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Developing a global living standards measure using census microdata

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Abstract: The measurement of living standards across the globe through initiatives such as the Human Development Index (HDI) or the Global Multidimensional Poverty Index (MPI) allowed re-examining inequality and development. In this study, we define a global measure of living standards based on information readily available in census microdata. We identify key living standards indicators that we are able to calculate consistently across census datasets to construct an index. We analyze living standards at the national and sub-national levels, using consistent spatial footprints. Changes in living standards are studied through time, taking advantage of census microdata samples available for the 1990, 2000, and 2010 rounds. We focus on a set of seven indicators defined in a similar manner across countries and census years. Overall results show progress for the countries examined, but progress is uneven and differs within and between countries; progress is also biased towards the urban population.

Keywords: living standards; assets; spatial harmonization; principal component analysis; census; IPUMS

1. Introduction and background

A non-monetary wealth approach has often been used in research when traditional monetary measures, such as household expenditures or income, are not available. An early application developed by Filmer and Pritchett (2001) exploited information on asset ownership to proxy for household wealth and analyze children's school enrollment. Several other studies have followed this perspective to represent household wealth (Bollet et al, 2002; Houweling et al, 2003; Lindelow, 2006; McKenzie, 2005; Montgomery et al, 2006). We also find related applications measuring living standards across the globe. The Demographic and Health Surveys (DHS) developed a wealth index as a composite measure of assets and dwelling characteristics (Rutstein and Johnson, 2004). The DHS wealth index is calculated using easy-to-collect data on a household's ownership of assets (such as televisions and bicycles), housing construction materials, and access to public utilities (such as water source or type of sanitation facilities.) The Human Development Index (HDI) was created in the nineties as a summary measure of achievement in key dimensions of human development: a long and healthy life (life expectancy at birth), being knowledgeable (mean of years of schooling for adults and expected years of schooling for children of school entering age), and having a decent standard of living (gross national income per capita) (UNDP, 2010; Sagar and Najam, 1998). A more recent effort is the Global Multidimensional Poverty Index (MPI), an international measure of multidimensional poverty that covers more than 100 developing countries. The MPI complements traditional monetary poverty measures by capturing acute deprivations in health, education, and living standards that a person faces simultaneously (Alkire and Santos, 2014; Alkire et al, 2020). The index is derived from ten indicators with equal importance, which are related to health (nutrition, child mortality), education (years of schooling, school attendance), and living standards (cooking, sanitation, drinking water, electricity, housing, assets).

Our paper draws from this rich research by defining a global measure of living standards based on information readily available in census microdata from the IPUMS International project (IPUMS, 2020). Our objective is to identify a set of key living standards indicators that we are able to calculate consistently across multiple census datasets, which will be used to define an index. We contribute to the literature on non-monetary wealth through the assessment of changes in living standards over different census rounds and at different spatial scales. The use of spatially harmonized geography to analyze change in non-monetary wealth is a unique addition to the measurement of poverty globally.

The effort to measure living standards acquires particular relevance in the context of the sustainable development goals framework. The United Nations (UN) proposes 17 Sustainable Development Goals (SDG) and 169 targets to call for action by all countries for the peace and prosperity of the globe (United Nations, 2015). The first SDG goal proposes to "end poverty in all its forms everywhere", urging researchers to measure poverty. One way to look at the issue would be the poverty line set by the World Bank at $1.90, the minimum amount of income that is adequate to survive. However, looking at a set dollar amount represents a unidimensional (Sen, 1992) way to express poverty. In our study, we build from specific goals set by the SDG framework to identify indicators that represent various dimensions of living standards.

2. Data and methods

2.1. Census data

This study uses census microdata samples from the IPUMS International project, the largest repository of international census samples (IPUMS, 2020). IPUMS currently includes sample data for 473 censuses and surveys from 102 countries. IPUMS consists of microdata, where each record represents a person, organized into households, for whom all individual census characteristics are known. The data include variables representing a broad range of population characteristics, including fertility, nuptiality, life-course transitions, migration, disability, labor-force participation, occupational structure, education, ethnicity, and household composition (Ruggles, 2003). IPUMS makes a significant contribution to demographic research by harmonizing data for cross-temporal and cross-national analysis. Multiple census (and/or survey) years are available for most countries in the database and variables are harmonized across the IPUMS samples such that a consistent coding is used across countries and samples.

For this study, we examine living standards across the 1990, 2000, and 2010 census rounds. Preliminary results cover 51 census samples from 21 countries, which span over one or more of these rounds. The analysis comprises the following censuses: Argentina 1991, 2001, 2010, Bolivia 1992, 2001, 2012, Brazil 1991, 2010, Chile 1992, 2002, Colombia 1993, 2005, Ecuador 1990, 2001, 2010, Paraguay 1992, 2002, Peru 1993, 2007, Uruguay 1996, 2006, 2011, and Venezuela 1990, 2001 from Latin America; Botswana 1991, 2001, 2011, Kenya 1999, 2009, Malawi 1998, 2008, Mozambique 1997, 2007, Rwanda 2002, 2012, Tanzania 2012, Uganda 1991, 2002, and 2014, and Zambia 1990, 2000, 2010 from Africa; and Indonesia 1990, 1995, 2005, Philippines 1990, 2000, 2010, and Vietnam 1989, 1999, 2009 from Asia. The sample sizes are 5 to 10% of the country's population. Since the data provided by IPUMS uses a consistent coding structure, constructing the indicators for cross comparability and analysis is convenient.

2.2. Spatial data

For each person record, census offices typically record geographic information at the administrative unit level, providing coded data and labels corresponding to place names. Each record in the census data includes identifiers or codes for one or more administrative level units. IPUMS provides data at the first administrative level for all countries, second administrative level for most countries, and most recently at the third administrative level for a few countries. Users of census microdata are limited by the timing of censuses (typically every 5 or 10 years) and by the unit levels identified in the data (typically administrative divisions within the country). Moreover, administrative level boundaries keep changing from one census to another posing a major challenge for researchers who study changes through time. Researchers interested in analyzing the changes in non-monetary wealth over time and across countries, need to hold space constant. With changing boundaries, the concept of constant space also becomes challenging. Until now, little has been done to spatially harmonize units, such that administrative units have a similar spatial footprint across the census years. However, given the rise in digital mapping capabilities and spatial analytical technologies, IPUMS census data collection has created integrated geographical units at the first and second administrative level of geography. The integrated geographical units take into consideration changing geographical boundaries, the temporal aspect of the data from multiple censuses, and the scalar aspect by considering the different administrative levels of geography.

Creating integrated geographical units involves several tedious steps including extensive digital and paper map acquisition; additional correspondences with National Statistical Offices (NSO's) and metadata acquisition from census publications; adequate research such that geographical codes and place names from the census data match digital GIS boundary files; creation of historical digital maps from older censuses using scanned images from census publications as reference maps; creation of small-area building blocks that cover consistent spatial extent over time (harmonization); the testing and implementation of techniques to group spatial units to meet the 20,000 persons threshold (regionalization) for confidentiality purposes; and the creation of GIS shapefiles and variables (Sarkar et al, 2015). All the above-mentioned processes are time consuming and describing each of them in detail is beyond the scope of this study. The GIS boundary files and variables created as the result of the processes described above are used in this study and provide a unique way to look at the living standards index through time using consistent spatial footprints.

2.3. Methods

In this study, the living standards measure is based on dwelling characteristics and human capital. We identified a set of indicators representing non-monetary wealth at the household level that are common across datasets and that can be constructed in a comparable manner. The selection of indicators, as we argue below, draws from global indices such as the MPI and the HDI, but it is also linked to specific goals within the SDG framework. The set of indicators analyzed are: 1) whether the dwelling is owned or rented (security of tenure), 2) access to electricity, 3) access to piped water, 4) improved sanitation (availability of a flush toilet or connection to public sewage), 5) permanent construction materials for the dwelling (finished floor, or cement, brick, or concrete walls or roof), 6) number of persons per room, and 7) years of schooling of the household head. We aggregate these seven indicators into a summary measure representing a household's living standards. This measure is constructed as a linear combination of the indicator variables by applying weights to each of them. Given weights w_i and wealth indicators x_i, the index is defined as:

$$WI = W'X = w_1x_1 + w_2x_2 + \cdots + w_9x_9 \ldots (1)$$

The choice of the specific indicators used in this study is driven by previous research and their importance from a policy perspective, besides data availability. Non-monetary wealth has been typically represented through dwelling characteristics (predominant materials in walls, floor, or roof), access to utilities (water, sewage, or electricity), and ownership of various durable assets (television, radio, etc.) (Filmer and Pritchett, 2001; Filmer and Scott, 2012; Houweling et al., 2003; Montgomery et al., 2000; Sanh and Stifel, 2000; Sanh and Stifel, 2003). The literature examining the relevance of specific indicators is not extensive, but there is evidence of higher relative importance of the water source, type of toilet or sewage, and access to electricity in the construction of such non-monetary measure (Houweling et al., 2003; Lovaton et al., 2021: McKenzie, 2005). Furthermore, the policy relevance of our selected indicators is highlighted by their commonalities with those defined by the UN's SDG framework (goals 1.4, 6.1, 6.2, 6.3, 7.1, 11.1). They also emphasize the concept of "adequate housing" outlined by the UN, particularly the security of tenure, availability of services and infrastructure, and habitability (United Nations, 2009). We prefer indicators that can be identified in a consistent manner across the selected countries and census years, among multiple candidate indicators. Thus, we dropped certain indicators from the analysis, such as the fuel used for cooking or ownership of a telephone, because these were not commonly available across census samples.

We use principal component analysis (PCA) to calculate the weights for this household measure. PCA is a data-reduction technique in which weights depend on the directions of larger data variability. The calculation of PCA used country-specific datasets (including the census rounds available for a country), but will ultimately be based on a pooled dataset including all countries and census rounds. This allowed us to work with the same weights to examine a specific country, and to perform the analysis across countries and census years (similar to Booysen et al, 2008, Sahn and Stifel, 2000). The household living standards index is defined as the first principal component of the data. Given the variance-covariance matrix of the data $\sum$, then PCA derives the weights w_j from the following optimization problem:

$$Max\ VAR(W'X) = W'\sum W\ subject\ to\ W'W = 1 \ldots (2)$$

3. Preliminary results

3.1. Living standards indicators

The indicators were calculated for 51 census samples from 21 countries and using harmonized census microdata from the IPUMS International project. A summary of preliminary results for the living standards indicators is shown in Table 1, including their corresponding coefficients calculated using principal component analysis (PCA). We also show an example for Argentina in Table 2, across the 1990, 2000, and 2010 census rounds. The results show unequal progress in living standards in the developing world. In the case of Argentina, for example, we observe relatively good indicator levels in the most recent census round; with overall improvements over time, particularly in access to piped water besides modest progress for other indicators, with the exception of access to electricity and schooling of the household head that remained almost unchanged.

However, there is significant variability in living standards across countries and time, with the largest needs observed for sanitation, water, and electricity. For instance, even though there are about 90% of households with flush toilets or connection to public sewage in Argentina 2010, we find only 34% in Botswana 2011, 3% in Malawi 2008, 47% in Vietnam 2009, and 13% in Zambia 2010. On average, for the countries included in the analysis, we observe the lowest living standard levels in the Africa region, especially if we are looking at electricity, water, and sanitation. Consistently with their relative variability, indicators 2, 3, and 4 receive the largest coefficients in PCA, while the smallest coefficient is assigned to indicator 1.

Table 1: Summary of living standards indicators across countries and principal component analysis (PCA) coefficients [1/]

Indicator	Africa	America	Asia	*Average across all countries*	*PCA coefficient*
1. Dwelling tenure (%)	83.1	87.1	92.6	*88.6*	*0.060*
2. Electricity (%)	15.8	85.2	70.4	*58.1*	*0.503*
3. Piped water (%)	20.7	76.8	27.9	*48.4*	*0.468*
4. Flush toilet or public sewage (%)	10.0	69.5	43.9	*44.0*	*0.462*
5. Permanent housing materials (%)	53.5	85.6	60.5	*69.8*	*0.422*
6. Persons per room	6.51	3.54	4.42	*4.74*	*-0.277*
7. Schooling of head (years)	7.51	9.86	9.74	*9.01*	*0.236*

Source: Integrated Public Use Microdata Series (IPUMS) International
1/ The summary of preliminary results include the 51 census samples listed in the data section.

Table 2: Argentina 1991-2010, living standards indicators

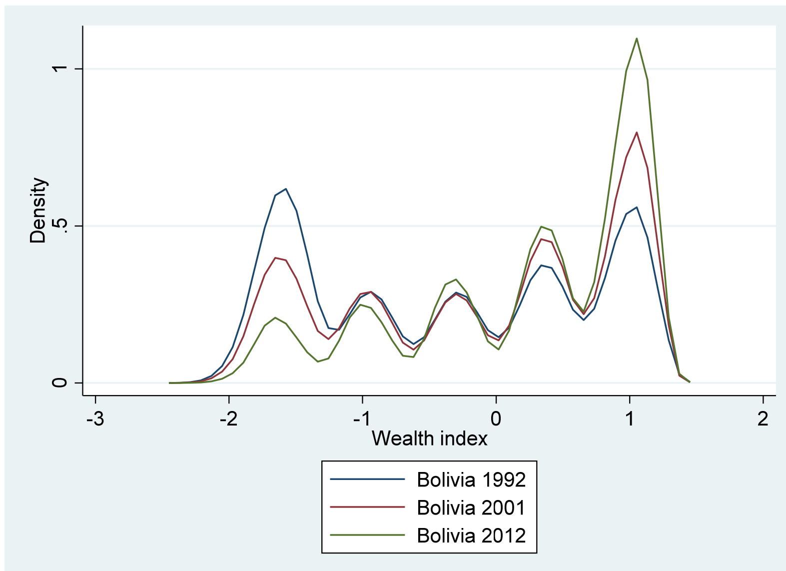
Indicator	Argentina 1991	Argentina 2001	Argentina 2010
1. Dwelling tenure (%)	85.3	86.1	88.2
2. Electricity (%)	94.6	93.0	94.4
3. Piped water (%)	68.3	80.1	97.8
4. Flush toilet or public sewage (%)	84.6	83.1	90.3
5. Permanent housing materials (%)	96.5	97.5	99.0
6. Persons per room	4.30	3.90	3.80
7. Schooling of head (years)	12.26	12.48	12.24

Source: Integrated Public Use Microdata Series (IPUMS) International

The living standards index generally shows improvement over time for all countries under analysis, with significant changes for cases like Bolivia or Indonesia, and particularly for the more recent census rounds. For example, in Bolivia, we observe significant differences between the 1990 and 2010 census rounds: access to electricity increased from 56% to 82%, piped water from 58% to 80%, flush toilet or connection to public sewage from 29% to 48%, and permanent housing materials from 54% to 73%. In Figure 1 below, we show a kernel density estimate for the living standards index distribution for the three Bolivia census samples, where we observe improvements in the scores over time particularly at the tails (where Bolivia 1992 has a higher mass in the left, while the opposite happens for Bolivia 2012).

More generally, we observe improvements over time in all indicators for Latin America and Asia, with smaller changes (if any) for the dwelling tenure and schooling of the household head. Nevertheless, in the case of Africa, changes over time vary by country, and we observe decreasing figures for the schooling of the household head in most countries. That is, we find countries like Botswana where most indicators improved (some significantly) across the three census rounds, while others like Uganda maintained the same levels for indicators such as water or sanitation for over three decades.

Figure 1: Bolivia 1992-2012, kernel density estimates for living standards index



Source: Integrated Public Use Microdata Series (IPUMS) International

The data reveals a few unexpected patterns for some specific indicators. In the case of the Kenya census samples, we found that almost all households own or rent their dwelling. In effect, there may be comparability issues in the data (with respect to other censuses): the 1999 census enumeration documents suggest that "rented" may comprise those dwellings that were provided by an employer (for free), while the 2009 census explicitly includes those that were provided or donated (also for free). Even though both the 1999 and 2009 censuses have a response option for "other forms of tenure" (including "unauthorized dwellings"), there are only a minor proportion of households indicating this option for 2009 and none for 1999. For Colombia, we observe an unexpected decrease over time in the indicators related to the dwelling tenure and piped water. However, changes in the phrasing of questions used to define the indicators may contribute to this behavior; in particular, we observe a decrease in the proportion of households that own or rent their dwelling between the 1990 and 2000 census rounds, when additional response options were introduced, as well as additional questions regarding the rent and mortgage amounts. Similarly, in the case of Zambia, the response options for the type of water supply changed between 1990 and 2000-2010, which may contribute to the differences across these samples: 36% piped water in 1990, with respect to 16% in 2000 and 2010. These issues may reduce the comparability of the living standards indicators across countries and time; that is, even though we are working with harmonized census data, there could always be differences in data collection that should be taken into account when analyzing the data.

3.2. Spatial trends

We spatially visualize our results with maps from all the census rounds available from South America and a couple of countries from Africa and Asia. We used GIS software, Arc View 10.6 to map all our results. Figure 2 (A, B, and C) displays the mean value for the living standards index at the lowest administrative level of geography available for each country. Not every country is represented in all the census rounds[1]. The mean values are sub-divided into three groups: "poor" with values below -0.5, "less poor" with values between -0.5 to 05 and "not poor" with values above 0.5 in the wealth index distribution. A shade of red means that the place is worse off, and a shade of green means the population has a better standard of living. Darkest green signifies the best living standards and subsequently darkest red signifies worst conditions. The map legend used for all the living standard index mapping is similar for effective comparison across countries and across time. Since we hold space constant, it is easy to analyze changes in the standard of living between census years for the different countries.

In the maps below, overall, the northern part of South America seems poorer relative to the southern section including Argentina and part of Brazil. Vietnam and Philippines appear poorer than Indonesia in the Asian region, while the African region in general looks much poorer than countries in Asia or most of South America. In addition, we observe that urban areas display higher values for the living standards index; some examples include the densely populated Bogota area in Colombia, Brasilia, Sao Paulo and Rio de Janeiro in Brazil, Dar es Salaam in Tanzania, Ho Chi Minh City region in Vietnam, and Manila area in Philippines. The overall improvement in living standards over time is evident from the maps and in the three regions of the world that we analyze; some exceptions include Colombia, Zambia and Kenya (discussed in more detail in section 3.1 living standards indicators.)

The SDG indicators along with a goal to end poverty encourage researchers to disaggregate poverty measures at the lowest available geographies, however the lowest level of geography might not be available all the time. First, acquiring the lowest level of geography both in terms of census microdata accessibility and map availability is challenging. If maps and data are available, there is always a balance between spatial harmonization to make units similar through time and the loss in finer detail as administrative units change over time. To preserve confidentiality, IPUMS regionalizes units below 20,000 population to its contiguous unit based on similar population density (Kugler et al, 2017). Also, IPUMS data is sample data and sometimes there are low number of cases in areas that have a lower population.

In Figure 2A(1) in the appendix, we visualize the changes in living standards index over time at the first administrative level of geography. The main goal in showing results at the first administrative level of geography is to portray the fact that a big picture analysis is feasible with disaggregation at the primary level of geography where data and maps at lower level geographies are harder to acquire. In Figure 2A(1), we see shades of green and red, but not the darkest green. Figure 2A shows the same map but it is represented at the second administrative level of geography. The advantages of lower-level disaggregation stand out, as we notice smaller administrative areas where the living standards is better than its neighbors and some darker green areas become prominent that were visually absent in Figure 2A(1).

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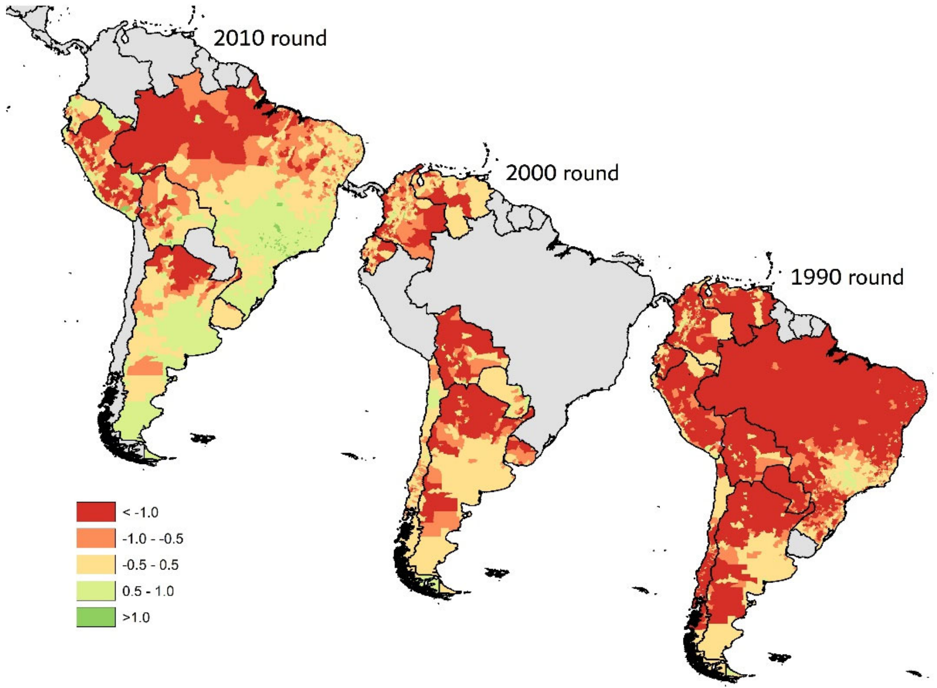
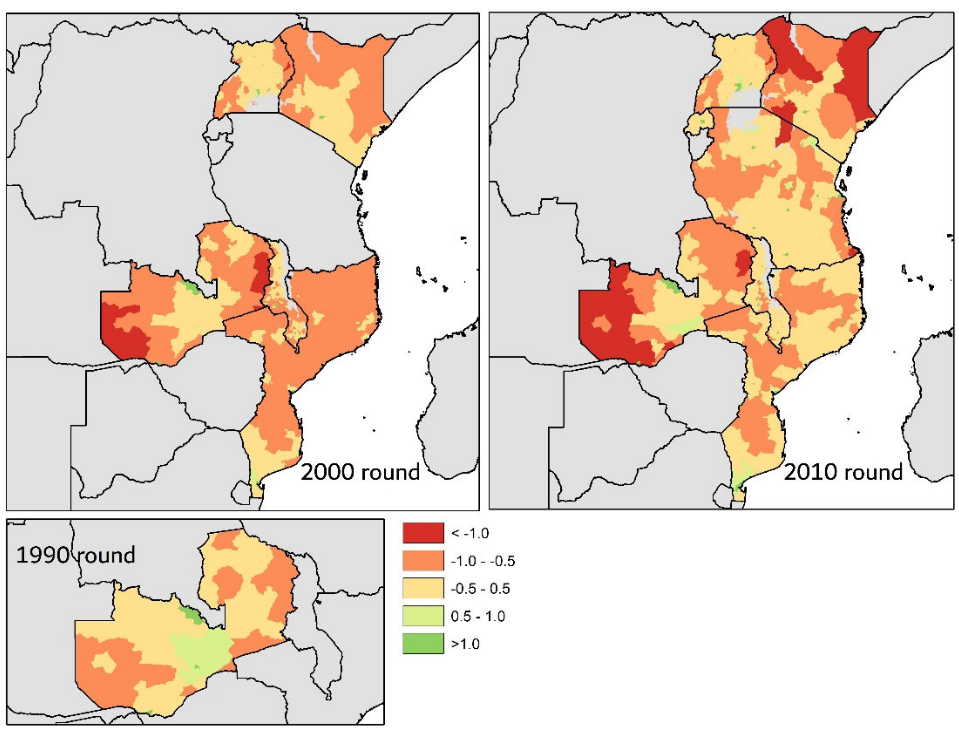
Figure 2: Living standards index in selected countries, from census rounds 1990, 2000, and 2010 at the second administrative level of geography[1/]



2A - Latin America



2B - Africa

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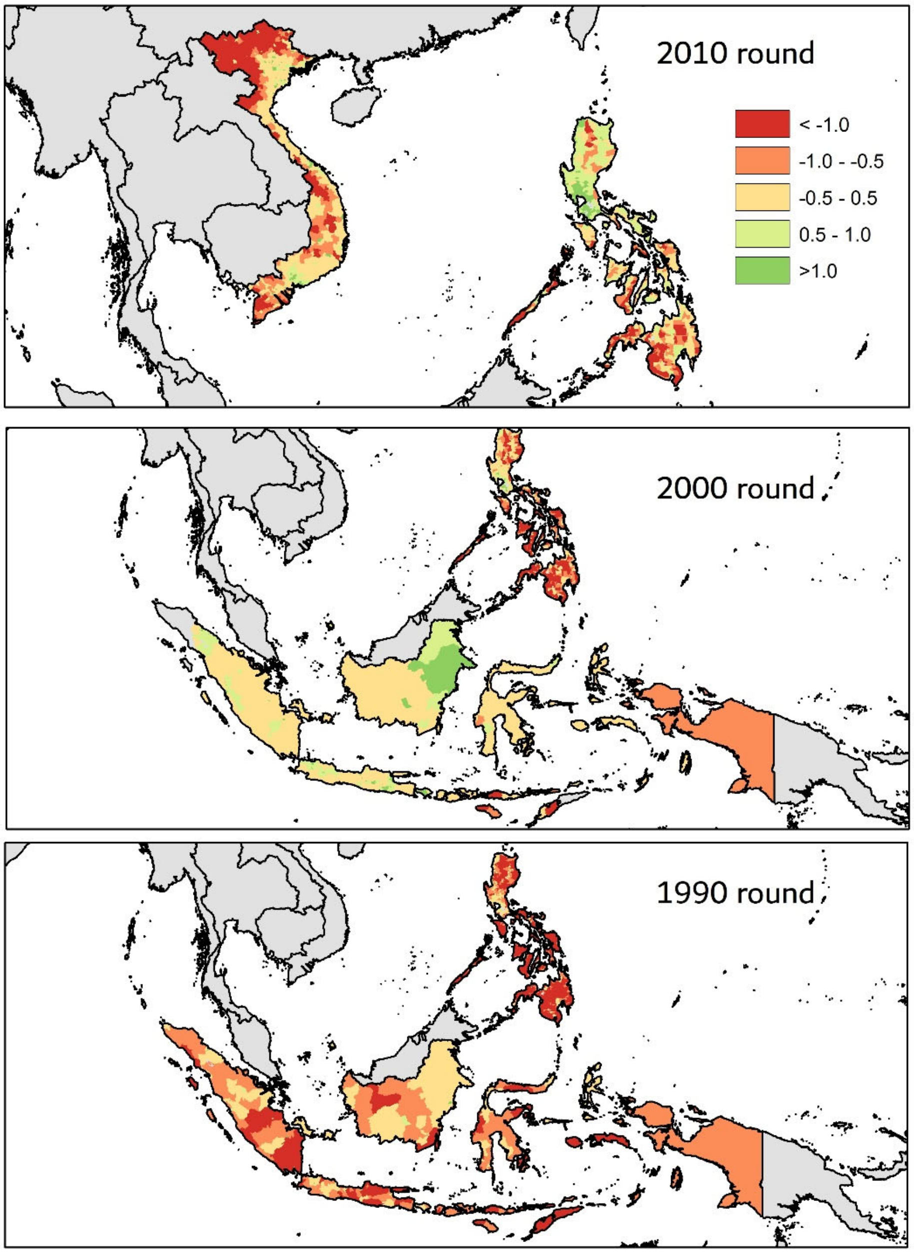

2C - South East Asia

Source: Integrated Public Use Microdata Series (IPUMS) International

1/ The figure includes census samples from 3 different census rounds from each country in the study: Tanzania 2012, Zambia 1990, 2000, 2010, Mozambique 1997, 2007, Uganda, 2014, 2002, Kenya 1999, 2009, and Malawi 1998, 2008 from Africa; Vietnam 2009, Indonesia 1995, 2010, and Philippines 2000, 2010 from Asia; Brazil 1991, 2010, Chile 1992, 2002, Colombia 1993, 2005, Venezuela 1990, 2001, Ecuador 1990, 2001, 2010, Peru 1993, 2007, Uruguay, 2010, Argentina 1991, 2001, 2010, Bolivia 1992, 2001, 2012, and Paraguay 1992, 2002 from Latin America.

3.3. Urban and rural gaps

One of the caveats of studying and analyzing living standards is the dependency on the types of assets that are recorded in censuses and surveys. Some of the assets like electricity, public sewage, piped water is biased towards the urban population thereby making the rural areas look relatively poorer than the urban areas. According to our study, a slum dweller in an urban area might have a better living standard index than a well to do family in the rural areas. Besides this, the definition of rural area versus urban area differs from one country to another and also from one census to another. Venezuela defines urban areas in 2001 as areas with a population of 2,500 or higher, whereas in the earlier censuses, urban areas in Venezuela were areas with 1000 or more inhabitants. Bolivia and Chile on the other hand define urban areas with localities above 2000 inhabitants. In our study, rural-urban population is based on how the country demarcates rural and urban population in the decennial census.

The indicators indeed show gaps between urban and rural populations. Table 3 below presents the average value for urban and rural for each indicator and all countries in the study, also disaggregated by the region of the world and census round. Overall, we observe that the largest gaps exist between urban and rural areas for electricity, water, and sanitation (consistent with previous findings). Furthermore, the urban/rural gaps are the largest for countries in Africa, while they have relatively similar size for Latin America and Asia. We argued before that the living standards index generally shows improvement over time for all countries under analysis. Even though part of the urban/rural gaps are slightly narrowing, we also notice that the gaps persist even in the most recent census round. The gaps in living standards indicators are reflected in the average scores for urban and rural areas, which also suggest that the urban population is consistently better off (Figure A.1 in the appendix).

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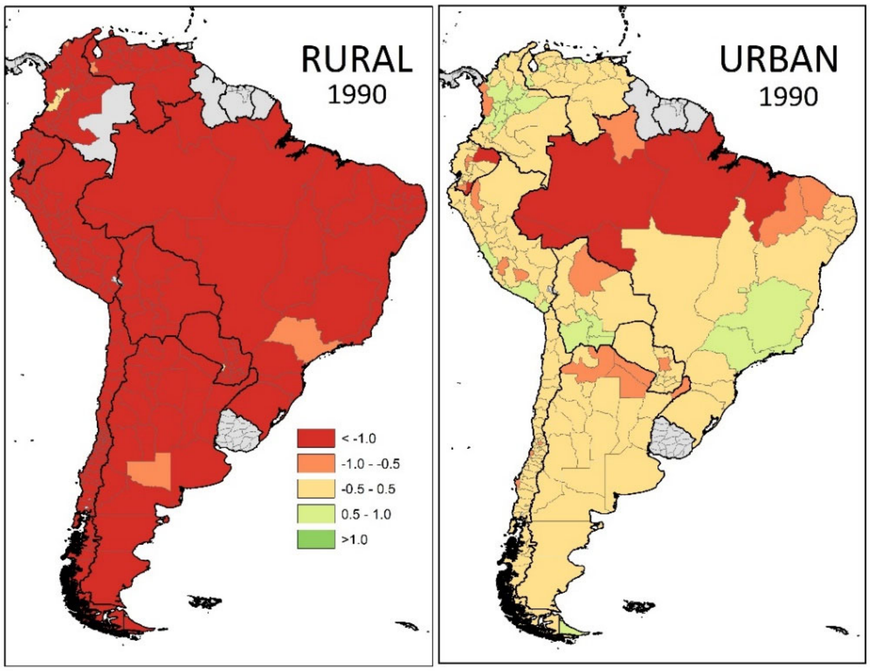
Table 3: Urban versus rural, living standards indicators

Indicator	1. Dwelling tenure (%)	2. Electricity (%)	3. Piped water (%)	4. Flush toilet or public sewage (%)	5. Permanent housing materials (%)	6. Persons per room	7. Schooling of head (years)
Urban	86.7	73.0	63.3	53.7	84.6	4.5	9.7
Rural	83.4	37.3	22.9	17.4	52.7	4.8	7.7
Africa							
Urban	*79.6*	*36.7*	*43.1*	*19.2*	*77.2*	*6.4*	*8.8*
Rural	*81.5*	*3.3*	*5.0*	*1.4*	*36.6*	*6.2*	*6.6*
Latin America							
Urban	*89.7*	*93.8*	*85.3*	*78.1*	*92.1*	*3.4*	*10.2*
Rural	*80.8*	*57.4*	*41.4*	*28.9*	*62.8*	*4.1*	*8.0*
Asia							
Urban	*93.1*	*91.1*	*44.1*	*57.7*	*79.0*	*3.3*	*10.3*
Rural	*95.1*	*52.7*	*8.3*	*18.5*	*58.0*	*3.8*	*9.0*
Round 1990							
Urban	*89.5*	*77.4*	*67.8*	*59.9*	*84.2*	*4.9*	*10.3*
Rural	*83.5*	*31.1*	*19.6*	*16.6*	*51.3*	*5.2*	*8.7*
Round 2000							
Urban	*78.1*	*67.7*	*61.7*	*50.1*	*83.6*	*5.1*	*9.8*
Rural	*76.1*	*39.5*	*24.5*	*18.9*	*53.0*	*5.3*	*7.9*
Round 2010							
Urban	*92.6*	*73.4*	*60.0*	*50.4*	*86.2*	*3.2*	*8.9*
Rural	*91.1*	*42.0*	*24.9*	*16.7*	*54.0*	*3.4*	*6.3*

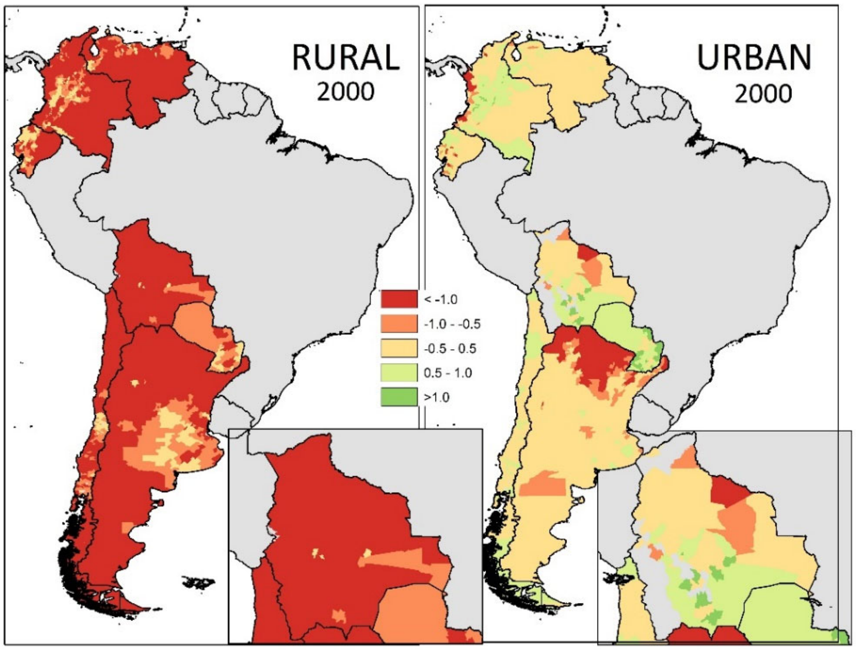
Source: Integrated Public Use Microdata Series (IPUMS) International

To account for differences in assets between the rural and the urban populations, we analyze the living standards index in Latin America at the second administrative level of geography for the rural and the urban areas separately. In Figures 3 A, B, and C we visualize rural versus urban mean asset index over time. If a second level administrative unit is entirely rural, there are no urban units on the map (e.g. south west part of Bolivia). At a glance, the rural areas look a lot worse than the urban population, but as we look at change over time, the scenario seems to improve both for the rural and for the urban areas in Latin America. Again, just like Figures 2A, B, and C, the standard of living is better in or near the capital cities than in areas away from the bigger urban areas. We also calculate the urban to rural difference in living standards index at the first administrative level of geography (Figure 5 in the appendix). What is surprising in the map is that the lowest difference in living standards is not necessarily the urban areas of Maputo (Mozambique), Nairobi (Kenya) or Kampala (Uganda) in the 2000 and 2010 census rounds. It is possible there is a higher percentage of urban slum population in the urban areas making the difference in living standards higher than we expected.

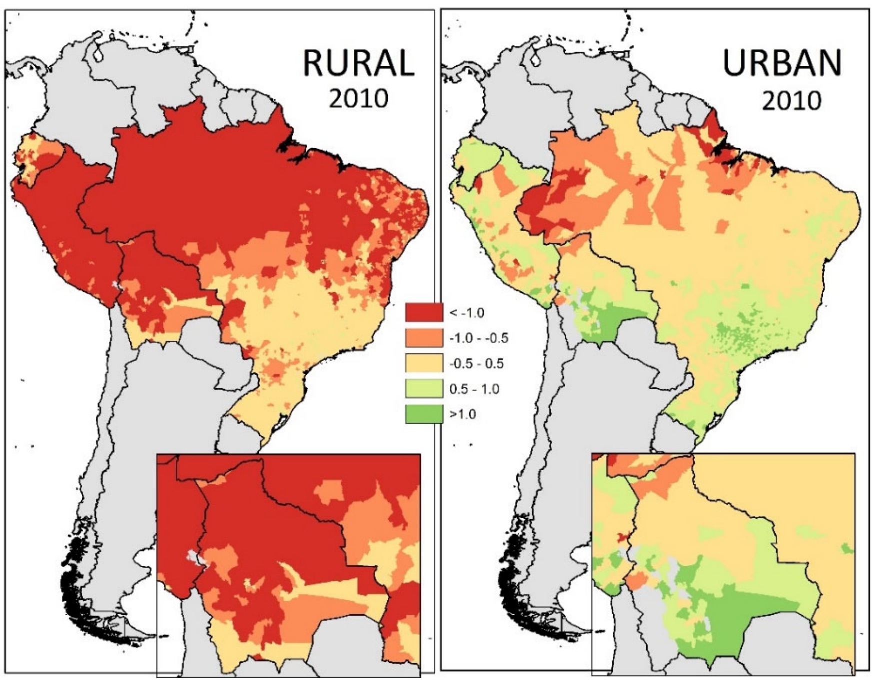
Figure 3: Living standards index disaggregated by urban and rural population in Latin America, from census rounds 1990, 2000, and 2010



3A Latin America, 1990 census round (first administrative level of geography)



3B Latin America, zooming on Bolivia, 2000 census round (second administrative level of geography)



3C Latin America, zooming on Bolivia, 2010 census round (second administrative level of geography)

Source: Integrated Public Use Microdata Series (IPUMS) International

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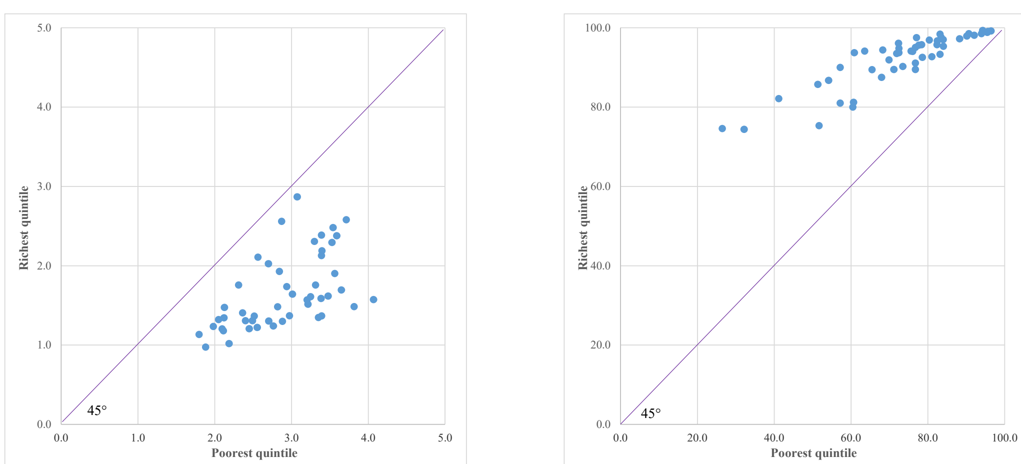
3.4. What living standards...?

In the last part of the analysis, we did some validation checks to verify if the constructed living standards measure could potentially be used to represent relative socioeconomic standing across census samples. We expect certain variables such as school attendance to be sensitive to changes in living standards at the household level. The hypothesis is that if our constructed living standards measure is correlated to household wealth, then we would observe that households with better scores show higher school attendance relative to those with worse scores. In order to test this hypothesis, we examined changes in four outcome variables across household quintiles of the index: school attendance (for children age 6-12), literacy (for persons age 18 or older), children ever born (for females age 15-49), and children surviving (for females age 15-49).

We show below in Figure 4 scatter plots for school attendance and children ever born, representing the average values for the richest and poorest quintiles; while the graphs corresponding to literacy and children surviving are included in the appendix (Figure A.2). Results confirm our hypothesis: we always find more children ever born for the poorest quintile (with respect to the richest), while school attendance is increasing for households with higher living standards scores. The disaggregated results quintile by quintile follow this same pattern, as well as those corresponding to literacy and children surviving. Furthermore, we also include a quick comparison of our living standards measure against GDP per capita in the appendix (Figure A.3), which shows a moderate to high correlation (0.69) between the two measures.

Figure 4: Mean values for selected outcomes,

richest and poorest quintile from living standards index



A) Children ever born (women age 15-49)

B) School attendance (children age 6-12)

Source: Integrated Public Use Microdata Series (IPUMS) International

Finally, we also tested our choice of indicators against additional information available for each census. The hypothesis is that the selected indicators represent a significant proportion of the overall variability of material well-being variables, such as housing characteristics, access to utilities, and ownership of appliances. For this purpose, we constructed census-specific indices using all the information available in each dataset. We followed a procedure analogous to Filmer and Pritchett (2001) to define these indices, creating indicator variables for each response option from categorical variables and then applying principal component analysis (PCA) to these indicators. Our preliminary results include calculations for Bolivia 1992, 2001, 2012, and Mozambique 1997, 2007. Even though the resulting indices are not strictly comparable to our living standards measure (given that they use different input variables producing also different PCA coefficients), we observe a high positive correlation between them (in Table 4.)

Table 4: Census-specific living standards index

	Correlation to living standards index	Input indicators
Bolivia 1992	0.95	60
Bolivia 2001	0.93	61
Bolivia 2012	0.93	82
Mozambique 1997	0.89	44
Mozambique 2007	0.89	63

Source: Integrated Public Use Microdata Series (IPUMS) International

4. Discussion and conclusions

The development of a comparable living standards measure using census microdata from developing countries provides additional insights with respect to monetary measures such as income per capita. In this study, we analyze changes in a living standards index over different census rounds for selected countries. Since we hold space constant, it is easy to analyze changes from one time period to another, between countries and also within countries; in effect, consistent spatial footprints help us analyze changes in living standards in a meaningful way. Preliminary results show overall improvements in living standards for most countries in the study, but progress is uneven between and within countries. Most notably, we observe the largest needs in sanitation, water, and electricity, with the lowest living standard levels for countries located in the Africa region. Furthermore, the indicators suggest a significant gap between urban and rural populations, which persist even for the more recent census round.

We explored the rationale for choosing the specific set of indicators used in the paper, by making comparisons against all the information available in each census (i.e. other "candidate" indicators) and identifying which indicators better represent the overall data variability among living standards variables. We find high correlations between our living standards index (based on selected indicators) and census-specific indices (using all the information available.) Finally, our validation strategy also examines inequalities in selected outcome variables (those that may be influenced by living standards or household wealth) using our living standards index. Indeed, we confirm that outcomes such as children ever born (for females age 15 to 49 years old) or school attendance (for children age 6 to 12 years old) show significant differences along the index distribution.

References

Alkire, S.; Santos, M.E. (2014) Measuring Acute Poverty in the Developing World: Robustness and Scope of the Multidimensional Poverty Index. World Development, Vol. 59, pp. 251-274

Alkire, S., Kanagaratnam, U., and Suppa, N. (2020). The global Multidimensional Poverty Index (MPI) 2020, OPHI MPI Methodological Note 49, Oxford Poverty and Human Development Initiative, University of Oxford.

Bollen, K.; Glanville, J.; & Stecklov, G. (2002). Economic status proxies in studies of fertility in developing countries: Does the measure matter? Population Studies, Vol. 56, No. 1, pp. 81-96.

Booysen, F., Van Der Berg, S., Burger, R., Von Maltitz, M. & Du Rand, G. (2008). Using an asset index to assess trends in poverty in seven sub-Saharan African countries. World Development, Vol. 36, No. 6, pp. 1113-1130.

Filmer, D. & Pritchett, L. (2001). Estimating wealth effects without expenditure data-or tears: An application to educational enrollments in states of India. Demography, Vol. 38, No. 1, pp. 115-132.

Filmer, D.; & Scott, K. (2012). Assessing asset indices. Demography, Vol. 49, No. 1, pp. 359-392.

Houweling, T.; Kunst, A.; & Mackenbach, J. (2003). Measuring health inequality among children in developing countries: does the choice of the indicator of economic status matter? International Journal for Equity and Health, doi: 10.1186/1475-9276-2-8.

Kugler TA, Manson SM, Donato JR. Spatiotemporal aggregation for temporally extensive international microdata. Comput Environ Urban Syst. 2017 May;63:26-37. doi: 10.1016/j.compenvurbsys.2016.07.007.

Lindelow, M. (2006). Sometimes more equal than others: how health inequalities depend on the choice of welfare indicator. Health Economics, Vol. 15, No. 3, pp. 263-279.

Lovaton Davila R., McCarthy A.S., Gondwe D., Kirdruang P., Sharma U. (2021). Water, walls, and bicycles: wealth index composition using census microdata. Journal of Demographic Economics, pp. 1–42. DOI: https://doi.org/10.1017/dem.2020.27

Minnesota Population Center. Integrated Public Use Microdata Series, International: Version 7.3 [dataset]. Minneapolis, MN: IPUMS, 2020. DOI: https://doi.org/10.18128/D020.V7.3

McKenzie, D. (2005). Measuring inequality with asset indicators. Journal of Population Economics, Vol. 18, No. 2, pp. 229-260.

Montgomery, M.; Gragnolati, M.; Burke, K.; & Paredes, E. (2000). Measuring living standards with proxy variables. Demography, Vol. 37, No. 2, pp. 155-174.

Steven Ruggles, Miriam L. King, Deborah Levison, Robert McCaa & Matthew Sobek (2003) IPUMS-International, Historical Methods: A Journal of Quantitative and Interdisciplinary History, 36:2, 60-65, DOI: 10.1080/01615440309601215

Rutstein, S. O.; & Johnson, K. (2004). The DHS wealth index. Maryland: MEASURE DHS, ORC Macro,

DHS Comparative Reports No. 6. Retrieved from http://dhsprogram.com/pubs/pdf/CR6/CR6.pdf

Sagar, Ambuj & Najam, Adil. (1998). The Human Development Index: A Critical Review. Ecological Economics, Vol. 25, No. 3, pp. 249-264.

Sahn, D. & Stifel, D. (2000). Poverty comparisons over time and across countries in Africa. World Development, Vol. 28, No. 12, pp. 2123-2155.

Sahn, D. & Stifel, D. (2003). Urban-rural inequality in living standards in Africa. Journal of African Economies, Vol. 12, No. 3, pp. 564-597.

Sarkar, S., Cleveland, L., Silisyene, M. & Sobek, M. (2015). Harmonized census geography and spatio-temporal analysis: gender equality and empowerment of women in Africa. Paper presented at the Annual Meeting of the Population Association of America, San Diego, CA in April.

Sen A. Inequality Reexamined. Oxford: Clarendon Press; 1992.

United Nations Development Programme (2010). Human Development Report 2010: The Real Wealth of Nations - Pathways to Human Development. New York. http://hdr.undp.org/en/content/human-development-report-2010

United Nations General Assembly (2015). Transforming our world: The 2030 agenda for sustainable development. Retrieved from: http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

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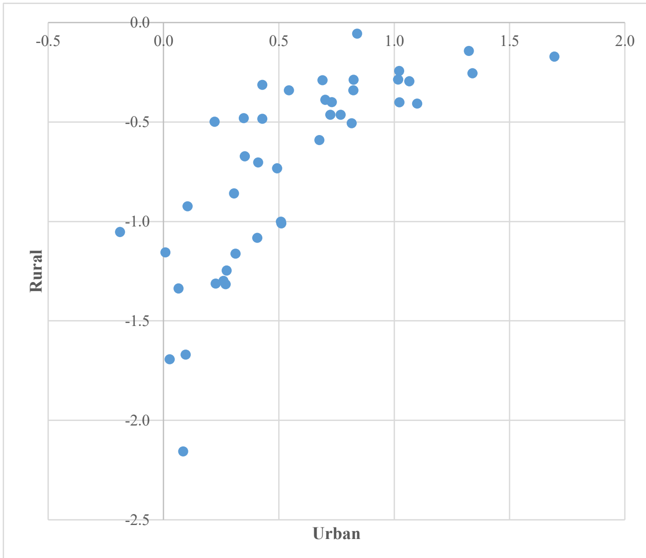
Appendix

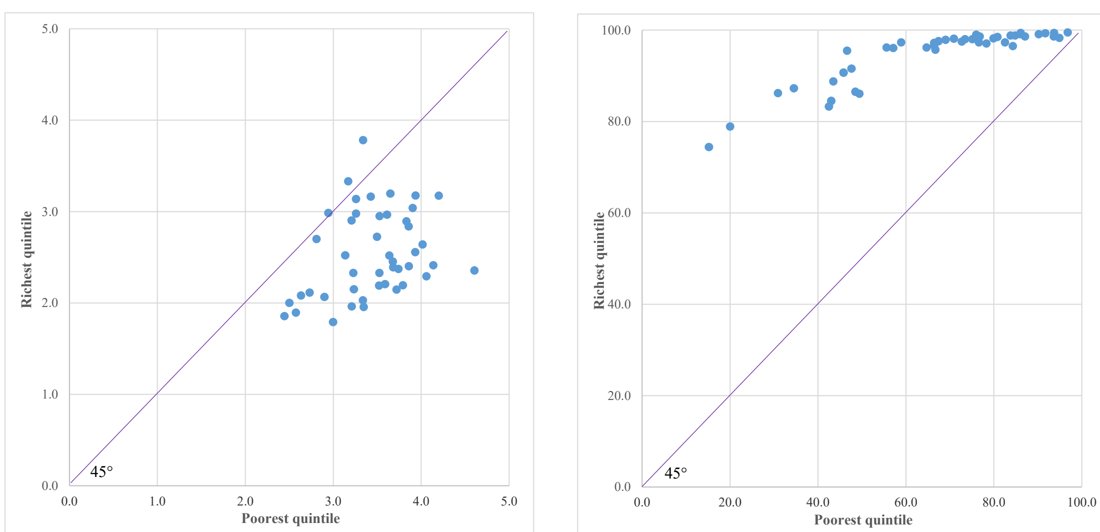
Figure A.1: Living standards index by urban/rural



Source: Integrated Public Use Microdata Series (IPUMS) International

Figure A.2: Mean values for selected outcomes,

richest and poorest quintile from living standards index



A) Children surviving (women age 15-49)

B) Literacy (persons age 18 or more)

Source: Integrated Public Use Microdata Series (IPUMS) International

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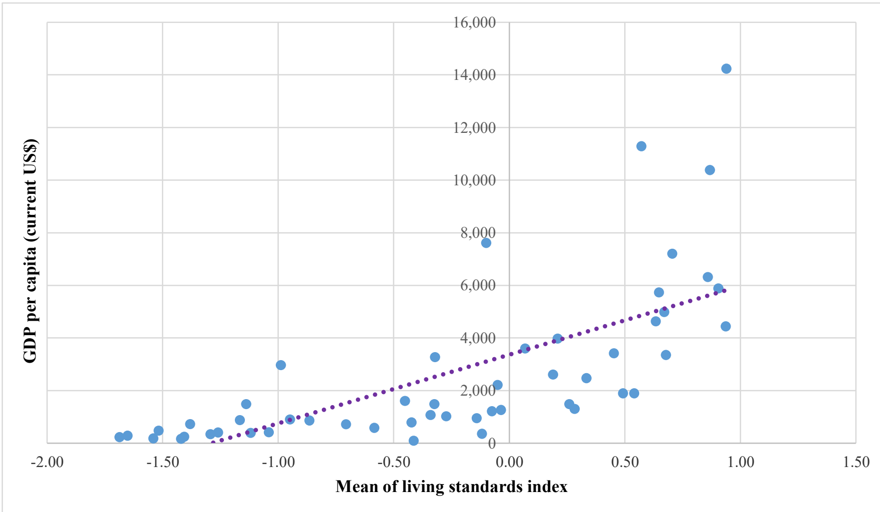
Figure A.3: Living standards index against GDP per capita (in current US$)



Source: Integrated Public Use Microdata Series (IPUMS) International and World Development Indicators

Figure 2A(1) Living standards index in selected countries, from census rounds 1990, 2000, and 2010 at the first administrative level of geography

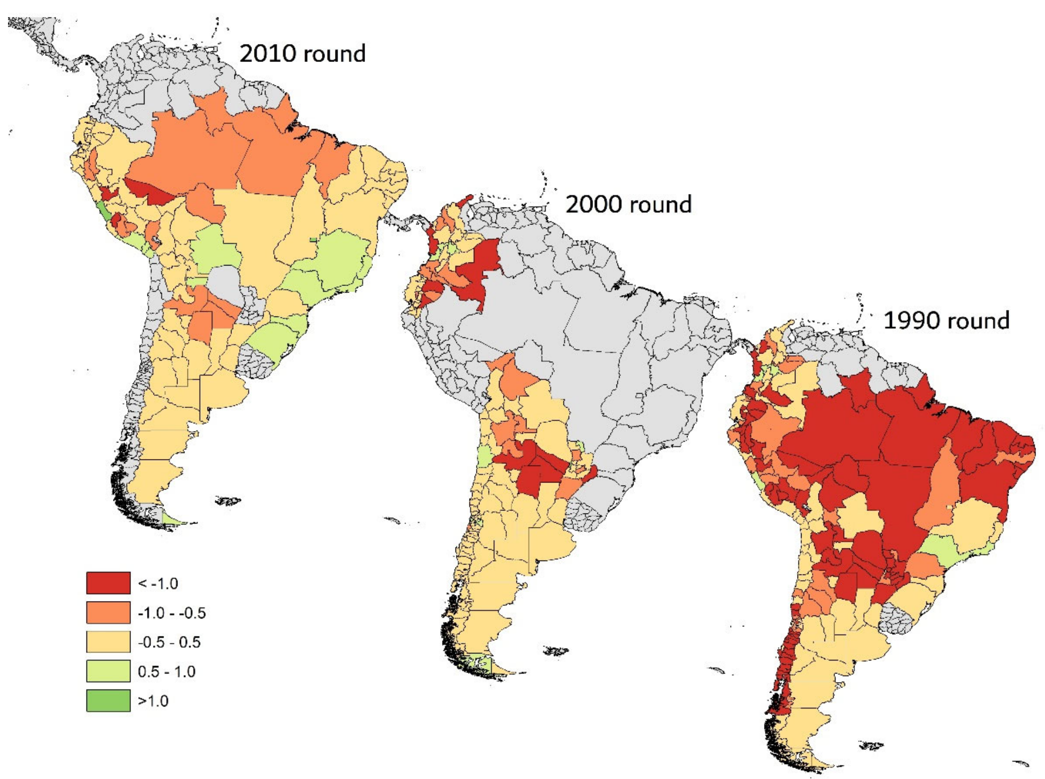


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Figure 5 Difference in urban and rural living standards index in selected African countries, from census rounds 1990, 2000, and 2010 at the first administrative level of geography