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1 Introduction

Since the late 20th century living conditions of people around the world improved considerably. In most regions of the world humans now enjoy longer lives (Riley, 2001), better education (Morrisson and Murtin, 2009) and higher living standards (Easterlin, 2000). While much is known about the average improvements of these dimensions over time, much less is known about the inequality part of the story. In particular, a spatial view on inequalities in 'living conditions' or 'human development' across geographical or administrative units within countries, has recently received considerable attention from researchers and policy-makers—and for good reasons.[1] First, individuals with similar socio-economic characteristics often concentrate in space, suggesting that increases in spatial inequality tend to be positively associated with greater levels of interpersonal inequality (Kanbur and Venables, 2005, Lessmann, 2014). Second, high levels of spatial inequality often come along with political and ethnic tensions (Ezcurra and Rodríguez-Pose, 2017), and could eventually lead to conflicts and civil wars (Buhaug *et al.*, 2011, Deiwiks *et al.*, 2012, Ezcurra and Palacios, 2016). Unsurprisingly, social- and territorial-cohesion goals have been explicitly included in the agendas of major recent development endeavors, like the 'EU 2020 Strategy' or the sustainable development agenda, where goal #10 invites to 'reduce inequality within and among countries'.

Attempts to assess the extent to which the living conditions across countries' sub-national units are evolving in a territorially cohesive way are hindered by the lack of both appropriate measures and the underlying data. On the one hand, currently existing methodological approaches, which include 'convergence' and 'inequality' analyses (e.g. Johnson and Papageorgiou, 2020, Cowell, 2011), have certain shortcomings as they fail to capture some intuitive notions one might want to take into consideration when assessing countries' territorial cohesion. While the former explore whether 'lower developed' regions are growing at a faster rate then the others, the latter examine the spread of the inter-regional distribution. However, none of them takes into consideration what is actually happening at the lower and the upper tails of the distribution. On their own, the existing methods are unable to ascertain whether and to what extent some specific regions are lagging behind or racing ahead of the rest. This deficiency is problematic as social progress might be easily overstated—even if improvements in both averages and inequalities are taken into account. Several authors argued forcefully that the situation of the worst-off is relevant for any evaluation of social arrangements or progress (e.g., Rawls, 1999, Sen, 1999, 2009). Indeed, in the sustainable development agenda the United Nations explicitly 'pledge that no one will be left behind' in the development process.[2] On the other hand, estimating the evolution of the living con-

[1] Throughout the paper, the expressions of 'living conditions', 'dimensions of human well-being', and 'human development' will be used interchangeably. In practice, these notions will be operationalized via the United Nations' Human Development Index (HDI) — see below.

[2] See https://sustainabledevelopment.un.org/post2015/transformingourworld.

ditions across countries' sub-national units is not an easy task. Data limitations have often restricted spatial inequality analyses to a handful countries, in particular when it comes to inequality in more comprehensive well-being measures (see Grimm *et al.* 2008, Permanyer *et al.* 2015 for examples from the global south and Veneri and Murtin 2018, Iammarino *et al.* 2019 for examples from the global north). Therefore, a truly global perspective analyzing countries' territorial cohesion has not been implemented yet. In this paper, we aim at making substantive contributions on both fronts.

On the methodological side, we propose new 'under-development' and 'over- development' measures that explicitly focus on what is happening at the bottom and the top of the inter-regional distribution, respectively. Together, these measures are meant to assess the extent to which countries' subnational regions are performing exceedingly better or worse than the national average, thus revealing whether living conditions are distributed in a territorially cohesive way. Conceptually, they are straightforward adaptations of well-known 'poverty' (Foster *et al.*, 1984) and 'richness' (Bose *et al.*, 2014) indices that are commonly applied to study what happens at the bottom and top tails of inter-individual income distributions. In the same way as poverty and richness measures enhance and complement the insights provided by inequality measures in the context of income distribution analysis, the new over- and under-development measures proposed in this paper are a useful complement to the 'convergence' and 'inequality approaches' commonly applied in the regional studies literature.

On the data side, we aim for a global coverage in our analysis of territorial cohesion in human development. For this purpose, we take advantage of the Subnational Human Development (SHD) Database (Smits and Permanyer, 2019), which contains estimates of the United Nations' Human Development Index and its sub-components across more than 160 countries and 1600 subnational units representing more than 99% of the world's population. Since such estimates are available from 1990 onwards, we are able to cover almost three decades in our analyses. More specifically, the richness of the dataset allows us to document (i) the levels and trends of inequality in human development, (ii) the levels and trends of over- and under-development, and (iii) the contribution of over-/under-development to inequality, and that for both within countries and in the world as a whole. Put differently, we will examine whether, and to what extent, the fact that some subnational units lag behind or race ahead of the rest contributes to the inequality in human development observed both from a local (i.e. country-level) and a global perspective. Our findings suggest that under- and, specially, over-development tend to disappear within countries all over the world. In contrast, from a global perspective, we detect the presence of a non-negligible set of under-developing subnational regions spanning across 11–25 countries that, in the last two decades, have failed to catch-up with the world average human development—a finding that remained concealed so far due to the insufficient granularity of currently existing databases and the limitations of 'convergence' and 'inequality' techniques.

The remainder of the paper is structured is follows: section 2 provides more background information on related research, section 3 introduces the applied methods and section 4 provides more details about our data. Section 5 presents the results for our within-country analysis and section 6 for our global analysis. Finally, section 7 offers some concluding remarks.

2 Background

The present study relates to different lines of previous research. On the conceptual side, one of the major criticisms leveled against the HDI is its neglect of inequalities. As a consequence some studies propose modifications of the measure itself to account for inequalities (e.g., Foster *et al.*, 2005, Seth, 2009). Other studies instead seek to calculate the HDI for subgroups to allow various comparative analyses subsequently. For instance, Grimm *et al.* (2008, 2010) calculate the HDI for income quintiles in 32 countries, Harttgen and Klasen (2011) for internal migrants and non-migrants in 16 low-income countries, whereas Harttgen and Klasen (2012) propose a method to proxy the HDI at the household-level, which is illustrated using 15 countries. Moreover, Permanyer (2013) proposes a municipality-level HDI, which is illustrated using census data from Mexico, whereas Permanyer *et al.* (2015) apply this approach to 13 African countries and document inequalities in human development at the national level. We follow these papers in exploiting subnational variation in human development to incorporate inequality into our analysis.

Accounting for within-country inequality along these lines, however, tends to restrict in the analysis to rather few countries, as is already evidenced by the previously referenced papers. Moreover, several recent studies, explore regional disparities in a similar fashion, however, using measures of well-being other than the HDI (e.g., Ballas *et al.*, 2017, Veneri and Murtin, 2018, Peiró-Palomino, 2018, Pinar, 2018, Iammarino *et al.*, 2019, Ayala *et al.*, 2020). These studies on the other hand are usually confined to industrialized countries and thus of limited geographical coverage, too. Using the SHDI database, we are able to offer an analysis of human development, which accounts for within-country inequalities and is of global scope (for a description of the data see Smits and Permanyer 2019 and for some first results Permanyer and Smits 2020).

On the methodological side, the concept of convergence has been operationalized in different ways. Two particular prominent approaches, β-convergence and σ-convergence, have been explored in research on the convergence of per capita income (e.g., Sala-i-Martin, 1996, Durlauf *et al.*, 2009). According to the first approach poor countries grow faster than rich countries, whereby they are effectively catching up. Essentially, one can test for β-convergence via regressing the growth rate, e.g., of income per capita on its initial levels. A significant negative coefficient would imply initially richer countries to grow at a slower pace. Instead, the so-called σ-convergence measures requires the standard deviation of a particular outcome variable across countries or regions to decrease over time. Since β-convergence is necessary but not sufficient for σ-convergence and some further results, many authors recommend to directly investigate the variance; for more details see Johnson and Papageorgiou (2020), a recent survey on the convergence of income per capita on the international level. Note, that these methods have also been applied to quality of life indicators (e.g., Mazumdar, 2003, Neumayer, 2004) including the HDI (Jordá and Sarabia, 2015).

While the standard deviation reflects dispersion, inequality measures satisfy several desirable axioms, which may prove useful in the analysis of convergence (e.g., Salas, 2002, Durlauf *et al.*, 2009). Indeed, inequality measures are well-understood and several measures allow instructive decompositions, e.g., into contributions of subpopulations or within- and between components (Cowell, 2011). By now inequality measures have been applied to examine convergence in income and various other dimensions of human well-being such as education and health (see below). In this paper we propose specific over- and underperformance measures to complement the analysis of convergence in particular using inequality measures to study territorial cohesion more comprehensively. Their application can be motivated along the lines of a Rawlsian social welfare function, the SDG paradigm to leave no one behind, or to quantify the contribution of recent progress by the top-performers.

Finally, on the empirical side our paper also relates to previous research on single dimensions of human well-being such as education, health, and income. A common feature of these studies is the application of conventional inequality measures to data which provide within-country variation in one form or another to study regional disparities. Moreover, these studies aim for a high coverage of the world population to allow for truly global assessments. For instance, using a large data set of 'macro-countries' Morrisson and Murtin (2013) find for the period of 1870–2010 a hump-shaped relationship for inequalities in education as measured by Gini and Theil indices for years of education. In a similar fashion, Jordá and Alonso (2017) provide new mean years of schooling estimates for 142 countries for 1970–2010 and document a decreasing global inequality using Gini and Theil measures, among others.

Similarly, global inequalities in health have been analyzed extensively. For instance, Edwards (2011) examines inequality in length of life (i.e. age at death) for 180 countries in 1970 and 2000 and inter alia apply Gini and Theil measures. Among other things the author documents (i) a substantial decline in inequality and (ii) that around 90% of total inequality is due to within-country variation (despite an increasing importance of the between-country component). Using data of the United Nations World Population Prospects, Permanyer and Scholl (2019) analyze inequality in length of life from 1950 to 2015 and document (i) a decline in inequality according to the Theil index and the variance and (ii) that most of the world variability in age-at-death can be attributed to within-country variability. Finally, research on global income inequality made recently substantial progress, see, e.g., Milanovic (2012) and Lakner and Milanovic (2015). While there is consensus on the extraordinary increases in inequality over the last two centuries, changes during the most recent decades are less clear cut and results often depend on method and data, see Anand and Segal (2015) for a survey.

Thus given the available evidence one may expect global inequality in subnational HDIs to decline, too. Indeed, in a first analysis of the SHDI data base Permanyer and Smits (2020) find the overall mean log deviation to decrease from 0.031 in 2000 to 0.0178 in 2017. In present paper we revisit this observation of declining inequality in human development and probe whether these recent developments in human development are really a flawless story of success. More specifically, we argue that conventional inequality measures cannot reveal the full picture needed to sufficiently assess progress based on the sustainable development paradigm.

As the various lines of empirical research also reflect, accounting for within-country variation and providing a meaningful analysis of trends at the same time, tends to reduce the global coverage of countries. Consequently, the state of knowledge remains fragmentary. We complement previous research by offering a more comprehensive analysis of regional disparities in terms of a single composite measure of human well-being, accounting for both between and within variation for 162 countries over almost 30 years.

3 Methods

In this section we describe the basic notation that will be used throughout the paper. We start with the concepts applied in country-specific analyses first, and then proceed to the global perspective that involves comparisons across all world countries.

3.1 Country level analysis

For any given country, the distribution of human development across its $r \in \mathbb{N}_+$ subnational regions is described by a vector of achievements $x = (x_1, \ldots, x_r)$ and population shares $p = (p_1, \ldots, p_r)$, where $x_i \in [0, 1]$ and $p_i \in [0, 1]$ correspond to the level of human development (as measured by the United Nations' HDI) and the population share of region i, respectively. As the human development index is frequently used as a measure of human well-being, our analyses employ population weights in all instances, including the measures of inequality, over- and under-development, and also when aggregating across countries. In this paper, we use one of the most popular inequality measures, the Gini index (G), which is defined as follows

$$G(x, p) = \frac{\sum_i \sum_j p_i p_j |x_i - x_j|}{2\mu} \tag{1}$$

where $\mu = \sum_i p_i x_i$ is the national-level mean. As is well-known, the values of G are bounded between 0 and 1, which are observed in the cases of perfect equality (i.e. all regions have the same level of HDI) and extreme inequality (i.e. all regions except one have the lowest possible HDI level of 0), respectively.

The extent of *under-development* in a given country relative to the national mean is defined as

$$U^{\alpha}(x,p) = \sum_i p_i \max\left\{\frac{\underline{z}-x_i}{\underline{z}}, 0\right\}^{\alpha} \tag{2}$$

where, $\underline{z} = a\mu$, $0 < a < 1$, and α is a non-negative parameter. Parameter a measures the fraction of countries' national performance that is used as an 'under-development threshold'.[3] The set of regions within a given country whose development level falls below this threshold (i.e. the 'under-developed regions') will be denoted as $\mathcal{U}$. When $\alpha = 0$, U^0 is analogous to a headcount poverty measure, and measures the share of the population in that country that lives in regions with a human development level below the threshold given by $\underline{z}$. Likewise, when $\alpha = 1$ and $\alpha = 2$, U^{α} are analogous to the 'poverty gap measure' and the 'squared gap measure' of the Foster-Greer-Thorbecke class of poverty measures (Foster *et al.*, 1984), respectively. Observe that $U^{\alpha}(x,p)$ is a purely *relative* measure of under-development: it captures the extent to which some regions are lagging behind the national average, irrespective of the absolute values of the distribution (i.e. a highly developed country can have an 'underdeveloped' region with a certain development level that would not qualify as such in the distribution of other, less-developed, countries). In addition to this, also note that population shares are taken into account, i.e. a more populous region lagging behind increases *ceteris paribus* our measures of under-development.

Using a similar notation, we can define the extent of over-development associated to the distribution as follows

$$O^{\alpha}(x,p) = \sum_i p_i \max\left(\frac{x_i-\overline{z}}{\overline{z}}, 0\right)^{\alpha} \tag{3}$$

where $\overline{z} = b\mu$, $1 < b$. $O^{\alpha}(x,p)$ should be interpreted as the extent of relative over-development we observe in a given country where the parameter b specifies the minimum relative over-performance a region is required to have for being identified as 'racing ahead'. The set of regions within a given country whose development level is above the over-development threshold $\overline{z}$ will be denoted as $\mathcal{O}$. Like in the previous case, when $\alpha = 0$, O^0 measures the share of the population in a given country that lives in regions with a human development level above the threshold given by $\overline{z}$. Likewise, when $\alpha = 1$ and $\alpha = 2$, O^{α} is a population-weighted average of over-development gaps and squared over-development

[3] Note that the technical design of this measure is very similar to the at-risk-of-poverty rate used in the European Union, which defines the threshold as 60% of the median household income.

gaps, respectively.

In this paper we want to explore the relationship between over-/ under- development and the inequalities in human development we observe across countries and in the world as a whole. In particular, we aim to assess the extent to which the phenomena of over- and under-development contribute to the existing inequality levels. For that purpose, we decompose the Gini index as $G = \sum_i G_i$, where each G_i is defined as

$$G_i = \frac{\sum_j p_i p_j |x_i - x_j|}{2\mu}. \tag{4}$$

Observe that G_i can be either interpreted as the 'degree of diversity' or region i from all other regions in the country (see Ceriani and Verme (2015), Kendall and Stuart (1958)), or as the contribution of that region to the extent of HDI inequality in that country. This decomposition has been chosen for its simplicity and normatively desirable properties[4] (see Ceriani and Verme (2015)). Taking advantage of this decomposition, we define the contribution of under- and over-development to countries' HDI inequality as

$$C_{\mathscr{U}} = \frac{\sum_{i \in \mathscr{U}} G_i}{G} \tag{5}$$

$$C_{\mathscr{O}} = \frac{\sum_{i \in \mathscr{O}} G_i}{G} \tag{6}$$

3.2 Global level analysis

In the empirical section of the paper we also explore the global distribution of human development across and within world countries. The Gini index of that distribution can be written as

$$\Gamma = \frac{\sum_c \sum_d \sum_i \sum_j p_{ci} p_{dj} |x_{ci} - x_{dj}|}{2M} \tag{7}$$

where p_{ci} is the population share of region i in country c (with respect to the world population), x_{ci} is the corresponding level of human development as measured by the SHDI, and M is the world mean of the SHDI distribution.

To define the measures of under- and over-performance associated to the global SHDI distribution we need to define global under- and over-development thresholds as fractions of the world SHDI average performance (M). Such thresholds determine what are the sets of global under- and over-developed subnational regions (i.e. akin to the $\mathscr{U}, \mathscr{O}$ sets defined at the country level). After that, one simply needs to apply equations (2) and (3) to the global SHDI distribution. The key difference between global or country-level measures of

[4]These properties are additivity, continuity, anonymity, symmetry, translation invariance, linear homogeneity.

under- and over-performance is the mean with respect to which the relative performance is assessed. Having defined the global over- and under-development thresholds, we can apply equations analogous to (5) and (6) to the global SHDI distribution to assess by how do over- and under-performing regions contribute to the global SHDI inequality Γ.

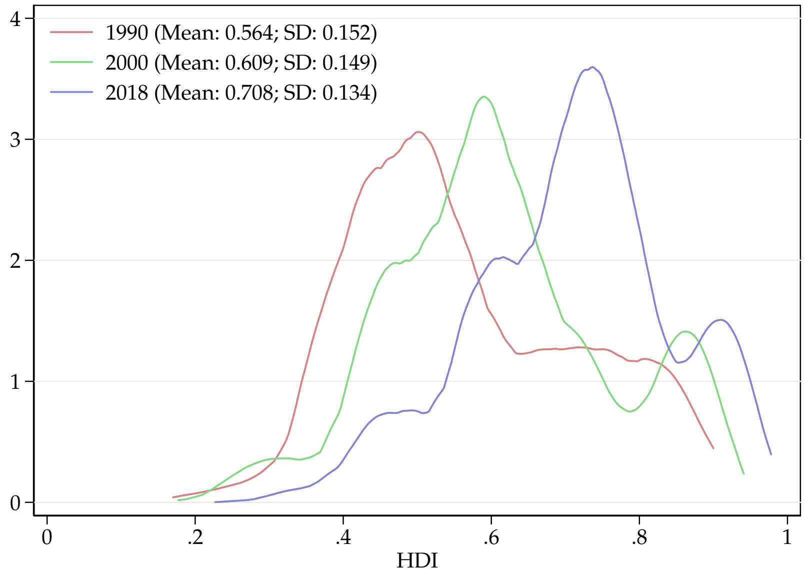
4 Data

This paper uses data of the Subnational Human Development Index Database version 4.0, which is freely available online, see Smits and Permanyer (2019). Methodologically, the SHDI is a translation of UNDP's official HDI to the subnational level. As such, it is an average of the subnational values of three basic dimensions: 'Education', 'Health' and 'Standard of living'. The specific indicators used in their definition include 'Mean years of schooling of adults aged 25+', 'Expected years of schooling of children aged 6', 'Life expectancy at birth' and 'Gross National Income per capita (PPP, 2011 US$)'. These indices are measured using a variety of data sources, ranging from censuses to socio-economic and demographic household surveys. More specifically, the Subnational Human Development Index Database was created on the basis of three data sources: (i) statistical offices, including Eurostat, the statistical office of the European Union, (ii) the Area Database of the Global Data Lab, (`www.globaldatalab.org/areadata`) and (iii) the HDI database of the United Nations Development Program (UNDP, `https://hdr.undp.org/data`). The use of indicators derived from household surveys for low- and middle-income countries means that for these countries only data is available for the years in which surveys were held. Subnational indicator values for other years therefore are estimated on the basis of interpolation and extrapolation from the survey years. Data validation analyses of Smits and Permanyer (2019) indicate that the errors due to using interpolated and extrapolated data are small.

The computation of the Subnational Human Development Index, first requires to estimate the education, health and standard of living subcomponents (e_i, h_i, s_i) and scale them between 0 and 1 (see Supplementary Materials section of Smits and Permanyer (2019) for details). Mimicking the most recent definition of UNDP's HDI, the Subnational Human Development Index for each subnational area 'i' is defined as $SHDI_i^m = \sqrt[3]{(h_i e_i s_i)}$. Like the original HDI, the SHDI takes values between 0 and 1. The former is reached whenever one of the three components attains the lowest possible level of 0 and the latter when all three components attain the maximal level of 1).

For some countries our data base contains entries since 1990, whereas other countries only join later. Data is available for most countries since 2000. For more information on the available years see table A.1. Nonetheless, the majority of our analyses rely on the entire period of observation to shed some light on long-run developments as well. Occasions where varying data availability matters are appropriately flagged.

Figure 1: The distribution of subnational HDIs over time



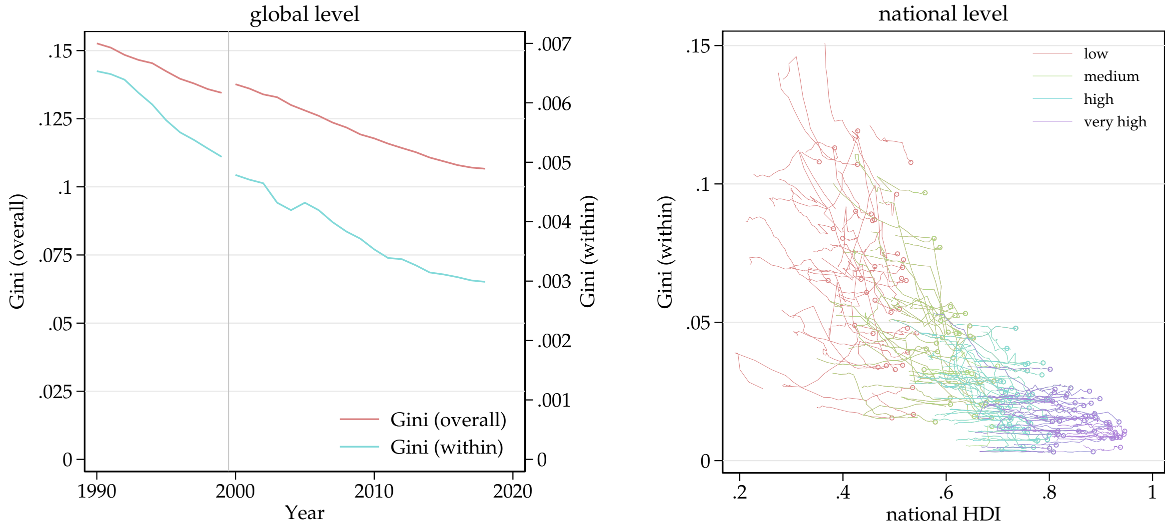
Notes: Underlying data is an unbalanced panel. In 2000 data for eleven low-HDI countries becomes available for the first time, thus values before and after 2000 are not directly comparable. Moreover, a few further countries are added in other years, see table A.1 for details

It is well-known that for most countries national HDIs increase over time.[5] Setting the stage for our subsequent analysis, figure 1 shows the distribution of subnational HDIs for three selected years. Figure 1 reveals that not only the HDIs increased on average, but in fact the entire distribution of the all subnational HDIs shifts to the right over the past 28 years. Additionally, there is also some evidence in support of global convergence as the standard deviation slightly declined, too. Note, however, that the degree of convergence as measured by this standard deviation is presumably underestimating true developments as several rather poor countries become available in our data base in 2000. Indeed, these countries account fot the small hump in the lower tail of the density in 2000. Yet, σ is decreasing. Nonetheless some countries experience stagnation or even decreases at some point.

How did inequality in human development change over this period of observation? Figure 2 provides more details. Specifically, the left-hand graph shows the trends for global *overall* inequality (i.e. Γ, as defined in equation (7)) colored in red, together with a population-weighted sum of the Gini coefficients across world countries (i.e. an average of world's within country SHDI inequality) colored in blue. As figure 2 clearly illustrates, both global overall inequality and the world average of within country inequality decline over time, which is consistent with the evidence on the individual dimensions surveyed in section 2, but also with with Permanyer and Smits (2020). Recall that some countries enter our database only later—in particular 11 rather poor countries are observed for the first time in 2000. The

[5]This data can explored and downloaded under http://hdr.undp.org/en/data.

Figure 2: Inequality trends of human development



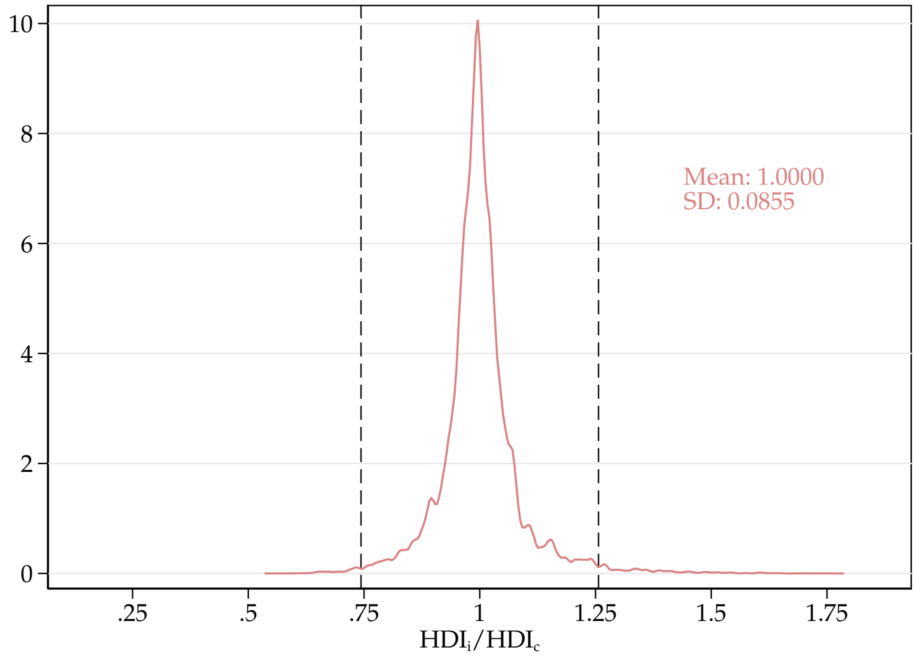
Notes: Left graph: Underlying data is an unbalanced panel. In 2000 data for eleven low-HDI countries becomes available for the first time, thus values before and after 2000 are not directly comparable. Moreover, a few further countries are added in other years, see table A.1 for details. Right graph: Each line describes the path of a country over time in terms of its subnational inequality and its overall level of the HDI, where the circle indicates the current margin (2018). Underlying levels of human development follow the official classification, i.e an HDI in [0,0.55) is 'low', in [0.55–0.7) 'medium', in [0.7,0.8) is 'high', and in [0.8,1] is very high.

vertical line in figure 2 indicates this break and seeks to caution against over-interpreting related global numbers. The right-hand graph in figure 2 shows the paths of within-country inequality in human development at the country-level for their available years. As such, the graph offers a disaggregated view on within-country inequality, and, moreover, takes the level of the HDI into account. Salient observations include (i) that inequality tends to be higher in countries with lower levels of human development, and (ii) that subnational inequality tends to decline or, at least, remains constant for most countries. Yet, for 24% of the countries we observe slight increases in SHDI inequality between 2000 and 2015. In our subsequent analysis we re-examine the success story of decreasing inequality in human development and use our new over- and under-performance measures to shed more light upon the tails of the underlying distributions to offer a fuller account of territorial cohesion in human development.

5 Cohesion within countries

This paper explores territorial cohesion in human development from two perspectives. This section has an exclusive focus on regional disparities *within* countries, whereas section 6 adopts a truly *global* perspective, with all subnational regions effectively being pooled. The present section first details the exact specification of our over- and under-performance measures in this context and then presents the related empirical findings.

Figure 3: Kernel density for relative HDI-performance of regions



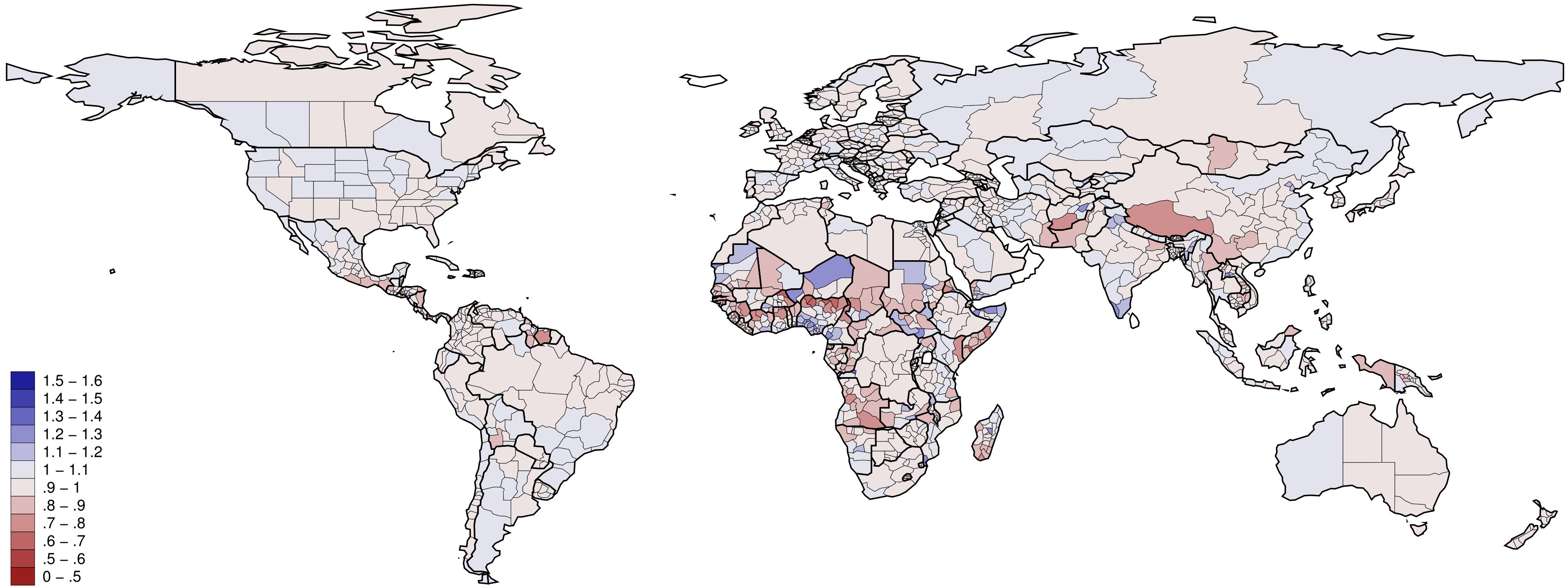
Notes: all country-year observation pooled, Epanechnikov kernel density using within country population weights, dashed lines at mean ± 3SD.

5.1 Specifying the relative performance measures.

Distribution of relative performance. In this section we are especially concerned with regions' either over- or under-performing relative to the *national* mean. Thus the underlying distribution of the this relative performance is of special interest. Figure 3 shows the kernel density for the HDI performance of subnational regions relative to the respctive national mean, i.e x_i/μ for our entire data set (all countries, all years). First, we observe a rather symmetric and relatively compressed distribution. Moreover, both tails turn out to be rather thin, with the right tail being somewhat longer. As figure 3 shows pooled data for all available countries and all years, values below say 0.75 and above 1.25 (which corresponds approximately to more than three standard deviations) can be considered as relatively rare as they tend to occur only for some specific countries in some of the years.

Choosing the cutoffs. A sense of the underlying distributions of relative performance is helpful for specifying our O^α and U^α measures as their cutoffs a and b both refer the relative performance. Specifically, regions potentially racing ahead or lagging behind can be found within the tails of this distribution. We emphasize that the choice of a, b is a normative decision (similar to poverty cutoffs) and can among other things also be motivated to identify political priorities. For the empirical exercises in this paper, figure 3 offers guidance on the implications of specific parameter choices. For simplicity, we confine our analyses to symmetric choices, even though in some applications other choices might be clearly preferable (e.g., due to the country-specific context, political priorities, etc.). Moreover, we note that there is a trade-off in choosing the parameters that has to be dealt with taking into account the specific context: While more conservative cutoffs result in lower values of the relative performance measures, lower contributions to inequality, and seemingly less relevance of over- and under-performance in general, they do allow much better to reflect and document the more extreme cases of racing ahead or falling behind. In contrast, too permissive cutoffs (which are too close to the mean performance), run the risk of making measures uninformative. For our within country analysis, we choose—rather conservatively—$a = 0.7$ for our $U^{\alpha}(x, p)$ measures and $a = 1.3$ for our $O^{\alpha}(x, p)$ measures, which approximately corresponds to identify regions as under- or over-performing, if their relative performance deviates more than 3 standard deviations. Additionally, we also report results for more permissive threshold ($a = 0.8, b = 1.2$). The main findings do not however depend critically on this choice.

Figure 4: Relative over- and underperformance in HDI within countries



Notes: Year of data is 2010, source of shape file is Global Data Lab.

Geographic distribution. The map in figure 4 shows the subnational performance relative to the national mean in 2010 and thus provides a complementary snapshot of its geographic distribution. By definition variation around the national mean performance is observed in every country. More substantial deviations of regions from the national mean, which are therefore potentially racing ahead or lagging behind are, however, only found in 15–20 countries. Moreover, several countries have in fact both regions racing ahead and lagging behind (e.g., Nigeria or Yemen). Furthermore, we note that most, but not all countries with strongly over- or under-performing regions are located in Sub-Saharan Africa. Finally, we can also clearly observe a gradient from coastal areas to inland in countries around the Gulf of Guinea.

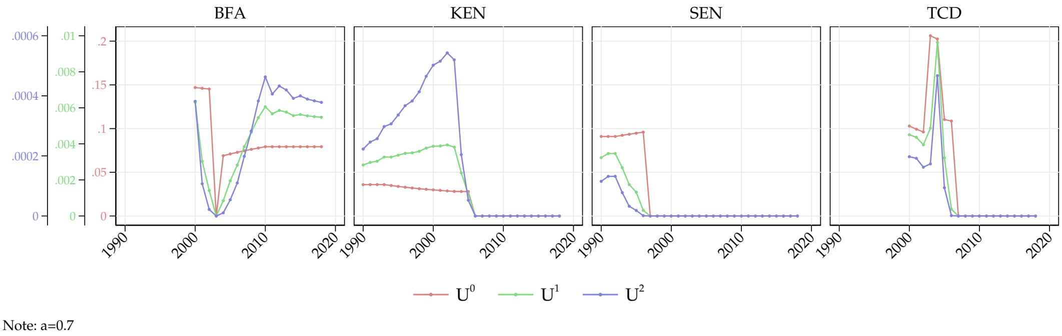
5.2 Empirical findings

Over- and under-performance measures. How do our relative over- and underdevelopment measures perform in practice? Figure 5 shows both over- and under-development measures for selected countries and that for several choices of α. The upper panel reveals, for instance, $U^0(x,p)$ to decline over time in most countries, which means that in most countries smaller proportions of their population are living in regions which are substantially under-performing in human development relative to the national mean performance. An important observations is, moreover, that the average gap in relative underdevelopment, U^1, suggests more gradual changes than the U^0 measures (see, e.g., Kenia or Senegal) and is, therefore, particular suited for monitoring progress. Together, both measures may provide useful information for national policy makers. In terms of further empirical findings, note that nowadays in particular two countries, Burkina Faso and Somalia, still have strongly relative under-developed regions (for $a = 0.7$). For results of all countries which are observed to have under-performing regions at some point during the period of observation, see figure A.1 in the appendix. Note that our findings suggest that the shrinking set of over- and under-performing regions tends to concentrate in countries with medium or low levels of human development and higher levels of SHDI inequality.

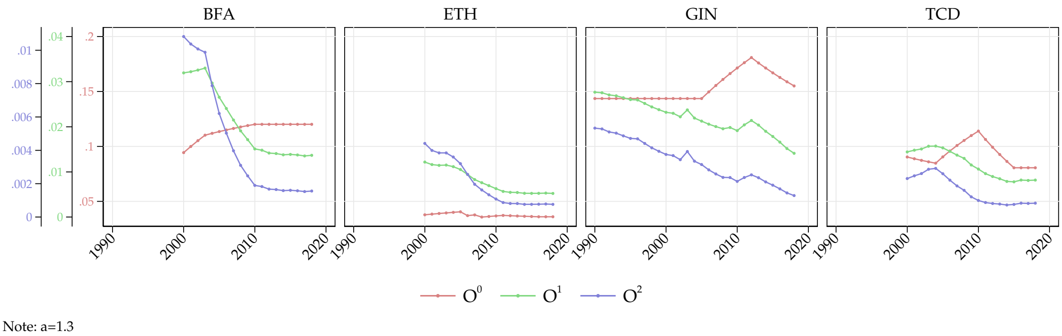
Relative over-development measures also tend to decline over time, but for our parameter choice ($a = 1.3$), we still find regions racing ahead in several countries (see also figure A.1 for all countries). Similarly, over-development measures O^1 and O^2 offer a more detailed account than O^0. Indeed, for some countries like Senegal or Ethiopia, we find $O^\alpha(x,p)$ and $U^\alpha(x,p)$ for $\alpha = 0$ to indicate no change at all, whereas both measures show clear trends for $\alpha = 1$. Notably, only Burkina Faso is found to still have both regions racing ahead and lagging behind, indicating a strong polarization of the country. Note that both findings, the higher prevalence of over- compared to under-performance and that both phenomena tend to vanish over time, do not originate from a particular parameter choice (see also figure X below).

Figure 5: Over- and under-development in HDI (selected countries)

(a) Under-performance

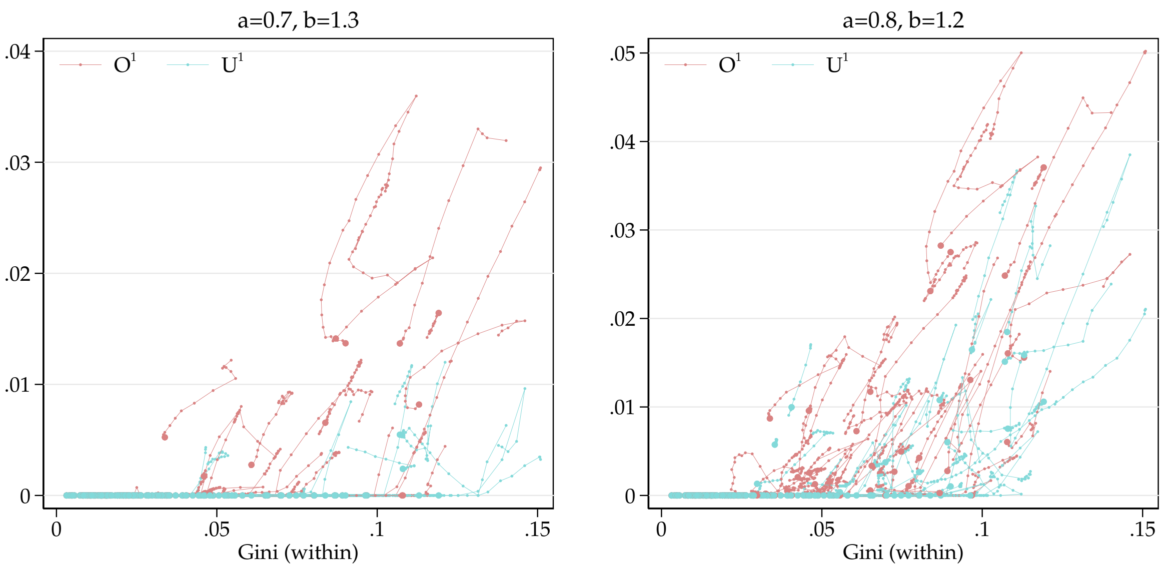


(b) Over-performance



Notes: Depicted countries are found to have at least one under-developed region ($a = 0.7$) or one over-developed region ($a = 1.4$) during the period of observation. Multiple vertical axis refer from inner to outer axis to U^0, U^1, U^2 and O^0, O^1, O^2, respectively.

Figure 6: Over- and Underperformance vs inequality (HDI)



Notes: Data for all countries and all years; larger dot indicates most recent observation of a countries' path.

Over-/under-performance and inequality. How exactly are over- and underperformance measures linked to sub-national inequality in human development in our data? First, in figure 6 we adopt a purely empirical approach as it shows country paths of O^1 and U^1 and the Gini-index at the same time and for conservative and liberal cutoffs, respectively. Visual inspection suggests, as expected, a positive link inequality as measured by the Gini-index and both over- and under-performance measures. Notably, particular high values of over- or under-performance, say 0.015 or more, are associated with relatively high levels of intra-national inequality, i.e. Gini-coefficients of around 0.075 or more. Importantly, 'high' Gini values (around 0.1 or more) may, however, also occur without or only slightly over- or underperforming regions. Thus, measures of over- and underperformance also provide information complementary to what inequality measures reflect, i.e. their relationship is not mechanical. The paths in figure 6 reveal, however, additional insights. First, the figure also reveals that for most countries, over- and under-performance measures decline over time. Moreover, we also observe that by tendency *changes* in both measures are aligned as well, i.e. decreases in over- and under-performance are frequently accompanied by decreases in within-country inequality. Furthermore, the figure also shows that countries with higher values in O^1, U^1 also have higher values of inequality, Together, these two observations suggest that the positive association of our over- and under-performance measures is supported by both cross-country and within-country variation. Finally, note that figure 6 also documents these observations not hinge upon the choice of parameters. Alternative values for α yield similar results, too (not shown).

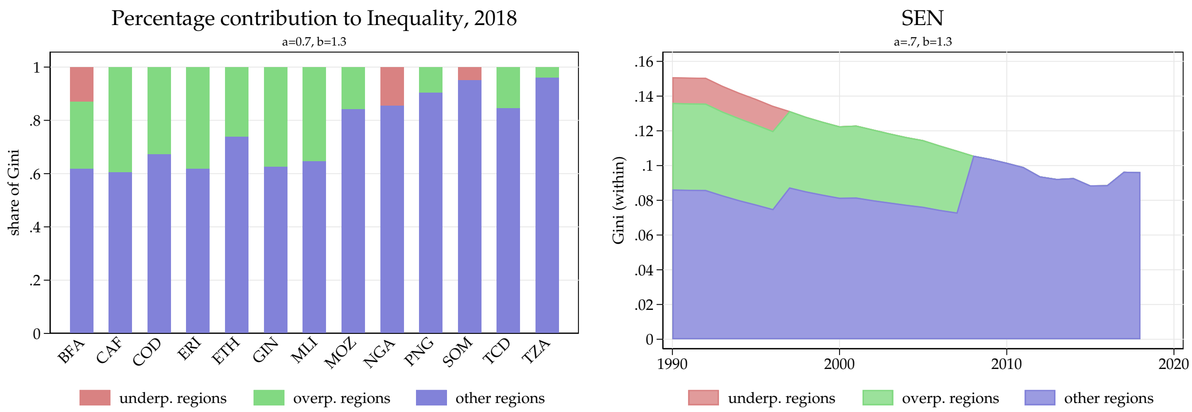
An alternative way to explore the nexus between both measures relies on the Gini-index decomposition outlined in section 3.1 to assess the importance of regions racing ahead or lagging behind for subnational inequality. Figure 7 (a) shows the contributions of over- and under-performing regions to the subnational inequality in human development for 2018 (left graph). The results first suggest that over-performance, if present, accounts for 15–40% of the observed inequality within countries, whereas under-performing regions, even if present only contribute 10% or less. In fact, 40% is the maximum contribution of over-performing regions for all previous years, whereas the minimum is less than .1 prior to 2010.[6] On average over-performing regions contribute 25–28% to national inequality (using all data from 1990–2018). Additionally, choosing alternative values for a and b results in similar conclusions (see figure A.2 panel (a)). Finally, the left-hand graph in figure 7 (a), however, also indicates that the lion share of subnational inequality is not driven by exceptionally over-performing regions.

Turning to the evolution of these contributions to inequality over time, the right graph of figure 7 showcases trends for a single country: Senegal. First, we observe Senegal's subna-

[6]Note that population size of a region matters: a less populous under-performer would have less impact ceteris paribus. Moreover, also note that this decomposition relies only the status of region—gaps or squared gaps do not enter the decomposition.

Figure 7: Regional contributions to within-inequality (Gini)

(a) current margin and country example over time

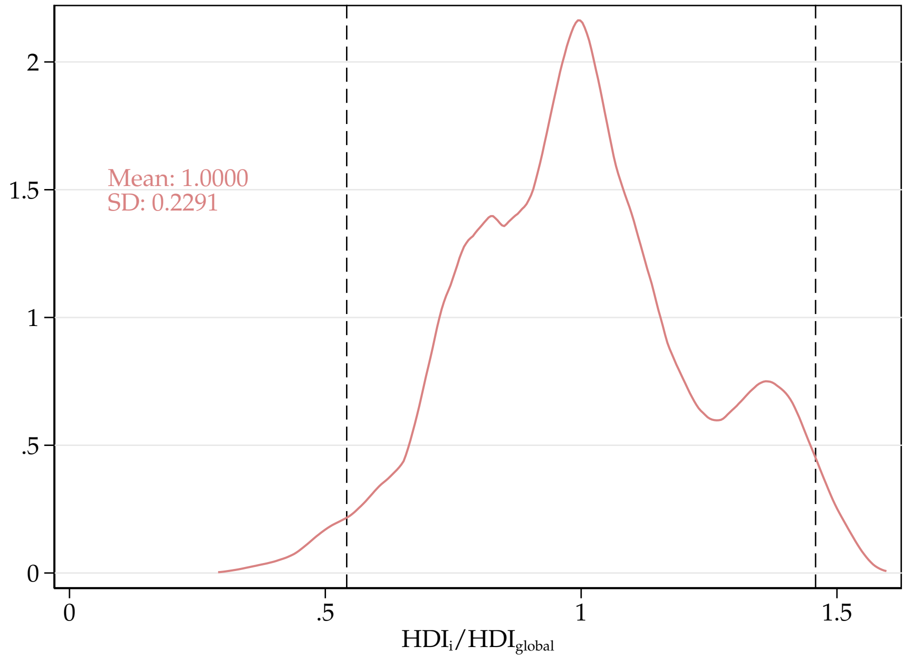


tional inequality to decline over the entire period of observation. Moreover, one can also see that this decrease begins with falling inequality in regular regions, then under-performing regions are catching up, and finally substantially over-performing regions disappear as well. Indeed, we observe similar pattern for many countries. A complementary in-depth view of other countries supports the general the general link between inequality and over- / underperformance, but also illustrates the non-uniformity of this relationship (see figure A.2, panel (b) for further examples). For instance, Chad, India, and Senegal all exhibit declining subnational inequality over the period of observation. In India over-performing regions were racing ahead less and less until they finally disappeared around 2005. While significant decreases of inequality in Chad until 2007 coincide with regions lagging behind to disappear, other regions racing ahead prevail even nowadays and inequality ceased to decline after 2010. Yet other countries however also experience increases in inequality, which are not driven by regions racing ahead (e.g., Guinea).[7]

In summary, empirical findings of this section include that in general the trend in decreasing global within-country inequality is accompanied by declining by racing ahead or lagging behind of subnational regions by national standards. In fact, nowadays regions overperforming contribute substantially less to within-country inequalities, than 30 years ago. Nonetheless, even nowadays we find that if over-performing regions are present they account for 15–40% of the within-country inequality. We also observe considerable heterogeneity in how exactly these trends manifest at the country-level, including polarization, stagnation, and setbacks.

[7]Note that one can also coherently analyze the contribution of regions which over- or under-perform within their countries to *global within-inequality*. Since such an analysis adds rather little in terms of additional insights, but complicates the presentation we omit related results. Such analyses are, however, available upon request.

Figure 8: Kernel density for relative HDI-performance of regions



Notes: all region-year observation pooled, Epanechnikov kernel density using region-to-global population weights, dashed lines at mean ± 2SD.

6 Global cohesion

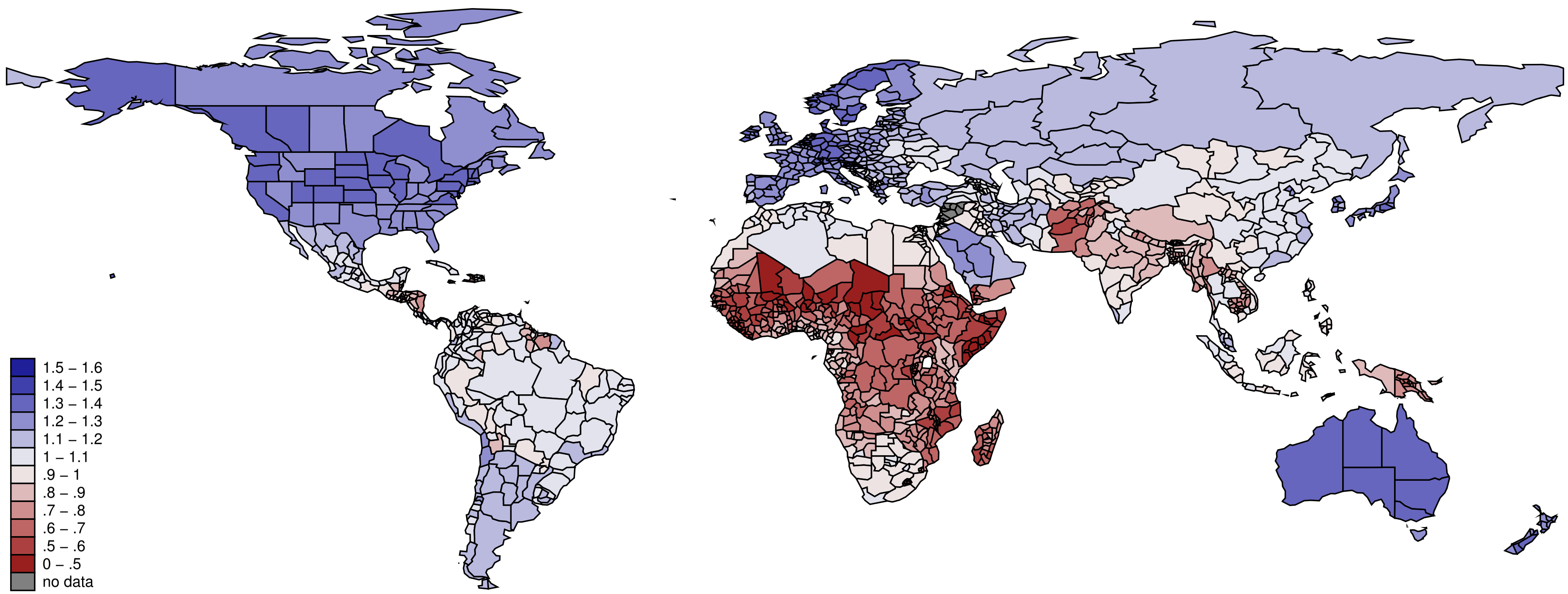
In this section we first specify our measures of over- under-performance relative to the global mean and then explore cohesion of the performance of subnational regions from a global perspective. This means we consider a single distribution of population weighted subnational HDIs. Inequality studied in this context, therefore, includes both within-country and between country inequality, whereas over- and underperformance measures now rely on the global, population weighted HDI.

6.1 Specifying the over- and under-performance measures

Distribution of relative performance. Analogously to the previous section, we first inspect the underlying distribution of relative performance to inform the choice of the thresholds of our over- and under-performance measures. Figure 8 shows the population-weighted kernel density for all regions in all years. This distribution turns out to be (i) less symmetric in particular there is a hump on the right-hand side (reflecting many subnational regions of OECD countries), (ii) less compressed (it has a larger standard deviation), and (iii) it has shorter but somewhat thicker tails. More extreme values are to be found in the tails, going beyond the mean plus minus two standard deviation approximately. These rather extreme values are again also rather rare as they are only observed for some countries in some of the years.

Choosing the cutoffs. Since our analysis of global cohesion relies on an entirely different distribution, which is shown in figure 8, we also adopt different thresholds for our over- and under-performance measures to account for this different nature of the exercise. More specifically, our (conservative) preferred choice is $a = 0.5, b = 1.5$, but we also report results for the more permissive cutoffs $a = 0.6, b = 1.4$. We again opt for rather conservative thresholds in order to focus on the more extreme cases of regions lagging behind or racing ahead. Naturally, more permissive cutoffs would, e.g., induce higher contributions for inequality.

Figure 9: Over- and underperformance relative to the global HDI.



Notes: Year of data is 2018, source of shape file is Global Data Lab.

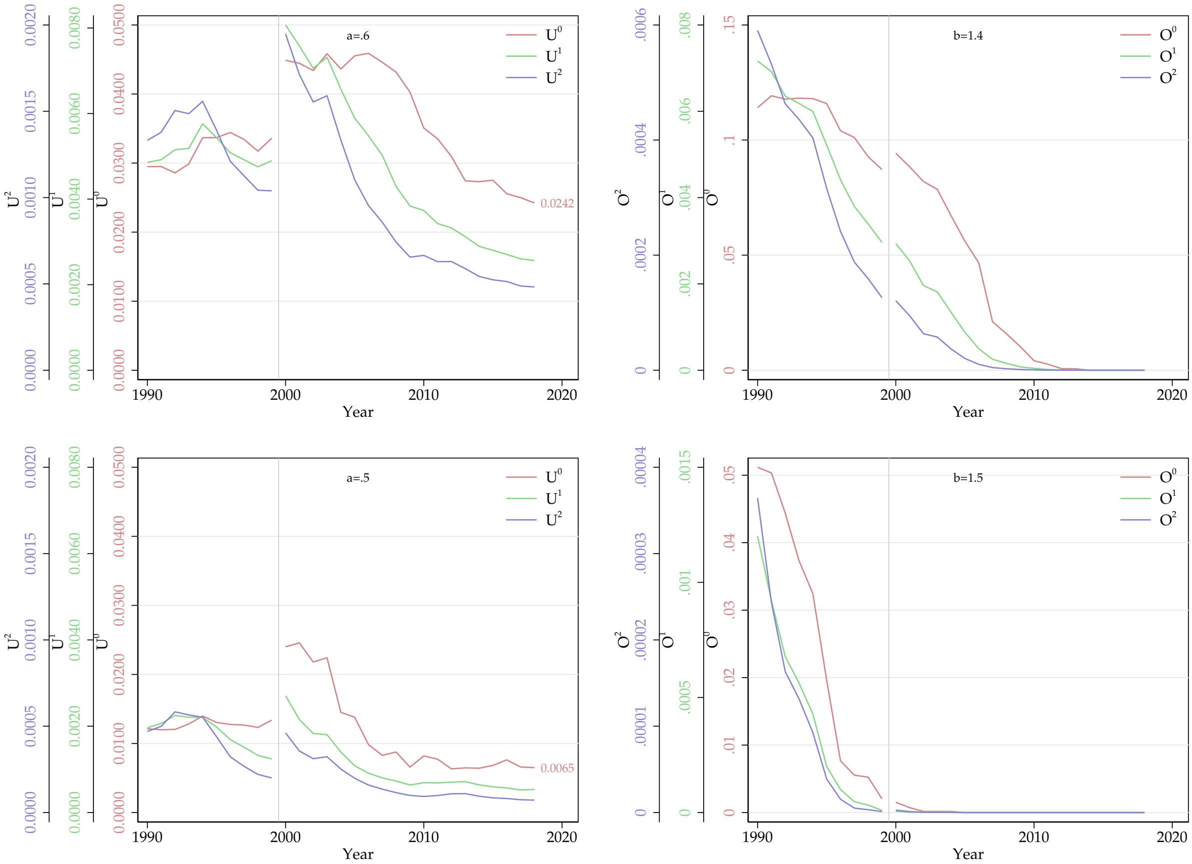
Geographic distribution. Turning to the geographic distribution of the subnational HDI performance relative to the global mean, figure 9 provides such a snapshot for 2018. First, we observe the well-known north-south divide and most globally under-performing regions are found in Sub-Saharan Africa, but also in South Asia and South-East Asia, and Latin America and the Caribbean. However, according to our preferred cutoffs ($a = 0.5, b = 1.5$) we find subnational regions lagging globally behind only in Sub-Saharan Africa and Afghanistan. Importantly, figure 9 also reveals that usually not entire countries lagging behind, but rather specific subnational regions within certain countries. The dividing line thus runs right through the middle of countries. In addition to this table A.3 documents this observation to hold for alternative choices of the threshold and if population shares are taken into account. Depending on the chosen cutoff we find globally under-performing regions in human development to be scatter over 11–25 countries.

6.2 Empirical Findings

Over- and under-performance measures. Turning to regional over- and under-performance in human development offers a more comprehensive assessment of territorial cohesion than relying on inequality alone. Figure 10 shows our O^α, and U^α measures for rather conservative ($a = 0.5, b = 1.5$) and somewhat more permissive thresholds ($a = 0.6, b = 1.4$). The vertical line cautions to directly compare values measures before and after 2000, as in this year eleven countries are observed for the first time, see table A.1 for details. For over-performance, we observe regions racing ahead to vanish by 2003 for $b = 1.5$ or by 2013 for $b = 1.4$, respectively. Under-performance, in contrast, is found to be relevant and non-negligible even nowadays, despite a steady decrease since 2000. Specifically, while the more permissive cutoff ($a = 0.6$) suggests improvements over the entire period of observation since 2000 in all three measures (U^0, U^1, U^2), the more conservative cutoff ($a = 0.5$) reveals this decrease to come to a halt around 2010. Importantly, none of the three measures indicates any substantial improvement since then, which implies that not only a considerable share of the world population is still living globally under-performing regions, but also that these regions fail to close the gap (and the squared gap) and thus are not catching-up with the global average.

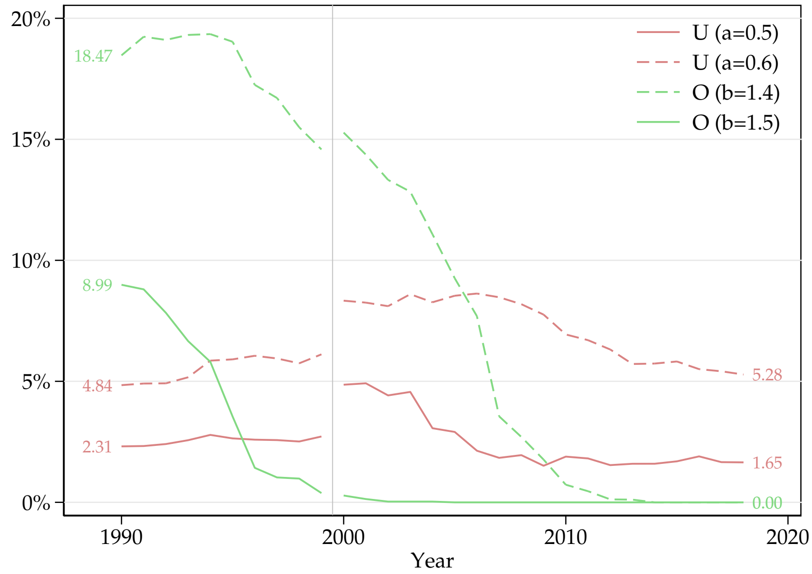
Since our global under-performance measures are defined with respect to a (fraction of the) world SHDI mean that increases over time, the existence of a 'long tail' of under-developed regions does not imply that their human development levels decline over time. Rather, our findings suggest that these subnational regions are not catching up sufficiently fast, i.e. their human development levels increase below world-average speed, so the lower tail of the distribution remains 'too long'. Since our U^0 measure reports population shares and the world population covered by our data approximately amounts to 7.5 billion in 2018, we can directly infer that the under-performing regions are home to circa 48–181 million

Figure 10: Global over- and underperformance



Notes: Underlying data is an unbalanced panel. In 2000 data for eleven low-HDI countries becomes available for the first time, thus values before and after 2000 are not directly comparable. Moreover, a few further countries are added in other years, see table A.1 for details.

Figure 11: Contributions of over- and underperformance to global inequality



Notes: Underlying data is an unbalanced panel. In 2000 data for eleven low-HDI countries becomes available for the first time, thus values before and after 2000 are not directly comparable. Moreover, a few further countries are added in other years, see table A.1 for details.

people (depending on the choice for the cutoff a), which is a non-neglible amount.

Contributions to inequality. First, recall that global total inequality is declining over the entire period of observation, as earlier shown by figure 2. The inequality decompositions detailed in section 3.2 allows us now to explore the role of over- and under-performing regions in this development. Figure 11 shows these contributions to inequality for both conservative and liberal cutoffs and resembles the previous figures on the measures themselves. Specifically, we observe the contribution of over-performing regions, which amounts to about 9% or 20% in 1990 for $a = 0.5$ and $a = 0.6$, respectively, to fade out over time. Contributions of regions falling behind to overall inequality, however, appear to be surprisingly stable over time. While declining in absolute terms, in relative terms the contribution of under-performing regions to global SHDI inequality ranges from about 5% in 1990 to 8% in 2000 to 5% in 2018, for the more liberal cutoff ($a = 0.6$). According the more conservative cutoff ($a = 0.5$) the relative contribution varies from 2% in 1990 to 5% in 2000 in falls to 2% in 2018 and is thus surprisingly constant, too. We therefore conclude that the composition of such global total inequality has shifted over time.

In summary, results in this section show that global over-performing regions in human development previously played an important role in 'making for global inequality', but not anymore. Additionally, our under-performance measure reveals a considerable population to live in regions, which fail to close the gap with global average performance and are, therefore, still lagging behind.

7 Discussion and Concluding Remarks

The present paper uses the Subnational Human Development Database (Smits and Permanyer, 2019) to investigate whether, and to what extent, the living conditions across the main sub-national units of 162 countries are evolving in a territorially cohesive way. For this purpose, we propose new over- and under-development indicators to complement conventional analyses of inequality, which are often used to study convergence among regions or countries. Specifically, these measures are akin to those commonly used in poverty measurement and allow to identify sub-national regions racing ahead or falling behind certain thresholds. Moreover, our approach also allows to construct national-level measures, which may be particularly useful for policy purposes, as they can reflect the share of the population living in over- or under-developed regions and the corresponding degree of over- or under-development.

In our empirical analysis we explore the regional performance in human development: first, relative to the national and then relative to the global average level of human development. Regarding the national-level analysis, our findings suggest that inequality in human development within countries is declining almost everywhere and, moreover, that around the world, over- and under-performance in human development within countries tend to disappear over time as well. That is, using the corresponding national HDI as a reference point, countries' sub-national SHDIs tend to become increasingly similar. The shrinking set of over- and under-performing regions tends to concentrate in countries with medium or low levels of human development and higher levels of SHDI inequality. All in all, these findings suggest that countries' territorial cohesion in terms of the SHDI has tended to increase. This finding, however, also implies that the current HDI metric becomes gradually less receptive to reveal disparities that might exist among countries' main administrative units.

What about the global distribution of human development across all world countries' sub-national regions? Previous research already documents declines in global inequality of human development (Jordá and Sarabia, 2015, Permanyer and Smits, 2020). Our results, moreover, suggest that the composition of such declining inequality has shifted over time. In the 1990s, around 9–19% and 2–5% of global inequality could be attributed to over- and under-performing regions. Almost 30 years later, the contributions of over-performing regions fell to 0%, whereas the one of under-performing regions more or less remains at 2–5%. Thus, while the group regions racing ahead in human development has vanished over time, the group of under-developed regions also decreased but did not entirely disappear: as of 2018, it was scattered over 11–25 countries depending on the applied threshold.

Remarkably, the set of under-developed regions cuts across national boundaries (i.e. it is not entire countries but rather certain regions within some countries that are really lagging behind), and the number of individuals living in those areas, 48–181 million (depending on the chosen cutoff), has barely declined since 2010 and neither did these regions close the gap with global average human development even partially. Uncovering the existence of this previously undetected—yet non-negligible and time-persistent—pocket of under-development has been possible thanks to the granularity of the SHDI database and the creation of over- and under-development indicators that complement 'inequality' and 'convergence' approaches. Indeed, while over-/under-performance on the one hand and inequality measures on the other reflect related phenomena, they are intrinsically different, thus providing complementary insights. High inequality in human development does not mechanically imply high regional over- or under-development within a country, or vice versa.

On the methodological side, we stress that all findings reported in the paper are contingent on the choice of the upper and lower cutoffs defining what regions are 'over-' or 'under-developed', which inherently involves a degree of arbitrariness. It should be reiterated that the choice of the cutoffs is a normative decision, and thus depends on the specific exercise at hand. Moreover, various types of information may enter such considerations, including the ultimate purpose of the measure, the political priorities, and of course the specific distribution of relative performance. All these pieces of information help agreeing on a threshold for how much a region may perform below average in a well-being indicator before being considered as being left behind. These considerations echo the problems and concerns related to the construction of poverty measures, which ultimately depend on the choice of an equally arbitrary poverty line—an issue that does neither invalidate interest nor usefulness of poverty analysis.

What can one conclude from these empirical findings? As is often the case, the glass can be seen half full or half empty. On the one hand, it seems that virtually all world regions are converging in very basic dimensions of human well-being (i.e. the ones linked to *essential* needs, like survival, basic education, or minimal income). Previous research in similar indicators lends additional support to this as countries' life expectancy levels tend to increase (despite occasional setbacks) and become increasingly similar globally (Permanyer and Scholl, 2019) and the number of individuals' years of schooling continues to increase and become more equally distributed globally (Jordá and Alonso, 2017) even though developments in regarding global income inequality seem somewhat more complex (Anand and Segal, 2015). From this perspective, there are several reasons why the SHDI trends around the world since the 1990s can be considered a success story, overall. On the other hand, some of our findings are less inviting for optimism. First, huge pockets of underdevelopment still persist, concealed under national level averages. Second, the overall convergence patterns could suggest that the traditional HDI metric might be less able to discern the existing differences in living conditions among or within countries. Indeed, there are good reasons to believe that the rosy picture that emerges when using the HDI to assess countries' and regions' socio-economic development can differ dramatically when one expands the focus to incorporate more 'advanced capabilities', i.e. dimensions of human well-being reflecting aspects of life likely to become more important in the near future (or that are currently relevant in high-income settings), like healthy aging, having high-quality and higher education, access to high-level technologies, and so on. Thus, one should be wary of the fact that generalized improvements in basic dimensions of human well-being might co-exist with the emergence of new layers of inequality in more advanced or complex dimensions.

The results shown in this paper document SHDI trends from the late 20th century up to 2018. Over this period the SHDI increased in most areas of the world following a rather smooth and monotonic path. The outbreak of the coronavirus pandemic in 2020 might put an end to these trends in a dramatic way. The unprecedented crisis unleashed by the pandemic is strongly affecting each of the HDI's dimensions: for income estimates suggest the largest contraction in economic activity since the Great Depression (e.g., World Bank, 2020); for health it is anticipated to reduce life expectancy through several different channels (e.g., Marois *et al.*, 2020, Trias-Llimós *et al.*, 2020); and for education increasing out-of-school rates around the world are already materializing, which are also expected to affect quality-adjusted years of schooling (Azevedo *et al.*, 2020). The implications that these changes will have on the distribution of human development across and within countries is likely to be harsh—yet still unknown (e.g., UNDP, 2020).

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A Additional Results

Table A.1: Countries, number of subnational regions and first survey year

Country	first year	# region	Country	first year	# regions	Country	first year	# regions
AFG	1990	29	GHA	1990	29	NLD	1990	29
AGO	1999	20	GIN	1990	29	NOR	1990	29
ALB	1990	29	GMB	1990	29	NPL	1990	29
ARG	1990	29	GNB	2005	14	NZL	1990	29
ARM	1990	29	GNQ	2000	19	PAK	1990	29
AUS	1990	29	GRC	1990	29	PAN	1990	29
AUT	1990	29	GTM	1990	29	PER	1990	29
AZE	1995	24	GUY	1990	29	PHL	1990	29
BDI	1990	29	HND	1990	29	PNG	1990	29
BEL	1990	29	HRV	1990	29	POL	1990	29
BEN	1990	29	HTI	1990	29	PRT	1990	29
BFA	2000	19	HUN	1990	29	PRY	1990	29
BGD	1990	29	IDN	1990	29	PSE	2004	15
BGR	1990	29	IND	1990	29	ROU	1990	29
BIH	2000	19	IRL	1990	29	RUS	1990	29
BLR	1995	24	IRN	1990	29	RWA	1990	29
BLZ	1990	29	IRQ	1990	29	SAU	1990	29
BOL	1990	29	ITA	1990	29	SDN	1990	29
BRA	1990	29	JAM	1990	29	SEN	1990	29
BRB	1990	29	JOR	1990	29	SLE	1990	29
BTN	2005	14	JPN	1990	29	SLV	1990	29
BWA	1990	29	KAZ	1990	29	SOM	2006	13
CAF	1990	29	KEN	1990	29	SRB	1990	29
CAN	1990	29	KGZ	1990	29	SSD	2010	9
CHE	1990	29	KHM	1990	29	STP	1990	29
CHL	1990	29	KOR	1990	29	SUR	2004	15
CHN	1990	29	KWT	1990	29	SVK	1990	29
CIV	1990	29	LAO	1990	29	SVN	1990	29
CMR	1990	29	LBN	2005	14	SWE	1990	29
COD	1990	29	LBR	1999	20	SWZ	1990	29
COG	1990	29	LBY	1990	29	SYR	1990	22
COL	1990	29	LSO	1990	29	TCD	2000	19
COM	2000	19	LTU	1990	29	TGO	1990	29
CPV	2000	19	LVA	1990	29	THA	1990	29
CRI	1990	29	MAR	1990	29	TJK	1990	29
CUB	1990	29	MDA	1990	29	TKM	2010	9
CZE	1990	29	MDG	2000	19	TLS	2002	17
DEU	1990	29	MDV	1995	24	TTO	1990	29
DJI	1995	24	MEX	1990	29	TUN	1990	29
DNK	1990	29	MKD	2000	19	TUR	1990	29
DOM	1990	29	MLI	1990	29	TZA	1990	29
DZA	1990	29	MLT	1990	29	UGA	1990	29
ECU	1990	29	MMR	1990	29	UKR	1990	29
EGY	1990	29	MNE	2003	16	URY	1990	29
ERI	2005	14	MNG	1990	29	USA	1990	29
ESP	1990	29	MOZ	1990	29	UZB	2000	19
EST	1990	29	MRT	1990	29	VEN	1990	29
ETH	2000	19	MUS	1990	29	VNM	1990	29
FIN	1990	29	MWI	1990	29	VUT	2005	14
FJI	1990	29	MYS	1990	29	XKO	2010	9
FRA	1990	29	NAM	1990	29	YEM	1990	29
GAB	1990	29	NER	1990	29	ZAF	1990	29
GBR	1990	29	NGA	2003	16	ZMB	1990	29
GEO	2000	19	NIC	1990	29	ZWE	1990	29

Table A.2: Incidence of over- and underperforming regions

(a) within country analysis

	under-performance				over-performance		
	(1) # region-years	(2) # regions	(3) # ctys		(1) # region-years	(2) # regions	(3) # ctys
a=.5	0	0	0	a=1.1	3605	162	73
a=.6	7	3	2	a=1.2	1514	75	43
a=.7	154	12	9	a=1.3	548	32	21
a=.8	1009	53	29	a=1.4	226	17	12
a=.9	4836	217	77	a=1.5	88	9	7
Total	47390	1692	162	Total	47390	1692	162

(b) global analysis

	under-performance				over-performance		
	(1) # region-years	(2) # regions	(3) # ctys		(1) # region-years	(2) # regions	(3) # ctys
a=.5	1514	96	24	a=1.1	17916	628	88
a=.6	4059	220	43	a=1.2	11298	439	63
a=.7	8189	385	51	a=1.3	6873	296	38
a=.8	12898	528	64	a=1.4	2431	169	21
a=.9	16838	660	77	a=1.5	355	60	9
Total	47390	1692	162	Total	47390	1692	162

Notes: Entire data set contains 162 countries, comprising 1688 regions in total, with 47,390 region-year observations.

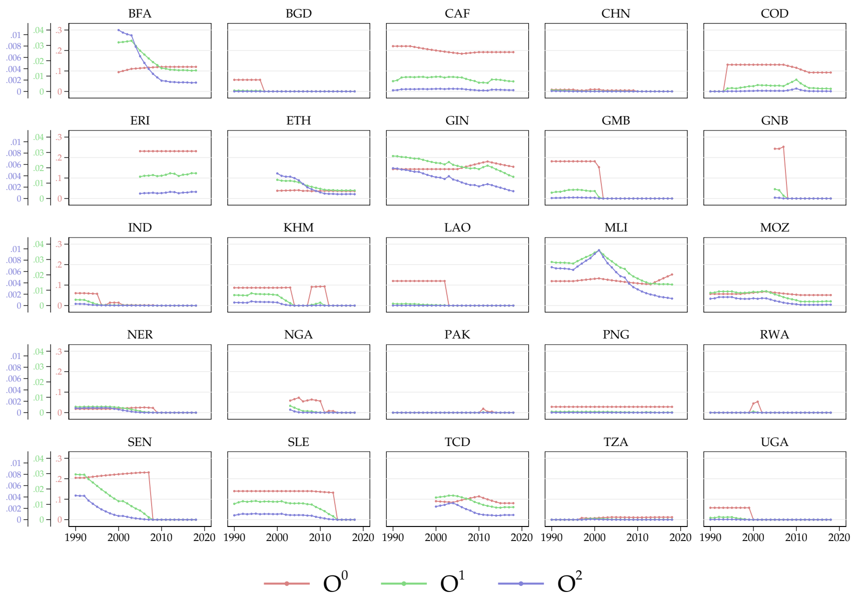
Table A.3: Globally underperforming regions

Country	(1) # up. regions	(2) share of up. regions	(3) population share
		$a = 0.6$	
AFG	1	0.12	0.13
BDI	2	0.40	0.42
BFA	8	0.62	0.61
CAF	5	0.83	0.81
CIV	2	0.20	0.10
CMR	1	0.10	0.19
COD	1	0.09	0.08
ERI	4	0.67	0.74
ETH	2	0.18	0.04
GIN	3	0.38	0.34
GMB	4	0.50	0.39
GNB	3	0.33	0.29
LBR	9	0.60	0.37
MDG	2	0.09	0.12
MLI	6	0.75	0.65
MOZ	4	0.36	0.45
NER	5	0.71	0.80
NGA	6	0.16	0.18
SDN	1	0.07	0.04
SEN	2	0.20	0.18
SLE	9	0.64	0.50
SOM	15	0.83	0.72
SSD	6	0.60	0.63
TCD	4	0.50	0.45
YEM	3	0.38	0.42
		$a = 0.5$	
BFA	2	0.15	0.17
CAF	3	0.50	0.49
ERI	2	0.33	0.31
GMB	2	0.25	0.19
GNB	1	0.11	0.11
MLI	2	0.25	0.16
NER	2	0.29	0.42
NGA	2	0.05	0.05
SOM	11	0.61	0.58
SSD	2	0.20	0.23
TCD	4	0.50	0.45

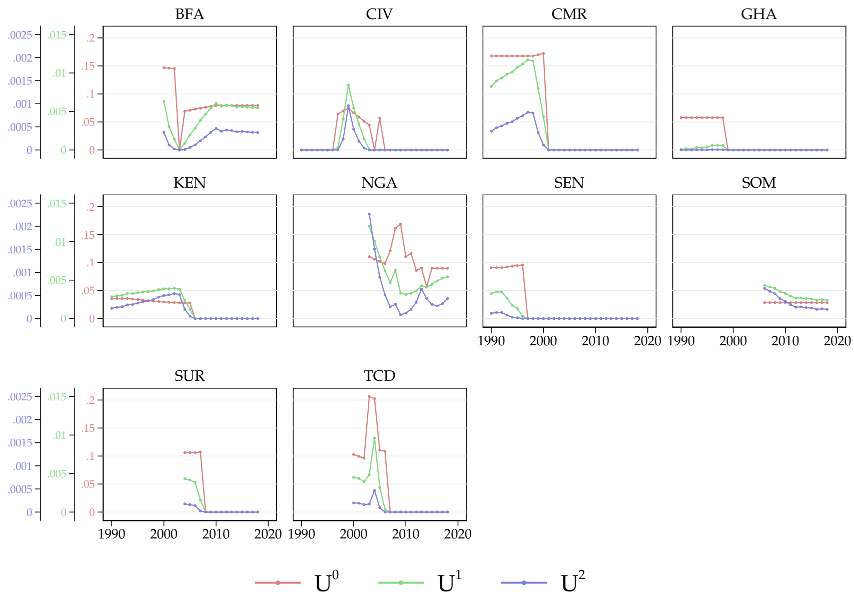
Notes: underlying data for only for 2018.

Figure A.1: Subnational overperformance in HDI

(a) Over-performance



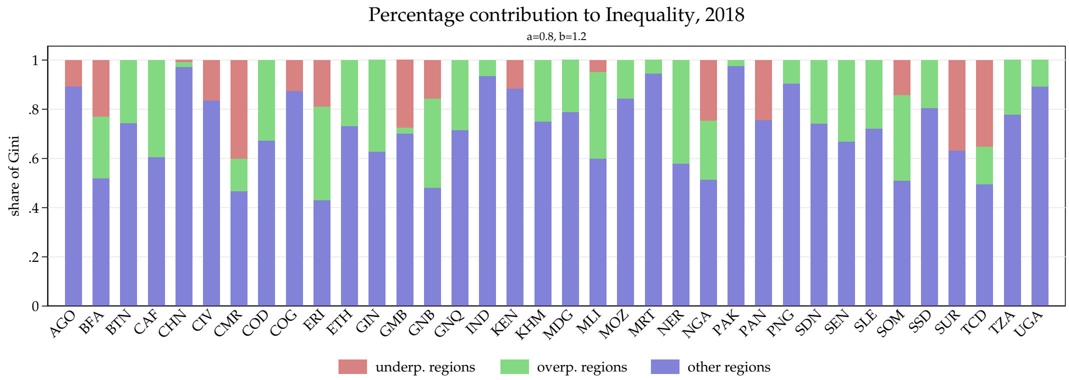
(b) Under-performance



Notes: Figure contains all countries having an overdeveloped region for $a = 0.7$, $b = 1.3$ at least once during period of observation are depicted.

Figure A.2: Regional contributions to within-inequality—additional results

(a) Contributions of over- and underperforming regions to within country-inequality



(b) Contributions over time—other selected countries