 669 | 35 308 | 110 324 | | 10 409 | 10 409 |
| CY | (S) | | | 7 841 | 7 554 | 15 395 | | | |
| LV | (S) | | | 6 675 | 6 755 | 13 430 | | | |
| LT | (S) | | | 7 581 | 8 279 | 15 860 | | | |
| LU | (S) | 7 517 | 7 809 | 8 041 | 8 371 | 31 738 | 5 565 | 5 844 | 11 409 |
| HU | (S) | | | 12 627 | 13 659 | 26 286 | | | |
| NL | (R) | | | 16 878 | 16 208 | 33 086 | | | |
| AT | (S) | | 7 850 | 9 194 | 10 961 | 28 005 | | 3 271 | 3 271 |
| PL | (S) | | | 31 484 | 29 931 | 61 415 | | | |
| PT | (S) | | 6 157 | 8 443 | 7 682 | 22 282 | | 2 483 | 2 483 |
| SI | (R) | | | 21 104 | 17 770 | 38 874 | | | |
| SK | (S) | | | 10 573 | 9 471 | 20 044 | | | |
| FI | (R) | | 13 356 | 12 398 | 11 682 | 37 436 | | 3 550 | 3 550 |
| SE | (R) | | 11 346 | 10 521 | 9 744 | 31 611 | | 2 925 | 2 925 |
| UK | (S) | | | 14 699 | 12 256 | 26 955 | | | |
| IS | (R) | | 5 213 | 4 826 | 4 615 | 14 654 | | 1 278 | 1 278 |
| NO | (R) | 9 664 | 11 436 | 9 061 | 7 455 | 37 616 | 6 220 | 6 227 | 12 447 |

Source: EU-SILC Users' database

Notes: (R) identifies countries relying on administrative registers for collecting household and individual income information. (S) refers to countries using survey data. Sample sizes are as used for estimating all measures reported in the core of the paper, namely after excluding any observation with missing, negative or extreme income at either time $t-\tau$ or time $t$, or with non-positive base sample weight at time $t$.

We follow standard practice in income distribution analysis and focus on variations over time in individualized single-adult equivalent household disposable income for the whole population. All members of a household at time $t$ are assumed to share equally total household income, adjusted by equivalence scales. Single-adult equivalent disposable income is generally considered as the best proxy for a person's contemporaneous standard of living. Specifically, household disposable income is computed as the sum over a period of twelve months and for all household members of gross personal income components (employee cash or near cash income; non-cash employee income; employers' social insurance contributions; cash benefits or losses from self-employment; unemployment benefits; old-age benefits; disability benefits and education-related allowances) plus gross income components at household level (income from rental of a property or land; family/children related allowances; housing allowances; regular inter-household cash transfers received; interests, dividends, profit from capital investments in unincorporated business; income received by people aged under 16) minus employer's social insurance contributions, interest paid on mortgage, regular taxes on wealth, regular inter-household cash transfer paid, income tax and social insurance contributions. This measure of annual household disposable income is then divided by the number of single adult equivalents in the household (according to the modified-OECD equivalence scale) to arrive at an individual measure of single-adult equivalent disposable income attributed to all household members.[4]

When trying to interpret results presented in this paper, it will be useful to bear in mind that a person's single adult equivalent income (to which we will refer simply as income) may vary through time for a variety of reasons: employment and labour market factors (e.g., tenure, promotion, job mobility, unemployment, retirement), but also household demographic factors (e.g., birth, death of a household member, divorce, "nest leaving"), as well as tax and benefit changes, evolution of returns on investments, of private transfers, etc. Some of these sources of variation are voluntary or at least within the control of individuals while others are beyond individuals' control. Some are foreseeable while others are not; some lead to gradual, limited changes while others take the form of large shocks; some are transitory in nature while others are persistent. When considering mobility of income, we look at the combined effects of these variations. It is beyond the scope of this paper to attempt to identify the sources of income variations in any detail.[5]

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[4]Dividing by the number of single adult equivalents in the household and not by the actual household size is meant to account for economies of scale in household consumption, thereby making comparisons of living standard across households of different size more meaningful.
[5]However, we summarize a "direct standardization"' analysis of these factors in Section 6.

Practically, we use the variable 'equivalent income' as directly provided in the EU-SILC user database (Eurostat, 2009*a*) deflated to 2005 prices using the harmonized index of consumer prices (available from Eurostat). All income changes we look at are therefore in real terms. A number of statistics estimated in this paper are sensitive to the presence of extreme and/or negative data, just like measures of inequality for example. To avoid presenting results driven by extreme data, we have recorded as missing any income smaller than 75% of the lowest percentile or higher than 125% of the highest percentile of the income series for each year and each country. The top and bottom percentiles of reference were estimated for each country and each year from the EU-SILC cross-section datasets. This recoding affected approximately one percent of the data in each country and year and stabilized estimates substantially compared to an alternative strategy to keep all incomes unrecoded (see Section 6).

We estimate standard errors for all statistics reported in the paper. All standard errors were estimated using the same bootstrap resampling procedure. All statistics have been re-estimated on 250 bootstrap samples drawn from the original EU-SILC user database. In drawing the bootstrap samples we attempted to approximate the original survey design as closely as possible with the information available in the data. This is only an approximation since identification of stratification variables is not released in the database for reasons of confidentiality and information about primary sampling units is partial. Also it was not possible to account for variability implied by data imputation and in the computation of sample weights. Our strategy was to sample households with replacement from each rotation group at the year of entry of the rotation group in the survey. This resampling was stratified by NUTS-1 region. To account for the dependence of the sample composition through time and within households we then select all members of the resampled households and all subsequent split-off household members originating from the resampled households. Bootstrap sampling was done using the repeated half-sample bootstrap algorithm of Saigo *et al.* (2001). Standard error estimates are based on the standard deviation of estimated indices over the 250 bootstrap replications. For any estimation in our pooled sample of income pairs, we use year $t$ base weights.

# 3. The magnitude and distribution of gains and losses

This first part of the paper illustrates the magnitude of income gains and losses in the different EU countries and documents the diversity of experiences observed within any given country. While conventional analysis of income distributions looks at the dispersion of income *levels* the focus here is on the distribution of income *changes* over time.

The building block of the analysis is a measure of individual income growth from one year to another. The gains of a person $i$ are captured by the *relative growth* of her income, that is by the value $\delta(y_i^1, y_i^2)$ in

$$\delta(y_i^1, y_i^2) = \exp(\ln(y_i^2) - \ln(y_i^1)) - 1 = \frac{y_i^2 - y_i^1}{y_i^1}$$

where $y_i^1$ and $y_i^2$ denote the income of person $i$ respectively in an initial year and in a final year. Two remarks are in order. First, while we will refer to people's income growth, nothing prevents $\delta(y_i^1, y_i^2)$ to be negative to reflect the reduction of a person's income. Second, with this measure of income growth, we are making an assumption that a gain from 100 to 150 is of the same magnitude as a gain from, say, 1000 to 1500 despite the fact that the growth in currency terms is higher in the second case. This has the effect of giving relatively more importance in our analysis to the currency gains of individuals with lower incomes, but this makes comparisons of growth figures more meaningful, especially when comparing individuals with different income levels, and more importantly in the context of this paper, when comparing aggregate values for countries with strikingly different income levels. However, be wary of this and realize that other choices could have been perfectly well justified.[6]

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[6]See for example Fields and Ok (1996), Fields and Ok (1999), D'Agostino and Dardanoni (2009) or Schluter and Van de gaer (2010) for relevant discussions.

Figure 1 establishes our point that the distribution of gains and losses is dispersed, with both winners and losers found in all countries, albeit in different proportions. Each row on the plot refers to a different country. The markers on the horizontal lines give the proportion of individuals observed (i) losing more than 25 percent of their income from year $t-1$ to $t$ (Figure 1) or $t-3$ to $t$ (Figure 1), (ii) losing at least some income, and (iii) gaining no more than 25 percent of income (the complement of the latter, that is, the proportion gaining more than 25 percent of income can be read from the distance to the right side of the plot; the closer the second cross to the middle of the plot, the greater is the proportion of "winners"). The number reported on the right hand side gives the mean relative income growth in the country. Countries are ordered from top to bottom by this value. New Member States labels are shifted to the right for ease of identification. In order to spot the potential impact of differences in data collection strategies on our estimates, countries relying on administrative, register data for collecting income information in EU-SILC are identified by orange and hollowed symbols, while gray and solid symbols are used for countries relying on survey data. All gains are in real terms.

While average income growth was positive in all countries, a substantial fraction of the population of many countries (between approximately 20 and 50 percent) experienced income losses. Up to 15 percent of people even experienced losses of more than a quarter of their initial year income. On the other hand, between 8 and 35 percent of the population had income gains larger than 25 percent between two consecutive years and the proportions go up to 12 to 60 percent if we compare incomes four years apart.

**Figure 1: Proportion of population (i) losing more than 25% of income, (ii) losing at least some income, (iii) losing some income or gaining no more than 25% of income**



(a) from year $t-1$ to $t$



(b) from year $t-3$ to $t$
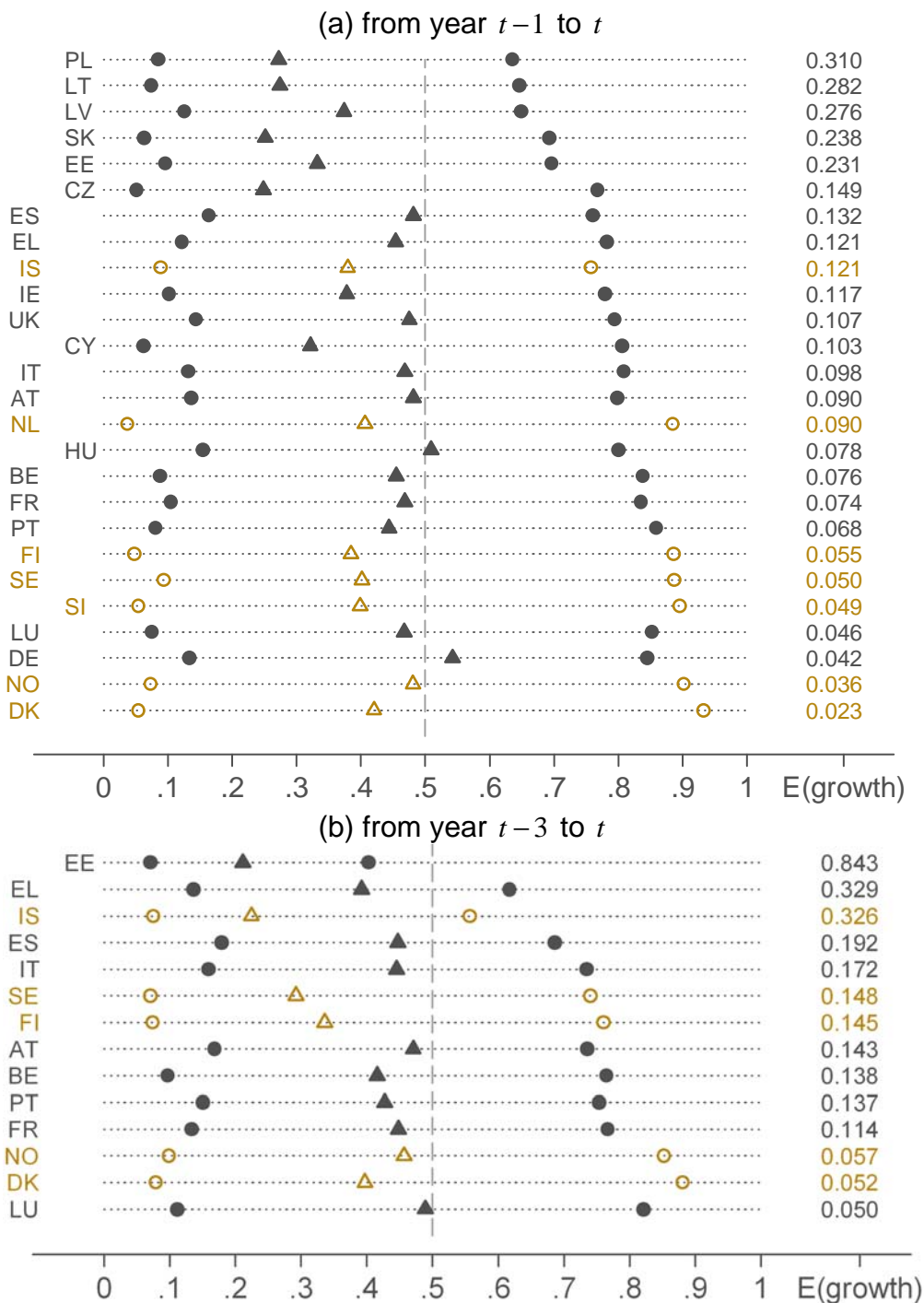
Source: EU-SILC Users' database

Reading note: Left-hand circles mark the proportion of individuals losing more than 25 percent of their initial income from year $t-\tau$ to $t$ in each country. Triangles mark the proportion of individuals with income at $t$ smaller than income at $t-\tau$. Right-hand circles mark the proportion of individuals losing income or not gaining more than 25 percent of their initial income. Countries are ordered from top to bottom by the value of the mean relative income growth which is reported on the right-hand side of the plot. New Member States labels are shifted to the right for ease of identification. Register countries are in orange hollowed markers.

To summarize the distribution of these gains and losses, we computed three types of indices. Each index emphasizes a distinct aspect of the distribution. The first, and simplest, is the mean relative income growth formally defined as

$$\text{E}(\delta; Y_1, Y_2) = \int_{\Omega_{\mathbf{y}}} \delta(y_1, y_2) dH(y_1, y_2)$$

where $\Omega_{\mathbf{y}}$ is the domain of all possible values for pairs $y_1$ and $y_2$, and $H$ is the joint, bivariate distribution of incomes in periods 1 and 2. This measure is indicative of the overall magnitude of income growth, but ignores the dispersion of individual experiences. Higher values for this measure will typically be preferred since they are indications of greater income gains.

The second measure is the mean absolute growth,

$$\text{E}(|\delta|; Y_1, Y_2) = \int_{\Omega_{\mathbf{y}}} |\delta(y_1, y_2)| dH(y_1, y_2).$$

This is often referred to as the Fields-Ok measure of income mobility (Fields and Ok, 1999). Such a measure is revealing of the degree of income volatility but treats gains and losses symmetrically. Greater dispersion in the gains and losses will translate into a larger value for this index. While this measure is indicative of the degree of variations in year-to-year incomes, something the mean income growth does not tell anything about, it is not obviously clear whether more of this is preferable or not. In particular this measure does not take into account whether incomes are growing or contracting.

Our third summary measure can be seen as a combination of the previous two. It is interpreted as an equally distributed equivalent income growth indicator computed as a weighted average of relative gains

$$W^{\upsilon}(\delta; Y_1, Y_2) = \int_{\Omega_{\mathbf{y}}} \omega(\delta(y_1, y_2); \upsilon)\delta(y_1, y_2)dH(y_1, y_2)$$

with

$$\omega(\delta(y_1, y_2); \upsilon) = \upsilon(1 - G(\delta(y_1, y_2)))^{\upsilon - 1}$$

where $G$ is the empirical cumulative distribution of the individual income growth indicators $\delta(y_1, y_2)$. It can be interpreted as a measure of income growth "deflated" by the degree of inequality in the income growth distribution. $W^\upsilon$ will be equal to the expected income gain in the hypothetical situation in which everyone has income growing in the same proportion. Any deviation from this equally distributed gain situation will result in a penalty that will reduce $W^\upsilon$ compared to $\mathrm{E}(\delta; Y_1, Y_2)$, provided the inequality aversion tuning parameter $\upsilon$ set to a value larger than one, that is, provided we want to penalize inequality in the gains distribution. $W^\upsilon$ can be interpreted as an 'equally distributed equivalent' index of relative income growth, and for example, countries with high average growth but very unequal gains will not appear to perform as well as in terms of $\mathrm{E}(\delta; Y_1, Y_2)$. This measure is a variant of classes of mobility measure axiomatically justified by Demuynck and Van de gaer (2010). It also leads to ranking countries in a way that is consistent with the dominance criteria suggested in Fields *et al.* (2002).

Estimates of these three summary measures are presented in Figure 2. As in Figure 1, countries are ordered from top to bottom by expected relative income growth and estimates are read off the abscissa of the plot. For each country, expected relative income growth is marked on the horizontal line by a circle, expected absolute income growth is marked by a triangle and equally distributed equivalent growth is marked by a square. Bootstrap variability bands are reported as shaded bars behind each point estimate (variability bands around point estimates are bootstrap standard errors times +/- 1.64).

**Figure 2: Estimates of expected relative income growth, expected absolute income growth and equally distributed equivalent income**

(a) from year $t-1$ to $t$



(b) from year $t-3$ to $t$
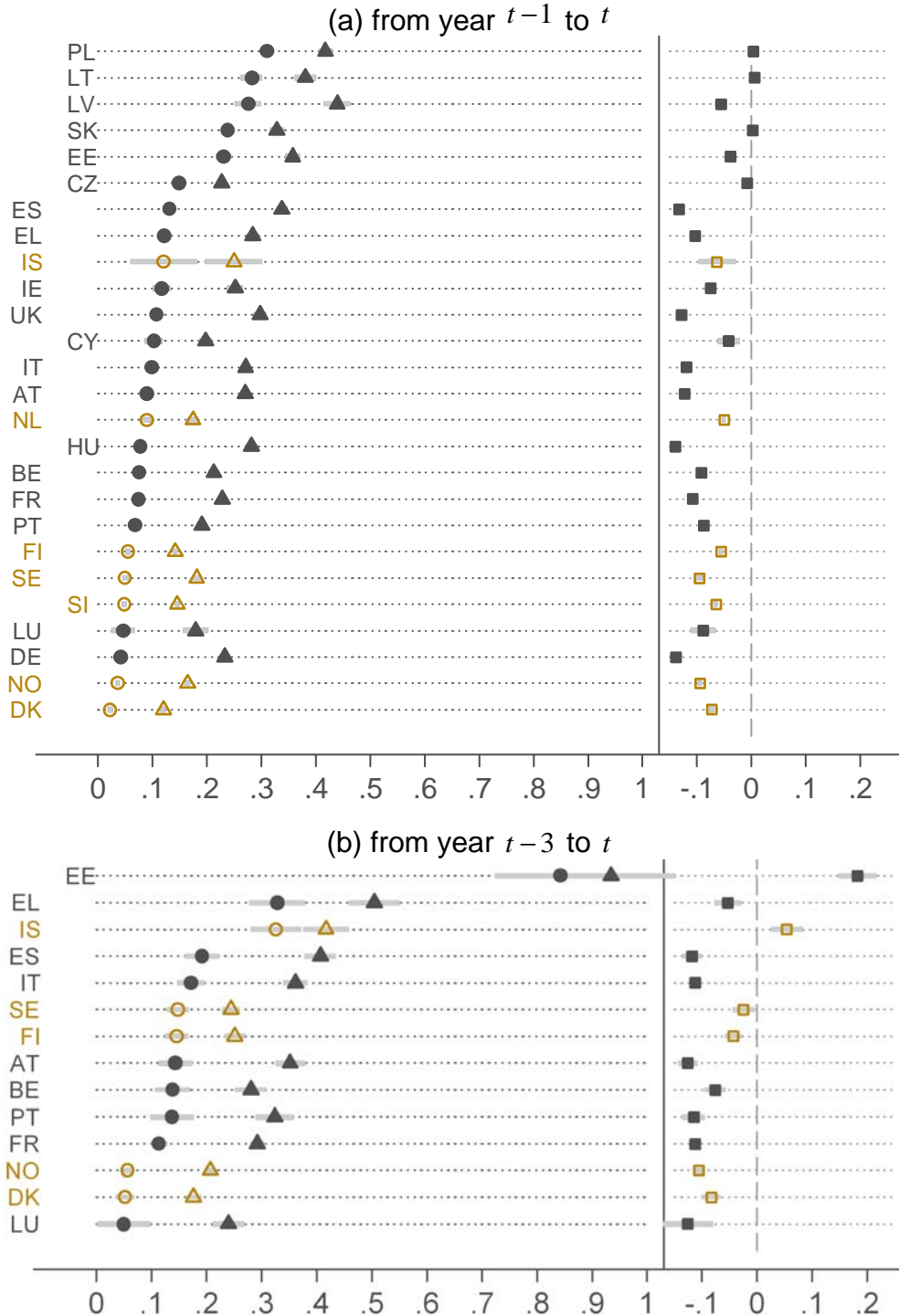


Source: EU-SILC Users' database

Reading note: Circles mark expected relative income growth ($\mathrm{E}(\delta; Y_1, Y_2)$). Triangles mark expected absolute income growth ($\mathrm{E}(|\delta|; Y_1, Y_2)$). Squares mark equally distributed equivalent growth ($W^2(\delta; Y_1, Y_2)$) Countries are ordered from top to bottom by the value of the expected relative income growth. Horizontal stripes show bootstrapped 1.64-standard-error variability bands. New Member States labels are shifted to the right for ease of identification. Register countries are in orange hollowed markers.

The prime observation is that countries with highest expected income growth are all recent EU Member States, namely all three Baltic states, Poland and Slovakia, as well as, to a lesser extent the Czech Republic. These are also countries with lower levels of income to start with. By contrast, expected income growth in Cyprus, Slovenia and Hungary has not been different from that of most other EU countries. Countries with the lowest expected growth tend to be those richest in levels. This suggests that catching up, or regression-to-the-mean, is taking place across EU countries.

Looking at expected absolute income growth reveals a different picture. Although it tends to be higher in countries with high expected income growth, it turns out be almost as high in countries such as Spain, the United Kingdom or Hungary, despite them having lower expected growth. This suggests that incomes have been particularly volatile, both upward and downward, in these three countries. On the other hand, income volatility appears smaller in the Netherlands, Slovenia or most Scandinavian countries. It is disturbing to note that estimates of income volatility appears in general smaller in EU-SILC 'register countries'. While sampling variability appears small with the sample sizes available in the dataset, there is indication of potential non-sampling error in the form of bigger measurement error in countries using survey data. We return to this issue in Section 6.

The ranking of countries changes when income growth is penalized by the inequality in the gains and losses. If Poland, Lithuania and Slovakia still exhibit the best performance, the Czech Republic appears to catch up with them almost entirely, thanks to a relatively equal distribution of gains and losses despite their smaller size. Scandinavian countries also appear to perform better than in terms of expected growth only. By contrast, four countries appear to perform substantially worse than others in this respect, namely Spain, the United Kingdom, and more surprizingly, Germany and Hungary.[7] The situation of Hungary is particularly perplexing in that it is not in line with observations made for all other new EU Member States. The message conveyed by the equally distributed equivalent index of income growth is clearly that looking at expected income growth may lead to misleading conclusions if one cares about inequality in gains.

The equally distributed equivalent income growth index incorporates the notion of inequality in gains and losses in the summary assessment of growth: inequality in gains and losses is penalized. There is however a related concern about the distribution of gains and losses that is not taken into account by this approach, namely whether those who start with lower income obtain higher gains. Inequality in gains and losses might after all be desirable if people with

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[7]Some authors have cautioned against potential problems in the German EU-SILC data (Hauser, 2008, Frick and Krell, 2010). Frick and Krell (2010) identified striking differences in measures of income mobility estimated from the German EU-SILC data and from the German Socio-Economic Panel (SOEP) data. Divergence between EU-SILC and alternative data sources has also been reported for Hungary (Lelkes *et al.*, 2009, p.44).

low incomes at the initial period get high income gains and richer people get lower growth (or suffer the losses). In other words, borrowing concepts from the taxation literature, it might be desirable if the distribution of gains and losses is 'progressive'. Such a distribution of gains and losses would, ceteris paribus, tend to reduce inequality of aggregate incomes and inequality in the second period (to the extent that this is not entirely offset by reranking among individuals). This issue is discussed in Bénabou and Ok (2001) and Jenkins and Van Kerm (2006). Another summary index is needed to capture the degree of progressivity of gains and losses. We follow Van Kerm (2009) and estimate

$$P^{\upsilon}(\delta;Y_1,Y_2) = \int_{\Omega_y} \omega(y_1;\upsilon)\delta(y_1,y_2)dH(y_1,y_2)$$
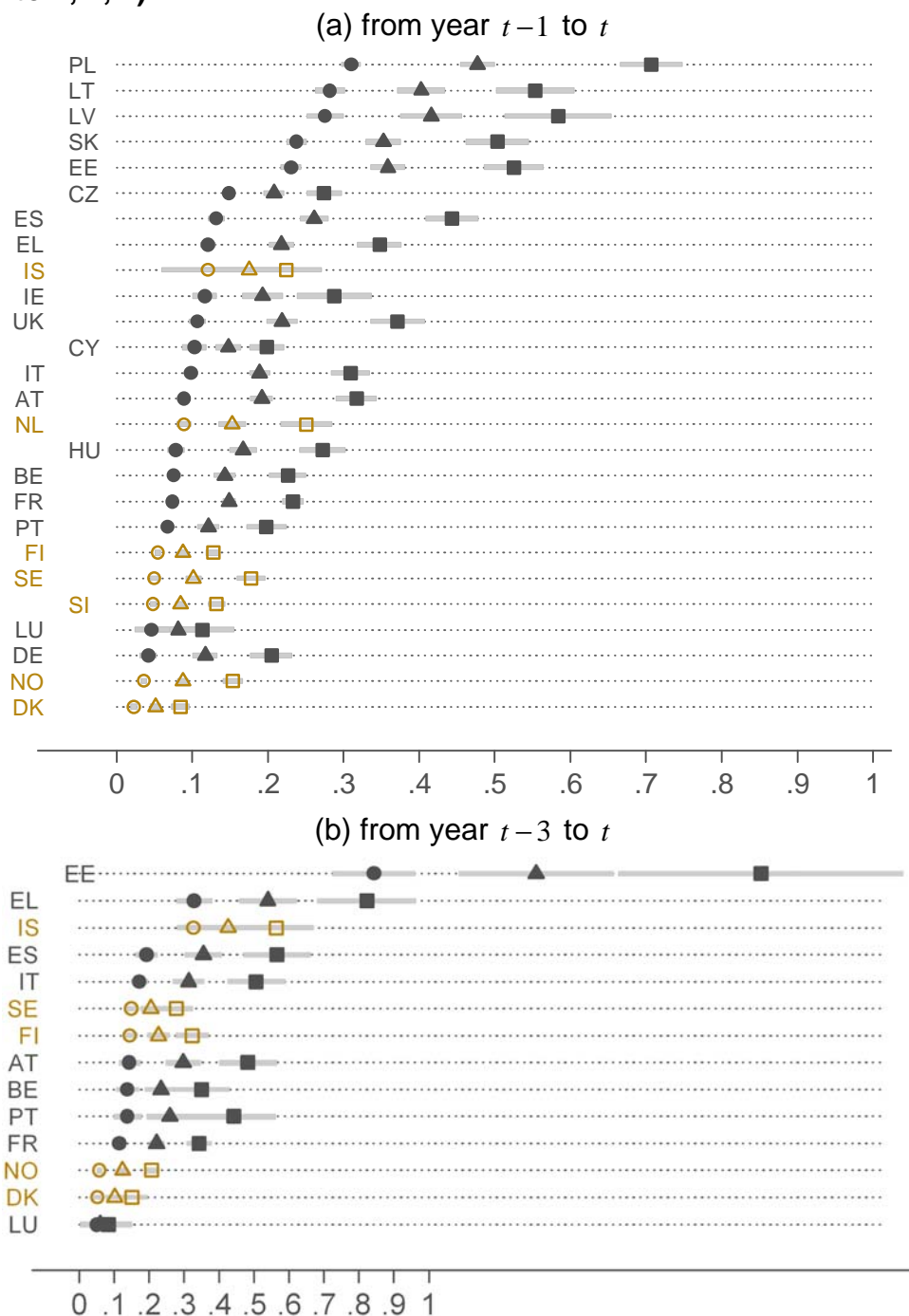
with

$$\omega(y_1;\upsilon) = \upsilon(1 - F_1(y_1))^{\upsilon-1}$$

where $F_1$ is the empirical cumulative distribution of individual income at the initial period. Clearly, this measure bears much similarity with the $W^{\upsilon}$ index. The only, but crucial, difference is that the weight is determined by a person's rank in the initial period income distribution. $P^{\upsilon}(\delta;Y_1,Y_2)$ is a weighted average of income gains with weights determined by initial income position. The value of $P^{\upsilon}(\delta;Y_1,Y_2)$ is therefore disproportionately driven by the income growth of initially poor people and measures the degree of regression-to-the-mean in income within countries. It can also be interpreted as a uniformly distributed equivalent income growth as if gains and losses were uniformly distributed over all income ranks in the initial distribution.

Estimates of the progressivity index $P^{\upsilon}(\delta;Y_1,Y_2)$ for $\upsilon$ equal to 1, 2 and 4 are shown in Figure 3. (The case of $\upsilon = 1$ is, in fact, the expected relative income growth.) The main observation is that income growth is clearly progressive. Increasing $\upsilon$, that is, putting more weight on low income people, leads to higher values for the uniformly distributed equivalent growth indices. This holds in all countries. However, the degree to which this is the case varies by country. Poland is the country exhibiting the highest level of progressivity. Interestingly, Spain, the United Kingdom and Germany –countries that were identified as having the most unequally distributed growth– exhibit a substantially higher degree of progressivity. Conversely, the Czech Republic appears to perform relatively badly with regard to the degree of progressivity in its income growth. While this is not necessarily true in principle, it appears that there is a tension between achieving progressivity in income growth and keeping the income gains relatively equally distributed. Hungary is again an exception since progressivity does not appear particularly high despite the high inequality in the distribution of gains and losses.

The progressivity analysis concludes our description of the distribution of gains and losses. We now examine the implications of these income variations on poverty dynamics (Section 4) and inter-temporal inequality (Section 5).

**Figure 3: Estimates of uniformly distributed equivalent income growth ($\upsilon$ equal to 1, 2, 4)**



(a) from year $t-1$ to $t$

(b) from year $t-3$ to $t$

Source: EU-SILC Users' database

Reading note: Circles mark estimates of uniformly distributed equivalent income growth with $\upsilon = 1$ which boil down to be the expected relative income growth ($P^1(\delta; Y_1, Y_2) = \mathrm{E}(\delta; Y_1, Y_2)$). Triangles mark estimates with $\upsilon = 2$ ($P^2(\delta; Y_1, Y_2)$) and squares mark estimates with $\upsilon = 4$ ($P^4(\delta; Y_1, Y_2)$). Countries are ordered from top to bottom by the value of the expected relative income growth. Horizontal stripes show bootstrapped 1.64-standard-error variability bands. New Member States labels are shifted to the right for ease of identification. Register countries are in orange hollowed markers.

# 4. Poverty dynamics

Results from Section 3 show that relative income gains are substantially larger for people with a low income at the initial period. A direct consequence thereof is that many people in poverty at a point in time manage to escape from it the following year and poverty rates measured at a point in time are not reflecting accurately neither the proportion of people in long-term poverty, nor the overall proportion of people ever affected by poverty over several years. Note however that while *relative* gains of people at the bottom of the distribution may be large, this is not a guarantee that the *nominal* gains are sufficiently large to move people above the poverty line, or at least well above the poverty line. Furthermore, with the typical definition of the poverty line as a fraction of some reference income (mean or median), countries with large average income gains will also see their poverty line rise at the same time. So the effect of mobility on poverty dynamics is not unambiguous.

Figure 4 illustrates this phenomenon: (i) triangles indicate poverty exit rates (the fraction of individuals in poverty at time $t-\tau$ that are not poor at time $t$), (ii) squares indicate poverty entry rates (the fraction of individuals not in poverty at time $t-\tau$ that are poor at time $t$), (iii) circles indicate the cross-section poverty rates, and (iv) crosses mark the value of the Laeken indicator of 'persistent at-risk-of-poverty' rate (that is the proportion of people poor at $t$ that are also poor in at least two of the three previous years) which is only defined for the $t-3$ to $t$ samples. Countries are ordered from top to bottom by decreasing level of poverty entry rate. As is conventional, we define a person as poor if her income is below a poverty line set at 60 percent of her country's median income.[8]

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[8]We estimated the value of the poverty line at each year from the EU-SILC cross-section datasets.

## Figure 4: Poverty exit and entry rates, poverty rates and 'persistent at-risk-of-poverty' rates

### (a) from year $t-1$ to $t$



### (b) from year $t-3$ to $t$
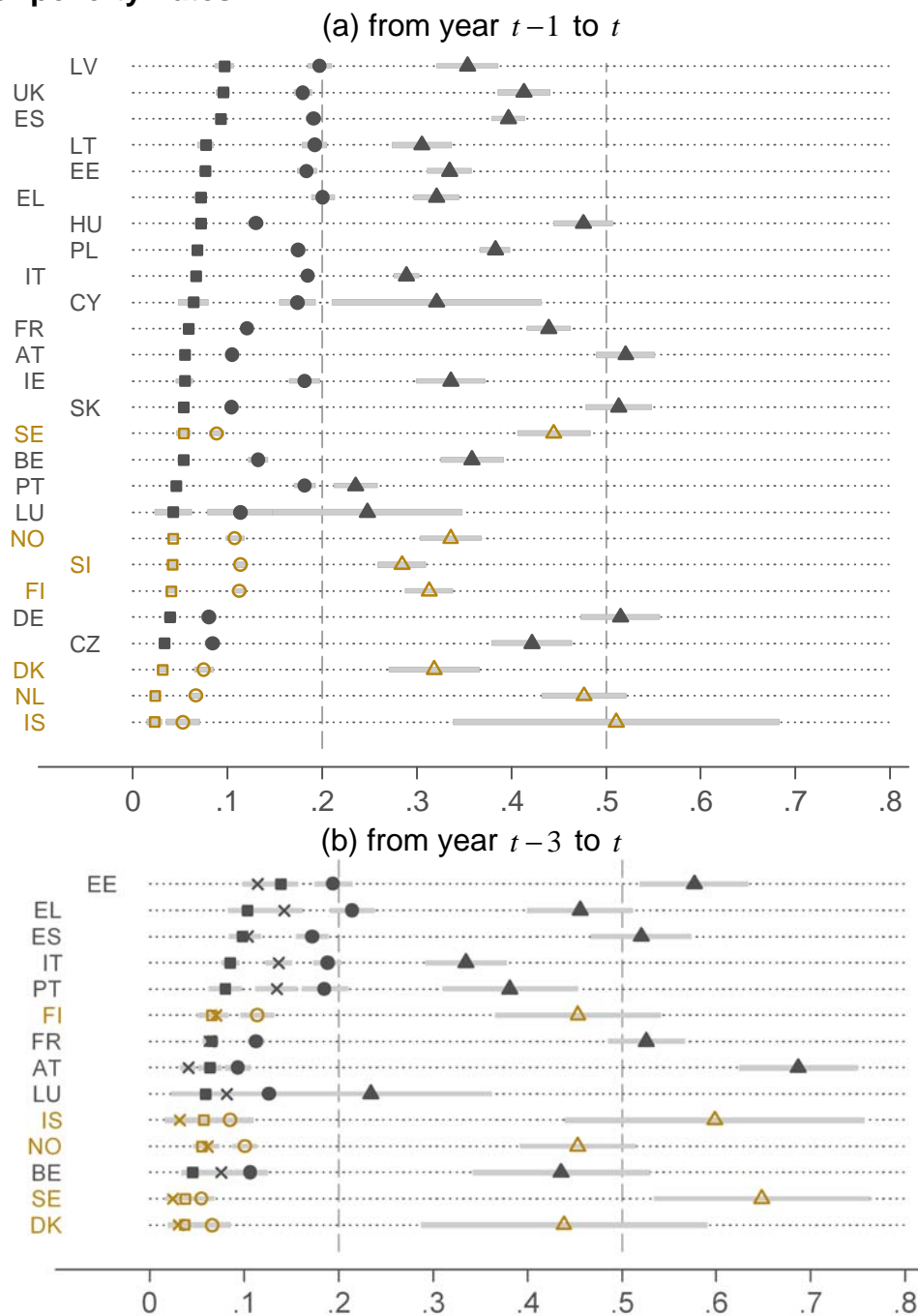


Source: EU-SILC Users' database

Reading note: Squares mark poverty entry rates. Circles mark cross-section poverty rates. Triangles mark poverty exit rates. Crosses mark estimates of the Laeken indicator of 'persistent at-risk-of-poverty' rate (that is the proportion of people poor at $t$ that are also poor in at least two of the three previous years); this is only defined for the $t-3$ to $t$ samples. Countries are ordered from top to bottom by decreasing level of poverty entry rate. Horizontal stripes show bootstrapped 1.64-standard-error variability bands. New Member States labels are shifted to the right for ease of identification. Register countries are in orange hollowed markers.

Our first observation is the great variety in exit rates which range from approximately 0.25 to 0.50 between $t-1$ and $t$ and from 0.25 to 0.70 between $t-3$ and $t$. Surprizingly, poverty exit rates do not appear to be related in any systematic way to our earlier statistics on expected income growth or even to uniformly distributed equivalent income growth measures. Countries with, say, an exit rate above 0.5 do not seem to have particularly high measures of progressivity. We should however be careful here when looking at country rankings because the poverty exit rates appear to have large standard errors.

Our second observation is that poverty rates are closely related to entry rates, whereas there is hardly any correlation with exit rates.[9] Some observations on the impact of poverty dynamics on poverty rates can however be made if we look at some specific cases. Take for example the four countries with the highest poverty rates (about 20 percent) in Figure 4, namely Estonia, Greece, Italy and Portugal. The first two are the countries with the highest entry rates while the last two are those with the lowest exit rates (with Luxembourg). Poverty in Greece and Estonia is therefore expected to be more 'dynamic' than in Italy and Portugal. However this only translates in a lower value for the Laeken indicator of 'persistent at-risk-of-poverty' for Estonia. On this last index also, we observe a close association with the entry rate and the poverty rate. In fact, it turns out that country rankings with respect to poverty rates and 'persistent at-risk-of-poverty' rates are almost identical.

Finally we note again an association between the estimated indices and the income data collection method, in particular with regard to the poverty rate and the entry rate.

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[9]See Jenkins and Cappellari (2009) for similar results on the dynamics of social assistance benefits receipts in Britain.

# 5. Income mobility and inequality in the medium term

Differential income gains and regression-to-the-mean in income described in Section 3 imply that inequality of income is smaller when several years of income flows are aggregated. This section examines how much this is the case in the different countries and whether this leads to any significant alteration in the apparent relative 'performance' of the different countries. Is there any support for a claim that countries with higher inequality in one year compensate this with higher mobility and, consequently, achieve similar levels of inequality when incomes are aggregated over several years?

Evidence reported in Figure 5 provides answers to this question. Circles on these plots indicate the average level of annual inequality as estimated from our sample, with inequality measured by the Gini coefficient.[10] Countries are ordered from top to bottom by decreasing level of annual inequality, with Portugal and Baltic States at the top and mostly Scandinavian countries at the bottom. Triangles mark the value of the Gini coefficient of aggregated incomes. In Figure 5a, aggregate income is merely the average of respondents' income for years $t-1$ and $t$. In Figure 5b, aggregate income is the average over the four years from $t-3$ to $t$. As demonstrated in, e.g., Shorrocks (1978), to the extent that there is mobility in income that is not merely a proportional growth in everyone's income –and estimates from earlier sections clearly show that this is far from the truth–, inequality of aggregated income will necessarily be lower than in the cross-sections. The question of interest is 'by how much?' According to Figure 5 the answer seems to be 'little': inequality is only moderately reduced if incomes are pooled over a few years. The squares on each figure give the value of the relative difference between (the average of) annual inequality and inequality of aggregated incomes –a measure that is frequently used as an index of mobility in its own right Shorrocks (1978)–. The reduction of inequality observed by averaging incomes over two years is stronger in Austria, Slovakia, Germany, and Hungary (despite its relatively low degree of progressivity of income growth). It is the lowest in Portugal which cumulates both the highest annual inequality and the lowest inequality reduction from aggregating income over time. Overall there does not appear to be any systematic relationship between the degree of annual inequality and the Shorrocks index, and therefore no support for a claim that higher mobility compensates for higher inequality among European countries – the case of Portugal being the clearest counter-example.

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[10]Our estimates may differ from values estimated elsewhere from the EU-SILC database for two reasons. First, we report averages over several years of the Gini coefficient and, second, we estimate the indices on our pooled longitudinal sample whereas the dataset of choice for estimation of annual inequality would typically be the EU-SILC cross-section data.

**Figure 5: Average annual inequality, inequality of aggregated $t-1-t$ income and Shorrocks index**

(a) from year $t-1$ to $t$



(b) from year $t-3$ to $t$
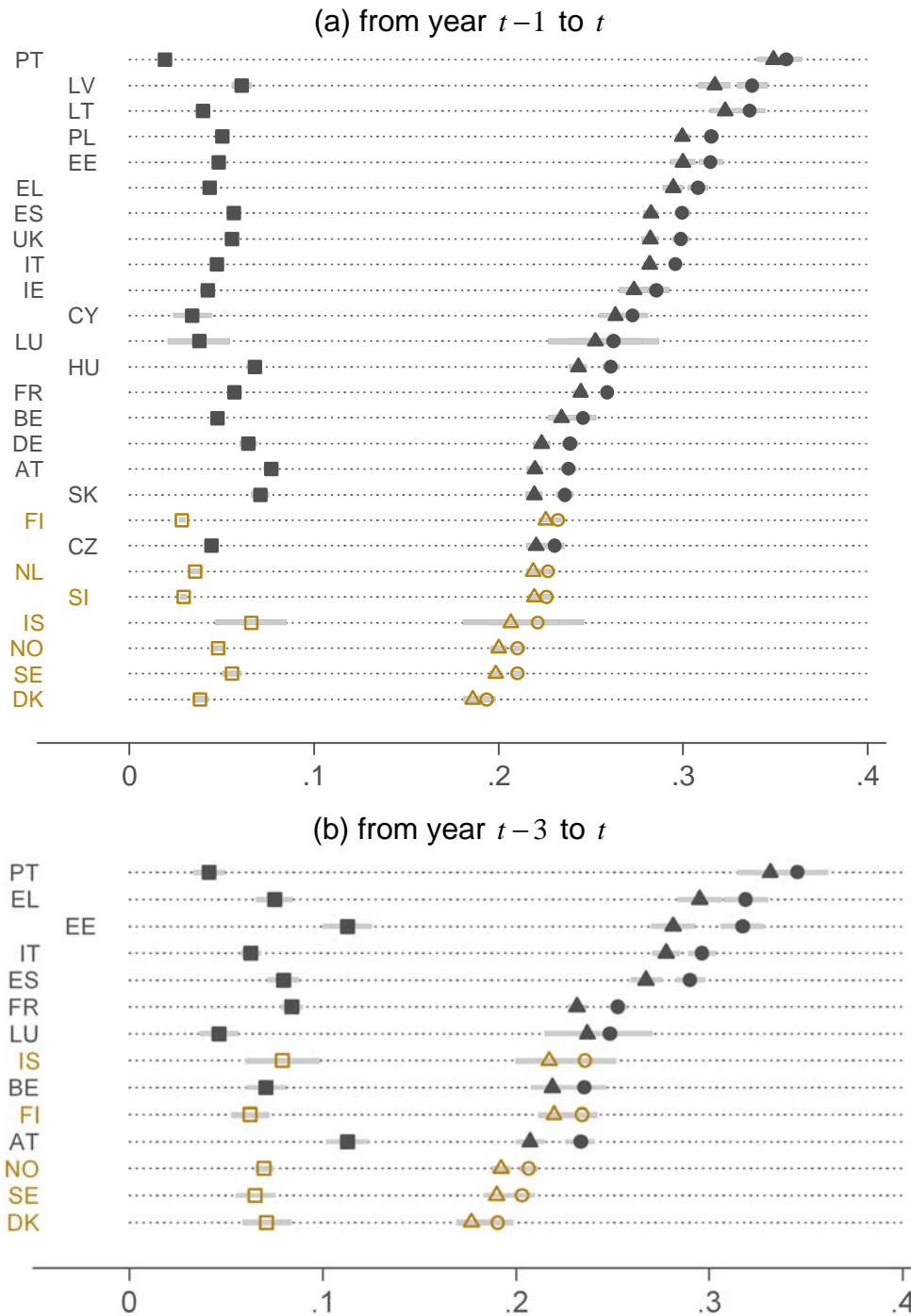


Source: EU-SILC Users' database

Reading note: Circles mark average level of annual inequality (Gini coefficient). Triangles mark the Gini coefficient of multi-period aggregated incomes. Squares mark the relative difference between annual inequality and inequality of aggregated incomes. Countries are ordered from top to bottom by decreasing level of annual inequality. Horizontal stripes show bootstrapped 1.64-standard-error variability bands. New Member States labels are shifted to the right for ease of identification. Register countries are in orange hollowed markers.

# 6. Discussion

## 6.1 Mean income, inequality and measures of income mobility

At this stage, we have covered and documented key aspects of the distribution of gains and losses and their impact on poverty and inequality. We attempt to wrap up this discussion here by relating our statistics to the degree of cross-section inequality and mean income. We do this informally by visual inspection of the patterns of the different indices in Figure 6a (where countries are sorted in decreasing order of mean income) and Figure 6b (where countries are sorted in decreasing order of inequality). We limit our analysis to the short-term, $t-1$ to $t$, estimates. In addition to the statistics shown earlier of expected relative income growth, expected absolute relative income growth, uniformly distributed equivalent growth, poverty entry and exit rates, and Shorrocks' index, we report two additional mobility indices that are frequently reported in analyses of income mobility, namely, the so-called Hart index

$$H(Y_1, Y_2) = 1 - r(\log(Y_1), \log(Y_2))$$

which captures the correlation of incomes over time ($r(\bullet, \bullet)$ denotes Pearson's correlation coefficient) and the average jump index

$$AJ(Y_1, Y_2) = \int_{\Omega_{\mathbf{y}}} |F_1(y_1) - F_2(y_2)| \, dH(y_1, y_2)$$

where $F_t$ is the CDF of period $t$ incomes, that discards all information about income changes but focuses on the degree of reranking in the distribution implied by the income mobility over time. Circles are used for recent EU Member States and triangles indicate a former EU15 Member State or Iceland and Norway.

**Figure 6: Contrasting statistics of mean income and inequality with income change and mobility indices**

(a) countries sorted by mean income
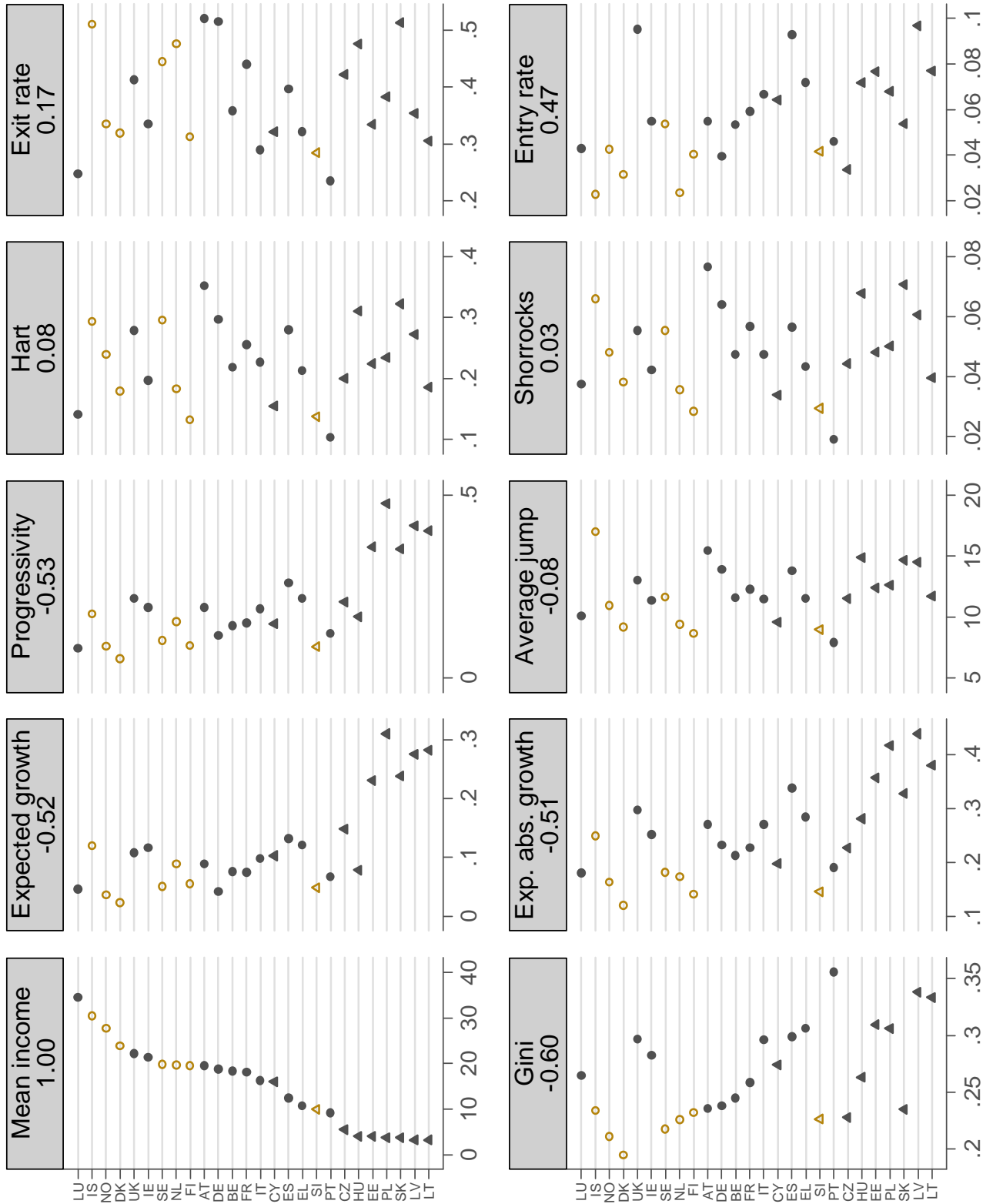
## (b) countries sorted by Gini coefficient
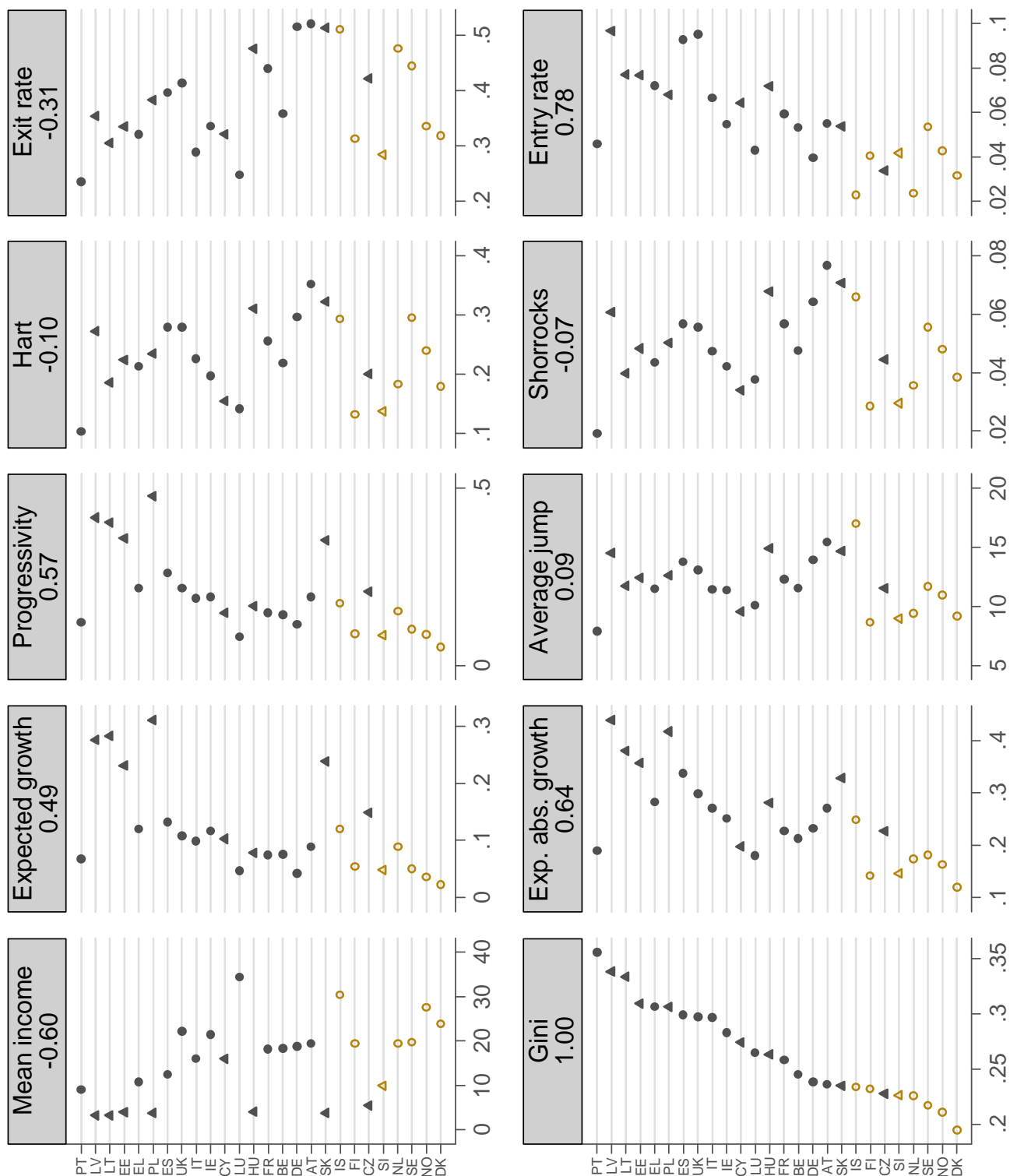


Source: EU-SILC Users' database

Reading note: Triangles mark estimates for new Member States, circles are used for other countries. Register countries are in orange hollowed markers. The numbers in each panel heading is the rank correlation with the country ordering variable (mean income (top) or Gini coefficient (bottom)).

A birds-eye view on these plots reveals a number of broad patterns. First, expected income growth is inversely related to the level of income, with low income countries experiencing bigger growth than richer countries. Second, this holds true if we consider uniformly distributed equivalent measures that focus on initially poorer people. Third, income volatility is closely related to annual inequality with more unequal countries also having more income volatility in income. Fourth, Shorrocks' index, Hart index and the average rank jump measure are highly correlated with each other but appear unrelated to mean income, inequality or any of the other summary measures of the distribution of gains and losses. These observations are confirmed by rank correlations. Now, if we look more closely at the situation of the different countries with respect to these ten summary statistics, it is difficult to draw any sharp conclusion. No clear patterns appear to emerge, beyond the catching up of new Member States. Even among this group of countries, experiences in terms of inequality in gains and losses, progressivity or reduction of long-term inequality have been diverse.

## 6.2 Accounting for cross-country differences?

A second element of discussion is about the explanations for the observed cross-country differences. Accounting for such a complex combination of results is complicated, and a task well beyond the scope of this paper. This is due both to the complexity of the measures themselves at an aggregate level and to the fact that potential causes of income gains and losses at the individual level are multiple and interdependent, as emphasized in Section 2. However, we have conducted a simple analysis to shed some light on the potential broad causes of the cross-country differences. Broadly speaking we attempted to quantify the amount of cross-country differences that can be accounted for by (i) differences in population composition (by age), (ii) differences in household demographic dynamics (crudely captured by the rate of change in household sizes) and (iii) differences in labour market dynamics (crudely captured by the rate of change in the number of workers in households from one year to another). Our analysis is an exercise of "direct standardization" as in Van Kerm (2004); an approach now popularly referred to as the DiNardo *et al.* (1996) reweighting technique. We have re-estimated our various summary measures for all countries after standardizing the population composition, the household demographic dynamics and the labour market dynamics to those observed in a baseline country, namely Italy (because the Italian sample is the largest available to us).

We do not report detailed results of this analysis in this paper for the reason that it did not lead to any useful conclusion. Unsurprizingly, standardization of the factors considered leads to more similar estimates of the various measures across countries. However the degree to which cross-country differences are accounted by our factors is typically small and often negligible. We are therefore left with large "unexplained" variations across countries that can not be explained merely by differences in demographic or labour market dynamics: it is what happens to people's income *given* demographic or labour market changes (or the absence thereof) that leads to most of the cross-country differences in the distribution of gains and losses. This seems to suggest that the welfare state and redistributive policies likely play a key role, but our analysis does not allow us to assert this in any conclusive way.

## 6.3 Measurement error

Our third element of discussion is about the overall reliability of our estimates. Like most indices used to summarize the income distribution in a cross-section perspective, the measures used in our analysis are sensitive to extreme data (van Praag et. al., 1983, Cowell and Schluter, 1998, Cowell and Flachaire, 2007, Van Kerm, 2007). Their relative frequency in the different country datasets and how we have treated them may possibly affect our observations. Additionally, measurement error –not necessarily in the form of outlying data– poses specific problems in analyses of income dynamics. The reason for this is simple. Imagine a simple 'classical' measurement error case in which incomes in our data are recorded with some purely random error. If the error is uncorrelated through time, then this will lead to apparent variations in income over time that might be entirely spurious. This problem is notoriously difficult to deal with (see, e.g., Bound and Krueger, 1991, Gottschalk and Huynh, 2010), in particular as measurement error is typically non-classical and the implications thereof are not unambiguous.[11] In the present analysis, our concern is that the degree of measurement error might differ from country to country according the survey design and thereby biasing our cross-country comparisons. Of obvious concern is the difference between countries using registers to collect income versus those relying on surveys. We have noted clear differences in some of our estimates, with respect to inequality (Figure 6b), income volatility (Figure 2), progressive income growth (Figure 3), or poverty rates and poverty entry rates (Figure 4). Note for example how Slovenia differs from the other new Member States in terms of many of these measures. Of course these differences might also be related to true differences between countries using register data, notably Scandinavian countries, and the survey countries because of their different institutions, welfare state, etc.

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[11]Gottschalk and Huynh (2010), for example, show that combination of non-classical error components may offset each other and lead to estimates of some mobility measures which are less affected than measures of inequality.

We have run a series of simple robustness checks in order to assess whether, and how much, measurement error and the treatment of extreme data might be driving our observations. The checks consisted in re-estimating all our measures on alternative subsamples. One subsample was composed of all available data with the exclusion of only negative incomes. This first subsample was therefore larger than the one we based all estimates reported so far on. A second subsample was being more protective in the treatment of extreme data: we dropped from our analyses observations of income growth based on an income above the top percentile or beyond the bottom percentile in any of the two years. This is a relatively common strategy in income mobility analyses. Considering that self-employment income is typically prone to measurement error, in a third subsample we also dropped all observations with income that include some self-employment earnings (or profits) in any of its components. Of course this reduces our sample sizes substantially (by between 15 percent and 45 percent, depending on country) and makes it not representative of the total population, but it allows us to assess basic robustness of the main conclusions. Finally we considered two subsamples from which we dropped all observations for which income is recorded has having been imputed by more than 10 percent or by more than 25 percent (or if household inflation factors have been used). For obvious reasons, imputation introduces measurement error and is likely to affect income change data. But the direction and magnitude of the influence will vary with the imputation models used in the different countries. Applying this deletion of imputed data further reduced our samples to between 30 percent and 70 percent of the original sample (but note that for several countries, it was not possible to identify imputed data reliably from the EU-SILC database and these were therefore dropped form this last robustness check).

To save space, we only summarize the main observations and do not report detailed results here. The first lesson we can draw from this exercise is that elimination of the most extreme data is needed for meaningful estimation of the type of measures we have used here. Our measures are not robust (in a statistical sense) and seem indeed to be driven arbitrarily large if we do not exclude the largest or smallest observations as in our first subsample. But estimation on the more conservative subsample than the one we primarily relied on did not further modify our estimates in any significant way. Second, removing the influence of self-employment income had relatively significant impacts, yet not extremely large in magnitude. In almost all cases, our various indices of income growth and mobility were reduced in size. The extent of this reduction varied in different countries –with countries most strongly affected being Greece, Spain and Italy– but reassuringly the broad patterns of cross-country differences in the various dimensions considered remained largely unchanged. Similar observations hold after removing the imputed data. Finally, the results pointed again to the 'register'/'survey' distinction. Register countries were affected in much smaller ways by our redefinition of estimation samples. This suggests that differences observed in our main analysis between register countries and survey countries are likely to be related in a non-negligible way to different influences of measurement error, and not just due to 'real', substantive differences. Interpretations should therefore be cautious.

# 7. Conclusion

Analysis of the distribution of gains and losses and their impact on medium-term inequality is worthy of investigation in its own right, beyond inspection of annual, cross-section income distributions. The availability in EU-SILC of longitudinal information on income for a broad set of countries is unique for this, and there is particular interest in monitoring the patterns of income dynamics in the most recent EU Member States. This paper has aimed to provide a first, broad-brush picture of what early releases of EU-SILC can reveal on these questions.

While some empirical regularities are identified –such as regression to the mean within and across countries or the limited inequality-reducing impact of mobility in the short-run –, no clear picture emerges from the analysis, especially when we try to link individual mobility to indicators of poverty dynamics. Understanding the inter-temporal distribution of income and how different aspects of it relate to each other remains relatively complex, both conceptually and empirically. The literature on the measurement of income mobility and inequality does not provide, to date, clear guidance or a unified framework about *how* this issue should be analyzed. The approach adopted in this paper to look primarily at the distribution of a particular individual income change indicator –namely the relative, or proportionate, growth in income– is one of potentially many other strategies. Empirical difficulties, such as one posed by measurement error and how it affects different aspects of the inter-temporal distribution of income, also need to be faced. The impact of relying on register or survey sources for income appears non-negligible in this respect; this is of concern given the design of EU-SILC.

Much remains to be done to go beyond the purely descriptive approach followed in this paper and to understand the mechanisms explaining the patterns observed. The simple reweighting approach attempted in this paper did not reveal successful as much of the income variations did not appear to be explained by changes in major household employment or demographic changes. A more refined analysis with more detailed definition of employment or demographic changes and/or with analysis by income source is needed, but this was beyond the scope of this paper. Any attempt will however be faced with measurement error issues outlined above, but also with well-known issues related to the mismatch between the income definition period (as of previous calendar year) and the time at which most employment and demographic characteristics are recorded (see, e.g., Debels and Vandecasteele, 2008).

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