Introduction

By many accounts, the living conditions of humankind have improved dramatically during the last century. On average, human beings now live longer, are better educated and enjoy a better standard of living than a hundred years ago. Yet, whenever these general improvements in human development are shared inequitably and benefit some groups to the detriment of others, it is difficult to speak about unequivocal social progress. For this reason, the United Nations have committed countries all over the world to reduce inequalities within and among countries (Sustainable Development Goal #10) and to leave 'no one behind' in the development process. Attempts to measure the distribution of human development and poverty around the world have faced an important limitation: most of the key indicators are reported at the country level, but much less is known about their internal distribution within countries. While there are multiple indications that subnational variation in human development can be substantial, until now it was not possible to study these differences for more than a handful of countries. The main aim of this paper is to investigate whether the generalized improvements in human development we are observing around the world involve all countries' regions in a territorially cohesive / equitable way or if, on the contrary, some of them are racing ahead or lagging behind with respect to the corresponding national performance. For that purpose, we document within-country variation in human development and in multidimensional poverty since the turn of the new Millennium, using subnational comparable units of analysis *across the globe*.

To explore whether improvements in human development are equitably distributed within countries around the world we take advantage of the new Subnational Human Development Database (SHD) and sub-national version of OPHI's Multidimensional Poverty Index (MPI), taken from the latest release in 2018, see Smits and Permanyer (2019) and Alkire et al. (2018), respectively. The SHD database provides a sub-national version of the Human Development Index and its three subcomponents for more than 1600 regions within 161 countries, which together cover above 99% of the world's population. This SHDI and its underlying indicators have at the national level the same values as the UNDP's HDI and its indicators, but show how the HDI and its indicators vary within countries. The global MPI was developed by OPHI and UNDP and is calculated at least yearly since 2010. The last 2018 update includes 105 countries and covers 91% of the developing regions. The subnational data for the global MPI contains poverty estimates for 1,127 regions across 88 countries. Both data sets are freely available online.

Providing a much higher-resolution picture than was previously available, the new databases open the possibility of studying global socio-economic change with unprecedented coverage and detail and increase the ability of policy-makers to monitor and achieve several Sustainable Development Goals. Here we use this SHDI and global MPI databases to (i) investigate whether and to what extent some sub-national regions are substantially below or above national average levels in human development and multidimensional poverty, (ii) assess the extent of inequality in human development and multidimensional poverty across the regions within countries, and (iii) explore whether population growth has contributed favorably/unfavorably to the dynamics of over and under-development, inequality and poverty within world countries over time.

Data

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, GDL-AD, (www.globaldatalab.org/areadata) and (iii) the HDI database of the United Nations Development Program (UNDP, https://hdr.undp.org/data).

The calculation of the global MPI uses data from DHS, MICS and PAPFAM and for some countries national surveys. Unlike the HDI all numbers have to be derived from a single survey data set. The global MPI comprises 10 indicators organized along three dimensions: health, education and living standards. More specifically, the indicators are child mortality, nutrition, education, school attendance, clean water access, improved sanitation facilities, cooking fuel, electricity, housing conditions, and an assets index. Technically, the global MPI uses the dual-cutoff counting approach. Households are considered deprived in a particular indicator if their achievement falls short of the respective deprivation cutoff. Then dimensions are weighted equally, as are indicators within dimensions. The global MPI requires a household for being identified as poor to have a weighted deprivation count of 33% or more of the maximum possible deprivation.

Methods

To compute the Subnational Human Development Index, we first 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 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. Moreover, we use in this paper the multidimensional poverty index (M_0) and one of its sub-indices the multidimensional headcount ratio (H). The latter is defined as the proportion of the population who is multidimensionally poor. The former is defined as the product HA, where A is the average deprivation score of multidimensionally poor people.

Conceptually, both HDI and global MPI seek to measure different phenomena. Three aspects are of particular importance. First, the HDI seeks to capture achievements in three dimensions over their entire range, from critically low to favourably high levels. The global MPI instead, is specifically designed to only register deprivations in dimensions, meaning critically low outcomes. Second, the HDI is a mean of three average achievements in one particular society, and therefore only draws on the marginal distributions of each dimension. The global MPI instead was devised to exploit the joint distributions of deprivations already in the identification step of poverty analysis. Finally, even though both measures seem to have the same dimensions (health education and living standards), both measures effectively use different indicators.

The extent of inequality in a given distribution can be measured using many different indices. In this paper, we use two of the most popular inequality measures: the Gini index (G) and the Mean Log Deviation (L). The distribution of human development across countries' subnational regions is described by a vector of achievements $x=(x_1,...,x_r)$ and population shares $p=(p_1,...,p_r)$. The extent of *under-development* in such distribution relative to the national mean is given by

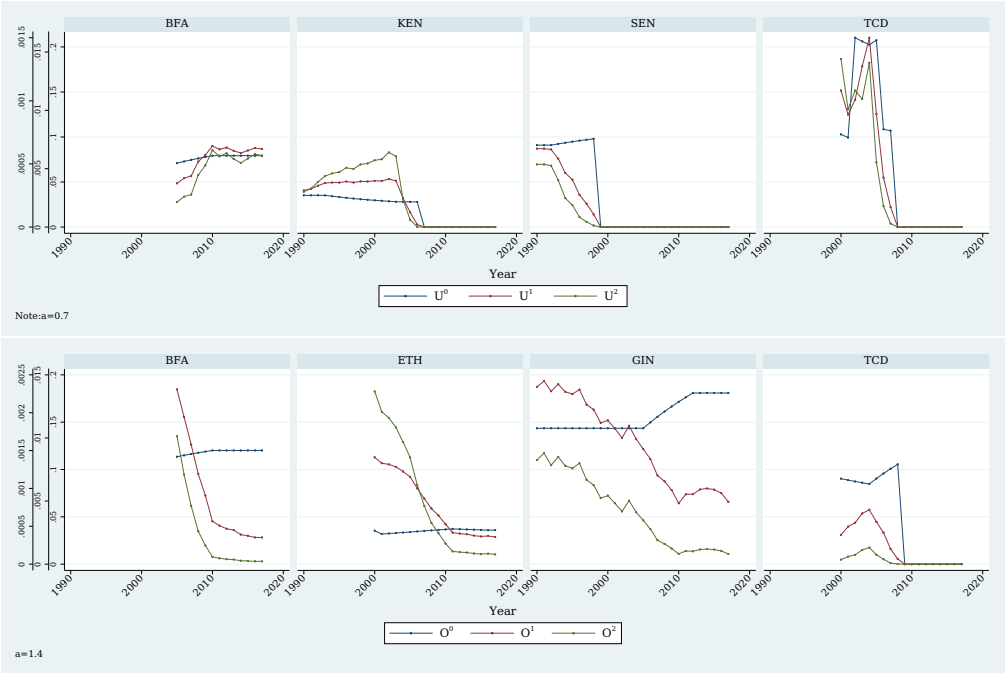
$$U^\alpha(x,p)=\sum_i p_i \max\left(\frac{z-x_i}{z},0\right)^\alpha \tag{1}$$

where, $z=a\mu$, $0<a<1$, $\mu=\sum_i p_i x_i$ is the national-level mean, and α is a non-negative parameter. Parameter 'a' measures the fraction of countries' national performance that is used as an 'under-development threshold'. To simplify notation, the gap $\max\left(\frac{z-x_i}{z},0\right)^\alpha$ will be written as g_i^α. 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 'underdeveloped' in the distribution of other, less-developed, countries). Using the same notation, we can define the extent of over-development associated to the distribution as follows

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

$O^\alpha(x,p)$ should be interpreted as the extent of relative over-development we observe in a given country.

Figure 1: Over- and under-development measures for human development index



Notes: Upper panel contains relative underdevelopment measures, lower panel shows different over-development measures, each time for selected countries. Under-development is defined using $a=0.7$, over-development using $a=1.4$. Multiple vertical axis refer from inner to outer axis to U^0,U^1,U^2 and O^0,O^1,O^2, respectively.

Moreover, both the over- and under-development measures as well as the inequality measures can be decomposed. Specifically, applying a Shapley decomposition to equations (1) and (2), we can isolate what part of the observed trends in under- and over-development within countries is attributable to population change and changes in the development levels of countries' subnational units. Addtionally, following Mookherjee and Shorrocks (1982), changes in (MLD-based) within-country inequality in human development can be decomposed in two clearly interpretable components as well: one reflecting the effect of changing population sizes, and the second reflecting the effect of changing levels of human development within countries' regions.

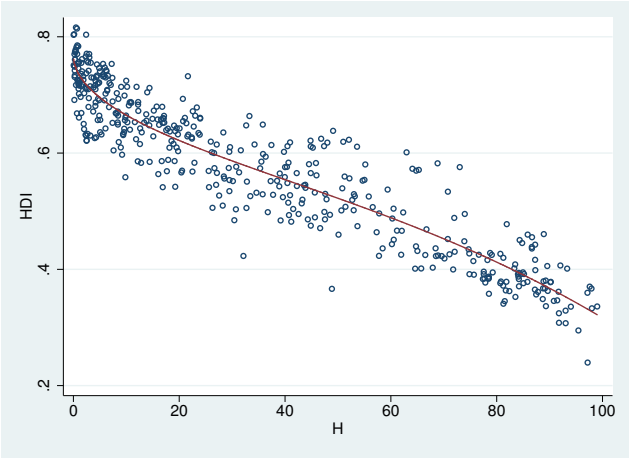
Preliminary results

Figure 1 shows both **under- and over-development** measures for selected countries. The upper panel reveals, for instance, that the share of people living in relatively under-developed regions, $U^0(x,p)$, tends to decline over time. Moreover, nowadays only few countries (e.g., Burkina Faso) are found to have strongly relative under-developed regions (for $a=0.7$). The the average gap in underdevelopment, U^1, suggests more gradual changes (see, e.g., Kenia or Senegal). Similarly, over-development measures O^1 and O^2 offer a more detailed account than O^0. For most countries we observe also *over*-development measures to decline. However, sub-national regions racing ahead in terms of human development are still frequently observed in many countries.

Figure 2 compares **human development and multidimensional** poverty. We observe a high (negative) correlation of around .9 for SHDI and the headcount ratio of the global MPI as theoretically expected. However, we also find substantial heterogeneity, i.e. both measures are rather poor predictors for each other. For instance, for a medium level of human development (around 0.5 or 0.6), we find headcount ratios of the global MPI ranging from 9% to 73%, which actually almost covers the entire range.

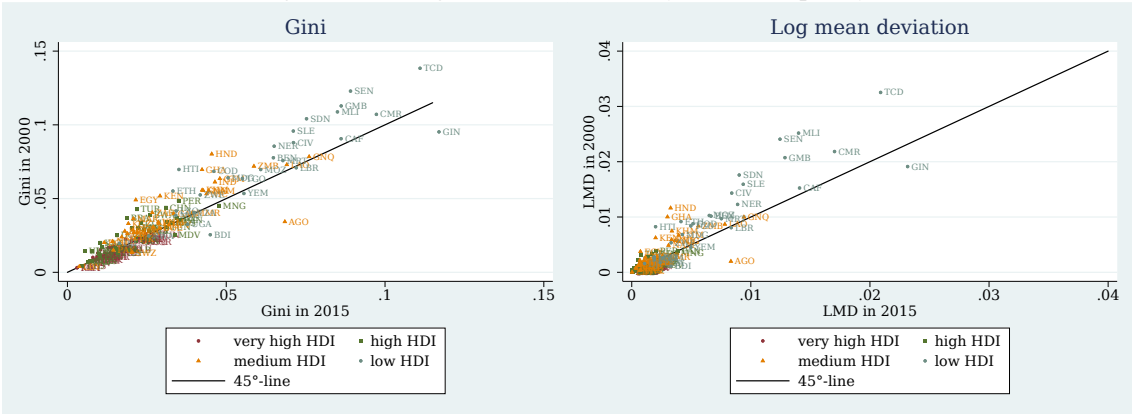
Finally, Figure 3 shows **changes of within-country inequality** in human development. More specifically, this figure depicts for two inequality measures, the Gini index and the log mean deviation, values observed in 2015 (horizontal axis) and values observed in 2000 (vertical axis). As can be seen, most countries are above

Figure 2: Human Development Index and Measures of Multidimensional Poverty



Notes: Horizontal axis show sub-national values of the multidimensional headcount ratio, vertical axis shows values of SHDI. Source: Authors' elaboration based on the global MPI (Alkire et al., 2018) and the SHDI Database (Smits and Permanyer, 2019).

Figure 3: Changes in within-country SHDI inequality.



Notes: Source: Authors' elaboration based on the SHDI Database (Smits and Permanyer, 2019).

the 45° equality line. This means that within-country SHDI inequality has decreased over time between 2000 and 2015. For 24% of the countries we observe an increase in SHDI inequality during this period, but these increases are quite small (the dots are very close to the 45° equality line) and are concentrated in the bottom left cluttered corner of the graph (i.e. for the group of countries with very high levels of human development). As can be seen, countries with low levels of human development tend to have higher levels of SHDI inequality.

References

Alkire, S., Kanagaratnam, U., and Suppa, N. (2018). The global multidimensional poverty index (MPI): 2018 revision. OPHI MPI Methodological Notes 46, Oxford Poverty and Human Development Initiative, University of Oxford.

Smits, J. and Permanyer, I. (2019). The subnational human development database. *Scientific Data*, 6:190038.

Mookherjee, D. and Shorrocks, A. , I. (1982). A Decomposition Analysis of the Trend in UK Income Inequality. *The Economic Journal*, 92, pp. 886–902.