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EVALUATING PATTERNS OF INCOME GROWTH WHEN STATUS MATTERS: A ROBUST APPROACH

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This paper addresses the problem of ranking growth episodes from a microeconomic perspective. While most of the existing criteria, framed in the pro-poor growth tradition, are either based on anonymous individuals or are used to identify them on the basis of their status in the initial period, this paper proposes new criteria to evaluate growth, which are robust to the choice of the reference period used to identify individuals. Suitable dominance conditions that can be used to rank alternative growth processes are derived by means of an axiomatic approach. Moreover, the theoretical results are used to rank the different growth episodes that have taken place in the past decade in Australia, Germany, Korea, Switzerland, and the U.S.

JEL Codes: D31, D63, D71

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1. INTRODUCTION

Since the pioneering work of Kuznets (1955), the analysis of the distributional implications of growth has become one of the most prominent topics in economics. However, the impressive number of contributions that soon followed were not able to reach a unanimous consensus on the effects of growth on the distribution. The scarcity of reliable data and the use of aggregate indicators of the distribution and its dynamics were among the main reasons for this lack of consensus (see Ferreira, 2010). After a period of reticence, this issue is now enjoying renewed and increasing interest among scientists and policymakers. The availability of better survey data has spurred the scientific community to adopt a different perspective to this analysis. There is, in fact, an increasing awareness in the recent literature that individuals, rather than a representative aggregate of the whole population, should be the focus of analysis for evaluating the impact of growth (see, among others, Ravallion, 1998, 2012; Ravallion and Chen, 2007; Benjamin *et al.*, 2011). Moreover, this aspect of growth has also taken center stage in the political agenda at an international level: for instance, one of the targets of the Sustainable Development Goals, which from the end of 2015 replaced the

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Millennium Development Goals, is to promote "inclusive economic growth," that is, growth that benefits all the segments of society.

Hence, as a response to the original macroeconomic approach, two alternative microeconomic approaches have been developed to evaluate growth and its distributional implications. The first is the disaggregated anonymous approach, which evaluates growth processes on the basis of the income change experienced by each part of the distribution (see, among others, Ravallion and Chen, 2003; Son, 2004; Essama-Nssah, 2005). Its main tool is the Growth Incidence Curve (GIC, Ravallion and Chen, 2003), which plots against each percentile of the distribution the mean income change of that percentile. This approach has, however, recently been criticized since, due to its anonymity properties, incomes of different individuals are used to compute the percentile specific growth, as those that are at a particular percentile in the initial income distribution are not necessarily at that same percentile in the second-period income distribution. Thus, measures of anonymous growth fail to capture the impact of re-ranking or mobility that is taking place during the overall growth process. This procedure can be satisfactory if the aim is an understanding of the pure cross-sectional impact of growth. In can, however, be undesirable if the aim is a more normative and intertemporal evaluation of growth.

In order to overcome this issue, a non-anonymous approach has recently been proposed, which relaxes the anonymity assumption and evaluates growth processes on the basis of individuals' growth experiences and their identities (see, among others, Jenkins and Van Kerm, 2006; Grimm, 2007; Bourguignon, 2011; Palmisano and Peragine, 2015; Palmisano and Van de gaer, 2016; Dhongde and Silber, forthcoming). In this approach, the identity of individuals is defined on the basis of their status, namely their position in the initial distribution of income. Its main tool is the non-anonymous Growth Incidence Curve (na-GIC: Grimm, 2007; Van Kerm, 2009; Bourguignon, 2011), which plots the change in mean income of those individuals belonging to the same quantile in the initial distribution of income as a function of their quantile in this initial distribution. This approach is also called history-dependent. The related frameworks usually give more weight to the growth experienced by the initially poor than to that experienced by the initially rich individuals.

In this paper, we share this view and we believe that, for the welfare evaluation of growth, the status of individuals does matter. This information allows us to find out who are the winners and losers from growth—useful information in, for example, the evaluation of the efficacy of policy reforms, which is usually hidden by the anonymity assumption in the standard anonymous approach.

However, the existing literature has developed dominance conditions in which the identification of individuals is exclusively based on their position in the income distribution of the first period (see, in particular, Van Kerm, 2009; Bourguignon, 2011; Palmisano and Peragine, 2015). This choice, though perfectly legitimate, is not the only one that is possible and is not supported by any normative grounded reason. Nevertheless, the choice of the reference period can have an impact on the result of a given comparison between countries or between growth episodes for the same countries. In other words, it is questionable, in the social evaluation of growth, to give priority only to the growth of the initially poor

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individuals, as compared to the initially rich, and not, for instance, to the growth of the finally poor individuals as compared to the finally rich.

Note that, in such frameworks, the attention on the poorer individuals in the final period also finds its justification in the sphere of public interventions that should, in general, target this group of the population. In fact, in terms of priority in public interventions (such as anti-poverty policies), it may be more meaningful to give relevance to the new poor rather than to those individuals who have exited from poverty.[1]

The considerations above are even more impelling when the evaluation of the distributional effect of growth concerns growth processes that take place over a long period or even over the full life span. In this case, the choice of the first-period distribution as the reference distribution can be justified by the belief that low income earlier in life may impact the standard of living later in life, but not the other way around. However, it does not imply that this belief will be universally accepted. There can be arguments in favor of the opposite belief, that is, living with a low level of income may matter more the closer an individual is to the end of his life (on this, see Hoy and Zheng, 2011).

In order to address this issue, this paper proposes a more general framework for the normative assessment and comparison of growth processes: within this normative framework, we are able to obtain dominance conditions that are robust with respect to the choice of the reference period used to identify individuals.

More particularly, we propose a social evaluation function (SEF) in which the status of the individuals both in the initial *and* in the final period can be used to evaluate growth. Then, we introduce desirable properties that allow us to consider classes of this SEF, within which the two periods equally affect the social evaluation of growth, and classes of this SEF within which the first-period status matters more or less than the final-period status. By demanding unanimity within these classes, we obtain distributional criteria to rank growth processes that turn out to be robust to the choice of the reference period used to identify individuals.

Hence, we provide new partial orderings for the ranking of growth processes that are based on the concept of upward dominance for continuous distribution and upward and downward dominance for discrete distributions. Last, we also propose a set of indexes that can be used to rank growth processes when the application of the partial dominance conditions does not allow us to infer which growth process is more desirable than the other. Thus, our framework represents an additional instrument in the researcher's toolbox to help in apprehending the distributional effects of growth, in particular when there is an interest in making comparisons of growth between two (or more) populations or over time.

It is interesting to note that our framework is also coherent with that part of the economic literature, mostly focused on happiness studies, in which increasing evidence is provided to show that an individual's well-being strictly depends on his income relative to that of others (on this, see Clark *et al.*, 2008). In fact, in our framework the evaluation of a person's income growth implicitly depends on the incomes of other individuals in the population.

[1]For different approaches to evaluating distributional dynamics, see Herault and Azpitarte (2016), Liberati (2015), and Prados de la Escosura (2015).

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We then adopt this theoretical framework to compare the distributional impact of growth in five different countries, namely Australia, Germany, Korea, Switzerland, and the U.S., in the past decade. We do this using the Cross National Equivalent File (CNEF), a dataset containing harmonized data on these countries. We find that Korea, followed by Australia, surfaces as the best-performing country, that is, its growth process, evaluated when both the initial- and final-period status matter, turns out to be the dominating process in the largest number of pairwise comparisons. On the other hand, the U.S., Germany, and Switzerland turn out to be the worst-performing, that is, their growth processes turn out to be the dominated one in most of the pairwise comparisons considered.

The empirical results also show that it does make a difference in the ranking of countries whether one is concerned with the initial status of individuals or with their status in the final distribution. Thus, they give further support to the relevance of adopting our generalized framework for the comparison of different growth processes.

The rest of this paper is organized as follows. Section 2 introduces the models used in the microeconomic-oriented literature on the distributional effect of growth and proposes the new framework. Section 3 provides the empirical analysis. Section 4 concludes.

2. Evaluating Patterns of Income Growth

In this section, we outline the setup and the standard tools used to assess alternative growth patterns. We then introduce our approach based on an extended concept of non-anonymity that is robust to the choice of the reference period.

2.1 *Standard Practices*

Let a society's income distribution be represented by the cumulative distribution function (*cdf*) $F : \Re_+ \rightarrow [0, 1]$. In a given period of time t, $F(y_t)=P(\tilde{y}_t \in \Re_+ : \tilde{y}_t \leq y_t)$, that is, the *cdf* returns the probability $p \in [0, 1]$ of observing income less or equal to $\tilde{y}_t$ in that society in period t. The mean income of this society is denoted by $\mu(y_t)$. Let the inverse of this *cdf* be denoted by $y_t(p_t)$, where $y_t(p_t)=inf\{y_t \in \Re_+|F(y_t) \geq p_t\}$; hence, $y_t(p_t) : [0, 1] \rightarrow \Re_+$ represents the income of the person whose rank in the distribution $F(y_t)$ is p_t. Then, p_t represents the status of the individual in t. We deal with a total number of periods, T, equal to 2, with $t=1$ representing the pre-growth period, while $t+1=2$ represents the post-growth period.

The standard anonymous practice to evaluate and compare the distributive performance of two growth processes consists in comparing their respective GICs and cumulative GICs. The GIC is formally defined as follows (Ravallion and Chen, 2003):

$$(1) \qquad g(p)=\frac{y_{t+1}(p_{t+1})}{y_t(p_t)}-1=\frac{L'_{t+1}(p_{t+1})}{L'_t(p_t)}(\gamma+1)-1, \text{for all } p \in [0, 1],$$

where $L'(p)$ is the first derivative of the Lorenz curve at percentile p, and $\gamma=\mu(y_{t+1})/\mu(y_t)-1$ is the overall mean income growth rate. The GIC plots the

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percentile specific rate of income growth in a given period of time. Clearly, $g(p) \geq 0$ ($g(p) < 0$) indicates a positive (negative) growth at p. A downward-sloping GIC indicates that growth contributes to equalize the distribution of income (i.e. $g(p)$ decreases as p increases), whereas an upward-sloping GIC indicates a non-equalizing growth (i.e. $g(p)$ increases as p increases). When the GIC is a horizontal line, inequality does not change over time and the rate of growth experienced by each quantile is equal to the rate of growth in the overall mean income.

Given two growth processes A and B, dominance of A over B is verified when the GIC of the former lies nowhere below that of the latter, in which case it is possible to state that under A all income percentiles have been growing more (or decreasing less) than under B. A dominance of the second order of A over B is verified when the cumulative GIC of the former lies nowhere below that of the latter, implying that A has been more progressive than B.

These criteria are based on the comparison of each income percentile at two different points in time. Therefore, although based on individual data, this procedure ignores the individuals' identity and does not allow us to trace their income dynamic. It is then necessary to resort to the non-anonymous versions of the GIC, namely the na-GIC and cumulative na-GIC, in order to address this issue. Letting $y_{t+1}(p_t)$ be the final-period income of an individual ranked p_t in the initial period, the na-GIC can be formally defined as follows (Grimm, 2007; Van Kerm, 2009; Bourguignon, 2011):

$$g(p_t) = \frac{y_{t+1}(p_t)}{y_t(p_t)} - 1, \text{for all } p_t \in [0, 1], \tag{2}$$

where $y_{t+1}(p_t) = \int_0^a y_{t+1}(p_t) \mathrm{d}f(y_{t+1}(p_t))$. In other words, the na-GIC associates to every quantile of the initial distribution the mean income growth of all individual units in that quantile. Note that the na-GIC is equivalent to a specific type of the Mobility Profile introduced by Van Kerm (2009). In the same vein as the anonymous approach, dominance of process A over B is verified when the na-GIC of the former lies nowhere below that of the latter. In this case, it is possible to state that under A the income of the individuals in each of the initial percentiles grows more (or decreases less) than under B. A dominance of the second order of A over B is verified when the cumulative na-GIC of the former lies nowhere that of the latter, implying that A favors more than B the income growth of the initially poor as compared to that of the initially rich.

Some recent contributions in the literature propose normative characterizations for the non-anonymous approach and hence provide a normative justification for the use of the na-GIC. In particular, they propose to evaluate growth episodes by means of a social evaluation function, which is assumed to be a function of the individuals' income change and the individuals' position in the initial distribution (see Bourguignon, 2011; Jenkins and Van Kerm, 2011; Palmisano and Peragine, 2015).

A major drawback of these frameworks, however, is their dependency on the first-period distribution, as they are *sensitive* to the status of individuals in the initial period but not to the status of individuals in the final period. Although the

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choice of the first period as the reference period to identify individuals is usually considered to be a natural choice, it still remains a purely arbitrary modeling choice. As discussed in Section 1, different considerations do motivate a generalization of these frameworks to allow for a more flexible assessment of the distributional impact of growth. We do this in the following section.

2.2 *The Model*

Our aim is to evaluate and compare growth processes according to an extended non-anonymous perspective. Therefore, we need to keep track of the status of individuals in both periods, where such status is represented by the rank of individuals in the initial and final distributions of income. For this reason, we denote by $\delta(p_t)$ the income change in moving from date t to $t+1$, for a given individual ranked p in the initial period, and by $\delta(p_{t+1})$ the income change in moving from date t to $t+1$, for a given individual ranked p in the final period.

We denote by $G^{(t,t+1)}$ the growth process taking place between t and $t+1$ and by D the set of admissible growth processes, that is, all possible combinations of each individual's initial and final income, represented by $\delta(p_t)$ and $\delta(p_{t+1})$, where $\delta : R_+ \rightarrow R$ is a continuous and non-constant function and, by definition of p, the individuals' rank in both the initial and the final period is used to identify them. We are interested in ranking members of D from a normative perspective and we assume that such ranking can be represented by a social evaluation function, $\widehat{W} : D \rightarrow R$. On the basis of the arguments outlined so far, we propose that social preferences over growth processes can be represented by the following social evaluation function, which is a generalization of the rank-dependent SEF proposed by Yaari (1988):[2]

$$\widehat{W}(G^{(t,t+1)}) = \frac{1}{2}\left(\int_0^1 v(p_t)\delta(p_t)\mathrm{d}p_t + \int_0^1 v(p_{t+1})\delta(p_{t+1})\mathrm{d}p_{t+1}\right), \tag{3}$$

or, equivalently,

$$\widehat{W}(G^{(t,t+1)}) = \frac{1}{T}\sum_{t=1}^{T}\int_0^1 v(p_t)\delta(p_t)\mathrm{d}p_t,\ T=2. \tag{4}$$

Thus, a social evaluation of growth is obtained as the average of the initial- and final-period sensitive growth. The first component of equation (3), $\int_0^1 v(p_t)\delta(p_t)\mathrm{d}p_t$, is a weighted sum of the income change experienced by the individuals that are identified according to their status in the initial period; the second component, $\int_0^1 v(p_{t+1})\delta(p_{t+1})\mathrm{d}p_{t+1}$, is a weighted sum of the income change experienced by the individuals that are identified on the basis of their status in the final period. The functions $v(p_t), v(p_{t+1}) : [0,1] \rightarrow R_+$ express the social weights attached to the income change of each individual and depend on the individual's

[2]For alternative applications, see also Donaldson and Weymark (1980), Aaberge (2001), and Peragine (2002).

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status in the society, as determined by his position in the initial ($v(p_t)$) and final ($v(p_{t+1})$) distribution.

Note that $\delta(p_t)$ and $\delta(p_{t+1})$ can be expressed through a variety of measures of individual income growth, including the absolute income change or the proportionate income change.[3]

That is, in order to evaluate growth, one needs to aggregate the income change experienced by each individual, using rank-specific weighting functions. Different preferences over growth processes can be expressible through our model imposing different restrictions on the social weights, and hence selecting different classes of weight profiles. These, in turn, define different classes of social evaluation functions (SEF).

The first restriction we impose reflects a standard monotonicity assumption.

Property 1. (*Pro-growth*). $v(p_t) \geq 0$ and $v(p_{t+1}) \geq 0$ for all $p_t, p_{t+1} \in [0, 1]$.

It implies that, all else equal, an experience of an increase in income at the individual level will not decrease $\widehat{W}(G^{(t,t+1)})$, whereas an experience of a reduction in income will not increase it. The marginal impact will instead be the same. A gain of income equal to δ experienced by an individual ranked p_t will result in an increase of $\widehat{W}(G^{(t,t+1)})$ equal to $v(p_t) * \delta$, while a reduction of δ experienced by the same individual will result in a reduction of $\widehat{W}(G^{(t,t+1)})$ equal to $v(p_t) * \delta$.[4] Therefore, the extent of the variation of our SEF due to a reduction of an individual's income equal to δ will be equal to the extent of the variation of our SEF generated by an increase of this individual's income of the same amount δ, whereas the direction of this variation will be different. In other words, this SEF is increasing in upward income mobility and decreasing in downward income mobility, whatever the relative status of individuals in the initial and final distributions.

The second property we consider makes our SEF distribution-sensitive.

Property 2. (*Pro-poor growth*). $\frac{\delta v(p_t)}{\delta p_t} \leq 0$ and $\frac{\delta v(p_{t+1})}{\delta p_{t+1}} \leq 0$ for all $p_t, p_{t+1} \in [0, 1]$.

This property requires that the first derivative of the social weight function $v(p_t)$ with respect to p_t and of $v(p_{t+1})$ with respect to p_{t+1} be negative. Therefore, the weighting function is decreasing with the rank of individuals, respectively, in the initial and final distributions. This mathematical property is expression of a transfer-sensitivity principle in the context of income growth (or income mobility) among individuals having different ranks in the reference distribution. According to Property 2, decreasing by a given amount the income change of an initially (finally) richer individual and increasing by the same amount the income change of an initially (finally) poorer individual will not decrease $\widehat{W}(G^{(t,t+1)})$. A reduction in income leads to a greater decrease in the social evaluation of growth the poorer the individual is in the initial (final) distribution. In the same vein, a rise in income leads to a greater increase in the social evaluation of growth the poorer in

[3]For alternative measures of individual income growth that could be used in this work, see Cowell (1985), Fields and Ok (1999a,b), Schluter and Van de gaer (2011), and Palmisano and Van de gaer (2016).

[4]Equivalently, a gain of income equal to δ experienced by an individual ranked p_{t+1} will result in an increase of $\widehat{W}(G^{(t,t+1)})$ equal to $v(p_{t+1}) * \delta$, while a reduction of δ experienced by the same individual will result in a reduction of $\widehat{W}(G^{(t,t+1)})$ equal to $v(p_{t+1}) * \delta$.

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the initial (final) distribution is the individual experiencing that increase. In other words, upward mobility (downward mobility) leads to a greater increase (decrease) in the SEF of growth the lower is the status of individuals either in the initial or in the final distribution.[5]

Properties 1 and 2 capture the main core of our paper, as they endorse an agnostic view with respect to the choice of the reference period. In fact, in previous contributions they have been imposed only with respect to $v(p_t)$, while letting implicitly $v(p_{t+1})$ be equal to 0.

The next two properties refine Property 2, allowing for situations in which a social planner would either prefer the initial-period status to the final one or the other way round.

Property 3. (*Preference for initial period*). $\frac{\delta v(p_t)}{\delta p_t} \leq \frac{\delta v(p_{t+1})}{\delta p_{t+1}} \leq 0$ for all $p_t, p_{t+1} \in [0, 1]$.

Property 3 reflects the idea that the status of individuals in the first period matters more than in the second period. In other words, a social planner would give more relevance to the growth of the initially poorer as compared to the growth of the initially richer than to the growth of the finally poorer as compared to the growth of the finally richer. According to this property, $\widehat{W}(G^{(t,t+1)})$ increases more if a progressive transfer of growth takes place according to the rank of individuals in the initial period, with respect to an increase of $\widehat{W}(G^{(t,t+1)})$ generated by a progressive transfer of growth taking place according to the rank of individuals in the final period. That is, a social planner endorsing these preferences would prioritize a transfer of positive income growth from an initially richer to an initially poorer individual over a transfer from a finally richer to a finally poorer individual.

An opposite argument is, instead, at the base of the next property.

Property 4. (*Preference for final period*). $\frac{\delta v(p_{t+1})}{\delta p_{t+1}} \leq \frac{\delta v(p_t)}{\delta p_t} \leq 0$ for all $p_t, p_{t+1} \in [0, 1]$.

According to Property 4, the social evaluation of growth would be more sensitive to the growth experienced by those poorer individuals in the final period than those who are poorer in the initial period. That is, a social planner endorsing these preferences would prioritize a transfer of positive income growth from a finally richer individual to a finally poorer individual over a transfer from an initially richer to an initially poorer individual. Therefore, this property makes the SEF more sensitive to the relative status of individuals in the final period than their status in the initial period.

The following families of social evaluation functions can be identified on the basis on the properties introduced above:

[5]Suppose that (5, 7, 13, 14) is the distribution of four individuals' income in the initial period. Given this initial distribution, an example of hypothetical growth process that can be defined as pro-poor according to our framework, in the case of positive mean income growth rate, could be the one generating the following vector of final incomes: (10, 11, 14, 15). In the case of no growth in mean income, a pro-poor growth process could be the one generating the following vector of final income: (7, 9, 11, 12). Finally, in the presence of a negative mean income growth rate, a pro-poor growth process could be the one generating the following vector of final incomes: (7 8 10 11).

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- $\widehat{\mathbf{W}}_1$ is the class of SEFs constructed as in equation (4) and with social weight functions satisfying Property 1.
- $\widehat{\mathbf{W}}_{1,2}$ is the class of SEFs constructed as in equation (4) and with social weight functions satisfying Properties 1 and 2.
- $\widehat{\mathbf{W}}_{1,3}$ is the class of SEFs constructed as in equation (4) and with social weight functions satisfying Properties 1 and 3.
- $\widehat{\mathbf{W}}_{1,4}$ is the class of SEFs constructed as in equation (4) and with social weight functions satisfying Properties 1 and 4.

2.3 *Results*

We now turn to identify a range of conditions to be satisfied for ensuring the dominance of one growth process over the other in terms of extended non-anonymous evaluation, for the different families of social evaluation functions $\widehat{\mathbf{W}}$ listed above. All the proofs are gathered in the theoretical appendix.[6]

We start by considering the class of social evaluation functions $\widehat{\mathbf{W}}_1$, for which the following result holds.

Proposition 1. *Given two alternative growth processes,* $G_A^{(t,t+1)}$ *and* $G_B^{(t,t+1)}$, $\widehat{W}(G_A^{(t,t+1)}) \geq \widehat{W}(G_B^{(t,t+1)})\,\forall\,\widehat{W} \in \widehat{\mathbf{W}}_1$ *if and only if*

$$(i)\ \delta_A(p_t) \geq \delta_B(p_t)\ \forall p_t \in [0,1] \tag{5}$$

and

$$(ii)\ \delta_A(p_{t+1}) \geq \delta_B(p_{t+1})\ \forall p_{t+1} \in [0,1]. \tag{6}$$

Proposition 1 characterizes two dominance conditions of the first order. The first condition requires that the distribution of the individuals' income change of growth process *A*, must lie nowhere below that of *B*, for all the initial social statuses (or initial income ranks). The second condition requires that the distribution of individuals' income change of growth process *A*, must lie nowhere below that of *B*, for all the final social statuses (or final income ranks). Hence, when we only impose pro-growth, to determine which growth process is preferable we need to check that for each rank of the initial and final periods, the growth experienced is higher in *A* than in *B*.

This class of SEFs is the expression of a simple efficiency-based criterion; no concern is expressed in terms of redistributional effects of growth.

Proposition 1 encompasses some interesting special cases. They are summarized in the following Corollaries 1 and 2.

Corollary 1. *Given two alternative growth processes,* $G_A^{(t,t+1)}$ *and* $G_B^{(t,t+1)}$, $\widehat{W}(G_A^{(t,t+1)}) \geq \widehat{W}(G_B^{(t,t+1)})\,\forall\,\widehat{W} \in \widehat{\mathbf{W}}_1$ *such that* $v(p_{t+1})=0$ *if and only if*

[6]The theoretical appendix is made available as Online Supporting Information.

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$$\delta_A(p_t) \geq \delta_B(p_t)\,\forall p_t \in [0,1]. \tag{7}$$

Corollary 2. *Given two alternative growth processes,* $G_A^{(t,t+1)}$ *and* $G_B^{(t,t+1)}$, $\widehat{W}(G_A^{(t,t+1)}) \geq \widehat{W}(G_B^{(t,t+1)})\,\forall\,\widehat{W} \in \widehat{\mathbf{W}}_1$ *such that* $v(p_t)=0$ *if and only if*

$$\delta_A(p_{t+1}) \geq \delta_B(p_{t+1})\,\forall p_{t+1} \in [0,1]. \tag{8}$$

According to Corollary 1, when we assume that the status of individuals in the final period is not relevant for growth evaluations, Proposition 1 boils down to the standard first-order non-anonymous growth dominance condition (see Van Kerm, 2009; Palmisano and Peragine, 2015). According to Corollary 2, instead, we would compare growth processes on the basis of growth dominance criteria that are non-anonymous with respect to the identity of individuals only in the final period.

We now consider the class of SEFs $\widehat{\mathbf{W}}_{1,2}$, for which the following result holds.

Proposition 2. *Given two alternative growth processes,* $G_A^{(t,t+1)}$ *and* $G_B^{(t,t+1)}$, $\widehat{W}(G_A^{(t,t+1)}) \geq \widehat{W}(G_B^{(t,t+1))})\,\forall\,\widehat{W} \in \mathbf{W}_{1,2}$ *if and only if*

$$(i)\int_0^{p_t} \delta_A(q_t)dq_t \geq \int_0^{p_t} \delta_B(q_t)dq_t\,\forall p_t \in [0,1] \tag{9}$$

and

$$(ii)\int_0^{p_{t+1}} \delta_A(q_{t+1})dq_{t+1} \geq \int_0^{p_{t+1}} \delta_B(q_{t+1})dq_{t+1}\,\forall p_{t+1} \in [0,1]. \tag{10}$$

Two conditions of the second order are characterized by this proposition. According to the first condition, we have to order increasingly individuals on the basis of their rank in the initial distribution and check that the cumulated income change be higher in A than in B at every p_t. According to the second condition, we have to order increasingly individuals on the basis of their rank in the final distribution and check that the cumulated income change be higher in A than in B at every p_{t+1}. If both conditions are satisfied, growth can be said to be more pro-poor in the dominating process than in the dominated one. That is, the growth differential between initially poorer and richer individuals is more favorable for the initially poorer, and the growth differential between finally poorer and richer individuals is more favorable to the finally poorer in the dominating process than in the dominated one.

As expected, Proposition 2 also encompasses some special cases that are worth observing; they are presented in Corollaries 3 and 4.

Corollary 3. *Given two alternative growth processes,* $G_A^{(t,t+1)}$ *and* $G_B^{(t,t+1)}$, $\widehat{W}(G_A^{(t,t+1)}) \geq \widehat{W}(G_B^{(t,t+1)})\,\forall\,\widehat{W} \in \widehat{\mathbf{W}}_1$ *such that* $\frac{\delta v(p_{t+1})}{\delta p_{t+1}}=0$ *if and only if*

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$$\int_0^{p_t} \delta_A(q_t)dq_t \geq \int_0^{p_t} \delta_B(q_t)dq_t \, \forall p_t \in [0,1]. \tag{11}$$

Corollary 4. *Given two alternative growth processes,* $G_A^{(t,t+1)}$ *and* $G_B^{(t,t+1)}$, $\widehat{W}(G_A^{(t,t+1)}) \geq \widehat{W}(G_B^{(t,t+1)}) \, \forall \, \widehat{W} \in \widehat{\mathbf{W}}_1$ *such that* $\frac{\delta \hat{v}(p_t)}{\delta p_t}=0$ *if and only if*

$$\int_0^{p_{t+1}} \delta_A(q_{t+1})dq_{t+1} \geq \int_0^{p_{t+1}} \delta_B(q_{t+1})dq_{t+1} \, \forall p_{t+1} \in [0,1]. \tag{12}$$

Corollary 3 states that when the status of individuals in the final period is not relevant for growth evaluations, the result of Proposition 2 ends up being equivalent to the standard cumulated non-anonymous growth dominance. In Corollary 4, the status of individuals in the first period is not relevant and to evaluate growth we would only need to check the dominance of the cumulated distribution of the individuals' growth, where these individuals are ordered increasingly on the basis of the final income distribution.

Propositions 1 and 2 are agnostic with respect to the choice of the reference period. The next propositions directly deal with this issue.

Proposition 3. *Given two growth processes* $G_A^{(t,t+1)}$ *and* $G_B^{(t,t+1)}$, $\widehat{W}(G_A^{(t,t+1)}) \geq \widehat{W}(G_B^{(t,t+1)}) \, \forall \, \widehat{W} \in \widehat{\mathbf{W}}_{1,3}$ *if and only if, given* $v(p_t)=v(p_{t+1})=0$ *for* $p_t, p_{t+1}=1$,

$$(i) \int_0^{p_t} \delta_A(q_t)dq_t \geq \int_0^{p_t} \delta_B(q_t)dq_t \, \forall p_t \in [0,1] \tag{13}$$

and

$$(ii) \sum_{t=1}^{T} \int_0^{p_t} \delta_A(q_t)dq_t \geq \sum_{t=1}^{T} \int_0^{p_t} \delta_B(q_t)dq_t \, \forall p_t \in [0,1]. \tag{14}$$

Proposition 3 characterizes a sequential dominance condition of the second order. In fact, *(i)* is the first step of this sequential dominance and requires that the cumulative growth be higher in A than in B at all ranks of the initial distribution, that is, at all p_t. This first step is equivalent to condition *(i)* in Proposition 2. Condition *(ii)* is the second and, in this specific case, the last step of this sequential dominance, given that $T=2$. It requires that the sum of the cumulative growth between the initial and the final period is higher in A than in B for all ranks $p \in [0,1]$. In order to perform this test, we have to merge the cumulative distribution of individual income changes, with individuals ordered on the basis of the initial income, with that of individual income changes, with individuals ordered on the basis of the final income. The merging takes place by summing at every p the cumulative growth up to the individual ranked p in the initial period to the cumulative growth of individuals ranked p in the final period. We then have to check that the sum between the cumulative growth of individuals ranked p in t and the cumulative growth of individuals ranked p in $t+1$ is higher in A than in B, and this dominance must be checked at every $p \in [0,1]$.

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Proposition 4. *Given two growth processes* $G_A^{(t,t+1)}$ *and* $G_B^{(t,t+1)}$, $\widehat{W}(G_A^{(t,t+1)}) \geq \widehat{W}(G_B^{(t,t+1)})\ \forall\ \widehat{W} \in \widehat{\mathbf{W}}_{1,4}$ *if and only if, given* $v(p_t)=v(p_{t+1})=0$ *for* $p_t, p_{t+1}=1$,

$$(i) \int_0^{p_{t+1}} \delta_A(q_{t+1})dq_{t+1} \geq \int_0^{p_{t+1}} \delta_B(q_{t+1})dq_{t+1}\ \forall\, p_{t+1} \in [0,1] \tag{15}$$

and

$$(ii) \sum_{t=1}^{T} \int_0^{p_t} \delta_A(q_t)dq_t \geq \sum_{t=1}^{T} \int_0^{p_t} \delta_B(q_t)dq_t\ \forall\, p_t \in [0,1]. \tag{16}$$

Proposition 4 characterizes a downward sequential dominance condition of the first order. *(i)* is the first step of this sequential dominance and requires that the cumulative growth be higher in A than in B at all ranks of the final distribution. It is equivalent to condition *(ii)* in Proposition 2. *(ii)* is the second and last step of this sequential dominance. As before, in order to prove *(ii)*, we have to merge the cumulative distribution of individual income changes, with individuals ordered on the basis of the initial income, with the distribution of individual income changes, with individuals ordered on the basis of the initial income. The merging takes place by summing at every p the cumulative growth up to the individual ranked p in the initial period to the cumulative growth up to individuals ranked p in the final period. We then have to check that the sum between the cumulative growth up to individuals ranked p in t and the cumulative growth of individuals ranked p in $t+1$ is higher in A than in B, and this dominance must be checked at every $p \in [0,1]$.

The difference between Propositions 3 and 4 is clear. According to the former, the dominance of A over B is checked starting from a distribution of individual income changes in which individuals are ordered on the basis of the first-period rank, whereas, according to the latter, we have to start from a distribution of individual income changes in which individuals are ordered on the basis of the final-period rank.

2.4 *Aggregate Measures*

The ordering of growth patterns that can be obtained using the dominance criteria proposed previously are robust but only partial. Complete rankings can, instead, be generated by imposing a specific functional form on the social weights and, thus, adopting a scalar measure. This will be particularly helpful when the framework discussed above fails to generate a ranking, thus leading to inconclusive results. For this reason, we propose the following family of aggregate measures of growth.

$$\tilde{W}(G^{(t,t+1)}) = \frac{1}{T}\sum_{t=1}^{T} \int_0^1 \omega_t (1-p_t)^{\omega_t - 1} \delta(p_t)\mathrm{d}p_t. \tag{17}$$

The expression of the social weights takes its inspiration from the generalized Gini coefficient (Donaldson and Weymark, 1980, 1983; Weymark, 1981; Yitzhaki,

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1983).[7] This index is attractive since different combinations of the parameter ω allow us to obtain indexes that satisfy different properties.

In particular, imposing $\omega_t = \omega_{t+1} = 2$, which corresponds to the standard Gini weight, we obtain an index of pro-poor growth. This is an aggregate index based on a SEF endorsing preferences for monotonicity and pro-poorness of growth, thus satisfying Properties 1 and 2, and that gives equal relevance to the status of individuals in both the initial and the final period. This index attaches to each $\delta(p$ $)$ a weight that is decreasing with the rank of the individual in the initial and final income distributions. This measure can be used to compare different growth processes on the basis of their ability to increase income from one period to the other and favor the income change of the most disadvantaged individuals as compared to those most advantaged.

By imposing $\omega_t = 3$ and $\omega_{t+1} = 2$, we obtain a preference for the initial-period index. This second index can be used if Proposition 3 is unable to guarantee a ranking. This index reflects the preferences of a social planner who regrets reductions in income from one period to the other, prefers growth processes that benefit poorer individuals more than richer individuals, and cares more about the relative status of individuals in the initial period than their status in the final period.

Finally, by imposing $\omega_t = 2$ and $= \omega_{t+1} = 3$, we obtain a preference for the final-period index that can be used if Proposition 4 is not able to guarantee a ranking. Differently from the previous index, it reflects the preference of a social planner who cares more about the relative status of individuals in the final period than their status in the initial period.

3 Empirical Application

In this section, we implement our theoretical framework in order to analyze the growth process experienced by five different countries over the past decade.[8]

3.1 *Data*

Our empirical illustration is based on the panel component of the last seven waves of the Cross National Equivalent File (CNEF). The CNEF was designed at Cornell University to provide harmonized data for a set of eight country-specific surveys representative of the respective resident population: the British Household Panel Study (BHPS), the Household Income and Labour Dynamics in Australia (HILDA), the Korea Labor and Income Panel Study (KLIPS), the Swiss Household Panel (SHP), the Canadian Survey of Labour and Income Dynamics (SLID), and the German Socio-Economic Panel (SOEP). In the present paper, we consider Australia, Germany, Korea, Switzerland, and the U.S. In particular, we consider the 2001, 2002, 2009, and 2010 waves for Australia, Germany, and Switzerland, 1999, 2000, 2007, and 2008 (the last wave available) for Korea, and 1999, 2001, 2007, and 2009 (the last wave available) for the U.S.

[7]For application of this weight in the context of growth evaluation, see Jenkins and Van Kerm (2011), Palmisano and Peragine (2015), and Palmisano and Van de gaer (2016).

[8]Note that the content of this empirical illustration is purely descriptive, as the main aim of this section is to show how our framework can be applied on real data.

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The unit of observation is the individual. Individuals with zero sampling weights are excluded, since our measures are calculated using sample weights designed to make the samples nationally representative. The measure of living standards is disposable household income, which includes income after transfers and the deduction of income tax and social security contributions. Incomes are expressed in constant 2005 prices, using country- and year-specific price indexes, and are adjusted for differences in household size, using the square root of the household size. They are then expressed in 2005 Purchasing Power Parity.[9] In line with the literature, for each wave, we drop the bottom and top 1% of the income distribution from the sample to eliminate the effect of possible outliers.

To mitigate the effect of measurement error and transitory income fluctuations, we construct two-year averages of household income for each two-year time period. This implies that we compare the income in 2001–2 against the income in 2009–10 for Australia, Germany, and Switzerland, the income in 1999–2000 against the income in 2007–8 for Korea, while given that the PSID is conducted every two years, we compare the income in 1999–2001 against the income in 2007–9 for the U.S. In order to identify individuals, we partition the initial and final distributions of income into 50 quantiles.[10] We use sample weights to compute all estimates with standard errors obtained through 500 bootstrap replications.[11]

3.2 *Results*

We now apply the dominance tests presented in Section 2, with individual growth being measured both in relative and absolute terms.[12]

The results are obtained through pairwise comparisons of the countries analyzed. We start from Proposition 1, where only the size of growth and its direction (positive vs. negative growth) matter.[13]

[9]We use OECD data for both the Consumer Price Index and the Purchasing Power Parity of each country considered.

[10]The descriptive statistics for each country are reported in Table B.1 in the empirical Appendix B, in the Online Supporting Information.

[11]For more details, see the empirical Appendix B, in the Online Supporting Information.

[12]Note that when the reference distribution is the initial-period distribution, relative income growth is measured by

$$\frac{\int_0^a y_{t+1}(p_t)\mathrm{d}f(y_{t+1}(p_t))-y_t(p_t)}{y_t(p_t)}$$

and absolute growth by

$$\int_0^a y_{t+1}(p_t)\mathrm{d}f(y_{t+1}(p_t))-y_t(p_t).$$

When the reference distribution is the final distribution, relative income growth is measured by

$$\frac{y_{t+1}(p_{t+1})-\int_0^a y_t(p_{t+1})\mathrm{d}f(y_t(p_{t+1}))}{\int_0^a y_t(p_{t+1})\mathrm{d}f(y_t(p_{t+1}))}$$

and absolute growth by

$$y_{t+1}(p_{t+1})-\int_0^a y_t(p_{t+1})\mathrm{d}f(y_t(p_{t+1})).$$

[13]For the sake of brevity, the detailed results for conditions (i) and (ii) are reported in the empirical Appendix B, in the Online Supporting Information.

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Table 1 shows that although the conditions imposed in this proposition are quite strong—it requires a first-order dominance of the income change experienced by each individual, where individuals are independently ordered on the basis of their first-period position in the income ladder and of their second-period position—some of the processes can already be ranked. In particular, when relative growth matters, the growth process that took place in Korea dominates the one that took place in the U.S. When absolute growth is concerned, inconclusiveness increases and we are able to prove that the Korean growth episode dominates the German and the U.S. ones. The remaining pairwise comparisons produce ambiguous results.

Figure 1 plots the na-GIC for each country, where non-anonymity is expressed with respect to initial-period status (panel on the left) and to final-period status (panel on the right), corresponding respectively to conditions *(i)* and (ii) of Proposition 1. The na-GICs are computed using both a relative measure of income growth (top panels) and an absolute measure (bottom panels). It is, then, possible to observe that the impossibility of obtaining a clear result for the remaining comparisons is due to the crossing of the na-GICs of the countries considered for some of the initial or final quantiles. For instance, when only initial status matters, Australia's growth process dominates that of the U.S. for all the distribution with the exception of some richest individuals; while condition *(i)* requires dominance for all the initial quantiles. A frequent crossing is instead observed between the na-GIC of the U.S., Germany, and Switzerland. Interestingly, Korea appears to dominate all the other countries when we focus only on the rank of individuals in the initial distribution. These dominances vanish when we only account for the final distribution as the reference one to identify individuals: there is some overlapping, especially at the very bottom of the distribution, between the na-GIC of Korea, Australia, Switzerland, and the U.S. Korea dominates only the U.S.

We now consider the test proposed in Proposition 2, endorsing the view that priority should be given to the growth experienced by those individuals initially/finally ranked lowest as compared to the growth experienced by those initially/finally ranked highest. Now, when the focus is on relative growth, imposing more restrictions on the social weight helps to increase our ability to rank countries in two more cases. That is, the Australian growth process now dominates those of Switzerland and the U.S. Figure 2, plotting the cumulated version of the na-GICs presented in Figure 1, shows that the ambiguity in the ranking of countries for the remaining comparisons is mostly due to the crossing of the cumulated curves between different countries when only final status matters; the na-GIC of each country crosses the na-GIC of at least one other country. Here, Korea's na-GIC crosses the Australian one at the middle of the distribution. In particular, for the bottom-down part of the distribution, the growth process of Australia proves to be better than that of Korea; the reverse is true, instead, for the bottom-up part of the distribution. The other intersections concern the na-GICs of Korea, Germany, and Switzerland in the poorest fifth of the final distribution. Finally, the U.S. na-GIC lies always below the German na-GIC up to the bottom 80% of the distribution; the reverse holds for the richest 20% of the distribution.

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TABLE 1

The Results of Propositions 1–4

	Australia	Germany	Korea	Switzerland	U.S.
Proposition 1					
Relative income change					
Australia		$\oslash$	$\oslash$	$\oslash$	$\oslash$
Germany			$\oslash$	$\oslash$	$\oslash$
Korea				$\oslash$	$\geq^{***}$
Switzerland					$\oslash$
Absolute income change					
Australia		$\oslash$	$\oslash$	$\oslash$	$\oslash$
Germany			$\leq^{***}$	$\oslash$	$\oslash$
Korea				$\oslash$	$\geq^{***}$
Switzerland					$\oslash$
Proposition 2					
Relative income change					
Australia		$\oslash$	$\oslash$	$\geq^{**}$	$\geq^{***}$
Germany			$\oslash$	$\oslash$	$\oslash$
Korea				$\oslash$	$\geq^{***}$
Switzerland					$\oslash$
Absolute income change					
Australia		$\oslash$	$\oslash$	$\oslash$	$\geq^{**}$
Germany			$\leq^{***}$	$\oslash$	$\oslash$
Korea				$\oslash$	$\geq^{***}$
Switzerland					$\oslash$
Proposition 3					
Relative income change					
Australia		$\geq^{***}$	$\leq^{*}$	$\geq^{***}$	$\geq^{**}$
Germany			$\leq^{***}$	$\leq^{*}$	$\oslash$
Korea				$\geq^{***}$	$\geq^{***}$
Switzerland					$\oslash$
Absolute income change					
Australia		$\geq^{***}$	$\oslash$	$\oslash$	$\geq^{***}$
Germany			$\leq^{***}$	$\oslash$	$\oslash$
Korea				$\oslash$	$\geq^{***}$
Switzerland					$\oslash$
Proposition 4					
Relative income change					
Australia		$\oslash$	$\oslash$	$\geq^{***}$	$\geq^{***}$
Germany			$\oslash$	$\oslash$	$\oslash$
Korea				$\oslash$	$\geq^{**}$
Switzerland					$\oslash$
Absolute income change					
Australia		$\oslash$	$\oslash$	$\geq^{***}$	$\geq^{**}$
Germany			$\leq^{***}$	$\oslash$	$\oslash$
Korea				$\geq^{**}$	$\geq^{*}$
Switzerland					$\oslash$

Notes: $\geq (\leq)$ indicates that the first distribution dominates (is dominated by) the second distribution.

$\oslash$ denotes a non-conclusive test. '*' means significant at 95%.

Source: Author's elaboration based on CNEF.

When the focus is on absolute growth, inconclusiveness reduces less. We are able to obtain a ranking in one more case with respect to Proposition 1; it concerns the dominance of Australia over the U.S. When both the size and the redistributive effect of growth matter, Korea turns out to be the best-performing country in terms of (initial and final) non-anonymous growth; the second-best-

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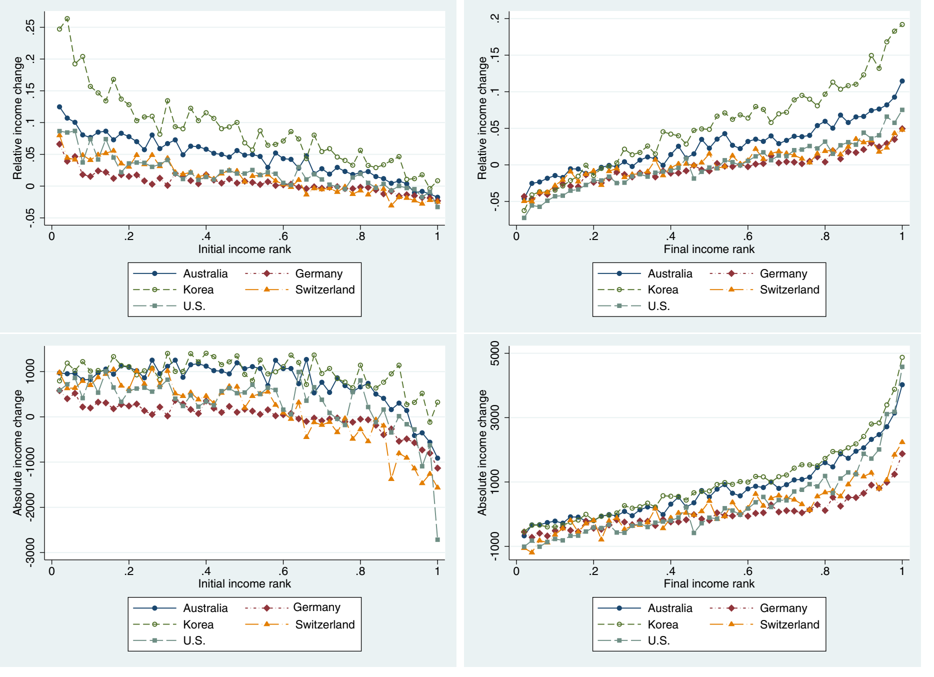

Figure 1. Non-anonymous Growth Incidence Curves: Relative Income Changes (Top Panels) and Absolute Income Changes (Bottom Panels). [Colour figure can be viewed at wileyonlinelibrary.com]

Notes: Anonymity is expressed with respect to initial-period status (panels on the left) and to final-period status (panels on the right).

Source: Author's elaboration based on CNEF.

performing is Australia, whereas the other comparisons produce incomplete results.

Finally, we perform the tests proposed in Propositions 3 and 4. They account for the possibility that the social planner, endorsing pro-poorness concerns, would either prefer the initial-period status to the final one (Proposition 3) or the other way round (Proposition 4). The results of Proposition 3 are reported in Table 1, while those of Proposition 4 are reported in Table 1.

When growth is measured in relative terms, Proposition 3 allows us to get a ranking of countries in almost all the cases, with the exception of the comparisons Germany versus U.S. and Switzerland versus U.S. The growth taking place in Australia is dominated by the growth taking place in Korea, but it dominates the growth taking place in Germany, Switzerland, and the U.S. Korea dominates all the other countries and, therefore, turns out to be the best-performing country. Interestingly, Switzerland dominates Germany, while Germany and the U.S. never rise up to be dominant countries. As for absolute growth, Australia together with Korea turn out to be the best-performing countries: they both dominate Germany and the U.S.

According to Proposition 4, instead, when growth is measured in relative terms, Australia turns out to be best-performing, as this country's growth process

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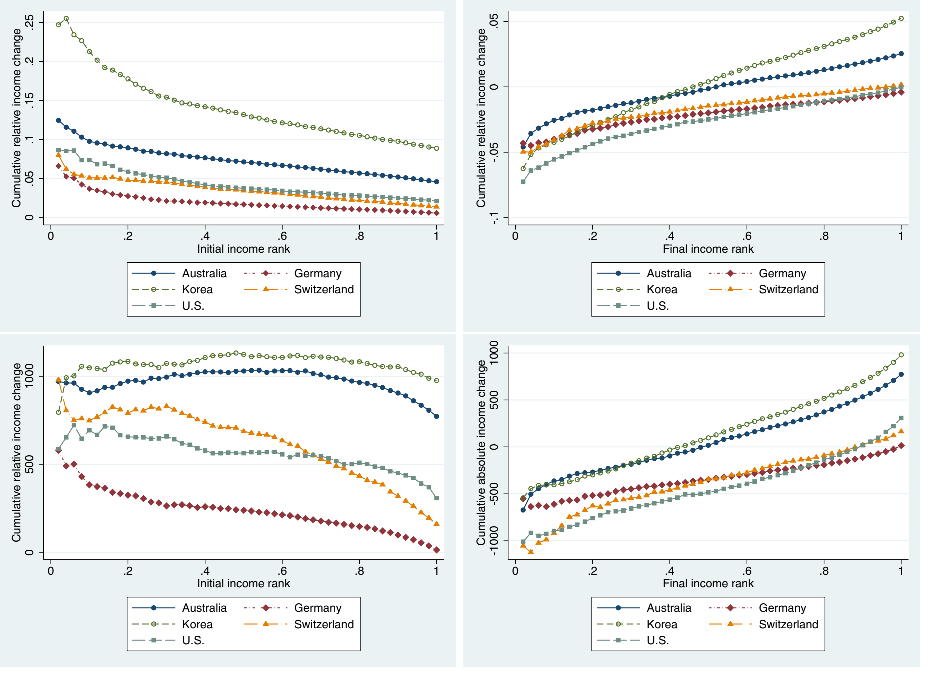

Figure 2. Cumulated Non-anonymous Growth Incidence Curves: Relative Income Changes (Top Panels) and Absolute Income Changes (Bottom Panels). [Colour figure can be viewed at wileyonlinelibrary.com]

Notes: Anonymity is expressed with respect to initial-period status (panels on the left) and to final-period status (panels on the right).

Source: Author's elaboration based on CNEF.

dominates that of Switzerland and the U.S. The second-best country is Korea, which dominates the U.S. Moreover, we can also prove the dominance of Switzerland over the U.S. When growth is measured in absolute terms, we observe a clear dominance only for five pairwise comparisons. In particular, Australia again dominates Switzerland and the U.S., while Korea dominates Switzerland, Germany, and the U.S.

If we consider the number of times a country turns out to be the dominant or the dominated one, we observe that Korea is, as expected, at the top of the ranking: it turns out to be the dominant country 15 times out of 32 pairwise comparisons and it is never dominated. It follows Australia, which turns out to be the dominant country 12 times but it is dominated once. The U.S. ranks at the bottom: it is dominated 15 times. It is followed by Germany—dominated eight times—and Switzerland, that turns out to be the dominant country once and the dominated one six times.

Finally, it is important to note that it does make a difference in the ranking of countries whether one is concerned only with the initial status of individuals or only with the relative status of individuals in the final distribution. When the focus is on relative growth, conditions *(i)* and *(ii)* in Proposition 1 provide different results (see Table 2 in the empirical Appendix B, in the Online Supporting

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TABLE 2

Aggregate indexes

	Australia	Germany	Korea	Switzerland	U.S.
Aggregate Index 1					
Relative income change					
Australia		≥**	≤*	≥***	≥**
Germany			≤***	≤*	≤*
Korea				≥***	≥***
Switzerland					≥*
Absolute income change					
Australia		≥**	≤**	≥***	≥***
Germany			≤**	≤**	≤**
Korea				≥***	≥***
Switzerland					≥**
Aggregate Index 2					
Relative income change					
Australia		≥***	≤**	≥***	≥**
Germany			≤***	≤*	≤
Korea				≥***	≥***
Switzerland					≥***
Absolute income change					
Australia		≥***	≤*	≥***	≥**
Germany			≤***	≤**	≤*
Korea				≥***	≥**
Switzerland					≥***
Aggregate index 3					
Relative income change					
Australia		≥***	≤*	≥***	≥***
Germany			≤***	≤**	≤**
Korea				≥***	≥***
Switzerland					≥*
Absolute income change					
Australia		≥***	≤*	≥***	≥***
Germany			≤***	≤**	≤**
Korea				≥***	≥***
Switzerland					≥*

Notes: ≥ (≤) indicates that the first distribution dominates (is dominated by) the second distribution. ⊘ denotes a non-conclusive test. '*' means significant at 95%.
Source: Author's elaboration based on CNEF.

Information). In particular, when only the status in the first period matters (condition *(i)*), it turns out that we obtain a clear ranking of Australia over Germany and Switzerland, of Korea over Germany and Switzerland, and of Switzerland over Germany that cannot be established when only the status in the final period matters (condition *(ii)*). By contrast, when only the second-period status matters (condition *(ii)*), Australia dominates the U.S., but this dominance does not hold when the initial status is considered. Also, when the focus is on absolute growth, conditions *(i)* and *(ii)* provide different results in Proposition 1. According to condition *(i)*, no clear ranking can be established between Australia and Switzerland, whereas Australia dominates Germany. According to condition *(ii)*, Australia dominates Switzerland but it does not dominate Germany.

Similar differences arise in Proposition 2. In particular, when growth is measured in relative terms, Korea dominates Australia, Germany, and Switzerland, while Australia, Switzerland, and the U.S. dominate Germany according to

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condition *(i)*, but not according to condition *(ii)*. Most importantly, there is a reversion in the sign of the dominance between Switzerland and the U.S.: the latter dominates the former according to condition *(i)*; the reverse happens according to condition *(ii)*. When growth is measured in absolute terms, Australia dominates Germany and Switzerland according to condition (i) but not according to condition *(ii)*, and Korea dominates Switzerland according to condition *(ii)* but not according to condition *(i)*.

The different conclusions generated by Propositions 3 and 4 are insightful (see Tables B.4 and B.5 in the empirical Appendix B, in the Online Supporting Information). It can be noted that if the focus is on relative growth, the dominance of Australia over Germany and of Korea over Australia, Germany, and Switzerland, as well as the dominance of Switzerland over Germany, which is found in Proposition 3, is not confirmed in Proposition 4, although such dominances arise in condition *(ii)* of the latter. This means that the extent of the difference in the evaluation of growth between Australia and Germany, between Korea and Australia, Germany, and Switzerland, and between Switzerland and Germany when initial-period status matters is such that it is able to compensate for the absence of difference in the evaluation of growth between these countries that is found when final-period status matters. The same observation holds for the dominance of Australia over Germany according to Proposition 3, when the focus is on absolute growth. Instead, the reverse is true concerning the dominance of Australia over Switzerland that is found in Proposition 4, but it is not confirmed in Proposition 3. In this case, the extent of the difference between these countries, when final-period status matters, is such that it is able to compensate for the absence of difference between these countries that is found when initial-period status matters.

The supremacy of the growth processes that have taken place in Korea and Australia is finally confirmed by the adoption of the scalar measure defined in equations (17) for the various combinations of the parameter ω proposed. The results, reported in Table 2, are quite robust to the choice of the parameter and to the individual measure of growth adopted, whether the absolute or the relative measure. In particular, the Korean growth process dominates all the others. It is followed by Australia, whose growth process dominates all the others, with the obvious exception of Korea. Switzerland ranks as the third-best-performing country: its growth process dominates that of Germany (but this dominance is not statistically significant) and the U.S., and it is dominated by Australia and Korea. Germany, followed by the U.S., ranks as the worst-performing: its growth process is dominated by all the others.[14]

We conclude our analysis by performing some robustness checks related to variations in household composition. It might be argued that the results of our analysis are sensitive to changes in household composition between the initial (first) period and the second period of the growth process. Hence we have

[14]Note that the framework outlined in Section 2 could also be applied to compare alternative or subsequent growth processes for a given country. This exercise would give relevant information in terms of understanding the growth dynamic specific to a given country or to evaluating the distributional implications of different policies for that country.

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recalculated our estimates using, for each growth process, only the subsample of individuals that did not experience change in household composition between the initial and final periods. The results (reported in the empirical Appendix B, in the Online Supporting Information) show that our conclusions are not affected.

4. Conclusions

An increasing number of contributions in recent years have proposed alternative models to evaluate and rank growth processes, adopting a non-anonymous or history-dependent approach, that is, accounting for the identity of individuals, usually represented by their relative position in the pre-growth distribution of income. In this work, we have generalized such a non-anonymous approach by providing a normative framework to rank growth processes that is robust to the choice of the reference period used to identify individuals.

In particular, we have adopted a bidimensional framework, where the two dimensions are, respectively, the rank of the individuals in the income distribution of the reference period and the income change experienced by each individual. We have, then, provided partial dominance conditions for ordering growth processes and we have shown how they relate to the existing conditions in the literature.

We have used this framework to assess and rank the growth processes that have taken place over the past decade in five different countries: Australia, Germany, Korea, Switzerland, and the U.S. Our results show that Korea, followed by Australia, proves to be the best-performing country, while Germany, Switzerland and the U.S. turn out to be the worst-performing countries, when both the initial and final periods are relevant reference periods to identify individuals.

The results derived in our paper can be extended in a number of directions. First, new dominance conditions can be obtained imposing more restrictions on the weight function, such as the principle of diminishing pro-poor growth sensitivity. The resulting dominance conditions would help to increase the possibility of ordering countries, although at the cost of further restricting the family of social evaluation functions to which such conditions would apply. Second, the framework proposed in this paper could be extended to endorse an intertemporal perspective, as recently explored in Bresson *et al.* (2015), which does not simply compare in a non-anonymous fashion the initial and the final periods, but is able to account for the income and status variation of individuals between these two periods. These extensions will be the subject of future research.

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