Society for the Study of Economic Inequality

Working Paper Series

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ECINEQ WP 2015 - 368

ECINEQ 2015 - 368
July 2015

www.ecineq.org

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Abstract

A long-lasting scientific and policy debate queries the impact of growth on distribution. A specific branch of the micro-oriented literature, known as 'pro-poor growth', seeks in particular to understand the impact of growth on poverty. Much of that literature supposes that the distributional impact should be measured in an anonymous fashion. The income dynamics and mobility impacts of growth are thus ignored. The paper extends this framework in two important manners. First, the paper uses an 'intertemporal pro-poorness' formulation that accounts separately for anonymous and mobility growth impacts. Second, the paper's treatment of mobility encompasses both the benefit of "mobility as equalizer" and the variability cost of poverty transiency. Several decompositions are proposed to measure the importance of each of these impacts of growth on the pro-poorness of distributional changes. The framework is applied to panel data on 23 European countries drawn from the 'European Union Statistics on Income and Living Conditions' (EU-SILC) survey.

Keywords: pro-poorness, income mobility, growth, poverty dynamics.

JEL Classification: D31, D63, I32

*We are very grateful to Philippe Van Kerm and Roberto Zelli for helpful suggestions and comments. This work has been carried out with support from Fonds National de La Recherche Luxembourg, SSHRC, FRQSC and the Partnership for Economic Policy (PEP), which is financed by the Government of Canada through the International Development Research Centre and the Canadian International Development Agency, and by the UK Department for International Department and the Australian Agency for International Development.

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1 Introduction

A long-lasting micro/macro-economic question of interest deals with the dynamic relationship between growth and distribution. There is, in particular, a specific branch of the micro-oriented literature, known as 'pro-poor growth', that is generating continuous attention both scientifically and policy-wise, with the main objective of assessing the extent to which poverty changes over time because of growth. A number of different analytical tools have been developed in the associated pro-poor growth literature for that purpose (see, *inter alia*, Ravallion and Chen, 2003, Son, 2004, Essama-Nssah, 2005, Essama-Nssah and Lambert, 2009, Duclos, 2009).

A common feature of these tools is that the identity of the growth beneficiaries is irrelevant in the analysis; that is, the analytical tools satisfy an 'anonymity' property. Anonymity is a standard property for the measurement of poverty and inequality, requiring that distributive measures be invariant to a permutation of individual income vectors. This is an often uncontroversial assumption and is in particular perfectly agreeable if the aim is to understand the purely cross-sectional effect of growth. Postulating anonymity implies that income dynamics are then ignored, namely that the mobility experience taking place because of growth is not of normative and measurement interest.

To see this, consider the following two separate transformations A and B, from one time period to another, undergone by a distribution of income of four individuals:

$$(4,6,9,9) \underset{A}{\rightarrow} (9,9,4,6), \tag{1}$$

$$(4,6,9,9) \underset{B}{\rightarrow} (4,6,9,9), \tag{2}$$

and assume that the poverty line is fixed to 7 in both periods. A common procedure to evaluate the pro-poorness of such income transformations is to compute the Rate of Pro-Poor Growth (RPPG, Ravallion and Chen, 2003), which would be equal to 0 for transformation A as the final marginal distribution of income is strictly identical to the initial marginal distribution. This would be true for all other measures of pro-poorness that can be expressed as functions of poverty in each single period of time.[1] The RPPG would also be equal to 0 for the transformation B. The income dynamics otherwise implied by A and B are, however, quite different: A leads to considerable mobility whereas B does not

[1] See for instance the indices proposed by Kakwani and Pernia (2000) and Kakwani and Son (2003).

and we may therefore wish their degree of pro-poorness to differ.

Because of this, recent contributions have argued that pro-poor and welfare judgments of the effect of growth should be based on a 'non-anonymous' perspective (see notably Grimm, 2007, Jenkins and Van Kerm, 2011, Bourguignon, 2011, Palmisano and Van de gaer, 2013, Palmisano and Peragine, 2014). Proponents of this emphasize the role played by mobility in the distributional effects of growth. While both the measurement of growth pro-poorness and the measurement of mobility are quite developed (see for instance Fields and Ok, 1999, Fields, 2008, Jäntti and Jenkins, 2015, for significant reviews), the analysis of the impact of mobility on growth pro-poorness is yet to be developed to our knowledge.

To distinguish the analysis of intertemporal pro-poorness from the standard analysis of pro-poor growth, we first consider the individual poverty trajectories over time. Second, consistent with Friedman (1962), we let growth pro-poorness be sensitive to the equalization effect of mobility on the distribution of permanent incomes. Third, we also let growth pro-poorness depend on the variability cost introduced by mobility, since time variability may reduce welfare if individuals are risk averse.

Whether growth is pro-poor is then determined by comparing observed intertemporal poverty with a benchmark consisting of the absence of any kind of distributional change. A natural benchmark for this is the poverty experienced in the first period replicated over the other periods.

Our measurement framework draws from Bibi, Duclos, and Araar (2014), who measure the welfare implication of mobility accounting for the cost of inequality across time and across individuals. However, their contribution is silent on the impact of growth and mobility on poverty (see also Gottschalk and Spolaore, 2002, Creedy and Wilhelm, 2002, Makdissi and Wodon, 2003).

This paper further explores various pro-poorness features of growth through a set of three additive decompositions. The first decomposition separates the measurement of anonymous growth from that of non-anonymous growth. The second decomposition isolates the unitemporal effects of income changes from multitemporal ones. The third decomposition separates the contribution of changes in inequality, reranking and pure growth in explaining the pro-poorness of growth.

Note that this paper's approach is both methodologically and conceptually different from previous contributions on the topic. For instance, Grimm (2007) introduces an Individual Rate of Pro-Poor Growth (IRPPG) which, being equivalent to the average income growth of the initially poor individuals divided by the proportion of those individuals in the population, specifically focuses on the impact of growth on the initially poor and ignores the negative income effects of those who experience deprivation after growth. Foster and Rothbaum (2012) use cutoff-based mobility measures to explain variations of poverty over time. However, their method only applies to two specific indices measuring snapshot poverty, namely the headcount ratio and the average poverty gap.

The contribution of this paper is thus twofold. The first is to account for the impact of an income transformation on intertemporal poverty and, in so doing, to disentangle the impact of anonymous growth from the impact of mobility (or non-anonymous growth). The second contribution is to extend the "mobility as equalizer" framework to take into account the impact of mobility on poverty, corrected for the cost of poverty transiency as well as the cost of inequality in the distribution of intertemporal poverty.

The rest of the paper is organized as follows. Section 2 introduces the conceptual framework. Section 3 proposes indices of intertemporal pro-poorness. Section 4 presents a set of decompositions of the proposed indices. An empirical illustration of this framework is contained in Section 5. Section 6 concludes.

2 General measurement of pro-poorness in an intertemporal setting

Assume that we are interested in the dynamics of a distribution of living standards (incomes, for short) and ill-fare of $n \in \mathfrak{N}$ individuals, with individuals denoted $i = 1, ..., n$ over T fixed time periods (annual or monthly for instance) of their life and with each generic period denoted by $t = 1, ..., T$. We assume T to be common to all individuals, *viz*, we are comparing people's lives over the same number of time periods.

We assume periodic income $y_{i,t}$ to be drawn from the set of non-negative real numbers $\Re_+$. Let $\boldsymbol{y}_{(i)} := (y_{i,1}, \ldots, y_{i,t}, ..., y_{i,T})$ then be the vector of individual i's incomes across the T periods and $\boldsymbol{y}_t$ be a cross-sectional vector of incomes at time t. The income profile $\boldsymbol{y}_i$ is the ith row of the $n \times T$ matrix $\boldsymbol{Y} \in \boldsymbol{\Omega}^{n,T}$, where $\boldsymbol{\Omega}^{n,T}$ is the set of all $n \times T$ matrices whose entries are non-negative real numbers. We assume that incomes have been normalized by the poverty line — which could be absolute (constant in real terms) or relative (to income norms that vary across time). Let then $\tilde{y}_{i,t} := \min(y_{i,t}, 1)$ be the periodic income censored at the poverty line. Over an individual's lifetime, poverty is measured by $p(\boldsymbol{y}_{(i)})$ with $p(\boldsymbol{y}_{(i)}) \geq 0$ whenever $\exists t \in \{1, \ldots, T\}$ such that $y_{i,t} < 1$ and

$p(\boldsymbol{y}_{(i)}) = 0$ otherwise. Total intertemporal poverty is measured by the index $P(\boldsymbol{Y})$.

In the traditional context of snapshot poverty analyses, testing the pro-poorness of a growth process implies comparing the observed final poverty level with the one observed under some given benchmark; such a benchmark could be either a desirable final level of poverty or a counterfactual one; denote it by $\hat{\boldsymbol{Y}}$.

Our own measurement of pro-poor growth is anchored in the *intertemporal pro-poorness evaluation function, IPP*$\big(P(\hat{\boldsymbol{Y}}), P(\boldsymbol{Y})\big)$, where $P(\hat{\boldsymbol{Y}})$ is benchmark poverty. This evaluation function is assumed to satisfy a set of standard properties.[2] They are, $\forall \boldsymbol{Y}, \boldsymbol{Y}', \hat{\boldsymbol{Y}}, \hat{\boldsymbol{Y}}' \in \boldsymbol{\Omega}^{n,T}$:

- *Normalization*: $P(\hat{\mathbf{Y}}) = P(\mathbf{Y}) \Rightarrow IPP(P(\hat{\boldsymbol{Y}}), P(\boldsymbol{Y})) = 0$;
- *Pro-poor*: $P(\hat{\boldsymbol{Y}}) > P(\boldsymbol{Y}) \Rightarrow IPP\big(P(\hat{\boldsymbol{Y}}), P(\boldsymbol{Y})\big) > 0$;
- *Anti-poor*: $P(\hat{\boldsymbol{Y}}) < P(\boldsymbol{Y}) \Rightarrow IPP\big(P(\hat{\boldsymbol{Y}}), P(\boldsymbol{Y})\big) < 0$;
- *More pro-poor*:
  - $P(\boldsymbol{Y}) < P(\boldsymbol{Y}') \leq P(\hat{\boldsymbol{Y}}) \Rightarrow IPP(P(\hat{\boldsymbol{Y}}), P(\boldsymbol{Y})) > IPP(P(\hat{\boldsymbol{Y}}), P(\boldsymbol{Y}'))$;
  - $P(\hat{\boldsymbol{Y}}) > P(\hat{\boldsymbol{Y}}') \geq P(\boldsymbol{Y}) \Rightarrow IPP(P(\hat{\boldsymbol{Y}}), P(\boldsymbol{Y})) > IPP(P(\hat{\boldsymbol{Y}}'), P(\boldsymbol{Y}))$;
- *More anti-poor*:
  - $P(\boldsymbol{Y}) > P(\boldsymbol{Y}') \geq P(\hat{\boldsymbol{Y}}) \Rightarrow IPP\big(P(\hat{\boldsymbol{Y}}), P(\boldsymbol{Y})\big) < IPP\big(P(\hat{\boldsymbol{Y}}), P(\boldsymbol{Y}')\big)$;
  - $P(\hat{\boldsymbol{Y}}) < P(\hat{\boldsymbol{Y}}') \leq P(\boldsymbol{Y}) \Rightarrow IPP\big(P(\hat{\boldsymbol{Y}}), P(\boldsymbol{Y})\big) < IPP\big(P(\hat{\boldsymbol{Y}}'), P(\boldsymbol{Y})\big)$.

In words, we require that the measure of pro-poor growth be increasing in $P(\boldsymbol{Y})$, decreasing in $P(\hat{\boldsymbol{Y}})$, and equal to zero if there is no difference between poverty in the actual and in the benchmark distributions. A broad class of measures would be consistent with these requirements. For expositional simplicity, we take the simple linear form

$$IPP(P(\hat{\boldsymbol{Y}}), P(\boldsymbol{Y})) := P(\hat{\boldsymbol{Y}}) - P(\boldsymbol{Y}), \tag{3}$$

which obeys all of the properties mentioned above.

We must also set a distributive benchmark. Different benchmark distributions will naturally lead to different evaluations of pro-poorness. The choice depends mainly on whether a relative or an absolute approach is taken to evaluate pro-poorness — the former approach stating that growth is pro-poor when

[2] Similar properties are used for instance in Fields (2010) to define mobility.

the incomes of the poor grow faster than some norm (often proportional to average or mean income) and the latter stating that growth is pro-poor when the incomes of the poor are growing absolutely speaking. For expositional simplicity, this paper follows an absolute approach, although generalizing to a relative approach would just mean that incomes would need to be divided by the norm (possibly by a simple adjustment of the poverty line).

Similarly, we must also agree on a concept of mobility. 'Mobility means different things to different people,' in the words of Fields (2008, p. 1), because both growth rates and the distribution of gains affect poverty over time. We interpret mobility as any temporal change in individual income. The benchmark is thus the absence of distributional changes. The benchmark is therefore a counterfactual income distribution $\boldsymbol{Y}_1 \in \boldsymbol{\Omega}^{n,T}$ in which every person's income is the same as that person's income in the first period.[3]

The index $IPP(P(\hat{\boldsymbol{Y}}), P(\boldsymbol{Y}))$ in (3) is then the difference between poverty in a counterfactual situation in which poverty in the first period is extended over the T-period horizon and observed intertemporal poverty.[4]

3 A family of intertemporal pro-poorness indices

3.1 Individual ill-fare

Let the (normalized) poverty gap be given by $g_{i,t} := 1 - \tilde{y}_{i,t}$, $\boldsymbol{g}_{(i)} := (g_{i,1}, \ldots, g_{i,t}, ..., g_{i,T})$ be the corresponding vector of normalized poverty gaps for individual i across T periods, and $\boldsymbol{G}$ be the corresponding $n \times T$ matrix of normalized poverty gaps for the whole population. Also, let the distribution of gaps at time t be given by the vector $\boldsymbol{g}_t := (g_{1,t}, \ldots, g_{n,t})$. The gap $g_{i,t}$ is a standard measure of individual poverty in the literature for both snapshot and intertemporal poverty measurement. It is, for instance, at the base of the well-known FGT class (Foster, Greer, and Thorbecke, 1984) of additive poverty indices as well as of its intertemporal generalizations in Foster (2009), Canto, Gradín, and del Rio (2012) or Busetta and Mendola (2012), not to mention specific members of the family of indices introduced by Hoy and Zheng (2011), Bossert, Chakravarty, and d'Ambrosio (2012) and Dutta, Roope, and Zank (2013). Using the FGT formulation, the

[3]This is consistent with the approach used in Chakravarty, Dutta, and Weymark (1985) and Fields (2010), although the benchmark in Chakravarty et al. (1985) is based on relative immobility, *i.e.* the *share* of each individual in total income is assumed to remain stable across time.

[4]This property is called normalization in Hoy and Zheng (2011), requiring that if an individual gets every period the same income level, then his lifetime poverty can be represented by snapshot poverty.

poverty of each individual i over the T periods can be measured by:

$$p_\beta\left(\boldsymbol{y}_{(i)}, z\right) := \sum_{t=1}^{T} \omega_t g_{i,t}^{\beta} \qquad \text{with } \beta \geq 0, \tag{4}$$

where ω_t is a weighting function that captures the sensitivity of poverty to the specific period in which deprivation is experienced and with $\sum_{t=1}^{T} \omega_t = 1$. If $\omega_t > \omega_{t+1}$ more importance is given to poverty experienced earlier in life, for instance in childhood; if $\omega_t < \omega_{t+1}$ more importance is given to poverty experienced later in life.[5]

The parameter β is a measure of aversion to inequality and variability in the poverty gaps. Higher levels of β give higher weights to a loss of income when income is already low than when it is large. For $\beta = 1$, (4) corresponds to the simple weighted average of i's poverty gaps across time. For $\beta > 1$, a sequence of income increments and decrements that keep the weighted mean of the gaps unchanged but reduces their intertemporal variability decreases $p_\beta\left(\boldsymbol{y}_{(i)}, z\right)$. (4) is a measure of "union" poverty since individuals are regarded as intertemporally poor whenever they are deprived during at least one time period.

In order to account explicitly for the cost of time variability, we use the poverty counterpart of the 'equally distributed equivalent income' introduced in Atkinson (1970) for the measurement of social welfare and inequality. The equally distributed equivalent (EDE) poverty gap for individual i, $\pi_\beta\left(\boldsymbol{g}_{(i)}\right)$, is given by:

$$\pi_\beta\left(\boldsymbol{g}_{(i)}\right) := p_\beta^{-1}\left(p_\beta\left(\boldsymbol{y}_{(i)}, z\right)\right) = \left(\sum_{t=1}^{T} \omega_t g_{i,t}^{\beta}\right)^{\frac{1}{\beta}}. \tag{5}$$

The EDE gap $\pi_\beta\left(\boldsymbol{g}_{(i)}\right)$ is the value of the gap that, if experienced at each period of i's lifetime, would yield i the same level of poverty over time as that generated by $\boldsymbol{g}_{(i)}$. For $\beta = 1$, $\pi_\beta\left(\boldsymbol{g}_{(i)}\right)$ equals the simple weighted average gap over time, that is $\pi_1\left(\boldsymbol{g}_{(i)}\right) = \sum_{t=1}^{T} \omega_t g_{i,t}$. For $\beta \geq 1$, $\pi_\beta\left(\boldsymbol{g}_{(i)}\right)$ is never lower than $\pi_1\left(\boldsymbol{g}_{(i)}\right)$ because of aversion to poverty variability. The difference can be interpreted as the cost of poverty variability for individual i:

$$c_\beta(\boldsymbol{g}_{(i)}) := \pi_\beta\left(\boldsymbol{g}_{(i)}\right) - \pi_1\left(\boldsymbol{g}_{(i)}\right). \tag{6}$$

[5](4) is a specific version of the lifetime individual poverty measure introduced by Hoy and Zheng (2011). See also Bresson and Duclos (2015).

Consequently, intertemporal poverty for i can be expressed as:

$$\pi_\beta\left(\boldsymbol{g}_{(i)}\right) = c_\beta(\boldsymbol{g}_{(i)}) + \pi_1\left(\boldsymbol{g}_{(i)}\right) \tag{7}$$

Hence, $\pi_\beta\left(\boldsymbol{g}_{(i)}\right)$ is (weighted) average intertemporal poverty plus the intertemporal cost of mobility.

3.2 Social ill-fare

The FGT formulation is also used to aggregate individual poverty:[6]

$$P_{\alpha,\beta}\left(\boldsymbol{Y}, z\right) := \frac{1}{n}\sum_{i=1}^{n}\left(\pi_\beta\left(\boldsymbol{g}_{(i)}\right)\right)^\alpha, \tag{8}$$

where $\alpha \geq 0$ is a parameter of aversion to poverty inequality across individuals. The EDE in the population, $\Pi_{\alpha,\beta}\left(\boldsymbol{G}\right)$, is given by:

$$\Pi_{\alpha,\beta}\left(\boldsymbol{G}\right) := \left(\frac{1}{n}\sum_{i=1}^{n}\left(\pi_\beta\left(\boldsymbol{g}_{(i)}\right)\right)^\alpha\right)^{\frac{1}{\alpha}}. \tag{9}$$

We can also define anonymous intertemporal poverty as $\Pi_\alpha = \Pi_{\alpha,\alpha}$. Switching the income of two poor individuals at a given period t will then leave the social evaluation of intertemporal poverty unchanged, whatever the income levels of the two individuals in the other periods.[7]

Although the indices $P_{\alpha,\beta}$ and $\Pi_{\alpha,\beta}$ are ordinally equivalent and so can be used indifferently for comparing any pair of distributions, $\Pi_{\alpha,\beta}\left(\boldsymbol{G}\right)$ can be usefully interpreted as the level of poverty which, if assigned equally to all individuals and across all time periods, would produce the same poverty level as that generated by the intertemporal distribution $\boldsymbol{G}$. It thus can be seen as an intertemporal generalization of the class of ethical poverty indices introduced by Chakravarty (1983) for snapshot monetary poverty. Since the index aggregates individuals' intertemporal poverty, it also incorporates early/late poverty sensitivity with weights w_t and parameter β.

[6] This corresponds to the index P_α^θ proposed by Bourguignon and Chakravarty (2003) in the context of multidimensional poverty measurement. It is different from Duclos, Araar, and Giles (2010), where $\alpha = \beta$ and $\omega_t = \frac{1}{T}\ \forall t \in \{1, \ldots, T\}$.

[7] This can be more easily seen if we express $\Pi_\alpha\left(\boldsymbol{G}\right)$ as:

$$\Pi_\alpha\left(\boldsymbol{G}\right) = \left(\sum_{t=1}^{T}\omega_t\frac{1}{n}\sum_{i=1}^{n}g_{i,t}^\alpha\right)^{\frac{1}{\alpha}} = \left(\sum_{t=1}^{T}\omega_t P_\alpha(\boldsymbol{g}_t)\right)^{\frac{1}{\alpha}}. \tag{10}$$

Figure 1: Inter-individual inequality *vs* intertemporal variability.

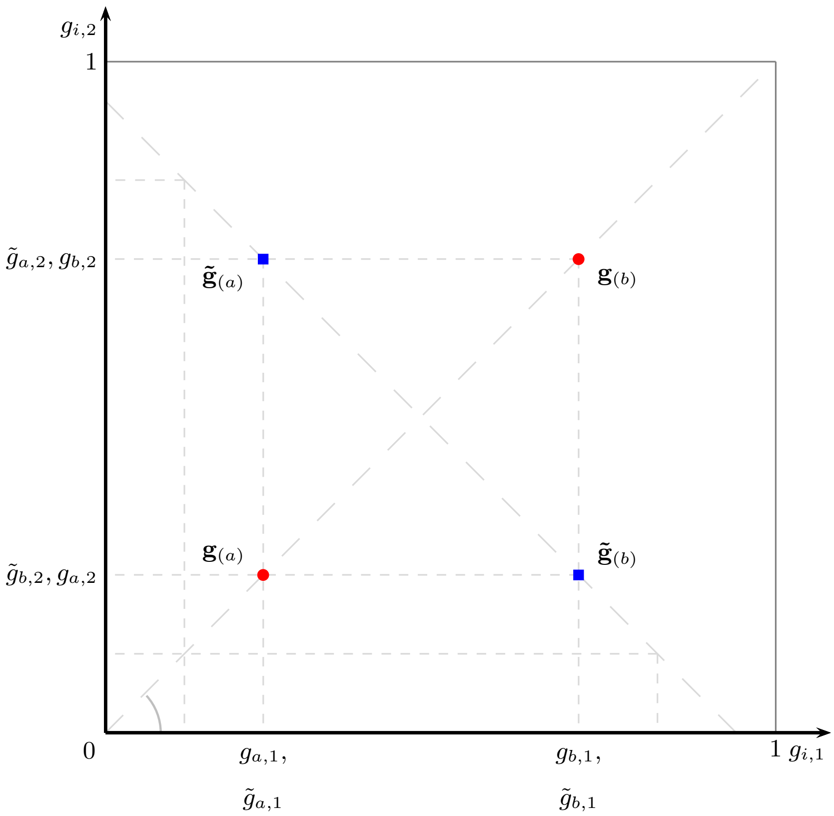


Figure 1 helps understand the trade-off between inequality reduction and income variability and its implications for pro-poor evaluation. It shows the poverty gap of two individuals, $i = a, b$, over a two-period lifetime horizon, $t = 1, 2$, in two different polar cases. For the sake of clarity, we assume that $\omega_1 = \omega_2$. In the first case with the circular dots, the two individuals experience identical poverty each period, that is, $g_{a,1} = g_{a,2} = \pi_\beta(\boldsymbol{g}_{(a)})$ and $g_{b,1} = g_{b,2} = \pi_\beta(\boldsymbol{g}_{(b)})$, but there is inequality of poverty between them. Thus $\Pi_{\alpha,\beta}(\boldsymbol{G}) = \Pi_\alpha(\boldsymbol{g}_1)$. The second case with the square dots is the reverse one: $\tilde{g}_{a,1} = \tilde{g}_{b,2} \neq \tilde{g}_{b,1} = \tilde{g}_{a,2}$, and $\pi_\beta\left(\tilde{\boldsymbol{g}}_{(a)}\right) = \pi_\beta\left(\tilde{\boldsymbol{g}}_{(b)}\right) = \Pi_{\alpha,\beta}\left(\tilde{\boldsymbol{G}}\right)$, namely, the two individuals are identical but experience different levels of poverty at different time periods.

The poverty ranking of these two income distributions will depend on the social aversion towards poverty variability and poverty inequality. Note that the distribution of periodic incomes is the same under the two processes. With the same degree of aversion towards variability and inequality (*i.e.* $\alpha = \beta$), the two distributions are judged poverty equivalent. This happens because, in the first case there are neither costs nor benefits generated by mobility, whereas, in the second case, the benefits of intertemporal poverty equalization are canceled out by the costs of variability. Indifference towards variability, $\beta = 1$, makes $\tilde{\boldsymbol{G}}$ better than $\boldsymbol{G}$. Indifference towards inequality ($\alpha = 1$) makes $\boldsymbol{G}$ better than $\tilde{\boldsymbol{G}}$. Hence, whether $\boldsymbol{G}$ has more poverty than $\tilde{\boldsymbol{G}}$ will depend on the values of α and β.

For the sake of illustration, consider the example (1) seen in the introduction. The sign of $IPP_{\alpha,\beta}$ will depend on the value assigned to the parameter of aversion to poverty variability and aversion to intertemporal poverty, whatever the choice of the weights. Let us consider the case of $\omega_1 = \omega_2$. With greater weight to variability aversion (assume $\beta = 3$ and $\alpha = 2$), the index is negative (*e.g.* $IPP_{2,3} = -0.027$), implying that the transformation is not pro-poor because of the cost of temporal variability. With $\alpha = 3$ and $\beta = 2$, the index is positive (*e.g.* $IPP_{3,2} = 0.029$) and the transformation is pro-poor because of the effect of poverty equalization.

Let

$$c_{\alpha,\beta}(\boldsymbol{G}) := \Pi_{\alpha,\beta}(\boldsymbol{G}) - \Pi_{1,\beta}(\boldsymbol{G}) \tag{11}$$

be the cost of inequality of intertemporal poverty across individuals. This is different from:

$$\frac{1}{n}\sum_{i=1}^{n} c_\beta(\boldsymbol{g}_{(i)}) = \Pi_{1,\beta}(\boldsymbol{G}) - \Pi_{1,1}(\boldsymbol{G}), \tag{12}$$

which is the average cost of poverty variability in the population. Substituting (12) into (11) and solving for $\Pi_{\alpha,\beta}(\boldsymbol{G})$ we find:

$$\Pi_{\alpha,\beta}(\boldsymbol{G}) = \frac{1}{n}\sum_{i=1}^{n} c_\beta(\boldsymbol{g}_{(i)}) + c_{\alpha,\beta}(\boldsymbol{G}) + \Pi_{1,1}(\boldsymbol{G}). \tag{13}$$

Equation (13) expresses total intertemporal poverty as the sum of three components: the cost of poverty variability, the cost of inequality in intertemporal poverty and the average individual intertemporal poverty gap in the population.

With the benchmark deprivation matrix $\boldsymbol{G}_1$, that is the deprivation matrix corresponding to $\boldsymbol{Y}_1$, we have $\Pi_{\alpha,\beta}(\boldsymbol{G}_1) = \Pi_\alpha(\boldsymbol{g}_1)$ with:

$$\Pi_\alpha(\boldsymbol{g}_1) = \left(\frac{1}{n}\sum_{i=1}^{n} g_{i,1}^{\alpha}\right)^{\frac{1}{\alpha}}, \tag{14}$$

which is initial cross-sectional poverty. The cost of inequality between individuals is the cost of inequality experienced in the initial period, that is, $c_\alpha(\boldsymbol{g}_1)$.

The benchmark level of poverty can then be expressed as:

$$\Pi_\alpha(\boldsymbol{g}_1) = c_\alpha(\boldsymbol{g}_1) + \Pi_1(\boldsymbol{g}_1). \tag{15}$$

which is the cost of inequality in the distribution of individual poverty gaps in the first period plus the average poverty gap in the first period.

3.3 Intertemporal pro-poorness indices

Using the poverty indices introduced previously, (3) can be expressed as:

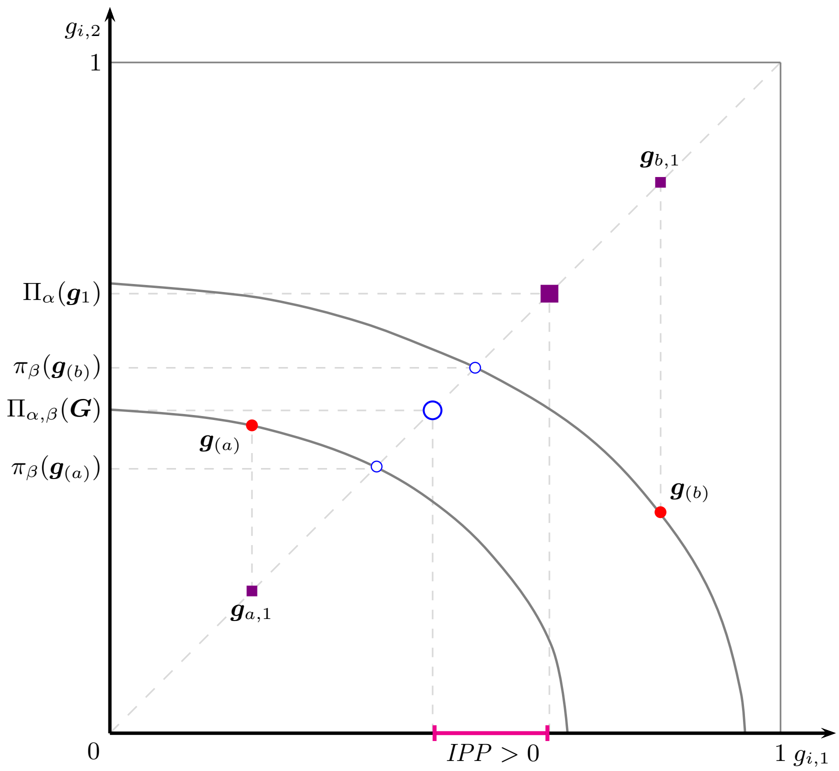
$$IPP_{\alpha,\beta} = \Pi_\alpha(\boldsymbol{g}_1) - \Pi_{\alpha,\beta}(\boldsymbol{G}). \tag{16}$$

The index equals 0 when growth leads everyone's deprivation unchanged. It is positive if intertemporal poverty is less than first-period poverty, and negative in the opposite case. If growth eliminates poverty at the subsequent periods, then $IPP_{\alpha,\beta}$ will be equal to $(1-\omega_1)\Pi_\alpha(\boldsymbol{g}_1) > 0$.

$IPP_{\alpha,\beta}$ incorporates the cost of temporal variability and the benefits of a possible reduction of inequality in individual poverty, both due to the effects of mobility. $IPP_{\alpha,\beta}$ obeys the usual social evaluation properties of population invariance, anonymity (in the identity of first-period incomes), scale invariance, continuity, and subgroup consistency. $IPP_{\alpha,\beta}$ is naturally increasing in the initial level of aggregate poverty and decreasing in the level of aggregate intertemporal poverty. The effects of a change in first-period gaps is ambiguous as it affects both benchmark and intertemporal poverty.

Figure 2 illustrates the computation of $IPP_{\alpha,\beta}$ in a two-person two-period case with loss aversion ($\omega_2 > \omega_1$) and primacy of aversion to inequality over aversion to variability ($\alpha > \beta$). The joint distribution of income gaps is shown by the two red circular dots $\boldsymbol{g}_{(a)}$ and $\boldsymbol{g}_{(b)}$. One observes that the poorest individual (namely b) has benefited from a dramatic improvement in his situation with the opposite happening to the initially less poor person (a). The computation of $\pi_\beta(\boldsymbol{g}_{(a)})$ and $\pi_\beta(\boldsymbol{g}_{(b)})$ can be seen by projecting on one axis the points at which the iso-poverty curves for each poverty profile across the diagonal of perfect immobility (the small blue circles). Aggregation across the population yields the EDE gap (the larger blue circle) $\Pi_{\alpha,\beta}(\boldsymbol{G})$. For the benchmark situation, we first generate the benchmark profiles (the smaller violet squares) by vertical projection of the observed profiles on the diagonal of perfect immobility. Aggregation across individuals leads to $\Pi_\alpha(\boldsymbol{g}_1)$ (the large violet squares). The difference between $\Pi_\alpha(\boldsymbol{g}_1)$ and $\Pi_{\alpha,\beta}(\boldsymbol{G})$ is here positive, indicating that growth

Figure 2: The intertemporal pro-poorness of a two-period growth/mobility process.



Note: The iso-poverty contours correspond to the case of $\beta = 2$, $\omega_1 = \frac{1}{3}$, and $\omega_2 = \frac{2}{3}$. For social aggregation, α is set equal to 3.

has been pro-poor from an intertemporal perspective.

4 Decompositions

We now provide three decompositions of the $IPP_{\alpha,\beta}$ index. For expositional simplicity, we set $T = 2$.[8] The generic poverty measure $\Pi_{\alpha,\beta}(\boldsymbol{G})$ will be denoted by $\Pi_{\alpha,\beta}(\boldsymbol{g}_1, \boldsymbol{g}_2)$ and benchmark poverty, $\Pi_\alpha(\boldsymbol{g}_1)$, by $\Pi_\alpha(\boldsymbol{g}_1, \boldsymbol{g}_1)$.

The first decomposition distinguishes between the anonymous and the mobility components of growth. This is given by:

$$IPP_{\alpha,\beta} = \underbrace{\Pi_\alpha(\boldsymbol{g}_1, \boldsymbol{g}_1) - \Pi_\alpha(\boldsymbol{g}_1, \boldsymbol{g}_2)}_{AG} + \underbrace{\Pi_\alpha(\boldsymbol{g}_1, \boldsymbol{g}_2) - \Pi_{\alpha,\beta}(\boldsymbol{g}_1, \boldsymbol{g}_2)}_{M} \tag{17}$$

Recall that $\Pi_\alpha(\boldsymbol{g}_1, \boldsymbol{g}_2)$ is anonymous intertemporal poverty and does not account for the benefits or the costs of mobility. AG therefore captures the poverty effect

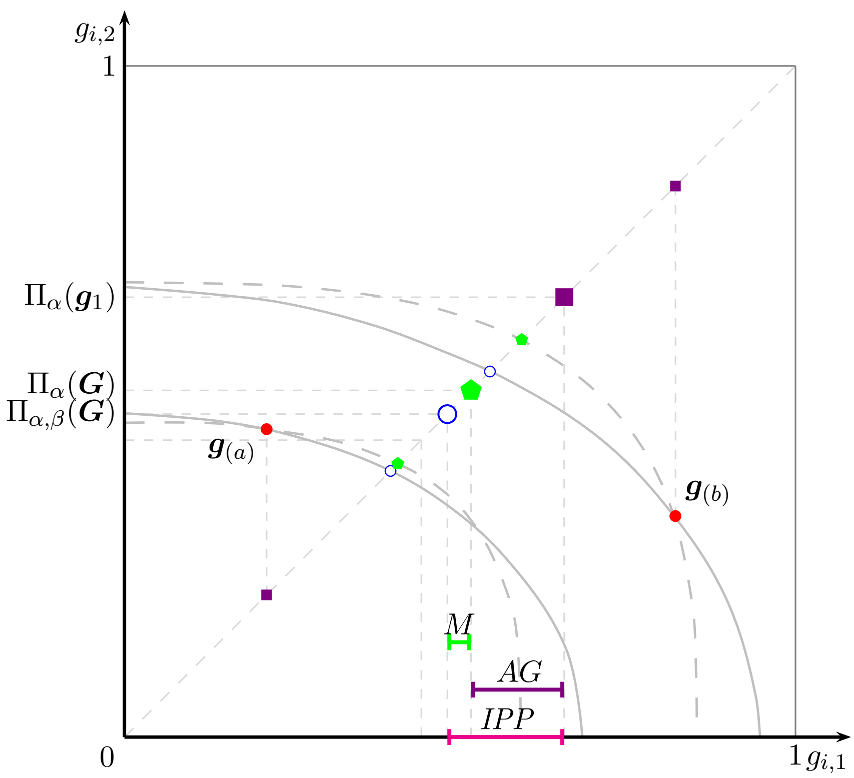
[8]See the appendix for a generalization to larger values of T.

of anonymous growth, while M captures the effect of mobility.

Considering again the example given by (1), we have $AG = 0$ and $M = 0.029$ with $\alpha = 3$ and $\beta = 2$. Since the anonymous growth impact is nil, the growth effect on intertemporal poverty is entirely attributable to a (pro-poor) mobility effect.

M will be positive when aversion towards inequality is stronger than aversion towards temporal variability, $\alpha > \beta$, and otherwise negative. The sign of the effect is not determined by the weights (ω_1, ω_2). If $\beta = \alpha$, then $M = 0$. $\beta = 1$ and $\alpha = 1$ lead to neutrality to variability and inequality and to $M \geq 0$ and $M \leq 0$, respectively.

Figure 3: Decomposing two-period intertemporal pro-poorness: growth and mobility



Note: The iso-poverty contours correspond to the case of $\beta = 2$, $\omega_1 = \frac{1}{3}$ and $\omega_2 = \frac{2}{3}$. For social aggregation, α is set equal to 3.

Figure 3 illustrates this decomposition using the case shown in Figure 2. The difference between the benchmark (the larger violet square) and anonymous intertemporal poverty (the larger green pentagon) is positive, indicating that the AG component is positive. The effect of mobility is shown by the difference between anonymous intertemporal poverty (the larger green pentagon) and the actual level of intertemporal poverty (the larger blue circle). Mobility exerts here a less important (but still positive) effect than the anonymous growth effect.

The second decomposition distinguishes further between standard anonymous pro-poorness and this paper's intertemporal approach. In a two-period setting, we can rewrite equation (13) as:

$$\Pi_{\alpha,\beta}\left(\boldsymbol{g}_1, \boldsymbol{g}_2\right) = \omega_1 P_1(\boldsymbol{g}_1) + \omega_2 P_1(\boldsymbol{g}_2) + \frac{1}{n}\sum_{i=1}^{n} c_\beta(\boldsymbol{g}_{(i)}) + c_{\alpha,\beta}\left(\boldsymbol{g}_1, \boldsymbol{g}_2\right), \tag{18}$$

which leads to the decomposition:

$$\begin{aligned} IPP_{\alpha,\beta} = {} & \underbrace{\omega_2\left[P_1\left(\boldsymbol{g}_1\right) - P_1\left(\boldsymbol{g}_2\right)\right]}_{\Delta P^c} + \underbrace{\omega_2\left[c_\alpha\left(\boldsymbol{g}_1\right) - c_\alpha\left(\boldsymbol{g}_2\right)\right]}_{\Delta c^c} \\ & + \underbrace{\left[\omega_1 c_\alpha(\boldsymbol{g}_1) + \omega_2 c_\alpha(\boldsymbol{g}_2)\right] - c_{\alpha,\beta}(\boldsymbol{g})}_{M^c} - \underbrace{\frac{1}{n}\sum_{i=1}^{n} c_\beta(\boldsymbol{g}_{(i)})}_{CV} \end{aligned} \tag{19}$$

ΔP^c reflects changes in the average periodic gaps, $P_1\left(\boldsymbol{g}_1\right)$ and $P_1\left(\boldsymbol{g}_2\right)$. ΔP^c is neutral with respect to variability and inequality. Δc^c is, up to a multiplicative term, the difference between the cost of inequality in the initial and in the final periods. Δc^c can be both positive or negative, depending on whether inequality in cross-sectional poverty has fallen or has increased between the two periods. Leaving aside the weight ω_2, together ΔP^c and Δc^c capture the usual measure of anonymous pro-poor growth in the spirit of Ravallion and Chen (2003).[9] The third component, M^c, is the difference between the weighted sum of the cost of unitemporal inequalities and the cost of intertemporal inequality, which is mobility's ability to decrease inequality between individuals, taking the cost of variability into account. The fourth component, CV, captures the cost of the variability generated by mobility. CV is always positive when $\beta > 1$: variability aversion always assigns a cost to the variability induced by mobility. Taken together, the two components M^c and CV capture the trade-off between the benefits and the costs of mobility, the intertemporal pro-poorness effects. Note that $\Delta c^c = 0$ and $M^c = 0$ with $\alpha = 1$, and $CV = 0$ when $\beta = 1$. In the limiting

[9] AG and the sum $\Delta P^c + \Delta c^c$ differ in general, since we have

$$AG = \left(P_\alpha(\boldsymbol{g_1})\right)^{\frac{1}{\alpha}} - \left(\omega_1 P_\alpha(\boldsymbol{g_1}) + \omega_2 P_\alpha(\boldsymbol{g_2})\right)^{\frac{1}{\alpha}}, \tag{20}$$

$$\Delta P^c + \Delta c^c = \omega_2\left(\left(P_\alpha(\boldsymbol{g_1})\right)^{\frac{1}{\alpha}} - \left(P_\alpha(\boldsymbol{g_2})\right)^{\frac{1}{\alpha}}\right). \tag{21}$$

Note that $AG = \Delta P^c + \Delta c^c$ when $\alpha = 1$; when $\alpha > 1$, we have instead $AG \leq \Delta P^c + \Delta c^c$.

case of $\alpha = \beta = 1$, $\Delta c^c = M^c_{\alpha,\beta} = CV = 0$, and thus $IPP_{\alpha,\beta} = \Delta P^c$, the difference in the average poverty gap.

Consider again our first example. The first two components, ΔP^c and Δc^c, are equal to 0 since the (anonymous) temporal distribution of income is the same in both periods. For $\alpha = 3, \beta = 2$, $M^c = 0.089$ is positive meaning that growth reduces inequality form an intertemporal perspective; inequality is the same in both periods, but enlarging the time-horizon to two periods, inequality is decreased with respect to the benchmark case. Lastly, $CV = 0.059$, which is mobility's variability cost.

The third and last decomposition also considers the reranking effect of growth. Denote by $\boldsymbol{g}_1^I$ a counterfactual distribution of poverty gaps in the first period that has the first period's mean gap, the second period's inequality and individuals arranged in the same order as in the first period.[10] Also denote by $\boldsymbol{g}_1^{IR}$ the distribution of poverty gaps in the second period scaled to have the mean poverty gap of the first period.[11] Note that the counterfactual distributions $\mathbf{g}_1^I$ and $\mathbf{g}_1^{IR}$ are constructed by considering the inequality and ranking of the distribution of the poverty gaps and not the distribution of income. Although this procedure may seem questionable, it is in line with sensitivity to inequality of poverty across time (through β) and to inequality of intertemporal poverty across individuals (through α).

Observing that $\Pi_\alpha(\boldsymbol{g}_1) = \Pi_{\alpha,\beta}(\boldsymbol{g}_1, \boldsymbol{g}_1)$, the third decomposition is then:[12]

$$\begin{aligned} IPP_{\alpha,\beta} = & \underbrace{\left[\Pi_{\alpha,\beta}(\boldsymbol{g}_1, \boldsymbol{g}_1) - \Pi_{\alpha,\beta}\left(\boldsymbol{g}_1, \boldsymbol{g}_1^I\right)\right]}_{I} + \underbrace{\left[\Pi_{\alpha,\beta}\left(\boldsymbol{g}_1, \boldsymbol{g}_1^I\right) - \Pi_{\alpha,\beta}\left(\boldsymbol{g}_1, \boldsymbol{g}_1^{IR}\right)\right]}_{R} \\ & + \underbrace{\left[\Pi_{\alpha,\beta}\left(\boldsymbol{g}_1, \boldsymbol{g}_1^{IR}\right) - \Pi_{\alpha,\beta}(\boldsymbol{g}_1, \boldsymbol{g}_2)\right]}_{PG}. \end{aligned} \tag{22}$$

It has three components. The first component I measures the intertemporal effects of inequality and variability in poverty ($\boldsymbol{g}_1$ and $\boldsymbol{g}_1^I$ have the same mean and the same ranking of individuals). I captures the effects of inequality across time and inequality across individuals through maintaining temporal ranks constant. An increase in inequality will always result in I being negative, no matter the

[10] In the case of example (1) in the introduction, given the distribution of poverty gap in the initial period and final period $\boldsymbol{g}_1 = (0.43, 0.14, 0, 0)$ and $\boldsymbol{g}_2 = (0, 0, 0.43, 0.14)$, $\boldsymbol{g}_1^I$ is given by $(g_{3,2}, g_{4,2}, g_{1,2}, g_{2,2}) \times \frac{P_1(\boldsymbol{g}_1)}{P_1(\boldsymbol{g}_2)} = (0.43, 0.14, 0, 0) \times \frac{0.285}{0.285}$.

[11] In the case of example (1), $\boldsymbol{g}_1^{IR} = (g_{1,2}, g_{2,2}, g_{3,2}, g_{4,2}) \times \frac{P_1(\boldsymbol{g}_1)}{P_1(\boldsymbol{g}_2)} = (0, 0, 0.43, 0.14) \times \frac{0.285}{0.285}$.

[12] See Ruiz-Castillo (2004) for a similar decomposition of the CDW (the Chakravarty et al. (1985)) ethical index of mobility.

combination of the values of the parameters. With $\alpha = \beta = 1$, given neutrality to intertemporal variability and inequality in poverty, I will be null.

The second component, R, captures the poverty effect of reranking ($\boldsymbol{g}_1^{IR}$ and $\boldsymbol{g}_1^{I}$ have same mean and same cross-sectional inequality, but differ in the ranking of individuals). $R = 0$ if there is no-reranking. When reranking occurs, the sign of R will depend on the values of the parameters. For $\alpha < \beta$, $R < 0$ because reranking generates time variability and the variability costs are deemed larger than the inequality benefits of reranking individuals. Alternatively, $R > 0$ for $\alpha > \beta$, since reranking helps equalizing poverty over time and the equalization benefits are higher that the variability costs. $\alpha = \beta = 1$ implies $R = 0$.

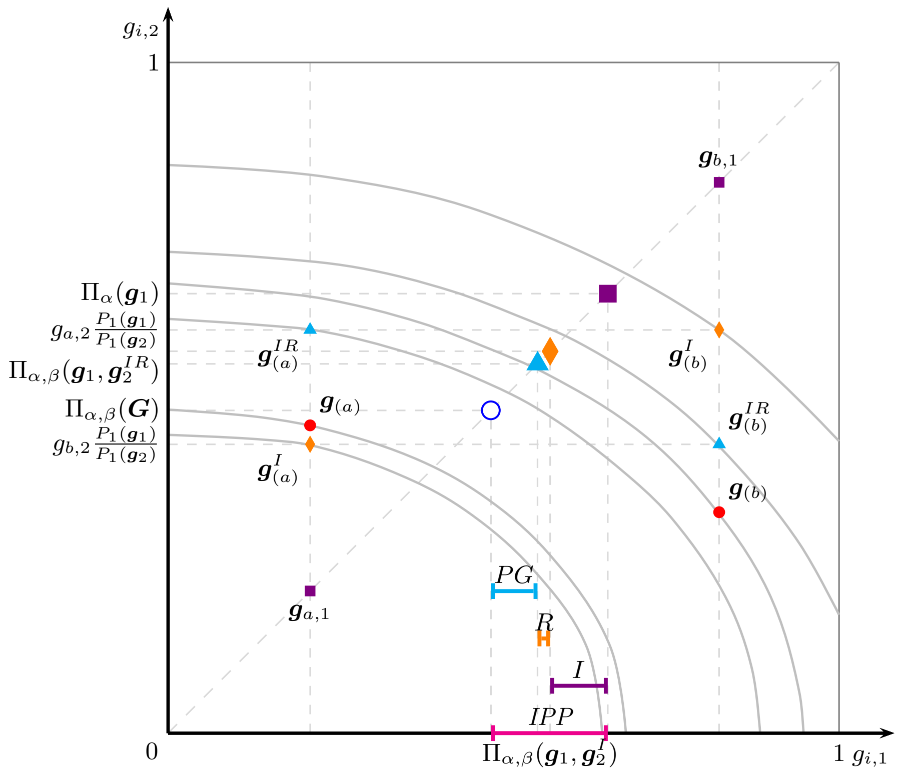
The third component PG captures a pure growth effect on poverty ($\boldsymbol{g}_2$ is $\boldsymbol{g}_1^{IR}$ scaled to the mean of $\boldsymbol{g}_2$). It will be positive (negative) if there is a reduction in individuals' intertemporal poverty due to pure growth. The sign of PG does not depend on the values of α and β, though the higher is β with respect to α, the higher tends to be the (negative or positive) value of the impact. When $\alpha = \beta = 1$, $IPP_{\alpha,\beta} = PG$: pro-poorness is determined by the pure growth effect. Note that AG is not purged from the effect of inequality (and reranking) while PG is.[13]

With the example in (1), $I = 0$ given that inequality is identical in both periods; $R = -0.03$ for $\alpha = 2, \beta = 3$, since there is a reshuffling of individuals in the distributions (the two initially poor individuals become the two richest), but the variability costs are higher than the benefits; and $PG = 0$ given that the average gap is unchanged.

This decomposition is sketched in Figure 4 using the scenario of the earlier Figure 3. In this situation, the inequality component I is supporting pro-poorness as indicated by the difference between the benchmark (the larger violet square) and the counterfactual profile $(\mathbf{g}_1, \mathbf{g}_1^I)$ (the larger orange diamond-shaped dots). The difference between the latter and the counterfactual scenario $(\mathbf{g}_1, \mathbf{g}_1^{IR})$ (the larger blue triangle) shows that reranking also supports pro-poorness, although to a lower extent than inequality. Finally, the impact of pure growth on pro-poorness is given by the difference between poverty in the counterfactual scenario $(\mathbf{g}_1, \mathbf{g}_1^{IR})$ (the larger blue triangle) and observed intertemporal poverty

[13] Note that this decomposition is path-dependent. The value of the components would be different with different 'paths' for the decomposition. For instance, one might have wanted to capture first the growth effect, then the reranking effect and finally the inequality one. No path is necessarily more correct than another (see, e.g. DiNardo, Fortin, and Lemieux, 1996). A possible procedure would be to apply a Shapley-Shorrocks decomposition, consisting of computing the Shapley-value of each effect across all possible paths of the decomposition (see Shorrocks, 2013).

Figure 4: Decomposing two-period intertemporal pro-poorness: inequality, reranking and growth



Note: The iso-poverty contours correspond to the case of $\beta = 2$, $\omega_1 = \frac{1}{3}$ and $\omega_2 = \frac{2}{3}$. For social aggregation, α is set equal to 3.

(the larger blue circle); PG also supports pro-poorness.

5 Empirical illustration

5.1 Data

This Section provides an empirical application of the tools developed above using the panel component of the Eurostat 'European Union Statistics on Income and Living Conditions' (EU-SILC). The EU-SILC, which started in 2005, is a representative survey of the resident population within each European country, interviewed every year. For the present paper we consider the 2006, 2007, 2008, and 2009 waves. Note that this time interval includes the period in which the economic crisis started in Europe, and this may help assess whether EU countries have performed differently in terms of pro-poorness.

The unit of observation used in the analysis is the individual. The measure of living standards is household disposable income, which includes all household members earnings, transfers, pensions, and capital incomes, net of taxes on wealth and incomes and of social insurance contributions. Incomes are expressed in Euros at PPP exchange rates and in constant 2005 prices and adjusted for differences in household size using the square root of the household size. The countries considered are: Austria (AT), Belgium (BE), Bulgaria (BG), Cyprus (CY), Czech Republic (CZ), Estonia (EE), Spain (ES), Denmark (DK), Finland (FI), France (FR), Hungary (HU), Iceland (IS), Italy (IT), Latvia (LV), Lithuania (LT),Malta (MT), Netherlands (NL), Norway (NO), Poland (PL), Portugal (PT), Slovenia (SI), Sweden (SE), and United Kingdom (UK). We perform the illustration using country-specific poverty lines fixed to 60% of their 2006 median income.

5.2 Results

We first start by evaluating the pro-poorness of the income transformation process that took place between 2006, 2007, 2008, and 2009 for the 23 European countries listed above. The assessment of intertemporal pro-poorness depends on the choice of the weights as well as on aversions to variability and to inequality of intertemporal poverty. Here, we choose to weight equally poverty in all the four periods. For α and β, we fix $\alpha = 2$, which is the most common value used in the literature, and let β be equal to 1, 2, 3 and infinity. The numerical values of our estimates of intertemporal pro-poorness, for all combinations of the value of α and β considered in this paper and for all the 23 European countries, are reported in Table 1. A graphical representation is available in Figure 5, where countries are ordered according to the average value of the four $IPP_{\alpha,\beta}$, namely $IPP_{2,1}, IPP_{2,2}, IPP_{2,3}, IPP_{2,\infty}$.

Some striking results stand out from Table 1 and Figure 5.

First, the value of $IPP_{\alpha,\beta}$ is positive for all countries when $\alpha = 2$ and $\beta = 1$, meaning that the benefits of equalization matter for pro-poorness judgments. $IPP_{\alpha,\beta}$ is also always positive when $\alpha = 2$ and $\beta = 2$, although lower than it is in the previous case, implying that, when we start to introduce variability concerns by increasing the value of β, pro-poorness declines. When $\alpha = 2$ and $\beta = 3$, that is, when more importance is given to the costs of mobility than to its benefits, our index is again positive for all countries, with the exception of Austria, Denmark, Sweden, and Spain. The costs generated by variability matter for pro-poorness judgments: as β increases, the index of pro-poorness of each country and the degree to which it changes is not the same across countries, meaning that variability affects each country's pro-poorness differently. As ex-

Table 1: Intertemporal pro-poorness indices $IPP_{\alpha,\beta}$ for 23 European countries, 2006–09.

Country	$(\alpha = 2, \beta = 1)$	$(\alpha = 2, \beta = 2)$	$(\alpha = 2, \beta = 3)$	$(\alpha = 2, \beta = \infty)$
AT	0.038	0.013	-0.0016	-0.050
BE	0.072	0.042	0.025	-0.032
BG	0.053	0.022	0.0049	-0.055
CY	0.041	0.028	0.020	-0.013
CZ	0.034	0.018	0.0078	-0.027
DK	0.031	0.00067	-0.016	-0.066
EE	0.057	0.030	0.015	-0.040
ES	0.068	0.019	-0.0097	-0.100
FI	0.032	0.013	0.0021	-0.034
FR	0.058	0.030	0.013	-0.041
HU	0.077	0.043	0.023	-0.039
IS	0.088	0.052	0.033	-0.025
IT	0.050	0.020	0.0012	-0.067
LT	0.058	0.034	0.019	-0.039
LV	0.086	0.051	0.030	-0.044
MT	0.052	0.021	0.003	-0.052
NL	0.045	0.018	0.0031	-0.046
NO	0.065	0.037	0.021	-0.037
PL	0.073	0.043	0.026	-0.030
PT	0.049	0.027	0.013	-0.039
SE	0.032	0.012	-0.001	-0.043
SI	0.028	0.018	0.011	-0.017
UK	0.065	0.026	0.004	-0.070

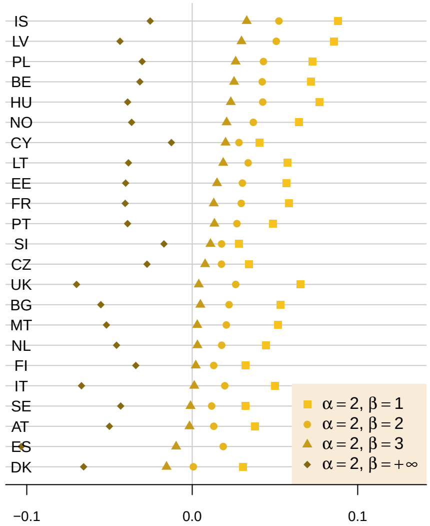
Notes: Authors' calculations based on EU-SILC.

pected, $IPP_{2,\infty}$ is always negative, because in this extreme case all that matters is the cost of mobility, and the effect of growth is judged by how much it worsens poverty between the initial period and the period in which each individual experiences the highest poverty.

Second, the distribution of intertemporal pro-poorness among countries is quite dispersed, showing that they have performed quite differently in the early phase of the crisis.

Third, the country rankings depend on the normative importance given either to inequality or to variability, that is, as we change the value of β. For example, for $IPP_{2,1}$ the best performing is Island, while the worst is Slovenia; for $IPP_{2,2}$, Island is again top ranked, while at the bottom we find Denmark; for $IPP_{2,3}$ Poland is the most pro-poor and Spain is the least; last, for $IPP_{2,\infty}$ Cyprus is

Figure 5: $IPP_{\alpha,\beta}$, $\alpha = 2$, for different β and for 23 European countries, 2006–09, ordered by the average value of the $IPP_{\alpha,\beta}$.



Note: Authors' calculations based on EU-SILC.

top ranked, while Spain is again bottom ranked.

A last interesting feature to notice is that, within each country, the four indices behave very differently. The country that shows less variability among the four $IPP_{\alpha,\beta}$ is Slovenia, which has a median rank in our sample. Alternatively, when $\beta = 1$, Spain is ranked among the best performing countries, while when $\beta = 3$ it ranks the worst. This again confirms that accounting for both the benefits and costs of mobility can be important for growth pro-poorness judgments.

We proceed by performing the three types of decompositions introduced above, each of them emphasizing a distinct aspect of growth pro-poorness. For expositional simplicity, we focus on two cases: (i) $\alpha = 2, \beta = 1$; and (ii) $\alpha = 2, \beta = 3$.

The estimates of the elements of the first anonymous/non-anonymous decomposition are reported in Table 2, where countries are sorted alphabetically. A more synthetic representation of the results is shown in Figure 6.

Table 2 shows clearly that distinguishing between anonymous and non-anonymous growth can matter. Note first that there is always a considerable amount of variability, which reduces the degree of pro-poorness of the 2006-09 growth process (shown by the $\beta = 3$ columns). Hence, a pure anonymous evaluation would overestimate the pro-poorness of the growth episode for all the countries consid-

Table 2: First decomposition: anonymous (AG) and non-anonymous (M) pro-poorness of growth for 23 European countries, 2006–09.

Country	($\alpha = 2, \beta = 1$)			($\alpha = 2, \beta = 3$)	
	IPP	AG	M	IPP	M
AT	0.038	0.013	0.025	-0.0016	-0.015
BE	0.072	0.042	0.030	0.025	-0.017
BG	0.053	0.022	0.031	0.0049	-0.017
CY	0.041	0.028	0.012	0.020	-0.0081
CZ	0.034	0.018	0.017	0.0078	-0.0099
DK	0.031	0.00067	0.030	-0.016	-0.016
EE	0.057	0.030	0.027	0.015	-0.015
ES	0.068	0.019	0.049	-0.0097	-0.028
FI	0.032	0.013	0.019	0.0021	-0.011
FR	0.058	0.030	0.029	0.013	-0.017
HU	0.077	0.043	0.034	0.023	-0.019
IS	0.088	0.052	0.036	0.033	-0.019
IT	0.050	0.020	0.030	0.0012	-0.018
LT	0.058	0.034	0.024	0.019	-0.015
LV	0.086	0.051	0.035	0.030	-0.021
MT	0.052	0.021	0.031	0.003	-0.018
NL	0.045	0.018	0.027	0.0031	-0.015
NO	0.065	0.037	0.028	0.021	-0.016
PL	0.073	0.043	0.030	0.026	-0.017
PT	0.049	0.027	0.022	0.013	-0.014
SE	0.032	0.012	0.020	-0.001	-0.013
SI	0.028	0.018	0.011	0.011	-0.0067
UK	0.065	0.026	0.039	0.004	-0.022

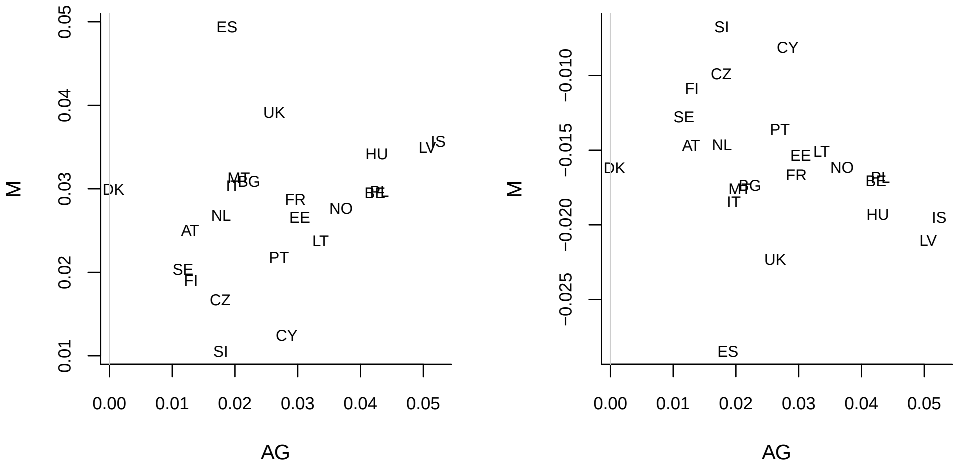
Notes: Authors' calculations based on EU-SILC. The AG component for $IPP_{2,3}$ is not reported because it is identical to the AG for $IPP_{2,1}$.

ered. The negative impact of variability is sometimes strong enough to revert the sign of the measure of anonymous pro-poorness of growth. For instance, AG with $\alpha = 2$ is never negative, but $IPP_{2,3}$, is negative for four out of the 23 countries. For these countries, therefore, the variability and cost of mobility exceed the intertemporal inequality reduction and growth benefits of the income transformation.

The inequality reduction effect of mobility can also be sizable, Figure 6 shows that the benefits of inequality reduction affect pro-poorness more strongly than the costs of time variability. With inequality aversion higher than variability aversion ($\alpha = 2, \beta = 1$), AG and M are strongly correlated, which also says that the greater the growth impact, the greater the expected intertemporal inequality benefit. In the opposite situation ($\alpha = 2, \beta = 3$), the correlation is negative but weaker in absolute value; the greater the impact of growth, the greater also its

Figure 6: First decomposition, anonymous (AG) and non-anonymous (M) for 23 European countries, 2006–09.

(a) $\alpha = 2, \beta = 1$.　　　　(b) $\alpha = 2, \beta = 3$.



Note: Authors' calculations based on EU-SILC.

variability cost.

Figure 7 orders countries by decreasing values of $IPP_{\alpha,\beta}$. With $\alpha = 2$ and $\beta = 1$, it is clear that both anonymous growth and the mobility benefits of intertemporal equalization affect intertemporal pro-poorness. The shares of AG and M in total $IPP_{2,1}$ vary considerably across countries. Denmark (DK) is perhaps the most extreme case since intertemporal pro-poorness is explained entirely by intertemporal inequality reduction benefits.

The panel on the right of Figure 7 ($\alpha = 2, \beta = 3$) shows again that the variability cost of mobility can exceed the growth effects. However, losses of pro-poorness due to variability are generally lower in absolute value than the gains of pro-poorness seen in the panel on the left. Moreover, the costs of mobility are usually more pronounced when anonymous growth pro-poorness is strong.

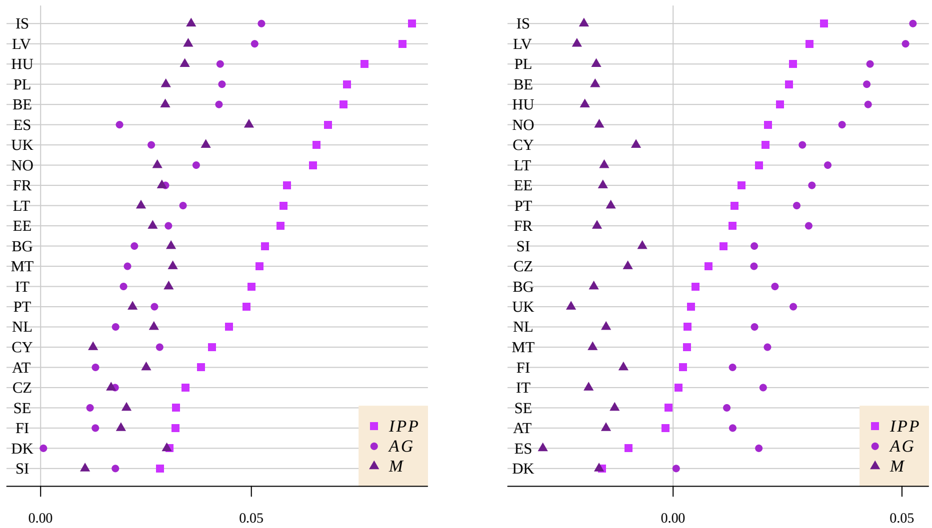
In both panels, the ranking of countries by AG is very different from that by IPP. Mobility, through variability and intertemporal inequality effects, therefore change considerably the assessment of growth pro-poorness.

The results of the second decomposition are reported in Table 3. Countries are ordered as in Table 2. Both the cross-sectional average poverty gaps ΔP^c and the costs of cross-sectional inequality Δc^c fall in all countries, with the exception of Denmark for which the costs of cross-sectional inequality increase. The difference between unitemporal and intertemporal costs is always positive when $\alpha > \beta$ and is still positive for 6 countries when $\alpha < \beta$. This says that the

Figure 7: First decomposition for 23 European countries, 2006–09, ranked by $IPP_{\alpha,\beta}$, anonymous (AG) and non-anonymous (M)

(a) $\alpha = 2, \beta = 1$.

(b) $\alpha = 2, \beta = 3$.



Note: Authors' calculations based on EU-SILC.

unitemporal and intertemporal costs of inequality differ, with mobility impacting more the latter. The last component, CV, which captures the cost of variability, can be strong enough to dominate the three others (this happens in Portugal, Bulgaria, UK, Italy, and Denmark) change the sign of IPP (as for Austria, Denmark, Spain, and Sweden) and affect significantly the ranking of countries.

This is also seen in Figure 8. The panel on the left shows that the contribution of the variation in the cross sectional costs of inequality (Δc^c) and of the intertemporal cost effect (M^c) can be large, with the average poverty gap effect (ΔP^c) weaker, though always positive. The costs of variability are nil since neutrality to variability is assumed.

On the right-hand panel, $IPP_{2,3}$ is mostly determined by the variation in the cross-sectional costs of inequality and by the variation in cross-sectional poverty, both almost always positive. The intertemporal inequality cost component is almost always negative and strong.

The results of the third decomposition (inequality change I, reranking R, and pure growth PG) are reported in Table 4. Countries are ordered as in Table 2. The magnitude and the sign of the components vary considerably across countries. This can be more easily seen on Figure 9, where countries are ordered as on Figure 8. For each country, the first component (I) is marked on

Table 3: Second decomposition: average poverty gap (ΔP^c), cross-sectional inequality (Δc^c), difference between intertemporal and unitemporal inequality (M^c), and variability (CV) components for 23 European countries, 2006–09.

Country	($\alpha = 2, \beta = 1$)				($\alpha = 2, \beta = 3$)			
	ΔP^c	Δc^c	M^c	CV	ΔP^c	Δc^c	M^c	CV
AT	0.0058	0.0082	0.024	0	0.0058	0.0082	-0.0011	0.015
BE	0.021	0.025	0.026	0	0.021	0.025	-0.0023	0.019
BG	0.016	0.011	0.027	0	0.016	0.011	-0.0023	0.019
CY	0.013	0.018	0.0093	0	0.013	0.018	-0.0025	0.0088
CZ	0.0088	0.0098	0.016	0	0.0088	0.0098	-0.0015	0.0093
DK	0.0042	-0.0032	0.03	0	0.0042	-0.0032	-0.002	0.015
EE	0.017	0.016	0.024	0	0.017	0.016	-0.0014	0.016
ES	0.015	0.005	0.049	0	0.015	0.005	0.0096	0.039
FI	0.007	0.0064	0.019	0	0.007	0.0064	-0.002	0.0093
FR	0.014	0.018	0.026	0	0.014	0.018	-0.0028	0.017
HU	0.017	0.031	0.028	0	0.017	0.031	-0.0054	0.02
IS	0.015	0.046	0.027	0	0.015	0.046	-0.013	0.015
IT	0.013	0.0074	0.029	0	0.013	0.0074	0.0044	0.024
LT	0.022	0.013	0.022	0	0.022	0.013	0.0031	0.02
LV	0.036	0.019	0.031	0	0.036	0.019	0.004	0.029
MT	0.0076	0.016	0.028	0	0.0076	0.016	-0.0059	0.015
NL	0.008	0.013	0.024	0	0.008	0.013	-0.0053	0.012
NO	0.012	0.03	0.023	0	0.012	0.03	-0.0059	0.015
PL	0.023	0.028	0.022	0	0.023	0.028	-0.0052	0.019
PT	0.013	0.015	0.021	0	0.013	0.015	0.0016	0.016
SE	0.0049	0.0076	0.02	0	0.0049	0.0076	-0.0042	0.0093
SI	0.0073	0.012	0.0091	0	0.0073	0.012	-0.0013	0.0068
UK	0.013	0.015	0.038	0	0.013	0.015	0.0068	0.03

Notes: Authors' calculations based on EU-SILC. Recall that $IPP_{\alpha,\beta}$ can be obtained as a function of the components listed in the Table, see equation (22).

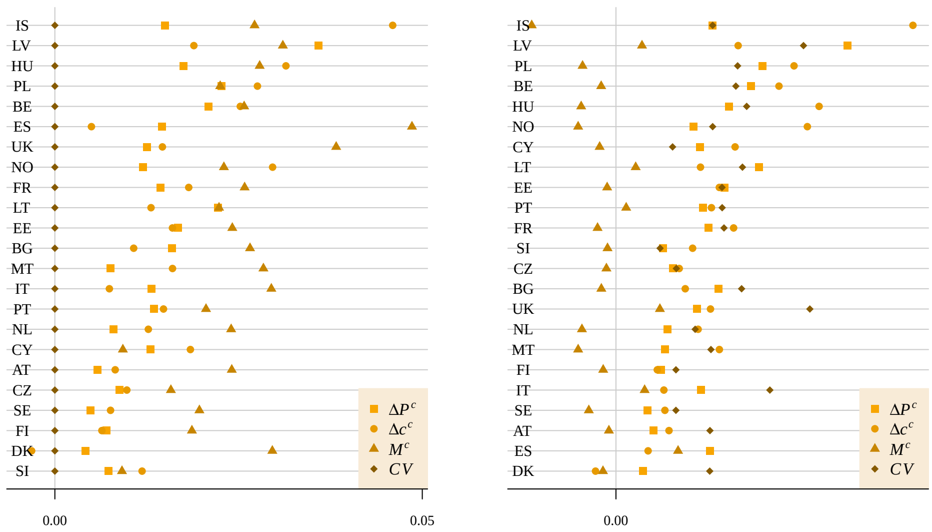
the horizontal line by a square, the second (R) by a dot, the third (PG) by a triangle.

From the left-hand panel in which $\alpha = 2$ and $\beta = 1$, we note that I is strong and negative and that its distribution differs considerably from PG: the higher is PG, the lower is I. On the contrary, the PG and R components are always positive and correlated; together they are able to offset the effect of I. Therefore, intertemporal pro-poorness is positive for all countries.

The panel on the right (with $\alpha = 2$ and $\beta = 3$) increases the dispersion of the components across the countries. As expected, given the increase in variability aversion, I falls but keeps a similar trend across the countries. PG further increases and shows a similar trend across the countries; it also diverges from I, dominates all the other components, and loses its correlation with R.

Figure 8: Second decomposition: average poverty gap (ΔP^c), cross-sectional inequality (Δc^c), difference between intertemporal and unitemporal inequality (M^c), and variability (CV) components for 23 European countries, 2006–09..

(a) $\alpha = 2, \beta = 1$. (b) $\alpha = 2, \beta = 3$.



Note: Authors' calculations based on EU-SILC.

Pro-poorness is then generally determined by the interactions of the three components, not by any one of them alone.

6 Conclusion

When is growth pro-poor? This paper argues that a comprehensive assessment of pro-poorness may require a shift from a purely cross-sectional perspective to a longitudinal one, thus accounting for individual poverty dynamics over time.

To this end, the paper proposes a family of aggregate indices of intertemporal pro-poorness. Differently from previous studies that compare the initial and final distributions of income, this paper's approach uses the additional information provided by the complete multiperiod joint distribution of income. The proposed indices aggregate equally-distributed-equivalent measures of the temporal poverty experienced by each individual in a society. The indices capture both the cost of variability and the benefit of intertemporal equalization induced by mobility. Three procedures show the effect of pure growth, cross-sectional inequality, intertemporal inequality, reranking and temporal variability in explaining growth pro-poorness.

Table 4: Third decomposition: inequality change (I), reranking (R), and pure growth (PG) for 23 European countries, 2006–09.

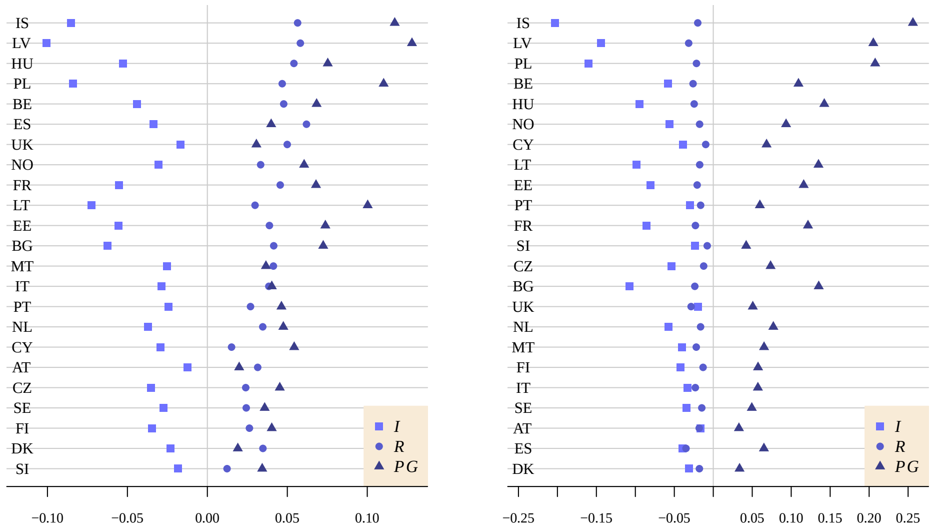
Country	($\alpha = 2, \beta = 1$)			($\alpha = 2, \beta = 3$)		
	I	R	PG	I	R	PG
AT	-0.013	0.031	0.02	-0.016	-0.018	0.033
BE	-0.044	0.048	0.068	-0.058	-0.026	0.11
BG	-0.062	0.042	0.072	-0.11	-0.024	0.14
CY	-0.029	0.015	0.054	-0.039	-0.0097	0.068
CZ	-0.035	0.024	0.045	-0.054	-0.012	0.074
DK	-0.023	0.035	0.019	-0.031	-0.018	0.034
EE	-0.056	0.039	0.074	-0.08	-0.021	0.12
ES	-0.034	0.062	0.04	-0.04	-0.035	0.065
FI	-0.035	0.026	0.04	-0.042	-0.013	0.057
FR	-0.055	0.046	0.068	-0.086	-0.023	0.12
HU	-0.053	0.054	0.075	-0.095	-0.025	0.14
IS	-0.085	0.056	0.12	-0.2	-0.02	0.26
IT	-0.029	0.038	0.04	-0.033	-0.023	0.057
LT	-0.073	0.03	0.1	-0.099	-0.017	0.14
LV	-0.1	0.058	0.13	-0.14	-0.032	0.21
MT	-0.025	0.041	0.037	-0.04	-0.022	0.065
NL	-0.037	0.035	0.048	-0.057	-0.016	0.077
NO	-0.03	0.033	0.061	-0.056	-0.018	0.093
PL	-0.084	0.047	0.11	-0.16	-0.022	0.21
PT	-0.024	0.027	0.046	-0.03	-0.016	0.06
SE	-0.027	0.024	0.036	-0.035	-0.015	0.049
SI	-0.018	0.012	0.034	-0.023	-0.0078	0.042
UK	-0.017	0.05	0.031	-0.019	-0.028	0.051

Notes: Authors' calculations based on EU-SILC.

An empirical illustration of the measurement framework for 23 European countries is also provided. It shows that, unless we impose extreme aversion to individual variability in income gaps, growth can be regarded as pro-poor over the 2006–09 period in most European countries, in spite of the difficulties that these countries faced during that period. The results further show that the intertemporal pro-poorness features of the income transformations that took place over 2006–09 vary considerably across European countries. They also vary within each country, depending on the normative relevance given to variability as opposed to inter-individual inequality. Thus, mobility, through variability and intertemporal inequality effects, does change significantly one's assessment of growth pro-poorness. Consequently, assessments framed into an anonymous or unitemporal perspective can provide an incomplete picture of the impact of growth on poverty and may also result in the implementation of inefficient anti-

Figure 9: Third decomposition for 23 European countries, 2006–09.

(a) $\alpha = 2, \beta = 1$. (b) $\alpha = 2, \beta = 3$.



Note: Authors' calculations based on EU-SILC.

poverty policies.

References

Atkinson, A. (1970): "On the Measurement of Inequality," *Journal of Economic Theory*, 2, 244–263.

Bibi, S., J.-Y. Duclos, and A. Araar (2014): "Mobility, taxation and welfare," *Social Choice and Welfare*, 42, 503–527.

Bossert, W., S. Chakravarty, and C. d'Ambrosio (2012): "Poverty and Time," *Journal of Economic Inequality*, 10, 145–162.

Bourguignon, Fr. (2011): "Non-anonymous growth incidence curves, income mobility and social welfare dominance," *Journal of Economic Inequality*, 9, 605–627.

Bourguignon, Fr. and S. Chakravarty (2003): "The measurement of multidimensional poverty," *Journal of Economic Inequality*, 1, 25–49.

Bresson, F. and J.-Y. Duclos (2015): "Intertemporal Poverty Comparisons," *Social Choice and Welfare*, 44, 567–616.

Busetta, A. and D. Mendola (2012): "The Importance of Consecutive Spells of Poverty: A Path-Dependent Index of Longitudinal Poverty," *Review of Income and Wealth*, 58, 355–374.

Canto, O., C. Gradín, and C. del Rio (2012): "Measuring poverty accounting for time," *Review of Income and Wealth*, 58, 330–354.

Chakravarty, S. (1983): "Ethically Flexible Measures of Poverty," *The Canadian Journal of Economics / Revue Canadienne d'Économique*, 16, 74–85.

Chakravarty, S., B. Dutta, and J. Weymark (1985): "Ethical indices of income mobility," *Social Choice and Welfare*, 2, 1–21.

Creedy, J. and M. Wilhelm (2002): "Income mobility, inequality and social welfare," *Australian Economic Papers*, 41, 140–150.

DiNardo, J., N. Fortin, and T. Lemieux (1996): "Labors Market Institutions and the Distribution of Wages, 1973-1992: A Semiparametric Approach," *Econometrica*, 64, 1001–1044.

Duclos, J.-Y. (2009): "What is "pro-poor"?" *Social Choice and Welfare*, 32, 37–58.

Duclos, J.-Y., A. Araar, and J. Giles (2010): "Chronic and transient poverty: Measurement and estimation, with evidence from China," *Journal of Development Economics*, 91, 266–277.

Dutta, I., L. Roope, and H. Zank (2013): "On Intertemporal Poverty Measures: The Role of Affluence and Want," *Social Choice and Welfare*, 41, 741–762.

Essama-Nssah, B. (2005): "A Unified Framework for Pro-Poor Growth Analysis," *Economic Letters*, 89, 216–221.

Essama-Nssah, B. and P. J. Lambert (2009): "Measuring Pro-Poorness: A Unifying Approach With New Results," *Review of Income and Wealth*, 55, 752–778.

Fields, G. (2008): "Income mobility," in *The New Palgrave*, ed. by L. Blume and S. Durlauf.

Fields, G. and E. Ok (1999): "The Measurement of Income Mobility: An Introduction to the Literature," in *Handbook of Income Inequality Measurement*, ed. by J. Silber, Kluwer Academic Publishers, chap. 19, 557–596.

Fields, G. S. (2010): "Does income mobility equalize longer-term incomes? New measures of an old concept," *The Journal of Economic Inequality*, 8, 409–427.

Foster, J., J. Greer, and E. Thorbecke (1984): "A Class of Decomposable Poverty Measures," *Econometrica*, 52, 761–766.

Foster, J. and J. Rothbaum (2012): "Mobility curves: using cutoffs to measure absolute mobility," mimeo, George Washington University.

Foster, J. E. (2009): "A class of chronic poverty measures," in *Poverty dynamics: interdisciplinary perspectives*, ed. by T. Addison, D. Hulme, and R. Kanbur, Oxford University Press, chap. 3, 59–76.

Friedman, M. (1962): *Capitalism and freedom*, Chicago: University of Chicago Press.

Gottschalk, P. and E. Spolaore (2002): "On the evaluation of economic mobility," *The Review of Economic Studies*, 69, 191–208.

Grimm, M. (2007): "Removing the Anonymity Asiom in Assessing Pro-Poor Growth," *Journal of Economic Inequality*, 5, 179–197.

Hoy, M. and B. Zheng (2011): "Measuring Lifetime Poverty," *Journal of Economic Theory*, 146, 2544–2562.

Jäntti, M. and S. Jenkins (2015): "Income Mobility," in *Handbook of income distribution*, ed. by A. Atkinson and F. Bourguignon, North Holland, vol. 2, chap. 10, 807–935.

Jenkins, S. and P. Van Kerm (2011): "Trends in Individual Income Growth: Measurement Methods and British Evidence," DP 5510, IZA.

Kakwani, N. and E. Pernia (2000): "What is Pro-Poor Growth?" *Asian Development Review*, 18, 1–16.

Kakwani, N. and H. Son (2003): "Pro-Poor Growth: Concepts and Measurement with Country Case Studies," *The Pakistan Development Review*, 42, 417–444.

Makdissi, P. and Q. Wodon (2003): "Risk-adjusted measures of wage inequality and safety nets," *Economics Bulletin*, 9, 1–10.

Palmisano, F. and V. Peragine (2014): "The distributional incidence of growth: a non-anonymous and rank dependent approach," *Review of Income and Wealth*, DOI: 10.1111/roiw.12109.

Palmisano, F. and D. Van de gaer (2013): "History dependent growth incidence: A characterisation and an application to the economic crisis in Italy," Working paper 2013-14, ECINEQ.

Ravallion, M. and S. Chen (2003): "Measuring Pro-poor Growth," *Economics Letters*, 78, 93–99.

Ruiz-Castillo, J. (2004): "The measurement of structural and exchange mobility," *Journal of Economic Inequality*, 2, 219–228.

Shorrocks, A. (2013): "Decomposition procedures for distributional analysis: a unified framework based on the Shapley value," *The Journal of Economic Inequality*, 11, 99–126.

Son, H. H. (2004): "A Note on Pro-Poor Growth," *Economic Letters*, 82, 307–314.

Appendix

Generalization to T periods

As mentioned in the main text, the decompositions provided in this paper can be generalized to time horizons of $T > 2$ periods.

The first decomposition is obtained by adding and subtracting in (16) the EDE of periodic individual poverty as follows:

$$\underbrace{\Pi_\alpha(\boldsymbol{g}_1) - \Pi_\alpha(\boldsymbol{g})}_{AG} + \underbrace{\Pi_\alpha(\boldsymbol{g}) - \Pi_{\alpha,\beta}(\boldsymbol{g})}_{M}$$

To generalize the second decomposition, observe that (13) can be rewritten as:

$$\Pi_{\alpha,\beta}(\boldsymbol{g}) = \omega_1 P_1(\boldsymbol{g}_1) + \omega_2 P_2(\boldsymbol{g}_2) + ... + \omega_T P_T(\boldsymbol{g}_T) + c_{\alpha,\beta}(\boldsymbol{g}) + \frac{1}{n}\sum_{i=1}^{n} c_\beta((g))$$

$IPP_{\alpha,\beta}$ can then be decomposed as :

$$\underbrace{\omega_2[P_1(\boldsymbol{g}_1) - P_1(\boldsymbol{g}_2)] + \omega_3[P_1(\boldsymbol{g}_1) - P_1(\boldsymbol{g}_3)] + ... + \omega_T[P_1(\boldsymbol{g}_1) - P_1(\boldsymbol{g}_T)]}_{\Delta P^c} +$$

$$+\underbrace{\omega_2[c_\alpha(\boldsymbol{g}_1) - c_\alpha(\boldsymbol{g}_2)] + \omega_3[c_\alpha(\boldsymbol{g}_1) - c_\alpha(\boldsymbol{g}_3)] + ... + \omega_T[c_\alpha(\boldsymbol{g}_1) - c_\alpha(\boldsymbol{g}_T)]}_{\Delta c^c}$$

$$+\underbrace{[\omega_1 c_\alpha(\boldsymbol{g}_1) + \omega_2 c_\alpha(\boldsymbol{g}_2) + \omega_3 c_\alpha(\boldsymbol{g}_3) + ... + \omega_T c_\alpha(\boldsymbol{g}_T)] - c_{\alpha,\beta}(\boldsymbol{g})}_{M^c} +$$

$$+\underbrace{\frac{1}{n}\sum_{i=1}^{n} c_\beta(\boldsymbol{g}_{(i)})}_{CV}$$

Lastly, when $T > 2$, the third decomposition can be obtained as :

$$\underbrace{\left[\Pi_{\alpha,\beta}(\boldsymbol{g}_1) - \Pi_{\alpha,\beta}\left(\boldsymbol{g}_1^I\right)\right]}_{I} + \underbrace{\left[\Pi_{\alpha,\beta}\left(\boldsymbol{g}_1^I\right) - \Pi_{\alpha,\beta}\left(\boldsymbol{g}_1^{IR}\right)\right]}_{R} +$$

$$+\underbrace{\left[\Pi_{\alpha,\beta}\left(\boldsymbol{g}_1^{IR}\right) - \Pi_{\alpha,\beta}(\boldsymbol{g})\right]}_{PG}$$

Here, $\boldsymbol{g}^I = (\boldsymbol{g}_1, ..., \boldsymbol{g}_t^I, ..., \boldsymbol{g}_T^I)$, where $\boldsymbol{g}_t^I$ denotes the counterfactual distribution of poverty gaps at time t obtained by preserving the same average poverty gaps and ranks as observed in the first period distribution. Similarly, $\boldsymbol{g}^{IR} = (\boldsymbol{g}_1, ..., \boldsymbol{g}_t^{IR}, ..., \boldsymbol{g}_T^{IR})$, where $\boldsymbol{g}_t^{IR}$ denotes the counterfactual time-specific distribution of poverty gaps obtained by keeping the same average poverty gap as that of the first period distribution.