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# An anatomy of urbanization in sub-Saharan Africa

Pierre-Philippe Combes<sup>a,\*</sup>, Clément Gorin<sup>b</sup>, Shohei Nakamura<sup>c</sup>, Mark Roberts<sup>d</sup>

<sup>a</sup> Department of Economics, Sciences Po-CNRS, and CEPR, France

<sup>b</sup> Centre d'Économie de la Sorbonne, Université Paris 1 Panthéon-Sorbonne, CNRS, France

<sup>c</sup> Poverty Global Department, World Bank, Australia

<sup>d</sup> Urban, Resilience, and Land Global Department, World Bank, United States

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## ABSTRACT

This paper analyzes urbanization patterns across Sub-Saharan Africa circa 2015 using a dartboard algorithm and high-resolution gridded population data to delineate urban areas and urban cores, cities and their population centers, and towns. Key empirical regularities are presented regarding urban hierarchies and internal city structures. Urbanization rates often exceed official ones and vary considerably across countries from 29.4 % in Gabon to 78.1 % in Kenya. Within countries, delineated areas show great size diversity following Zipf's law, without much urban primacy. Cities' land area increases slightly less proportionally to their population. Monocentric population patterns with declining population density toward peripheries largely dominate, though some large multicentric extended, not necessarily capital, cities exist.

## 1. Introduction

Over the last six decades, Sub-Saharan Africa (SSA) has been the world's fastest urbanizing region. Between 1960 and 2023, the share of its population living in officially classified urban areas increased more than 16-fold from around 33.3 million to almost 542 million, while the share of its population living in such areas climbed from 14.6 to 43.0 percent.<sup>1</sup> This rapid urbanization is, moreover, set to continue in the decades ahead. By 2050, more than 1.26 billion people will live in SSA's cities, more than 2.3 times the number today. Such rapid urbanization carries with it important economic, social, and environmental implications for the development of a region in which about 45 percent of people lived in extreme poverty in 2022.<sup>2</sup>

Despite its rapidity and importance, however, little is known about the detailed anatomy of patterns of urbanization across SSA countries. This neglect reflects both a lack of detailed official data on urban settlements, and, partly also related to this, a relative lack of research

interest among economists in the region's urbanization.<sup>3</sup> Against this backdrop, this paper aims to provide a detailed descriptive analysis, for the year circa 2015, of patterns of urbanization across SSA countries. In doing so, the paper distinguishes two types of urban area – cities and towns. To identify these areas, the paper applies a modified version of the de Bellefon et al. (2021) dartboard algorithm to high-resolution gridded population data. The procedure identifies significant peaks of population density compared with the counterfactual population density under randomness. This allows for a consistent statistical definition of urban areas across all SSA countries, thereby overcoming the measurement problems that arise from relying on official definitions of urban areas, which vary widely across SSA countries (World Bank, 2009; Roberts et al., 2017; Dijkstra et al., 2021). Such a consistent definition also has the advantage, compared to alternative approaches for delineating urban areas, of not relying on ad hoc thresholds.

As part of its analysis, the paper presents evidence on key features of SSA's urban landscape, both across and within urban areas. Looking

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\* Corresponding author.

E-mail addresses: [pierrephilippe.combes@sciencespo.fr](mailto:pierrephilippe.combes@sciencespo.fr) (P.-P. Combes), [clement.gorin@univ-paris1.fr](mailto:clement.gorin@univ-paris1.fr) (C. Gorin), [snakamura2@worldbank.org](mailto:snakamura2@worldbank.org) (S. Nakamura), [mroberts1@worldbank.org](mailto:mroberts1@worldbank.org) (M. Roberts).

<sup>1</sup> The statistics on urbanization cited in this paragraph are based on data from the United Nations' World Urbanization Prospects: 2018 Revision (<https://population.un.org/wup/>).

<sup>2</sup> Extreme poverty is defined based on the global extreme poverty line of \$3.00 a day (2021 Purchasing Power Parity exchange rates). Data on extreme poverty is from the World Bank's World Development Indicators (<https://databank.worldbank.org/source/world-development-indicators>).

<sup>3</sup> Exceptions include several papers by Henderson and various co-authors (Henderson and Turner, 2020; Henderson et al., 2021a, b; Henderson et al., 2021a).

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across urban areas, the paper provides evidence on, inter alia, aggregate differences in levels of urbanization between countries, numbers of urban areas, the share of land they occupy, their population densities, and the structure of urban hierarchies as captured by, for example, Zipf's law, as well as on how these features of urbanization correlate with both a country's population and level of development. Meanwhile, looking within cities, it provides evidence on key empirical regularities such as the number of population (sub-)centers and population and built-up density gradients.

The paper yields several main findings relating to fundamental features of SSA's urbanization process. These include the findings that most SSA countries are already (much) more urbanized than had previously been thought based on official national statistics. On average, across SSA countries, around 75 percent of the population lives in urban areas, compared to the official average urbanization rate of 45 percent. This urban population is distributed between cities (urban areas with at least one very dense core), which account for about 56 percent of a country's population on average, and towns, which make up the remaining urban population. Cities typically have around 40,000 inhabitants and are highly dense, with an average density of about 1000 inhabitants per km<sup>2</sup>—30 times denser than the average for their country. This is probably the concept which is closest to the usual notion of urban settlements. By contrast, towns are smaller units, slightly over 1000 inhabitants on average, with an average population density less than half that of cities, but which, nevertheless, are still almost 10 times denser than the average for their country. Towns represent a grayer form of urbanization that may otherwise be easily overlooked, but the dashboard approach allows for their identification as small areas of population concentration different from purely non-urban areas that have very low and more uniformly distributed population density.

Within SSA cities, more than two-thirds of residents live in dense urban cores, that have an average density of around 4000 inhabitants per km<sup>2</sup> and which collectively host 38 percent of their country's population. Notably, unlike findings from developed countries, urban areas in SSA show an elasticity of built-up area with respect to population that typically exceeds unity, indicating that built-up area more than doubles with population. This pattern suggests horizontal urban sprawl rather than vertical development, possibly due to high vertical development costs stemming from land market inefficiencies and policy constraints. Together, the 47 SSA countries that we study host 16,034 cities, giving an average of 341 cities per country (median 169), while towns usually number in the thousands. A country's largest city typically accounts for about 20 percent of its population, although SSA countries do not appear to suffer from excessive primacy. Both city and town distributions closely follow Zipf's law, with average coefficients slightly above and below one respectively. Finally, the paper provides the full distribution across SSA countries of these statistics as well as their individual values for each country. All data, including code, sources, urban delineations, statistics, and maps for all countries, are available for download from a companion website: <https://sites.google.com/view/anatomy-of-urbanization-in-ssa>.

Our granular data also enables us to document intra-city distributions of population for all SSA countries. Nearly 80 percent of cities on average across countries are characterized by a single population center – i.e., by a single significant peak of population density. A further 12 percent of cities on average have two population centers only. Even in the cases in which a city has multiple population centers, there is a clear domination by one of those centers – the largest center is typically 23 times larger than the second one on average, with negative population and built-up density gradients from this dominant center. These gradients are significantly different from zero in 94 percent of the cities for population and a large share of the within city population variation is explained by the single distance to the main population center. Hence, overall, for SSA, and even if one should assess the relationship between population and employment concentration, the monocentric city model seems to be remarkably relevant. Still, we show that the number of

centers increases with city size. Importantly, a country's capital city generally stands as an outlier, with more (sub-)centers, three in the median country and 8.9 on average across all SSA countries. Also, in a few countries with relatively uniform population densities across parts of their areas, we document the existence of 37 extended urban areas that have land areas of at least 1500 km<sup>2</sup>. These metropolises also tend to encompass a very high number of population sub-centers, up to several hundred in some cases, interconnected by population corridors along roads. Again, even if standing as outliers among SSA cities, these extended urban areas constitute a little documented phenomenon.

Our paper contributes to three interrelated literatures. First, it contributes to a nascent literature that provides new evidence on patterns of urbanization in Africa using satellite data. This includes Henderson et al. (2022), who use data from the European Union's Global Human Settlements built cover data set, *GHS-BUILT*, to examine patterns of settlement growth across SSA between 1975 and 2014. They identify a rapid growth in the number of settlements – from about 47,500 to around 111,500 – with evidence of complementary (competitive) patterns of growth for nearby settlements of different (similar) size. Henderson et al. also empirically reject Gibrat's law, which underpins Zipf's law in Gabaix (1999), finding that built-up area growth has been fastest for the settlements that were initially smallest in 1975.

This nascent literature also includes work by OECD/SWAC which uses data on populations and built-up area extents for urban agglomerations from the *Africapolis* database (see OECD/SWAC, 2020; OECD/UN ECA/AfDB, 2022; OECD et al., 2025). In this database, urban agglomerations are identified as contiguous built-up areas from Google Earth and other satellite imagery, with a population of at least 10,000. Although they focus on a much narrower set of around 9000 settlements than Henderson et al. and their analysis also covers North Africa in addition to SSA, the authors similarly provide evidence of a rapid growth in the number of urban agglomerations since 1950 (see also Heinrigs, 2020). They further document the emergence of larger networks of cities, some of which straddle national boundaries.

Whereas the above studies focus on urbanization dynamics over time, we focus instead on providing a detailed empirical description of the anatomy of SSA's urbanization for a single year – circa 2015. A notable advantage of this is that it allows us to make use of much higher quality gridded population data. In doing so, we avoid relying on built-up area data only, which allows us to capture the intensive margin of urbanization relating to population density. In particular, our analysis relies on high-resolution gridded population data that is derived, in part, from the digitization of building footprints from very high-resolution satellite imagery. Specifically, we use constrained *WorldPop* data for SSA countries as an input into our urban area delineation algorithm. Unlike the more standard unconstrained *WorldPop* data, which allocates population more generally across grid cells, whether built-up or not, based on many spatial covariates of population, the constrained *WorldPop* algorithm restricts the spatial allocation of population from larger administrative units to only built-up grid cells, where built-up area is identified based on building footprints.<sup>4</sup> The building footprints, in turn, come from the Digitize Africa project, which applied Artificial Intelligence techniques to 50 cm resolution satellite imagery for circa 2015 to map all buildings in 51 SSA countries. Because of its

<sup>4</sup> For a more detailed description of the differences between *WorldPop*'s constrained and unconstrained data sets see [https://www.worldpop.org/methods/top\\_down\\_constrained\\_vs\\_unconstrained/](https://www.worldpop.org/methods/top_down_constrained_vs_unconstrained/). In both cases, population is allocated to grid cells using machine learning methods described in Stevens et al. (2015).

precision, this built-up area data is higher resolution than the corresponding 2015 built-up area data from the GHS-BUILT data set used by Henderson et al. (2022).<sup>5</sup> Compared to Henderson et al. (2022) and OECD et al. (2025), focusing on a single time-period also allows us to go deeper into describing patterns of urbanization for that period. This includes providing empirical analysis of the internal spatial structures of cities, a topic about which little is known empirically, especially for SSA.

The second, related, literature to which our paper contributes is that on methods for the more accurate and consistent delineation of urban areas across countries. While there is a strand of the urban economics literature that has long been concerned with the questions of how to rigorously define urban and metropolitan areas (see, for example, Berry, 1960; Fox and Kumar 1965; Berry et al., 1969; Kanemoto and Kurima, 2005; Duranton, 2015) and how to delineate urban areas across countries in a comparable manner (Hall and Hay, 1980; Cheshire and Hay, 1989), the development and large-scale application of algorithms for the more accurate and consistent delineation of urban areas across countries was, for a long time, constrained by both data and computing costs. However, with greater availability of increasingly high-resolution and low-cost satellite imagery, improvements in remote sensing techniques for extracting useful data from satellite images, and declining computational costs for applying algorithms to those data at regional and global scales, there has been an upsurge of research interest in urban delineation. This has led to the development and application of several new algorithms for the more accurate and consistent delineation of urban areas across countries (see, inter alia, Uchida and Nelson, 2009; Dijkstra and Poelman, 2014; Zhou et al., 2015; Ch et al., 2021; Dingel et al., 2021; Dijkstra et al., 2021).

One shortcoming of most of these algorithms, however, is that they rely on one or more, arbitrary, thresholds to delineate an urban area. For example, the widely used degree of urbanization approach (Dijkstra and Poelman, 2014; Dijkstra et al., 2021) relies on two such thresholds to identify urban settlements – namely, an overall population threshold for the settlement and a population density threshold for each 1 km<sup>2</sup> population grid cell that belongs to it.<sup>6</sup> Similarly, approaches that use nighttime lights data to delineate urban areas typically rely on an arbitrary threshold of nighttime light intensity (see, for example, Dingel et al., 2021; Zhou et al., 2015). The use of common thresholds, however, means that the resultant delineated urban areas reflect a mix of both a country's general population density (to which average light intensity also tends to be strongly positively correlated) and its degree of spatial concentration. For example, consider two countries with the same land area (or the same country at two different points in time) that have an identical spatial distribution of population. If the second country (or the later date) has a higher total population, applying a fixed population density threshold will result in a larger share of land being classified as urban, even though the degree of spatial concentration remains unchanged.

<sup>5</sup> In the GHS-BUILT data set, the quality of the satellite imagery used to derive built-up area is also likely to be lower for earlier years which introduces an additional source of measurement error for any dynamic analysis of SSA's urbanization process. Similar considerations apply to the OECD/SWAC's (2020) dynamic analysis of urbanization patterns in Africa based on Africapolis data.

<sup>6</sup> The degree of urbanization uses a variety of such thresholds to distinguish different types of urban area. In "level 1" of the approach, a distinction is drawn between urban clusters ("towns and suburbs") that satisfy an overall population threshold of 5000 and a population density threshold of 300 people per km<sup>2</sup>, and urban centers ("cities") that satisfy thresholds of 50,000 people and 1500 people per km<sup>2</sup> for overall population and population density respectively (Dijkstra et al., 2021). As mentioned above, the Africapolis data utilized by OECD/SWAC (2020) and OECD et al. (2025) uses a population threshold of 10,000 to identify urban areas.

In the extreme hypothetical case where a country's spatial population distribution remains completely uniform over time, a marginal increase in total population that pushes average population density from just below to just above a fixed threshold would cause its urban population share to jump abruptly from zero to 100 percent. Hence, a country which has no spatial concentration of its population can go from being classified as entirely rural to entirely urban, or *vice versa*, based on a small change in its total population. Similarly, two countries of the same size with identical uniform population distributions could be classified either as fully rural or fully urban, based on a small difference in total population. To the extent that one regards the defining characteristic of urbanization within a country to be the degree of spatial concentration of its population, then methods that conflate this with general population density are unsatisfactory.

To overcome this limitation, we apply a slightly modified version of the de Bellefon et al. (2021) dartboard algorithm that draws its inspiration from the dartboard approach to measuring spatial concentration proposed by Duranton et al., 2005, which also inspired the identification strategy for prime locations by Ahlfeldt et al., 2025. These approaches are based on the intuition that areas of spatial concentration must be in the tail of a counterfactual density (of firms, employment, population, built-up, nighttime light, ...) distribution under spatial randomness. As these algorithms ground the identification of spatial concentration in a statistical approach, they avoid the need for arbitrary, and often globally uniform, density thresholds. This enables the de Bellefon et al. (2021) approach to provide a much cleaner measure of urbanization, understood as the degree of spatial concentration of a country's population. In essence, the algorithm identifies urban areas as statistically significant peaks of population density. This is achieved by comparing the observed spatial distribution of population density with the counterfactual spatial distributions that would arise if the population were instead randomly distributed across a country's potentially inhabitable area. Urban cells are those where the observed population density is above the 95th percentile of the counterfactual distribution under randomness.

Whereas de Bellefon et al. (2021) originally applied their algorithm to France using data on building footprints as input, we instead apply the algorithm on a much larger spatial scale – i.e., to all SSA countries – using constrained *WorldPop* population data at a 250m×250m resolution as input. We also modify the algorithm to exclude deserts from the definition of a country's potentially inhabitable area, adding to the original algorithm's exclusion of water bodies and both areas at extreme elevations and which have extreme slopes. This exclusion of deserts is important for SSA countries such as Mauritania, Niger, Mali, and Chad, where deserts cover more than 50 percent of their land areas. Not excluding deserts would mechanically decrease the counterfactual density and make these countries appear more urbanized overall than they really are, i.e. when people do not really have the possibility to establish permanent settlements in the desert. Our exclusion of deserts, and, more generally, of uninhabitable areas, also distinguishes our application of the dartboard algorithm from the simpler version used by Henderson et al. (2022) in which they impose thresholds that are fixed over time in their analysis of SSA urbanization dynamics, beyond the fact they focus on built-up settlements rather than population.<sup>7</sup>

Another key advantage of the dartboard algorithm is that the counterfactual density threshold to be considered significantly urban is specific to each cell and, most importantly, defined relative to a country's own overall density. Therefore, our approach provides a more accurate

<sup>7</sup> Given that built-up area has generally expanded over time, this mechanically increases the number of settlements that Henderson et al. (2022) identify over time, even if the distribution of the new settlements would have matched anterior ones. The full dartboard approach would have allowed for an assessment relative to each year's overall development.

identification of urban areas than alternative methods. This is particularly relevant for very densely or sparsely populated countries, which would be classified as very highly urbanized or largely unurbanized under a common thresholds approach, partly irrespective of their levels of spatial concentration.<sup>8</sup>

The third, and final, literature to which our paper contributes is the descriptive literature on the structures of both urban systems and the internal structures of urban areas. This includes the extensive literature on Zipf's law – see, among many others, Gabaix (1999), Eeckhout (2004), Dobkins and Ioannides (2001), Black and Henderson (2003), Duranton (2007), Desmet and Rappaport (2017), Bosker and Buringh (2017), de Bellefon et al. (2021), Düben and Krause, 2022, and Henderson et al. (2022). It also includes papers which estimate population density gradients for cities and/or empirically analyze the number of (sub-)centers or “prime locations” that any given urban area has (see McDonald 1987; Giuliano and Small 1991; McMillen 2001; Zhou et al. 2015; Ellis and Roberts 2016; Goswami and Lall 2016; Roberts 2018; De Bellefon et al., 2021; Liotta et al., 2022; Ahlfeldt et al., 2025). Importantly, the spatial distributions of population and employment within a city, even if directly related to one another in any urban economics model, do not, in reality, match one-to-one. Different papers tend to study one or the other. In our case, we focus on population concentration, mostly because spatially fine-grained employment data is not available for most SSA countries. As a result, and beyond using advanced data and methods, we provide a global picture of spatial population patterns for the whole of SSA that is consistent both between countries and between the macro (i.e., between city) and micro (i.e., within city) geographical scales.

The structure of the rest of the paper is as follows. Section 2 describes the data and methodology – i.e., the modified dartboard algorithm – that we apply to delineate urban areas across SSA. Section 3 presents analysis of overall urbanization patterns across SSA countries, which includes analysis of Zipf's law. Section 4 examines how these patterns correlate with both a country's population size and level of development. Section 5 zooms in to provide an overview of patterns relating to the internal structures of cities. Section 6 briefly compares our results to those from the alternative application of the degree of urbanization approach to delineating urban areas. Section 7 concludes.

## 2. Methodology and data

### 2.1. Dartboard algorithm

Our application of the de Bellefon et al. (2021) dartboard algorithm proceeds in four steps. In the first step, a country's gridded population data at 250m×250m resolution is (slightly) smoothed using a bi-square kernel with a bandwidth of 10 grid cells, equivalent to a radius of 1.25 km.<sup>9</sup> In the second step, 5000 random reshuffles of the country's (smoothed) populated grid cells are performed across the subset of grid

cells considered potentially habitable. This gives a counterfactual population density distribution for the country under the assumption of randomness. In the third step, the country's observed (smoothed) population density is compared to its counterfactual density, and grid cells with values above the 95th percentile of the counterfactual distribution are classified as urban. While the 95th percentile may be considered an arbitrary choice, it is, nevertheless, less arbitrary than the choices of population (density) thresholds that characterize other approaches to delineating urban areas. This is because of the universality of the 5 percent level as a criterion for statistical significance. Finally, in the fourth step, contiguous sets of urban cells are delineated as urban areas.<sup>10</sup>

While the above four steps allow us to identify and delineate a country's urban areas, they do not distinguish between different types of urban areas. We therefore proceed, again for each country, to perform a second random reshuffling of all grid cells that belong to urban areas to generate a counterfactual population density distribution within those areas. Contiguous urban area cells with a population above the 95th percentile of this second counterfactual distribution are classified as “urban cores”, and represent areas of very high density, or high density at the second order. Urban areas containing one or more cores are classified as “cities”, while those lacking a core are labelled as “towns.”

In applying the above methodology, we follow de Bellefon et al. (2021) in defining cells as potentially habitable if they: (i) do not intersect with a water body; (ii) are not at high altitude, defined here as below the 99th percentile of altitude among inhabited cells; and (iii) are not on very steep slopes, defined similarly using the 99th percentile of slope steepness among inhabited cells. We also define as uninhabitable grid cells which intersect with a desert. This last criterion is applied to the 14 SSA countries in our sample – Botswana, Cabo Verde, Chad, Eritrea, Eswatini, Ethiopia, Kenya, Mali, Mauritania, Mozambique, Namibia, Niger, Somalia, and South Africa – where desert covers more than 0.5 percent of their land area.

### 2.2. Data

The main input to the dartboard algorithm is the constrained *WorldPop* gridded population data (UN adjusted version) from the University of Southampton's *WorldPop* group for the year 2015. This data has an underlying resolution of approximately 100m×100m, but to avoid excessive compute times and ensure compatibility with other spatial layers that we use to classify cells as potentially habitable, we aggregate the data into 250m×250m grid cells. As with other “top down” gridded population data sets, the constrained *WorldPop* algorithm generates a grid by distributing census-based population counts from larger sub-national administrative units across the cells within each unit. In the case of constrained *WorldPop*, population is distributed

<sup>8</sup> A drawback of the dartboard method is that it is applied to a given area, in our case each of the SSA countries. Thus, cities that straddle a border, such as Brazzaville and Kinshasa which straddle the border between the Democratic Republic of Congo and the Republic of the Congo, have each of their parts belonging to different countries defined based on different counterfactual densities. This could be resolved by applying the method to the ensemble consisting of both countries. We could moreover apply the method to the entirety of SSA, which would however give a different picture from that produced in this article, since it would correspond to a notion of spatial concentration relative to this aggregated economy and not to each of the individual countries.

<sup>9</sup> This is a slight smoothing, also because weights decline by a factor of 20 over the 1.25 km range. The purpose is only to remove a few artificial peaks or zeros due to either measurement errors in the data or isolated specific cells such as large boulevards or cross-roads. The robustness of results to the choice of the bandwidth is studied in de Bellefon et al. (2021) for France and we also assessed it for SSA: no quantitatively large difference emerges in either case.

<sup>10</sup> Contiguity is defined as Queen's contiguity (cells share common sides or corners). Two urban cells are also identified as belonging to the same urban area when they are separated by no more than one non-urban cell or by no more than two non-urban cells when one of those cells is uninhabitable. This allows for the filling of small “holes” within urban areas that may remain even after smoothing because of, for example, roads or small green areas or small uninhabitable areas such as water bodies.

unevenly across cells within a given admin unit based on weights derived from a random forest model (Stevens et al., 2015), allocating population only to built-up cells.<sup>11</sup> This built-up classification is based on the extremely detailed building footprints for SSA produced under the Gates Foundation sponsored Digitize Africa project.<sup>12</sup> The quality and resolution of this building footprint data is comparable to, if not better than, the building footprint data that de Bellefon et al. (2021) use for France in their original application of the dartboard algorithm.

The spatial data used to define a country's potentially habitable areas come from two sources. Water bodies and deserts are identified from the European Space Agency's GlobCover product (Bontemps et al., 2013), while elevation and slope data are derived from SRTM30, a near-global digital elevation model (DEM) that combines data from the Space Shuttle Radar Topography Mission flown in February 2000 and the U.S. Geological Survey's GTOPO30 dataset.<sup>13</sup>

### 3. Descriptive analysis of overall urbanization patterns

We start with a description of overall patterns of urbanization in SSA. In doing so, we seek to answer basic and fundamental questions such as how urbanized are SSA countries? Although it may seem that the answer to this question is already well-known given official data on urban area populations, this official data relies on definitions of urban areas that vary widely across countries and which, moreover, often fail to reflect patterns of urbanization on the ground (World Bank, 2009; Roberts et al., 2017; Dijkstra et al., 2021). As a result, prevailing policy narratives of urbanization in SSA – such as the idea that SSA countries are urbanizing rapidly from a low base and in a way that they are not prepared for – are based on potentially misleading data, which, in turn, may imply misguided policy prescriptions.

In this section, we also analyze how population is distributed between cities and towns and describe fundamental differences in the characteristics of these urban areas, and their spatial concentration across SSA countries. Beyond simply counting urban settlements and comparing their size, we estimate two fundamental relationships: first, the elasticity of an urban area's total and built-up areas with respect to its population, shaped by factors such as local land use regulation; and second, Zipf's law, which measures the degree of size inequality among urban areas. Although these foundational relationships have been extensively researched and reliably estimated for developed countries, they remain understudied in SSA countries, and more broadly for developing countries. Establishing whether SSA countries follow similar patterns as developed countries is important to assessing how insights from urban economics in developed countries translate to SSA countries.

#### 3.1. Aggregate differences across countries

Before commenting on urbanization characteristics across SSA countries, it is worth noting that these countries vary considerably in population, area, and overall average population density (Fig. 1).<sup>14</sup> The

<sup>11</sup> The random forest model uses spatial covariates including land use classes, nighttime lights, climate variables (temperature/precipitation), slope, distance to roads/rivers, water bodies, protected areas, OpenStreetMap attributes, and infrastructure (health facilities/schools) to derive distribution weights. While similar covariates are used across countries, the model is estimated separately for each country, resulting in different weights. Stevens et al. (2015) validate their methodology by comparing population counts against census data and other gridded population products. For details, see Stevens et al. (2015) and the WorldPop website (<https://www.worldpop.org/>).

<sup>12</sup> See <https://ui.adsabs.harvard.edu/abs/2019AGUFMIN11D0688H/abstract>

<sup>13</sup> See [https://icesat.gsfc.nasa.gov/icesat/tools/SRTM30\\_Documentation.html](https://icesat.gsfc.nasa.gov/icesat/tools/SRTM30_Documentation.html) for more information.

<sup>14</sup> More exhaustive summary statistics for the variables described in Figs. 1–2 are provided in annex 1, table A1.

population at the 90th percentile of the distribution across countries (51.5 million) is 46.8 times that at the 10th percentile (1.1 million), while the corresponding ratios for land area and population density are 273.5 and 22.4 respectively. The particularly large variation in area reflects the presence of both geographically large countries such as the Democratic Republic of Congo (DRC), Sudan and Chad, and tiny island nations such as Comoros, São Tomé and Príncipe, and Seychelles.<sup>15</sup>

Turning to the urbanization patterns derived from the dartboard approach, Fig. 2 presents statistics for four types of urban area.<sup>16</sup> **Urban areas** refer to all areas identified as urban (i.e., all areas which consist of contiguous sets of cells with population above the 95 percentile of the counterfactual distribution); **Cores** refer to contiguous sets of cells with population above the 95 percentile of the counterfactual distribution within urban areas; **Cities** refer to all urban areas that contain at least one core; while **Towns** are urban areas without a core. In this classification, cities represent a stricter definition, maybe closer to common perceptions, of urban areas, which exclude grayer areas of urbanization (i.e., towns), while cores denote the highest-density urban places. Comparing panels (a) and (b) of Fig. 2, countries are, on average, much more urbanized than official statistics suggest – across the 47 SSA countries, the mean (median) urban dartboard share of the population is 75.1 percent (76.1 percent), around 30 percentage points higher than the corresponding shares based on official data. Even when considering cities alone, SSA countries appear more urbanized than official statistics suggest. On average, around 56 percent of a SSA country's population lives in cities (panel e), compared to 44 percent based on official definitions. On average across countries, most people in cities live in core areas, with a mean share of the national population in cores of 39.1 percent (panel k). In contrast, urban areas occupy a tiny share of a country's total area: the mean (median) share is 5.9 percent (4.8 percent) for all urban areas, 3.4 percent (2.3 percent) for cities and even less for towns. Only a few countries have shares slightly above 10 percent (panels c, f and i). Panels (d), (g), (j) and (m) of Fig. 2 present the distribution of average population density across the 47 countries for urban areas, cities, towns, and cores, respectively. In all cases, density is normalized using each country's overall average population density. For each country, these panels therefore show, how many times denser each type of area is compared to the national average population density. As expected, this factor exceeds unity for all countries, regardless of the type of urban area. The mean (median) ratio of average urban to national population density is 19.9 (13.2). This factor is around twice as large for cities and half as large for towns.

Around the higher than official average levels of urbanization, however, there is also considerable variation across countries – compare, for example, urban population shares at the 90th and 10th percentiles (i.e., the five largest and five lowest values). For urban areas, population shares range from 61.0 percent at the 10th percentile to 88.6 percent at the 90th percentile (Fig. 2, panel b). If we focus just on cities, the range is even larger – from 41.0 percent to 73.8 percent (panel e). This variation, which is also mirrored in the variation in the share of a country's land area that its urban areas and cities occupy (see panels c and f), reflects differences in the spatial concentration of a country's own population or, to put it another way, the unevenness of the spatial distribution of its population.

Population densities of different types of urban areas also vary

<sup>15</sup> Under a common global thresholds approach to defining urban areas, such as the degree of urbanization or a nighttime lights thresholding approach, the large variation in average population density translates, almost mechanically, into large variation in levels of urbanization across countries. However, these variations in average density will have no *mechanical* effect on urban shares of the population as calculated using the dartboard approach. Section 4 examines the correlation between the share of a country's population that lives in cities, and its population density and area.

<sup>16</sup> Annex 2, table A3 lists key urbanization statistics for individual countries.

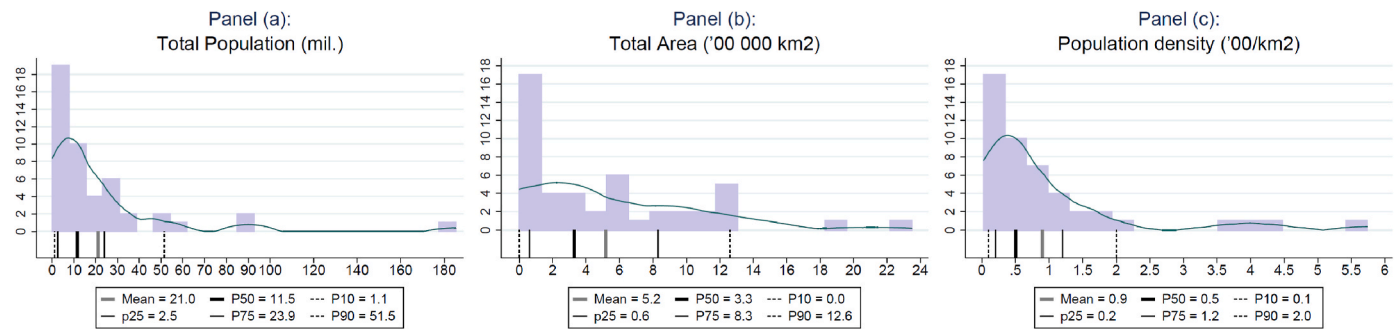


**Fig. 1.** Distributions of population, area, and density across 47 SSA countries

**Notes:** Each panel represents the distribution across SSA countries of the variable indicated in the panel's title, which also provides the units for the horizontal axis. The vertical axis is the number of countries. The mean, median, first and third quartiles, first and last deciles of the distribution are reported in the legend and represented by vertical bars of different thickness and style below the chart. Corresponding summary statistics can be found in annex 1, [table A1](#). Values for individual countries are provided in annex 2, [table A3](#).

widely across countries. For urban areas, average density, relative to the overall country, ranges from 5.3 at the 10th percentile of the distribution across countries to 40.2 at the 90th percentile ([Fig. 2](#), panel d). The corresponding inter-decile range for cities is even larger – from 5.9 to 77.4 (panel g), while for towns it is smaller – from 3.9 to 18.2 (panel j). Cores correspond to places of very high population density. The average population density in urban cores is 123.5 times higher than in the overall country on average (median at 72.1) (panel m). This compares to cities, for which the average (median) density is “only” 35.8 (24.0) times that for the country overall (panel g). By construction, urban cores host a smaller share of national population than cities (39.1 percent on average) (panel k).

### 3.2. Differences across countries in characteristics of cities and towns and their spatial concentration

Having described *aggregate* differences in basic urbanization characteristics across countries, for a deeper understanding of the differences in urbanization patterns across countries we now turn to a description of the numbers and characteristics of cities and towns ([Fig. 3](#)). Panel (a) shows that the mean (median) city population across countries is 46,600 (38,200), while panel (d) shows that of a town is 1300 (1000).<sup>17</sup> The corresponding mean (median) areas of cities and towns are 41.3 km<sup>2</sup> (30.9 km<sup>2</sup>) and 2.6 km<sup>2</sup> (2.5 km<sup>2</sup>) respectively (compare panels b and e). Unsurprisingly, cities tend to be much more densely populated than towns – the median city density is 870 people per km<sup>2</sup>, more than twice that for towns (410 people per km<sup>2</sup>) (panels c and f). On average, countries also have many more towns than cities – the mean number of cities per country (342.1) is less than one-tenth the mean number of towns (3,800) (compare panels g and j). The fact that we detect so many small towns partly reflects the fact that, unlike many other approaches, the dartboard approach imposes no minimum population threshold in defining urban areas. Hence, at the bottom end of the population and area distributions, towns, while still representing significant peaks of population density, can be very small. At the 10th percentile, the average town population is just 400 people (panel d), while the average area is 1.7 km<sup>2</sup> (panel e). This is consistent with towns representing a grayer form of urbanization than cities. For both cities and towns, the mean number of units per country and the mean population are noticeably larger than the corresponding medians, implying positively skewed distributions.

A closer comparison between two countries with similar total land

area but otherwise contrasting characteristics, Rwanda and Lesotho, helps us further illustrate some of the previous findings and the richness of the conclusions one can reach. Lesotho has a much lower overall population density and a particularly uneven spatial distribution of population, while Rwanda is denser with a much more even distribution ([Fig. 4](#), panel a). Applying a common threshold, the degree of urbanization approach implies that Rwanda is far more urbanized than Lesotho, with 2015 urban population shares of 82.5 percent and 26.0 percent, respectively.<sup>18</sup> However, given the relative threshold that it applies, the dartboard approach paints a very different picture. For this approach, Lesotho's uneven spatial distribution of population translates into a much higher urban share of the population once its low density is accounted for, with 50.8 percent of the population living in cities, while only 34.1 percent of Rwanda's population is classified as living in cities. Hence, according to the dartboard approach, Rwanda is around 33 percent *less* urban than Lesotho, contrasting with the degree of urbanization approach, which suggest that it is 3 times *more* urban.<sup>19</sup>

Panel (b) of [Fig. 4](#) shows the extents of the cities and towns, as delineated by the dartboard approach, in the two countries. Despite Lesotho's much lower overall population density (9.1 versus 442.0 people per km<sup>2</sup>), its stronger level of spatial concentration leads to fewer cities (37 against 65 respectively) and their average population is only around three times smaller (25,832 against 60,289). This implies that, relative to the country overall, urban population density is far higher in Lesotho than in Rwanda (7.9 and 4.0 times overall average population density for cities respectively). This uneven population distribution makes Lesotho's cities also cover a smaller share of the territory, despite the fact that the share of population living in cities in Lesotho is twice that in Rwanda. Hence, cities occupy 6.4 percent of Lesotho's land area, while they occupy 8.6 percent of Rwanda's land area. This is visible in the maps in panel (b) which show that Lesotho's cities and cores are

<sup>17</sup> To calculate these values, we: (i) calculate the mean population for cities and towns for each country; and then: (ii) calculate the corresponding mean (median) values across countries. Summary statistics for areas and population densities are calculated in a similar manner.

<sup>18</sup> For results for all individual countries, see annex 2 [table A3](#). The degree of urbanization results are those reported by the European Commission's Joint Research Center based on its GHS-SMOD-R2019A data set. Recently released results using the GHS-SMOD-R2023A data set report urban shares of the population of 94.1 percent and 39.0 percent for Rwanda and Lesotho respectively in 2025. We focus on the 2015 degree of urbanization results for comparability with our dartboard results. Note that in the degree of urbanization approach, a country's urban share of the population corresponds to the share of its population that lives in what the approach refers to as either an “urban center” or an “urban cluster.”

<sup>19</sup> In making these comparisons of results between the dartboard and degree of urbanization approaches we focus on the stricter definition of urban areas (i. e., cities only) under the dartboard approach. This is because of the small average size of dartboard towns, which make them less comparable to degree of urbanization urban areas. If we include dartboard towns in the comparison, the differences in results between the two approaches appear even more stark.

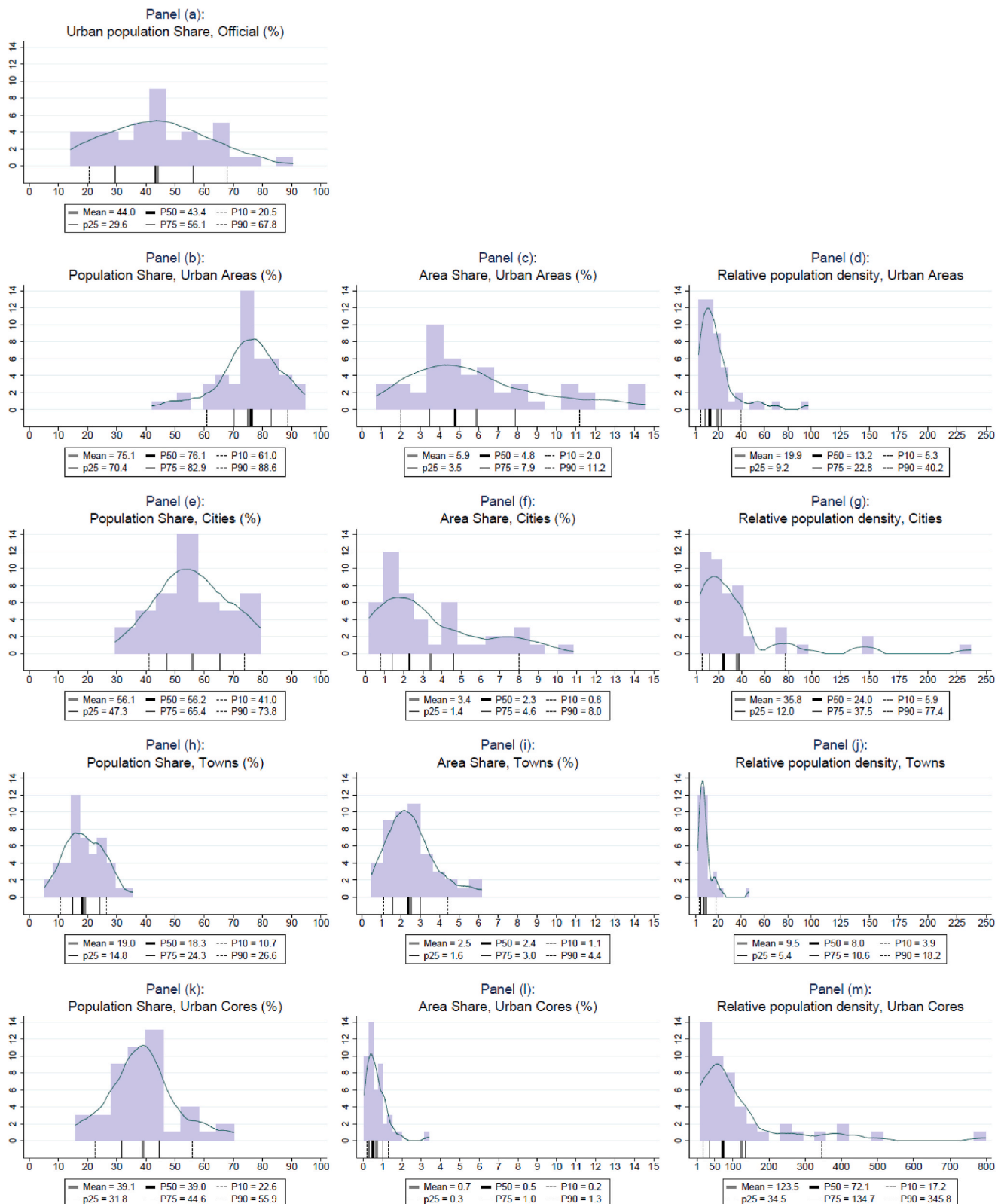


**Fig. 2.** Distribution of urbanization characteristics across 47 SSA countries

**Notes:** Each panel represents the distribution across SSA countries of the variable indicated in the panel's title, which also provides the units for the horizontal axis and the type of areas concerned. The vertical axis is the number of countries. The mean, median, first and third quartiles, first and last deciles of the distribution are reported in the legend and represented by vertical bars of different thickness and style below the chart. Relative density is the density in an urban area/city/town/urban core relative to the average density in the country, then averaged over all urban areas/cities/towns/urban cores. Corresponding summary statistics can be found in annex 1, [table A1](#). Values for individual countries are provided in annex 2, [table A3](#).

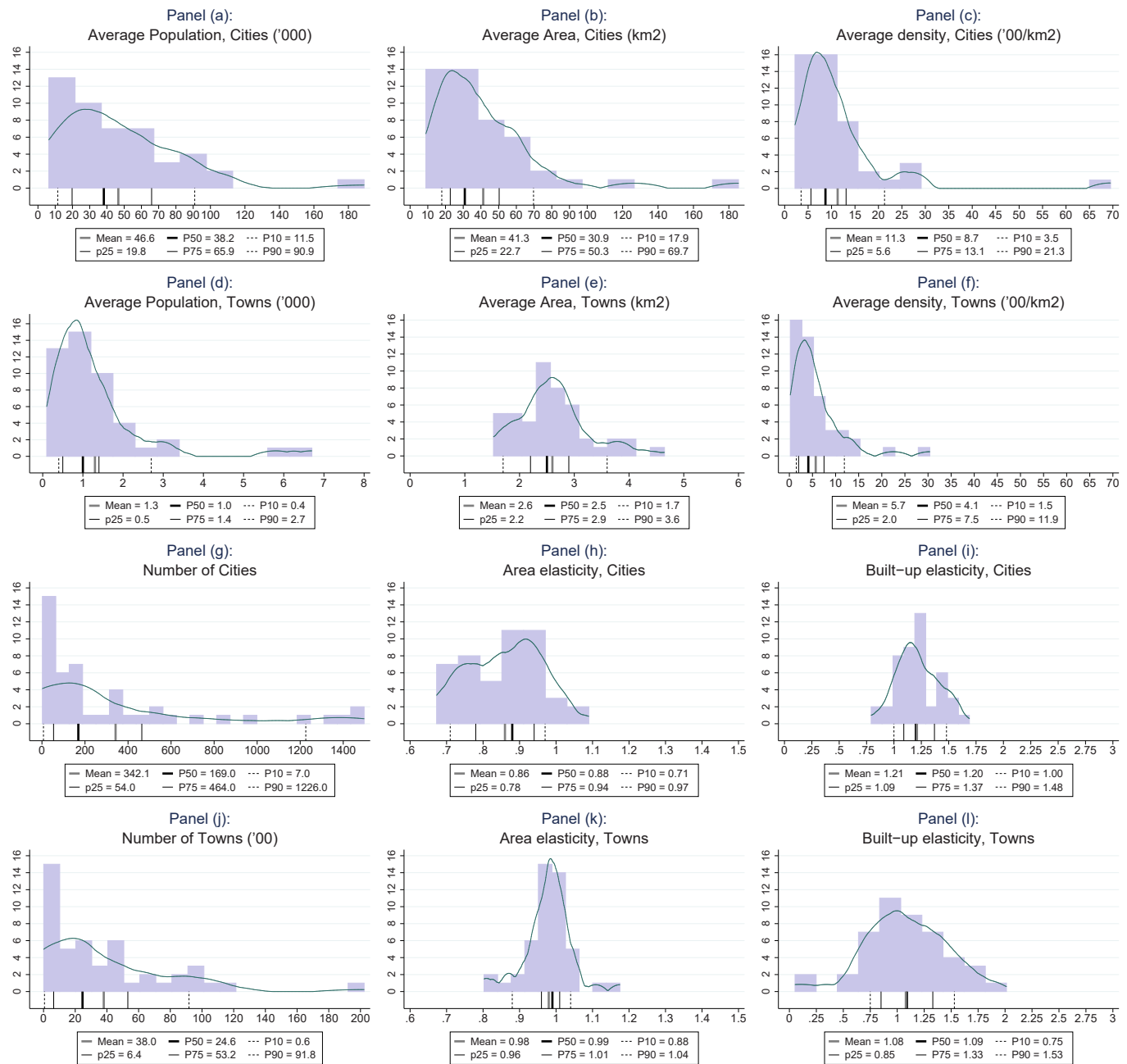


**Fig. 3.** Distribution of characteristics of cities and towns across 47 SSA countries

**Notes:** Each panel represents the distribution across SSA countries of the variable indicated in the panel's title, which also provides the units for the horizontal axis and the type of areas concerned. The vertical axis is the number of countries. The mean, median, first and third quartiles, first and last deciles of the distribution are reported in the legend and represented by vertical bars of different thickness and style below the chart. São Tomé and Príncipe is not considered for built-up elasticity because no built-up data is available for the country. Corresponding summary statistics can be found in annex 1, [table A2](#). Values for individual countries are provided in annex 2, [table A3](#).

generally more compact than Rwanda's cities and cores. Another example of Lesotho's higher spatial concentration of population is the distribution of towns, represented in green on the maps. As with cities, Lesotho's towns cover a smaller share of the territory (4.8 percent) than do Rwanda's (5.8 percent), yet they again host a larger share of population (22.5 percent versus 15.8 percent). Even when just considering urban cores, similar conclusions hold. Cores in Lesotho account for 1.3 percent of the land and 28.2 percent of the population, compared to 1.7 percent and 16.5 percent respectively in Rwanda. Overall, the two countries present markedly different urbanization patterns, the fine details of which the dashboard approach captures.

Returning to [Fig. 3](#), we also present summary statistics for two estimated elasticities – the elasticity of *overall* area with respect to population across cities (panel h) and towns (panel k) and the elasticity of *built-up* area with respect to population across cities (panel i) and towns (panel j). Note that a settlement's built-up area may be smaller than its overall area due to the presence of open spaces. For overall area elasticities, the estimates are less than 1 for most countries for cities – at the 90th percentile across countries, the estimated elasticity is 0.97. This implies that a doubling of a city's population is associated with a slightly less than doubling of its overall area, hence a slightly higher density. This is consistent with standard urban economics models ([Alonso, 1964](#);

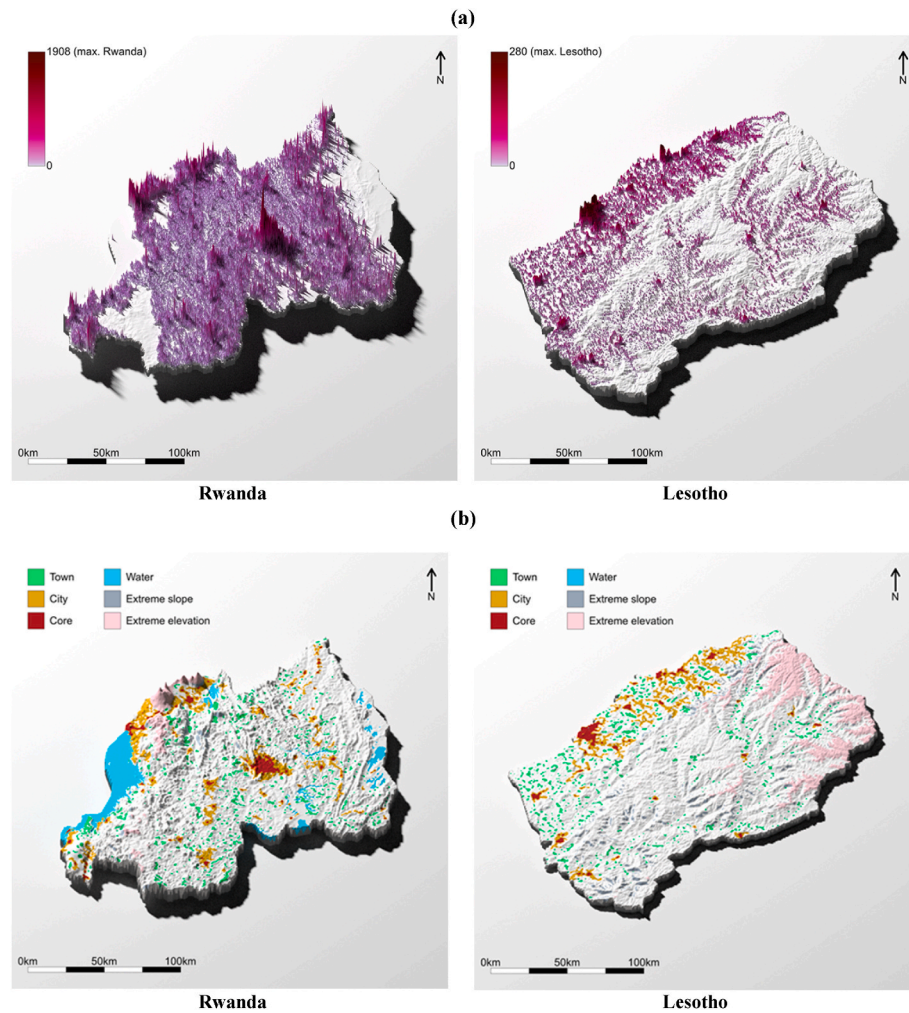


**Fig. 4. (a). Spatial distributions of population – Rwanda and Lesotho**  
**Fig. 4(b). Delineated areas using the dartboard approach – Rwanda and Lesotho**

**Notes:** In panel (a), maps are constructed using constrained *WorldPop* gridded population data. Spike heights are proportional to a grid cell's population density. Panel (b) depicts the extents for cities, their cores and towns as delineated using the dartboard approach. Also shown are the uninhabitable areas of each country for the three criteria of water, elevation and slope. Similar maps for all 47 SSA countries can be downloaded at <https://sites.google.com/view/anatomy-of-urbanization-in-ssa>.

Mills, 1967; Muth, 1969) and the intuition that a city's population growth is absorbed both at the extensive margin, through spatial expansion, and at the intensive margin, through an increase in population density. It is worth noting, however, that even though overall area elasticities are estimated to be less than 1 for most countries, they remain fairly high, with a median of 0.88 and estimates falling below 0.75 in only eight countries.<sup>20</sup>

In contrast to the overall area elasticities, estimated built-up area elasticities for cities are larger than 1 for most SSA countries. Indeed, the median (mean) estimated elasticity of built-up area with respect to population is 1.20 (1.21) for cities. Hence, for the median country, a doubling of a city's population is associated with a 120 percent increase in its built-up area.<sup>21</sup> These estimates larger than unity stands in sharp contrast with findings for developed countries and cities. For instance, Ahlfeldt and Pietrostefani, 2019 estimate an elasticity of approximately

0.60 for a large global sample of cities, while de Bellefon et al. (2021) estimate an elasticity of 0.84 for all French urban areas, as defined using the dartboard algorithm, with a population greater than 100 and 0.89 for the 500 largest French urban areas. This suggests that SSA cities tend to be more extensively covered by built surfaces as their populations grow, leading to the disappearance of open space. Although the data cannot distinguish between different types of built surface, they include not only residential homes, but also commercial and industrial premises, roads and other types of impervious surfaces.

There are at least three, non-mutually exclusive, explanations for the difference between our estimated built-up area elasticities for cities in SSA countries (greater than 1) and those from the literature for developed countries (less than 1). First, planning regulations for the protection of open space may be more prevalent and/or better enforced in developed countries than in SSA countries. Second, as noted above, built-up includes not only residential built-up, but also built-up associated with industrial and commercial uses. If industry is more land-intensive than housing, and more populous cities in SSA countries dedicate a larger share of land to industrial activities, this could help explain the higher estimated elasticities for these countries. This is especially relevant if such compositional changes in built-up area across cities of different size are less pronounced in developed countries, as we

<sup>20</sup> 0.75 is the average value that de Bellefon et al. (2021) estimate for France over all their delineations (personal communication available upon request).

<sup>21</sup> Although not as marked, towns also exhibit a similar pattern to cities when it comes to the estimation of overall and built-up area elasticities with respect to population (compare panels k and l in Fig. 3).

might expect given both their more service-oriented economies and the tendency of manufacturing to gravitate towards smaller cities, where land tends to be cheaper (World Bank, 2009). Third, elasticities greater than 1 for SSA countries may reflect limitations in our built-up area data, which comes from a different source, the European Commission's Global Human Settlement Layer (GHSL), than our gridded population data, *WorldPop*.

Turning to levels of spatial concentration of urban populations across countries, panel (a) of Fig. 5 shows that the mean inter-quartile ratio for city population is 14.4, while the median is 3.7. This indicates that, on average, population distribution across cities in SSA countries is highly uneven, with some cities being much more populous than others. Similar patterns emerge for towns in panel (d), though the concentration is less pronounced, with the mean inter-quartile ratio (3.7) being closer to the median (3.5).

Related to this, the mean (median) share of a country's population that lives in its capital city is 20.4 (17.3) percent. Over three quarters of SSA countries have more than 10.9 percent of their populations residing in their capital city (see Fig. 5, panel b; and annex 1, table A2), while a quarter have capital cities that account for 24.7 percent or more of their population. The most extreme cases are São Tomé and Príncipe and Seychelles, where, in both cases, almost two-thirds of the population lives in the capital city. Comoros is also an exception insofar as its capital city, Moroni, lacks an urban core and is therefore only classified as a town according to our methodology, despite being home to 17.0 percent of the country's population. Among non-island countries, Gambia has the highest share of its population (50.0 percent) living in its capital city. Annex 3, table A4 provides the population shares and other characteristics of all capital cities. It also includes the populations of capital cities as reported by the Population Division of the United Nations (2018) in its World Urbanization Prospects: 2018 Revision database.<sup>22</sup> In most cases, these figures closely align with the populations derived using our dartboard approach, despite the UN population estimates being based on official national definitions that differ across countries. Still, some striking exceptions emerge. For instance, our delineation methodology occasionally merges adjacent urban areas into a single city when the population density between them remains above the counterfactual distribution under randomness, contrasting with official definitions that often strictly adhere to administrative boundaries. For example, Cotonou (Benin), Nairobi (Kenya), Pretoria (South Africa), and, to a lesser extent, Accra (Ghana) have dartboard populations that greatly exceed those reported by the UN. Conversely, a few capital cities, such as Asmara (Eritrea), Brazzaville (Republic of the Congo), Kinshasa (DRC) and Nouakchott (Mauritania) have smaller dartboard populations compared to the UN figures.

Notice that a country's capital city is not necessarily its largest city according to our methodology. Several well-known cases illustrate this point. In Côte d'Ivoire, Adjame is not the capital city, despite accounting for 20.6 percent of its population. By contrast, the official capital, Yamoussoukro, is only home to 1.1 percent of the population. Similarly, in Malawi, Blantyre is much more populous (19.0 percent of the population) than the capital city, Lilongwe (8.6 percent). Lagos and Dar-es Salam provide even more striking examples. They host 6.6 percent and 11.0 percent of Nigeria's and Tanzania's populations, respectively, compared to just 1.2 percent in Abuja and 0.6 percent in Dodoma, their respective capital cities.

In terms of urban primacy, the mean (median) population share of the largest city across SSA countries is 22.7 (19.0) percent.<sup>23</sup> This suggests that urban primacy in SSA is not systematically higher than in

developed countries. Among the 44 countries and territories classified as high-income by the World Bank and for which data are available, the mean (median) share of the population that lived in the largest city, as officially defined, in 2021 was 27.1 (21.1) percent.<sup>24</sup> According to the dartboard approach, 17.0 percent of France's population lives in its largest city, Paris (de Bellefon et al., 2021), a figure close to the SSA median. By contrast, countries such as the UK, the US and Germany exhibit lower levels of urban primacy, with London, New-York, and Berlin accounting for around 14.1, 5.7 and 4.3 percent of national population, respectively, based on data from the World Bank's World Development Indicators.<sup>25</sup>

A particular feature of the dartboard algorithm is that it delineates a small number of cities, in a few SSA countries only, that span very large areas. This occurs when population density is both relatively high and uniformly distributed across vast territories, sometimes only connected by narrow population corridors, such as those following major roads.<sup>26</sup> While such areas might not intuitively be thought of as single cities, they represent extended urban areas with relatively high population density, and remain fully consistent with our approach, as they encompass only pixels above the 95th percentile of the counterfactual density, even if only marginally. Nonetheless, they may differ from more conventional cities, including capital cities, both in their general characteristics and in their internal structures, as we will see below.

More specifically, if we define "extended cities" as those that cover an area larger than 1500 km<sup>2</sup> (an admittedly ad hoc criterion), we observe 37 of them out of the more than 16,000 delineated across SSA. Their characteristics are presented in annex 3, table A5. These extended cities are found in 19 SSA countries. Ethiopia has the highest number, eight, followed by DRC, Nigeria, South Africa, Tanzania and Uganda, each with three. Some of these extended cities correspond to national capitals – for instance Accra (Ghana), Antananarivo (Madagascar), Cotonou (Benin), Harare (Zimbabwe), Kampala (Uganda), Khartoum (Sudan), Nairobi (Kenya), and Pretoria (South-Africa). This is not the case for most extended cities, however. In several cases, these extended cities account for a larger share of the national population than the capital city. This typically occurs when the capital city is not the country's main economic center, as in Nigeria or Tanzania, or in a few exceptional cases, such as the vast area around Shashamane in Ethiopia, which is home to 14 million inhabitants, more than 3.5 times the population of Addis Ababa. The land area of these extended cities is often much larger than that of the capital city – up to more than 70 times for the largest Namibian extended city, and 18 and 11 times for the largest extended cities in Ethiopia and South Sudan, respectively. A representative intermediate example is the extended city of Onitsha (Nigeria), which has a population of 11.2 million, comparable to that of Nigeria's former capital, Lagos. It spans an area roughly equivalent to a 40 km by 130 km rectangle, although some gaps reduce its actual land area to 4800 km<sup>2</sup> instead of the full (40 km \* 130 km = ) 5200 km<sup>2</sup>. Thus, despite a similar population, it covers more than three times the land area of Lagos and 5.6 times that of the current capital, Abuja (which has only 2.3 million inhabitants). This extended city includes not only Onitsha, but also Owerri and Aba, which are usually considered as

<sup>24</sup> This calculation excludes both Hong Kong SAR, China, and Macao SAR, China.

<sup>25</sup> <https://databank.worldbank.org/source/world-development-indicators>.

<sup>26</sup> An important caveat here is that, although population density may be high and relatively uniformly distributed over a vast area, it cannot be uniformly distributed over a country's *entire* potentially inhabitable area. As per earlier discussion, if this were the case, the dartboard algorithm would detect only a relatively low level of urbanization.

<sup>22</sup> <https://population.un.org/wup/>.

<sup>23</sup> Notwithstanding the fact that not all SSA countries have their largest city as their capital city, average levels of urban primacy calculated based on capital city population shares are very similar to those calculated based on largest city population shares.

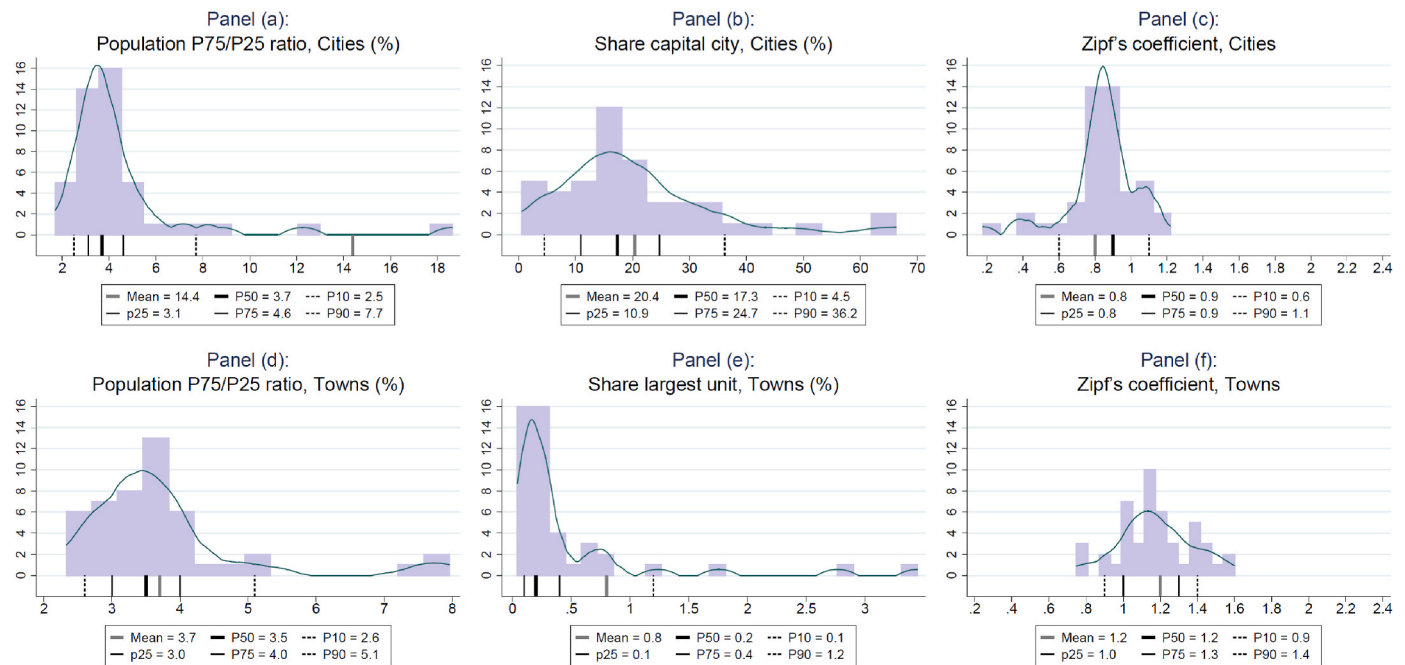


**Fig. 5.** Distribution of measures of spatial concentration for cities and towns across 47 SSA countries

**Notes:** Each panel represents the distribution across SSA countries of the variable indicated in the panel's title, which also provides the units for the horizontal axis and the type of areas concerned. The vertical axis is the number of countries. The mean, median, first and third quartiles, first and last deciles of the distribution are reported in the legend and represented by vertical bars of different thickness and style below the chart. In panels (c) and (f), Zipf's coefficient is estimated separately for each country using [Gabaix and Ibragimov \(2011\)](#) "Rank - 1/2" estimator. Seychelles is not considered for the population P75/P25 ratio for cities because of its extreme value of 475 (two cities only, the second being very small). Comoros is not considered for the share of the largest unit for towns because of its extreme value of 17, which arises because its capital city, Moroni, is a town. Corresponding summary statistics can be found in annex 1, [table A2](#). Values for individual countries are provided in annex 2, [table A3](#).

separate cities, reflecting its multicentric structure, which we document below.<sup>27</sup>

Despite the presence of some extreme extended cities, the distribution of city-sizes in SSA countries generally conform well to Zipf's law, which implies that a country's largest city is twice as populous as its second largest, three times as populous as its third largest, and so on. The mean (median) estimated Zipf's coefficient for cities across SSA countries is 0.8 (0.9) ([Fig. 5](#), panel c), which is close to estimates for developed countries – [de Bellefon et al. \(2021\)](#), for example, report a value of 0.81 for French cities. Meanwhile, [Soo \(2005\)](#) and [Brakman et al. \(2009\)](#) report mean estimated Zipf's coefficients of 0.90 and 0.88 respectively for large samples of countries when defining cities as "cities proper". A Zipf coefficient of 0.8–0.9 indicates slightly more spatial concentration than predicted by Zipf's law, typically due to a long tail of small cities. However, as shown in [table A3](#) (annex 2), a few countries deviate markedly: Seychelles, Lesotho and Gambia have Zipf's coefficients for cities of 0.2, 0.4 and 0.5 respectively, indicating large disparities in population sizes. Zipf's law also holds reasonably well for towns ([Fig. 5](#), panel f), although in this case, the mean and median estimated coefficients exceed unity, implying less spatial concentration across towns than is predicted by the law, opposite to the pattern observed for cities.

#### 4. Correlates of urbanization characteristics across countries

To better understand how urbanization characteristics vary across SSA countries, we estimate the following three regressions for each characteristic:

$$UC_i = a + b \ln(POP_i) + u_{1i} \quad [1]$$

$$UC_i = c + d \ln(DEN_i) + e \ln(AREA_i) + u_{2i} \quad [2]$$

$$UC_i = f + g \ln(DEN_i) + h \ln(AREA_i) + j \ln(GDP\_PC_i) + u_{3i} \quad [3]$$

where  $UC_i$  denotes the urbanization characteristic in question for country  $i$ ,  $POP_i$  a country's population,  $DEN_i$  its overall average population density,  $AREA_i$  its land area, and  $GDP\_PC_i$  its GDP per capita level. Equation [1] correlates the urbanization characteristic with a country's overall size, as measured by its population. Equation [2] then decomposes this effect into intensive (average overall population density) and extensive (area) margins. Finally, equation [3] examines the relationship between the urbanization characteristic and a country's GDP per capita, controlling for both the intensive and extensive margins of country size. We estimate equations [1]–[3] as cross-sectional OLS regressions for 2015. Given that a country's urbanization characteristics may potentially affect its GDP per capita, as well as other potential endogeneity problems, these regressions should be interpreted as capturing (partial) correlations in the data rather than causal effects.

[Table 1](#) presents the results from estimating equations [1]–[3] for each urbanization characteristic. For brevity, only the results for cities are shown. Several interesting findings emerge. First, there is a strong and statistically significant negative relationship between an SSA country's overall population and the share of its population that lives in officially defined urban areas – i.e. more populous SSA countries tend to have lower official urban population shares (col. [1]). This negative relationship holds at both the intensive and extensive margins but is stronger at the former margin (col. [2]). Controlling for size, a country's official urbanization level is also strongly correlated with its GDP per capita, confirming the well-established positive relationship between a country's levels of urbanization and economic development (col. [3]).

<sup>27</sup> Using Africapopolis data, [OECD/SWAC \(2020\)](#) also identify Onitsha as a "mega agglomeration" with a population of 8.8 million in 2015 compared to a population of 1.1 million reported in the United Nations' World Urbanization Prospects: 2018 Revision (<https://population.un.org/wup/>).

**Table 1**

OLS regression results - relationship between country size and urbanization characteristics, cities only.

| Dependent variable | (1)        |                | (2)         |           | R <sup>2</sup> | (3)         |           |              |                |
|--------------------|------------|----------------|-------------|-----------|----------------|-------------|-----------|--------------|----------------|
|                    | Population | R <sup>2</sup> | Density     | Area      |                | Density     | Area      | GDP per cap. | R <sup>2</sup> |
| Official urban     | −3.38**    | 0.10           | −7.66***    | −3.55**   | 0.18           | −4.64**     | −1.24     | 10.39***     | 0.41           |
| Pop. share         | 0.35       | 0.00           | −4.00**     | 0.17      | 0.18           | −1.78       | 1.87*     | 7.63***      | 0.43           |
| Area share         | −0.13      | 0.01           | 1.31***     | −0.08     | 0.42           | 1.45***     | 0.03      | 0.48         | 0.44           |
| Average pop.       | 1843.58    | 0.01           | 17169.36*** | 2474.30   | 0.29           | 20026.06*** | 4661.90   | 9828.41*     | 0.34           |
| Average area       | 2.04       | 0.01           | −1.67       | 1.89      | 0.03           | 1.20        | 4.08      | 9.86*        | 0.09           |
| Rel. pop. density  | −2.05      | 0.01           | −25.73***   | −3.02     | 0.43           | −23.54***   | −1.35     | 7.52         | 0.45           |
| No. cities         | 179.47***  | 0.44           | 132.21**    | 177.53*** | 0.46           | 124.16**    | 171.37*** | −27.68       | 0.46           |
| Area elas.         | −0.00      | 0.01           | 0.04***     | −0.00     | 0.33           | 0.04***     | −0.00     | −0.01        | 0.34           |
| Built-up elas.     | −0.02      | 0.02           | −0.03       | −0.02     | 0.02           | −0.03       | −0.02     | −0.02        | 0.03           |
| Pop. P75/P25       | −18.79***  | 0.19           | −13.62      | −18.57*** | 0.20           | −7.47       | −13.86**  | 21.17*       | 0.26           |
| Pop. sh. capital   | −6.49***   | 0.51           | −5.07***    | −6.44***  | 0.53           | −3.92**     | −5.56***  | 3.95**       | 0.58           |
| Zipf's coef.       | 0.07***    | 0.37           | 0.03        | 0.07***   | 0.45           | 0.01        | 0.06***   | −0.05*       | 0.49           |

**Notes:** Estimation results for equations [1]–[3] for different urbanization characteristics. All regressions are estimated using data for 47 SSA countries. \*, \*\* and \*\*\* denote significance at the 1 percent, 5 percent and 10 percent levels respectively.

Including GDP per capita, however, causes the coefficient on area to lose statistical significance. Overall, therefore, the results suggest that more developed and less densely populated SSA countries have higher official urbanization levels.

Controlling for size, the existence of a positive relationship between a country's levels of GDP per capita and urbanization continues to hold when urban areas are defined using the dartboard approach rather than official definitions. However, opposite to our findings based on official definitions, the share of population that lives in cities is significantly positively related to its area (albeit only at the 10 percent level) – and therefore to its population at the extensive margin – after controlling for both GDP per capita and population density. Together, GDP per capita, area and overall average population density account for 43 percent of the variation in the shares of population that live in cities across SSA countries.

For the share of a country's land area that is occupied by cities, the results are quite different. Neither a country's level of development nor its area is correlated with this share (col. [3]). However, countries with higher average population density tend to have larger shares of their areas devoted to cities. This suggests that cities in these countries are more “sprawling”, perhaps because of stronger congestion forces that bid-up the price of land and push cities outward. Supporting this interpretation, more densely populated countries also tend to have less densely populated cities, irrespective of whether we control for a country's level of development (cols. [2] and [3]).<sup>28</sup> This is also consistent with the fact that the city area elasticity with respect to the city population increases with density, while the built-up elasticity slightly decreases, though not significantly (see Section 3.2). Unsurprisingly, countries that are more populous, at either the intensive or extensive margins, tend to have more cities, although there is no correlation between a country's level of development and its number of cities. This suggests that, as SSA countries become richer, urbanization occurs primarily through the growth of existing cities, rather than the emergence of new ones. Consistent with this, both the average population and average area of a country's cities are significantly positively correlated with its GDP per capita (at the 10 percent level), controlling for country size (col. [3]).

Regarding the distribution of city sizes, more developed and geographically smaller SSA countries tend to have higher shares of their populations living in their capital cities (col. [3]). We also observe that more populous countries tend to have a smaller spread of population sizes across cities, as evidenced by the regression results for the inter-quartile city population ratio. Consistent with this, a country's

estimated Zipf coefficient is significantly positively correlated with its population (col. [1]), where the relationship between the Zipf coefficient and population is driven by area rather than population density (col. [2]). Controlling for size, a country's estimated Zipf coefficient is also negatively correlated with its level of GDP per capita at the 10 percent level (col. [3]).

## 5. Spatial concentration within cities

Having described patterns of urbanization across SSA countries, at both the aggregate and urban area (i.e., city and town) levels in Sections 3 and 4, we now turn to describe features of the internal structures of cities and how these differ across SSA countries and cities. Given that comprehensive evidence is generally lacking on internal city structures, especially for SSA, this section represents one of the most novel contributions of our analysis.

The discussion of the internal structures of cities for developed countries naturally tends to focus on the concept of employment (sub-) centers (McDonald, 1987; Giuliano and Small, 1991; McMillen, 2001; Goswami and Lall, 2016) or “prime locations” (Ahlfeldt et al., 2025),<sup>29</sup> which in turn determine equilibrium patterns of population distribution (see Fujita and Thisse, 2013). Literature often tests the presence of employment mono-centricity, as predicted by many models, versus multicentricity, and whether employment density declines from the center toward the periphery. In contrast, our analysis focuses on population (sub-)centers, which we define as significant peaks of population density within a city's own boundaries. To identify these center(s), we perform 5000 random reshuffles of a city's cells within its own extent. For each city, this yields a counterfactual distribution of population under the assumption of randomness. A (sub-)center is then defined as a contiguous set of cells whose population densities exceed the 95th percentile of the city's counterfactual distribution.<sup>30</sup> Even though it would be interesting to also test for multicentricity and negative employment gradients in SSA, our focus on population is partly motivated by data availability (i.e., a lack of spatially granular employment data for SSA countries) and partly by our intrinsic interest in such centers in a developing country context. In this context, high density areas

<sup>28</sup> This is true irrespective of whether or not we measure city density in absolute terms or relative to a country's overall average population density.

<sup>29</sup> Ahlfeldt et al. (2025) define “prime locations” as significant clusters of employment density within a city. They identify these clusters using an algorithm that shares some resemblance with the dartboard algorithm.

<sup>30</sup> Important to note here is the distinction between a city's population “center” and its “core.” As described in Section 2.1, “cores” are identified through a second-order random reshuffling of urban cells across all urban areas of a country and, by definition, all cities must have at least one core. By contrast, population centers are identified by the random reshuffling of cells within each individual city.

may reflect not only a desire to live near employment opportunities, given high intra-city transport costs, but also the widespread presence of slum settlements, particularly in large cities. Many of these settlements are small, yet extremely dense, such as with so-called “pocket slums” (Singh and Gadgil, 2017). Given the widespread prevalence of urban sprawl in developing countries, cities with multiple population (sub-) centers may also arise as they “absorb” surrounding settlements or “merge” with neighboring cities through, for example, ribbon development along connecting transport arteries (Ellis and Roberts, 2016), which also relates back to our discussion of “extended cities” in Section 3.2.

In the following sub-sections, we first present evidence on the numbers of population (sub-)centers within cities before turning to an analysis of population and built-up density gradients. These gradients are estimated based on the distance to a city’s central point as defined by the barycenter of its largest center. For brevity, we focus on cities in this section as their internal structures are likely to be more complex and interesting than those of towns.

### 5.1. Numbers of population (sub-)centers within cities

Fig. 6 shows that the mean (median) number of population (sub-) centers per city across countries is 1.7 (1.5) (panel a), while the mean (median) share of cities that have a single center is 77.4 (80.0) percent (panel b). In contrast, the mean (median) share of cities that have two centers is 11.6 (9.4) percent (panel c), which is slightly more than the mean (median) share of cities that have three or more population centers. Hence, most cities in SSA have a unique population center.

Still, the number of population centers tends to increase with city size, with a mean elasticity of 0.23 as reported in panel (d) of Fig. 6. Some cities in SSA have a remarkably large number of sub-centers. Capital cities, in particular, tend to have more (sub-)centers than regular cities (panel e), with a median of three, and a mean of 8.9. The relatively higher mean reflects the presence of capital cities with exceptionally large numbers of population sub-centers, such as Nairobi (Kenya), Pretoria (South Africa) and Khartoum (Sudan) with 83, 65 and 56 (sub-)centers respectively (annex 3, table A4). Unsurprisingly given the huge areas that they cover, the extended cities that we identified in Section 3.2 are often characterized by an even larger number of population (sub-)centers. Out of the 37 extended cities identified, 22 have

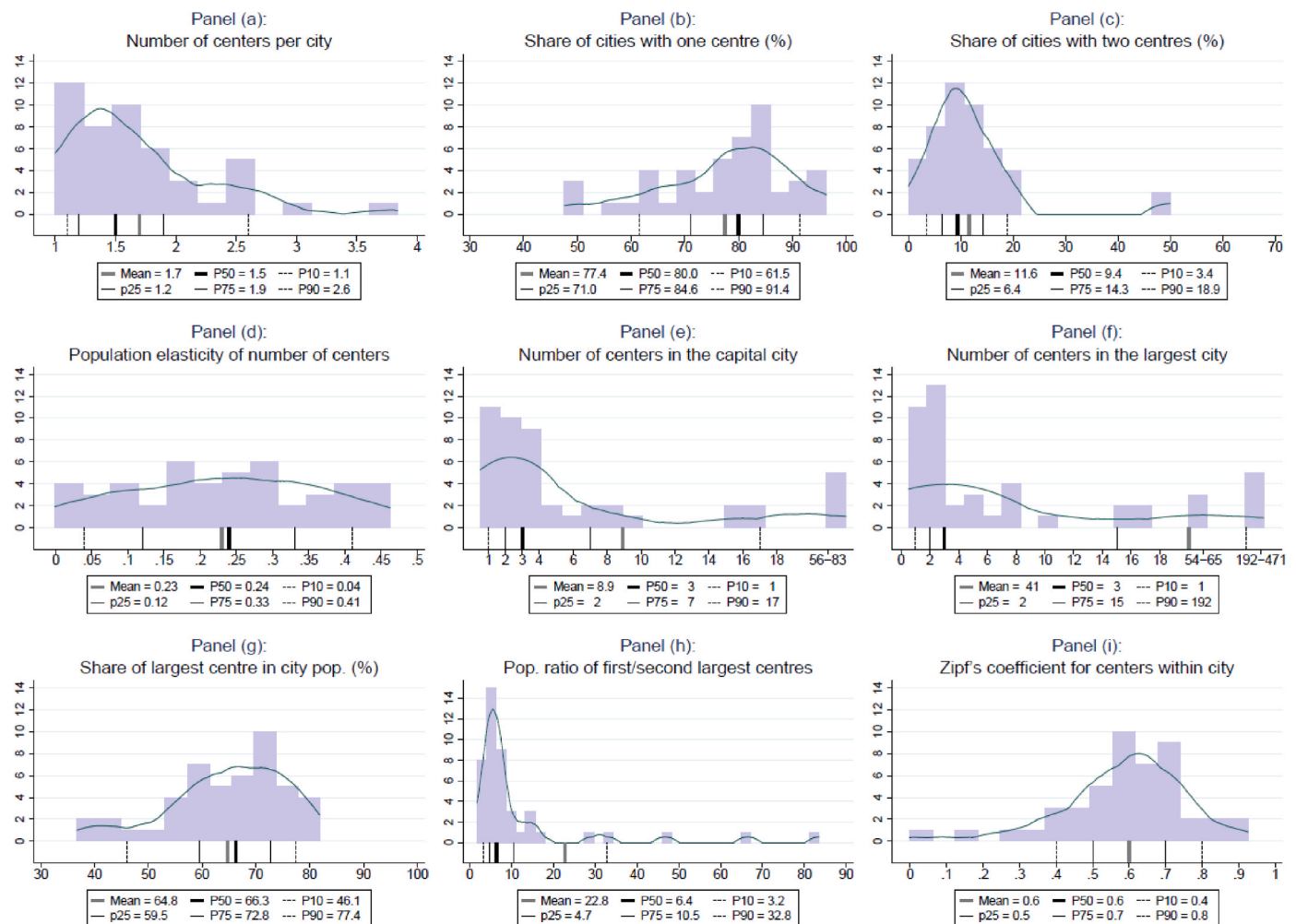


**Fig. 6.** Distribution of city population center characteristics over 47 SSA countries

**Notes:** Each panel represents the distribution across SSA countries of the variable indicated in the panel’s title, which also provides the units for the horizontal axis. The vertical axis is the number of countries. The mean, median, first and third quartiles, first and last deciles of the distribution are reported in the legend and represented by vertical bars of different thickness and style below the chart. São Tomé, the capital city of São Tomé and Príncipe, for which the ratio of the populations of its first and second largest centers is 521, is excluded from panel (h). As the country also has only one city with furthermore two centers only, the Zipf’s coefficient for centers is not computed for this country. Corresponding summary statistics can be found in annex 4, table A6. Values for individual countries are provided in annex 4, table A7.

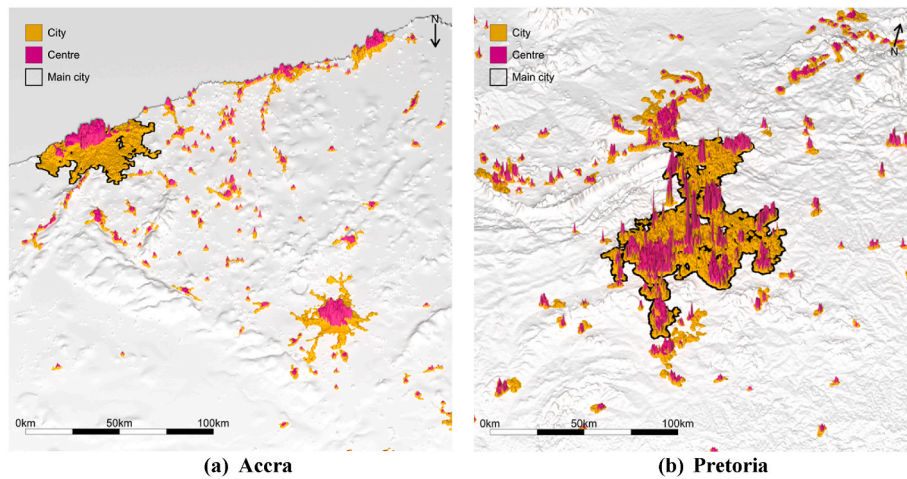


**Fig. 7.** Examples of different types of cities, around Accra (Ghana) and Pretoria (South-Africa)

**Notes:** Maps constructed using constrained *WorldPop* gridded population data. Spike heights are proportional to a grid cell's population density. The spatial extents of Accra and Pretoria are marked by a black line.

more than 40 (sub-)centers. Kisumu, Kenya, represents the most extreme case with 471 (sub-)centers (annex 3, [table A5](#)).

The existence of many population centers can arise for two reasons: (i) a proliferation of many separate slums, including small “pocket slums”, throughout a city; and/or (ii) the absorption of surrounding smaller settlements and the merging of neighboring cities, often through ribbon development along transport arteries. [Fig. 7](#) provides an illustration of different types of development, contrasting Ghana (panel a) with South Africa (panel b). Accra, along with other Ghanaian cities, appears relatively compact, with a clearly defined city extent and a dominant center. In contrast, Pretoria (South Africa), classified as an extended city, forms part of a vast urbanized area covering almost 21,000 km<sup>2</sup> with 65 population (sub-)centers. These include large centers, such as Johannesburg, Soweto, and Alberton, as well as smaller ones, connected to the central population center through ribbon-type development, similar to patterns observed in many Asian countries ([Ellis and Roberts, 2016](#)).<sup>31</sup>

However, this pattern of numerous urban sub-areas, many of which are narrowly connected, is the exception rather than the norm. Our results indicate that the patterns shown in [Fig. 7](#) for Ghanaian cities near Accra are much more typical of SSA. Most SSA cities have a dominant population center, with any additional surrounding population (sub-)centers being much smaller. Consistent with this, the mean (median) share of a city's largest center in its population across countries is 64.8 (66.3) percent ([Fig. 6](#), panel g), while the mean (median) ratio of the population of a city's largest center to its second largest center is 22.8 (6.4) ([Fig. 6](#), panel h). In cities with multiple population centers, the distribution of center sizes tends to follow a Zipf-like pattern, with size decreasing with population rank ([Fig. 6](#), panel i). The estimated Zipf's coefficient, with a mean and a median at 0.6, is smaller than that for cities, indicating that the size of population centers within a city declines faster than the size of cities within countries.

## 5.2. City population and built-up density gradients

Having identified population (sub-)centers within cities, we now turn to the estimation of intra-city population and built-up density gradients, measured from the barycenter of a city's largest population center. The first (second) row of [Fig. 8](#) presents summary statistics for triplets of  $R^2$  values for the following three sets of *grid cell level* regressions for population (built-up) density. These regressions are

estimated separately for each country, pooling all cities within a country (i.e., each row reports  $[R^2_{eqn.[4]}, R^2_{eqn.[5]}, R^2_{eqn.[6]}]$ ):

$$\ln(DEN_i) = \alpha + \theta_{c(i)} + \varepsilon_{1i} \quad [4]$$

$$\ln(DEN_i) = \alpha + \theta_{c(i)} + \beta \ln(d_i) + \varepsilon_{2i} \quad [5]$$

$$\ln(DEN_i) = \alpha + \theta_{c(i)} + \beta_{c(i)} \ln(d_i) + \varepsilon_{3i} \quad [6]$$

where  $DEN_i$  denotes either the average population density ([Fig. 8](#), panels a–c) or built-up density (panels d–f) of grid cell  $i$ ,  $\theta_{c(i)}$  a city-specific fixed effect for city  $c$  of which cell  $i$  is a part, and  $d_i$  the distance from the centroid of cell  $i$  to the barycenter of the city's largest center. The difference between equations [5] and [6] is that while the former imposes a common density gradient across all cities within a country, the latter allows the gradient to differ across cities.

For any given country, the  $R^2$  from the estimation of equation [4] measures how much of the variation in density across the grid cells that belong to its cities can be explained by differences in density *between* its cities. Correspondingly,  $(1 - R^2)$  measures the variation that is attributable to cell level variation *within* cities. Panels (a) and (d) of [Fig. 8](#) shows that both the mean and median  $R^2$  across all SSA countries are 0.06 for population density and 0.27 for built-up density respectively. Hence, on average for SSA countries, only 6 percent of the variation in population density and 27 percent of the variation in built-up density is due to differences across cities, with the vast majority of the variation occurring within cities. Even at the 90th percentile of the distribution of estimated  $R^2$  values, only 12 percent (41 percent) of the cell level variation in population (built-up) density is explained by the variation across cities.

By adding  $\ln(d_i)$  to equation [4], equation [5] allows a grid cell's average density not only to vary across a country's cities, but also with the distance between that cell and the barycenter of the largest population center of the city of which it is a part. For population density, the mean  $R^2$  from equation [5] is 0.18 for each country, three times higher than the mean  $R^2$  of 0.06 from equation [4] (compare panel b with panel a of [Fig. 8](#)). These results highlight that the distance to a city's largest center is an important source of variation in population density at the grid cell level. This effect is even more pronounced for built-up density, for which the mean  $R^2$  increases from 0.27 to 0.45 once distance to the largest population center is included (compare panel e with panel d). The explanatory power of distance further increases when we allow distance gradients to vary across cities, as in equation [6] and panels (c)

<sup>31</sup> Results for individual countries are presented in annex 4, [table A7](#).

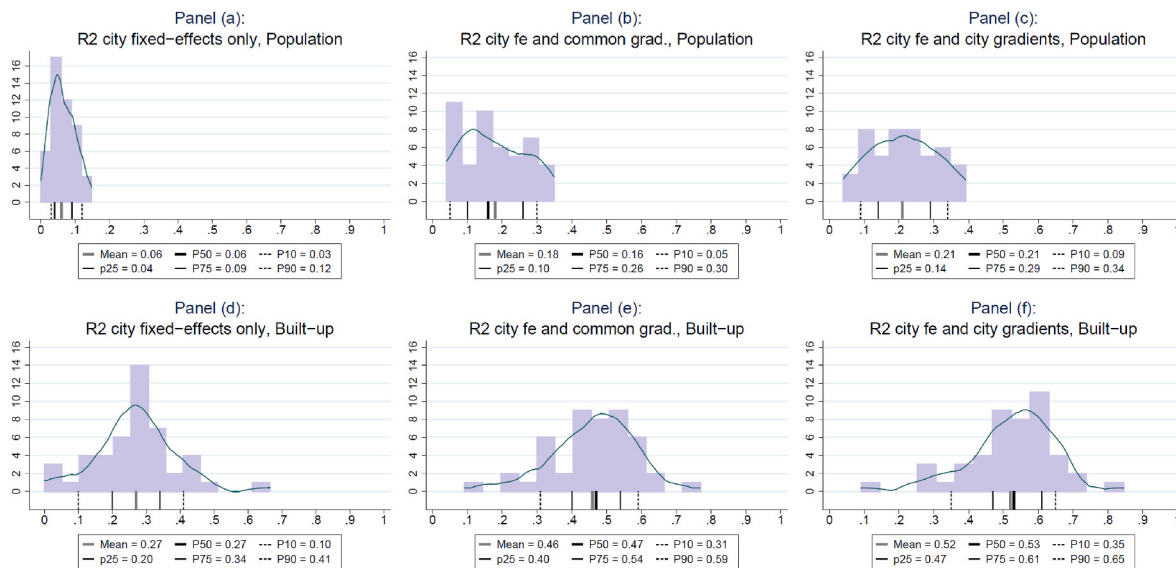


**Fig. 8.** Average within and between city population and built-up variations

**Notes:** Each panel represents the distribution across SSA countries of the variable indicated in the panel's title. The vertical axis is the number of countries. The mean, median, first and third quartiles, first and last deciles of the distribution are reported in the legend and represented by vertical bars of different thickness and style below the chart. Panels (a) and (d) report  $R^2$  values from the estimation of equation [4], panels (b) and (e)  $R^2$  values from the estimation of equation [5], and panels (c) and (f)  $R^2$  values from the estimation of equation [6]. Corresponding summary statistics can be found in annex 5, table A8. Values for individual countries are provided in annex 5, table A9.

and (f) for population and built-up density respectively. This follows from the fact that both the mean and median  $R^2$  values from the estimation of equation [6] are greater than the corresponding  $R^2$  values from the estimation of equation [5]. At the 90th percentile across countries, the city-specific fixed effects and distance to a city's largest population center can, when allowing for heterogeneity in distance gradients across cities, account for 34 percent of the variation in population density and 65 percent of the variation in built-up density across individual cells. Although we cannot establish the extent to which population centers correspond to employment centers in SSA countries, the observed increase in explanatory power is consistent with urban economic theory – i.e., the Alonso-Muth-Mills model – which predicts that a city's density gradients will depend on commuting costs to its employment center. These costs include both monetary costs and the opportunity cost of commuting time (Alonso, 1964; Mills, 1967; Muth, 1969), and are likely to vary across cities depending on, for example, the quality of transport infrastructure.<sup>32</sup>

The role of commuting costs also explains why, for most cities in most SSA countries, the density gradients estimated from equation [6] are negative (panels a–f, Fig. 9). On average across countries, 94.2 (76.2) percent of cities have population (built-up) density gradients that are significantly negative at the 10 percent level, while 5.8 (22.1) percent of cities have population (built-up) density gradients that are either not significantly different from zero or cannot be estimated because the city is too small. Only a small fraction, 0.1 (1.7) percent of cities on average have population (built-up) density gradients that are significantly positive.

The median across countries of the median city gradient in the country is  $-1.5$  for both population and built-up densities, respectively (panels g and j, Fig. 9), varying from  $-2.2$  at the 10th percentile to  $-0.50$  at the 90th percentile for population density (panel g) and from

$-1.7$  to  $-0.9$  for built-up density (panel j). When we instead focus on population and built-up density gradients at the 90th percentiles (“bottom decile” gradients in absolute value) and examine the distributions of these across countries, we still see the near universal prevalence of negative gradients (panel i and l).

Fig. 10 provides a few examples of typical within-city patterns for population density. The plots in the first row relate to the two largest cities in South Africa – namely, Pretoria and Cape Town – and Onitsha, in Nigeria. In each case, the presence of many (sub-)centers means that distance from the largest centre explains only a small proportion of the within-city variation in population density. Typically, locations within 5 km of the largest center all have high density. However, beyond this distance, densities vary significantly depending on direction, some areas show a steep drop, while others maintain relatively high densities, reflecting the presence of secondary centers, as in the case of Pretoria in panel (a) of Fig. 7. Although the overall density gradient remains significantly negative, its absolute value is small. The lower envelope of the scatterplot shows that, in some directions, population density decreases rapidly with distance. However, in other directions, distant population density peaks correspond to the presence of sub-centers. This pattern corroborates our finding about the number of population sub-centers in Pretoria, and may reflect the role of historical legacies, such as segregation laws, that restricted residential mobility, preventing people from relocating to the most attractive locations. Similar (local) peaks also appear for other extended cities, albeit for different reasons, as shown by the within-city gradients reported in annex 3, table A5.

Within-city patterns of population density that are more typical of SSA cities are illustrated in the second row of Fig. 10 (panels d–f), using the examples of the capital cities of Ghana, Angola and Somalia – i.e., Accra, Lunda and Mogadishu, respectively. While Accra and Luanda have 7 and 8 (sub-)centers respectively, and Mogadishu only one, all three cities exhibit similar patterns. Population density remains consistently high within 4–5 km of the main center, followed by a sharp decline in all directions. As a result, distance to the main center alone explains a large share of the within-city variation in density, over one third, and the estimated gradients are much steeper. For instance, density typically drops by a factor of more than 5 between 1 and 10 km. Even though sub-centers exist in some cases, they are notably smaller

<sup>32</sup> Liotta et al. (2022) arrive at similar conclusions regarding monocentricity and the presence of negative population density gradients within cities (192 worldwide are considered) and the large explanatory power of distance to the city center. Interestingly, they show that these results also apply to housing rents, as predicted by the monocentric city model.

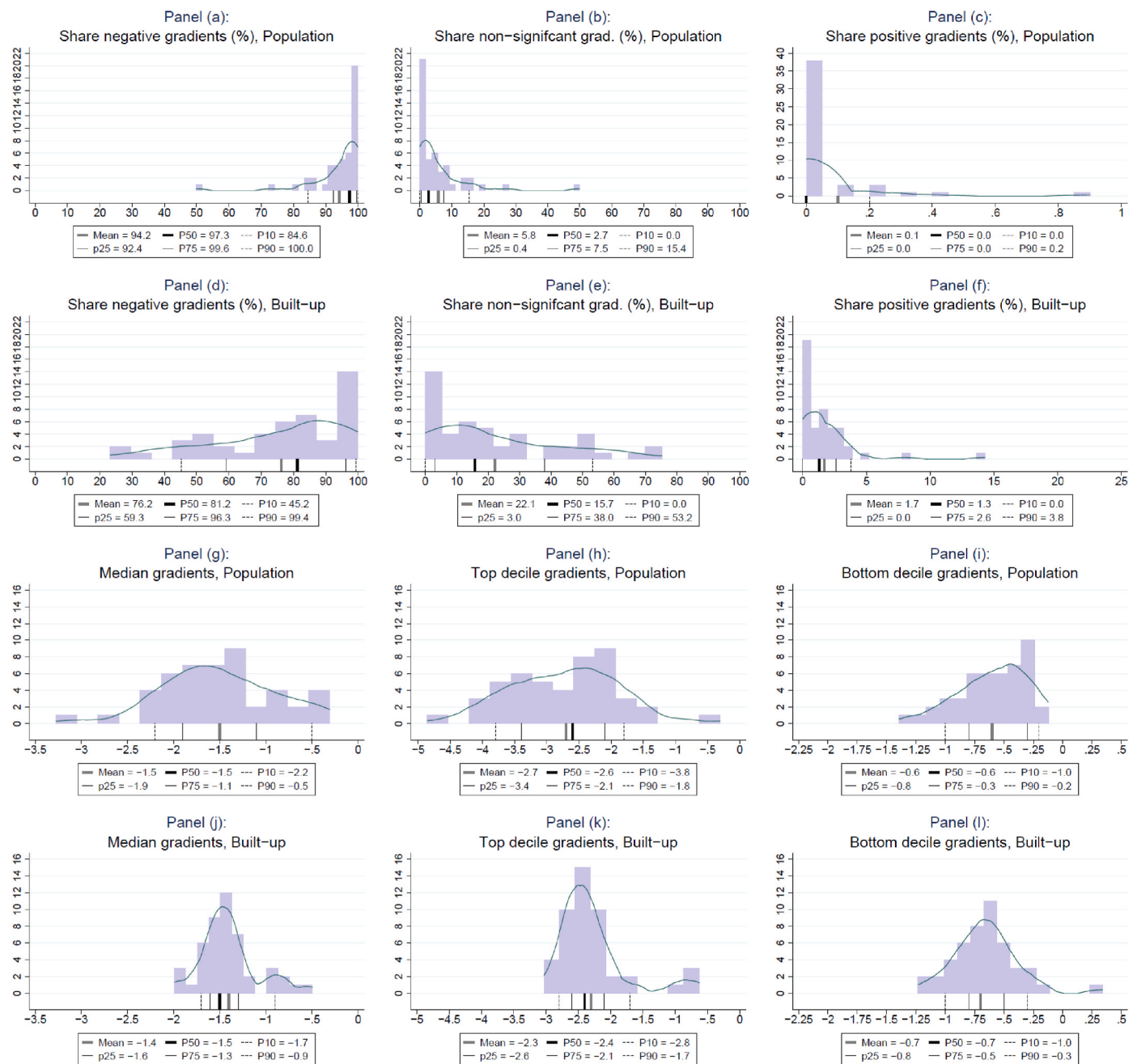


**Fig. 9.** Distribution of within-city population and built-up density gradients over 47 SSA countries

**Notes:** Each panel represents the distribution across SSA countries of the variable indicated in the panel's title. The vertical axis is the number of countries. The mean, median, first and third quartiles, first and last deciles of the distribution are reported in the legend and represented by vertical bars of different thickness and style below the chart. Panels (a), (c), (d) and (f) are based on gradients that are significant at the 10 percent level. Corresponding summary statistics can be found in annex 5, [table A8](#). Values for individual countries are provided in annex 5, [table A9](#).

and less dense than the main center. As reported in annex 3, [table A4](#), this pattern is commonly observed among capital cities, though it is less pronounced in those also classified as extended cities.

Overall, the prevalence of cities with a single population center and negative population and built-up density gradients from the largest center, combined with the strong explanatory power of these gradients, suggests that the monocentric city model provides a good approximation of urban structure in most SSA cities. This conclusion comes with the important caveat that our analysis is based on the distribution of population, not employment, which is the primary driver of population concentration in monocentric models. Whether employment is similarly concentrated in SSA cities remains an open question (see [Ahlfeldt et al.](#),

2025 for employment gradients in three US and 125 global cities).

## 6. Comparison with degree of urbanization

So far, our analysis has relied on the dartboard approach to identify and delineate urban areas for SSA countries. However, alternative approaches exist, one of which is the “degree of urbanization” (DoU) approach of [Dijkstra and Poelman \(2014\)](#) and [Dijkstra et al. \(2021\)](#). Unlike the dartboard method, the DoU approach relies on the definition of identical thresholds across countries to identify urban areas, a feature that limits its ability to capture differences in spatial concentration across countries, as illustrated in the discussion of [Fig. 4\(a\)](#) and (b)

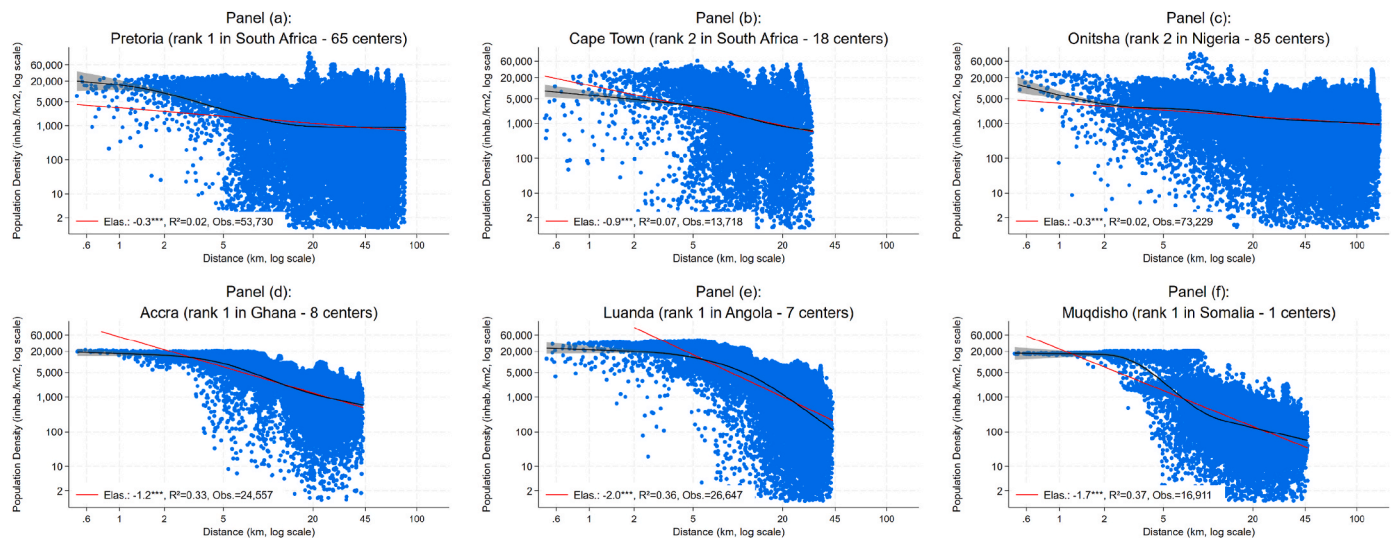


**Fig. 10.** Within-city population density plots for some cities

**Notes:** Population density at the cell level as a function of distance to the city's largest center. Log scale on both axis. Linear and spline fits added. 'Elas.' reports the slope of the log linear fit,  $R^2$  its  $R^2$ , and 'Obs.' the number of cells in the city. For readability, points closer than 500 m to the center and with population density below 1 are removed.

above for Lesotho and Rwanda. Despite this, the DoU approach has been widely applied both in academic papers (see, for example, [Henderson et al., 2022](#); [Bryan et al., 2025](#)) and policy reports by international agencies, including by the World Bank ([Ferreira and Roberts, 2018](#); [Lall et al., 2021](#); [Mukim and Roberts, 2023](#)). This warrants a brief comparison between the results of our dartboard method and those derived from the alternative DoU approach, focusing on cross-country differences in urbanization levels for brevity. For comparability, we restrict the dartboard results to cities only, excluding the smallest urban entities (i.e., towns), to align more closely to the DoU's definition of urban areas. This corresponds to a stricter definition of urban under the dartboard approach than if we were to also include towns.<sup>33</sup> The comparison highlights the relative strengths of each method and the distinct yet complementary perspectives they offer on urbanization. This exercise also contributes to a growing literature that compares how different urban delineation approaches shape our understanding of urbanization patterns (see, for example, [Roberts et al., 2017](#); [Bosker et al., 2021](#)).

The DoU defines an urban area as a contiguous set of 1 km<sup>2</sup> population grid cells, where each cell has a population density of at least 300 people per km<sup>2</sup>, and the total population of the set of cells is at least 5000. Unlike the dartboard approach, which identifies urban areas based on *relative* thresholds, the DoU is an *absolute* approach.<sup>34</sup> Importantly, the use of a 1 km<sup>2</sup> population grid is part of the DoU approach. Accordingly, to apply this approach, we aggregate the constrained *WorldPop* data to a 1 km<sup>2</sup> resolution, rather than the 250m×250m resolution used for the dartboard approach.

As shown in [Fig. 11](#), similar to the dartboard approach, the DoU approach yields higher estimates of urbanisation rates than official national definitions. Therefore, both approaches indicate that most SSA countries are more urbanized than official definitions suggest. However, this is true for a greater number of countries under the dartboard

approach (38 out of 47) than under the DoU (35 out of 47). Estimates of urbanization rates from both methods are positively correlated with official rates. This correlation is, however, somewhat weaker for the DoU owing to the presence of four outliers – Burundi (BDI), Comoros (COM), Mauritius (MUS), and Rwanda (RWA) – which, according to this approach, are far more urbanized than official statistics suggest. This is not surprising, as these are the four most densely populated countries in SSA. The DoU, being an absolute approach, mechanically translates high average population densities into high urbanization rates. When Burundi, Comoros, Mauritius and Rwanda are excluded from the DoU sample, the correlation between the method's estimated urbanization rates and official figures become much stronger. Specifically, the  $R^2$  increases from 0.15 to 0.52.

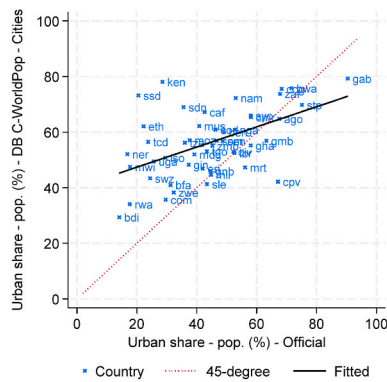
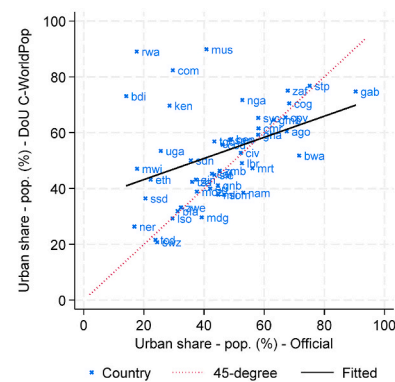
Although urbanization rates from both the dartboard and DoU approaches are positively correlated with official rates across countries, the two approaches yield urbanization rates that are effectively uncorrelated with each other – the  $R^2$  from regressing the dartboard rate on the corresponding DoU rate is 0.03. This lack of correlation reflects the fact that the dartboard (DB) approach isolates concentration within a country, whereas the degree of urbanisation (DoU) mixes spatial concentration with the country's overall population density.

As expected from the previous results, Rwanda, Comoros, Burundi, and Mauritius are the four SSA countries where the urbanization rate based on the DoU approach most exceeds that based on the dartboard method ([Table 2](#); see also panel a of [Fig. 13](#) for an illustration of this for Rwanda).<sup>35</sup> Conversely, the dartboard method suggests considerably higher urbanization than the DoU for South Sudan, Chad, Namibia, Niger, and Botswana. These contrasting results reflect the fundamental differences between the two methods: the dartboard method is relative, while the DoU is an absolute approach. The relatively higher urbanization rates for the latter group of countries under the dartboard approach reflect highly uneven spatial population distributions. In

<sup>33</sup> Results are qualitatively identical if we include towns, as defined by the dartboard approach, in the comparison. These additional results are available on request.

<sup>34</sup> A related difference between the approaches is that while our application of the dartboard approach takes account of the presence of significant desert areas, the DoU does not. Hence, the dartboard approach identifies urban grid cells based on their density *relative to the density of all cells within a country that are potentially habitable*, where the potentially habitable areas exclude deserts.

<sup>35</sup> Cabo Verde, which is listed in [Table 2](#) as having the fifth largest margin by which the urbanization rate based on the DoU exceeds that based on the dartboard approach, has the tenth highest population density out of the 47 SSA countries considered in this paper.

(a) Dartboard ( $R^2 = 0.26$ )(b) Degree of Urbanization ( $R^2 = 0.15$ )**Fig. 11. Correlation with official urban population shares across 47 SSA countries – dartboard approach (cities only) and degree of urbanization**

**Notes:** In each graph, the horizontal axis shows the share of a country's population that lived in officially defined urban areas in 2021 based on data from the United Nations World Urbanization Prospects: 2018 Revision database (<https://population.un.org/wup/>). The vertical axis in panel (a) shows the share of a country's population that lives in cities as defined by the dartboard approach, while the vertical axis in panel (b) shows a country's urbanization rate based on the degree of urbanization.

**Table 2**

Largest differences in urbanization rates between the dartboard (DB) and degree of urbanization (DoU) approaches.

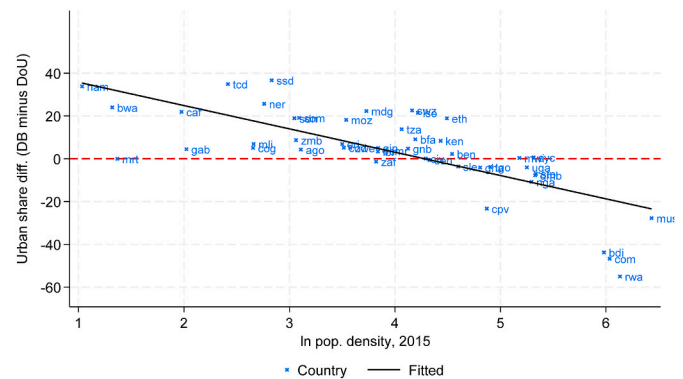
| Top 5 – DB > DoU |      |      |          | Top 5 – DoU > DB |      |      |          |
|------------------|------|------|----------|------------------|------|------|----------|
| Country          | DB   | DoU  | DB - DoU | Country          | DB   | DoU  | DB - DoU |
| South Sudan      | 73.2 | 36.5 | 36.7     | Rwanda           | 34.1 | 89.1 | -55.0    |
| Chad             | 56.5 | 21.6 | 34.9     | Comoros          | 35.7 | 82.4 | -46.7    |
| Namibia          | 72.3 | 38.5 | 33.8     | Burundi          | 29.4 | 73.1 | -43.7    |
| Niger            | 52.1 | 26.4 | 25.7     | Mauritius        | 62.2 | 89.9 | -27.7    |
| Botswana         | 75.8 | 51.8 | 24.0     | Cabo Verde       | 42.2 | 65.5 | -23.3    |

**Note:** Results based on 47 countries. Urbanization rates for the dartboard approach are based on cities only.

contrast, the DoU approach captures the average population density, which is low in these countries compared to Burundi, Comoros, Mauritius, and Rwanda.<sup>36</sup>

Finally, and in line with the observations above, there is a strong and statistically significant correlation, at the 1 percent level, between the difference in the urbanization rates generated by the dartboard and DoU approaches (i.e., dartboard *minus* DoU) and a country's average population density (Fig. 12). This underscores the largely mechanical effect of a country's average population density on urbanization levels under the DoU approach.

Beyond these general differences, comparing the urbanization maps obtained from each method, available for systematic exploration at <http://www.arcgis.com/apps/Compare/index.html?appid=c1cb50e173e54c58b4770b7db8ea1c65>, is particularly insightful. Fig. 13 illustrates how the DoU approach classifies most of Rwanda as urban (in blue and pink), simply because population density is, as shown in Fig. 3, uniformly high across the country. In contrast, the dartboard approach is more selective, better identifying urban areas as relative density peaks. As a result, there are very few areas classified as urban by the dartboard method but not by the DoU approach (as indicated by the near absence of orange areas on the map). This being said, both methods tend to agree on the densest parts of the country. In Lesotho, a country with below average overall population density, the opposite pattern emerges. The

**Fig. 12. Correlation between difference in urbanization rates and average population density across countries ( $R^2 = 0.53$ )**

**Notes:** Data on average population densities taken from the World Bank's World Development Indicators (WDI) database (<https://databank.worldbank.org/source/world-development-indicators>). Urbanization rates for the dartboard approach as based on cities only.

dartboard approach captures urban density peaks not classified as urban under the DoU approach (orange areas). Conversely, areas classified as urban by the DoU and not by the dartboard approach (pink areas) are rare. These comparisons illustrate the advantage of using relative thresholds, which are more selective and adapt to the local context, notably by accounting for uninhabitable areas, a key consideration in countries with large desert regions for example.

The discussion above highlights that while the dartboard and DoU approaches align on some broad patterns of urbanization in SSA – most notably that most SSA countries are more urbanized than official data suggest – they can produce markedly different results for individual countries. These discrepancies reflect the distinct perspectives on urbanization adopted by each method: absolute versus relative, high-density places versus spatial concentration. Both perspectives offer valuable insights, and when combined, provide a more nuanced understanding of urbanization. As such, the two approaches should be considered as complementary rather than competing methods.

## 7. Summary and conclusion

Sub-Saharan Africa has, over the last six decades, been among the world's fastest urbanizing regions. By 2050, the number of people living

<sup>36</sup> A large share of land area in Chad (50.1 percent) and Niger (66.9 percent) is desert. If we were to calculate average population densities only over the "potentially habitable" areas of these countries, these would be much higher.

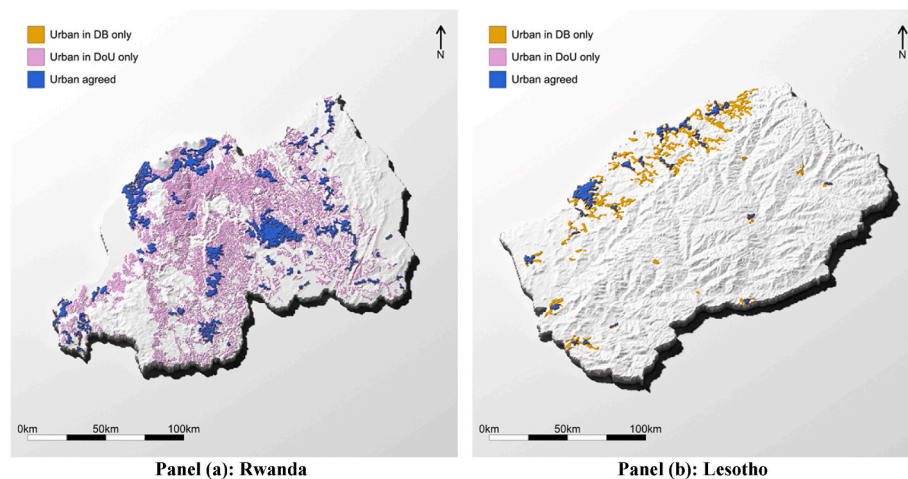


**Fig. 13. Maps of urban areas in Rwanda and Lesotho – dartboard vs- degree of urbanization**

**Notes:** The two maps are color coded according to whether the dartboard and degree of urbanization approaches agree or disagree on the classification of areas as urban. DB denotes dartboard approach (cities only) and DoU degree of urbanization. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

in its towns and cities is projected to expand by an additional 0.72 billion. Despite this rapid transformation, surprisingly little is known about the detailed patterns of urbanization across the region's countries. In this paper, we have attempted to bridge this gap by applying the dartboard algorithm to gridded population data derived from very high-resolution satellite imagery of building footprints, enabling us to delineate urban areas across 47 SSA countries. Using this data, we have provided a detailed descriptive analysis of patterns of urbanization within the region for circa 2015, capturing variation both across and within urban areas.

Our results reveal, inter alia, that most SSA countries are more urbanized than suggested by official definitions. Nevertheless, significant differences remain in the share of the population living in urban areas across countries, with this share being positively correlated with both a country's level of development and its land area. For most countries, and regardless of the type of urban area considered – i.e., cities, towns, or both – built-up area elasticities are greater than one, implying that a doubling of an urban area's population is associated with a more than doubling of its built-up area. The overall land area of cities also expands in almost exact proportion to population. In this regard, SSA countries differ from high-income countries, which typically have built-up area elasticities that are less than unity and lower land area elasticities. However, along other dimensions, urbanization patterns within SSA more closely resemble those in developed countries. Hence, SSA countries tend to have both capital cities whose shares of national population and levels of urban primacy are, on average, similar to those in high-income countries. Besides, city size distributions within the region conform well to Zipf's law, with similar slope estimates. Regarding the internal structures of cities, most cities in SSA countries possess only a single statistically significant peak in population density, along with both negative population and built-up gradients. However, this is not true for all cities. Many of the largest cities in the region, including capital cities, contain numerous densely populated (sub-)centers. In some cases, these reflect densely populated informal settlements; in others they result from urban expansion over a wide area, where a dominant population center is linked with many smaller population sub-centers via ribbon development along major transport arteries. Despite this complexity, the populations of centers within cities, where multiple exist, follow a strong rank-size distribution – on average, a city's largest center has 22.8 times the population of its second largest center. As a result, the monocentric urban structure, with population density declining from a main center to the periphery, remains, with a few exceptions, a good approximation, even for those cities with multiple centers.

While our analysis offers new insights into urbanization patterns across and within SSA countries, several limitations should be acknowledged. Most notably, our analysis is limited to a single cross-section, circa 2015, due to limitations in the underlying population data used as input to the analysis. Thus, the detailed map of building footprints that supports the construction of spatially precise population data is only available for this period. Moreover, even for this year – though it is the best available – the reliability of our population data remains constrained by the quality of the census data available from national population Censuses in the region. In some SSA countries, this data is quite outdated, and in many cases, it is only available for large administrative regions, rather than, for example, small census tracts. This limitation explains the need for top-down gridding methods to estimate population distributions in the first place. In this context, improving the quality and spatial resolution of available population Census data for SSA countries is essential to advance our understanding of urbanization in the region.

#### CRediT authorship contribution statement

**Pierre-Philippe Combes:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Clément Gorin:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Shohei Nakamura:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Mark Roberts:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

One of the authors is an Editorial Board Member/Editor-in-Chief/Associate Editor/Guest Editor for *Regional Science and Urban Economics* and was not involved in the editorial review or the decision to publish this article.

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from the University of Southampton's *WorldPop* group in generating constrained *WorldPop* gridded population data for 2015. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

## Annex 1. Country and urbanization characteristics over 47 SSA countries

**Table A1**

Country general and urbanization characteristics

|                    |             | Mean  | Std. Error | P10  | P25  | P50   | P75   | P90    |
|--------------------|-------------|-------|------------|------|------|-------|-------|--------|
| Population (mil.)  | Country     | 21.0  | 32.0       | 1.1  | 2.5  | 11.5  | 23.9  | 51.5   |
| Area ('000s km2)   | Country     | 517.0 | 541.1      | 4.6  | 58.0 | 325.9 | 831.1 | 1258.0 |
| Official urban (%) | Country     | 44.0  | 17.4       | 20.5 | 29.6 | 43.4  | 56.1  | 67.8   |
| Pop. share (%)     | Urban Areas | 75.1  | 11.2       | 61.0 | 70.4 | 76.1  | 82.9  | 88.6   |
|                    | Cities      | 56.1  | 12.3       | 41.0 | 47.3 | 56.2  | 65.4  | 73.8   |
|                    | Towns       | 19.0  | 6.6        | 10.7 | 14.8 | 18.3  | 24.3  | 26.6   |
|                    | Urban Cores | 39.1  | 11.8       | 22.6 | 31.8 | 39.0  | 44.6  | 55.9   |
| Area share (%)     | Urban Areas | 5.9   | 3.5        | 2.0  | 3.5  | 4.8   | 7.9   | 11.2   |
|                    | Cities      | 3.4   | 2.7        | 0.8  | 1.4  | 2.3   | 4.6   | 8.0    |
|                    | Towns       | 2.5   | 1.3        | 1.1  | 1.6  | 2.4   | 3.0   | 4.4    |
|                    | Urban Cores | 0.7   | 0.6        | 0.2  | 0.3  | 0.5   | 1.0   | 1.3    |
| Rel. Pop. density  | Urban Areas | 19.9  | 18.0       | 5.3  | 9.2  | 13.2  | 22.8  | 40.2   |
|                    | Cities      | 35.8  | 43.4       | 5.9  | 12.0 | 24.0  | 37.5  | 77.4   |
|                    | Towns       | 9.5   | 7.2        | 3.9  | 5.4  | 8.0   | 10.6  | 18.2   |
|                    | Urban Cores | 123.5 | 150.9      | 17.2 | 34.5 | 72.1  | 134.7 | 345.8  |

**Notes:** *Official urban* refers to the share of the population living in officially nationally defined urban areas; *Pop. share* to the share of national population that lived in the type of area indicated in the second column in 2015; *Area share* to the share of a country's land area occupied by the type of area indicated in the second column in 2015; and *Rel. Pop. density* to the density of the type of area indicated in the second column relative to the average density in the country, averaged over all areas of the corresponding type in the country. PXX corresponds to the XXth percentile in the cross-country distribution.

**Table A2**

Characteristics of delineated areas across 47 SSA countries

|                           |             | Mean   | Std. Error | P10    | P25    | P50    | P75    | P90    |
|---------------------------|-------------|--------|------------|--------|--------|--------|--------|--------|
| Average pop. (inhab.)     | Urban Areas | 5021   | 4485       | 1588   | 1989   | 2817   | 7208   | 12,475 |
|                           | Cities      | 46,590 | 34,425     | 11,524 | 19,798 | 38,154 | 65,921 | 90,905 |
|                           | Towns       | 1308   | 1265       | 407    | 549    | 1004   | 1436   | 2667   |
|                           | Urban Cores | 23,198 | 17,524     | 5961   | 9139   | 18,344 | 33,501 | 46,255 |
| Average area (km2)        | Urban Areas | 5.7    | 3.2        | 2.8    | 3.9    | 5.3    | 7.1    | 9.2    |
|                           | Cities      | 41.3   | 31.2       | 17.9   | 22.7   | 30.9   | 50.3   | 69.7   |
|                           | Towns       | 2.6    | 0.7        | 1.7    | 2.2    | 2.5    | 2.9    | 3.6    |
|                           | Urban Cores | 5.7    | 3.4        | 2.6    | 3.7    | 4.9    | 6.6    | 9.3    |
| Average den. (inhab./km2) | Urban Areas | 620    | 617        | 177    | 204    | 449    | 799    | 1324   |
|                           | Cities      | 1126   | 1064       | 355    | 560    | 867    | 1308   | 2128   |
|                           | Towns       | 572    | 562        | 148    | 198    | 409    | 745    | 1194   |
|                           | Urban Cores | 3038   | 2212       | 936    | 1821   | 2643   | 3747   | 5264   |
| Number of units           | Urban Areas | 4146   | 4467       | 64     | 673    | 2601   | 5497   | 10,407 |
|                           | Cities      | 342    | 431        | 7      | 54     | 169    | 464    | 1226   |
|                           | Towns       | 3804   | 4086       | 57     | 636    | 2461   | 5319   | 9181   |
|                           | Urban Cores | 511    | 674        | 10     | 64     | 223    | 751    | 1840   |
| Area elasticity           | Urban Areas | 0.89   | 0.07       | 0.82   | 0.85   | 0.91   | 0.94   | 0.96   |
|                           | Cities      | 0.86   | 0.10       | 0.71   | 0.78   | 0.88   | 0.94   | 0.97   |
|                           | Towns       | 0.98   | 0.07       | 0.88   | 0.96   | 0.99   | 1.01   | 1.04   |
|                           | Urban Cores | 0.94   | 0.06       | 0.87   | 0.91   | 0.94   | 0.98   | 1.01   |
| Built-up elasticity       | Urban Areas | 1.22   | 0.23       | 0.89   | 1.08   | 1.22   | 1.39   | 1.53   |
|                           | Cities      | 1.21   | 0.20       | 1.00   | 1.09   | 1.20   | 1.37   | 1.48   |
|                           | Towns       | 1.08   | 0.38       | 0.75   | 0.85   | 1.09   | 1.33   | 1.53   |
|                           | Urban Cores | 1.40   | 0.19       | 1.09   | 1.28   | 1.43   | 1.53   | 1.59   |
| Pop. P75/P25              | Urban Areas | 4.8    | 2.5        | 3.0    | 3.6    | 4.2    | 5.0    | 7.2    |
|                           | Cities      | 14.4   | 68.7       | 2.5    | 3.1    | 3.7    | 4.6    | 7.7    |
|                           | Towns       | 3.7    | 1.2        | 2.6    | 3.0    | 3.5    | 4.0    | 5.1    |
|                           | Urban Cores | 9.1    | 28.2       | 3.0    | 3.5    | 4.0    | 5.6    | 8.7    |
| Pop. Sh. Larg.            | Urban Areas | 22.3   | 13.4       | 8.9    | 15.0   | 19.0   | 29.0   | 36.2   |
|                           | Cities      | 22.3   | 13.4       | 8.9    | 15.0   | 19.0   | 29.0   | 36.2   |
|                           | Towns       | 0.8    | 2.5        | 0.1    | 0.1    | 0.2    | 0.4    | 1.2    |
|                           | Urban Cores | 16.1   | 9.0        | 6.0    | 9.3    | 14.3   | 19.7   | 31.4   |

(continued on next page)

Table A2 (continued)

|               |             | Mean | Std. Error | P10 | P25  | P50  | P75  | P90  |
|---------------|-------------|------|------------|-----|------|------|------|------|
| Pop. Sh. Cap. | Cities      | 20.4 | 14.4       | 4.5 | 10.9 | 17.3 | 24.7 | 36.2 |
| Zipf's coef.  | Urban Areas | 0.8  | 0.2        | 0.6 | 0.7  | 0.9  | 0.9  | 1.0  |
|               | Cities      | 0.8  | 0.2        | 0.6 | 0.8  | 0.9  | 0.9  | 1.1  |
|               | Towns       | 1.2  | 0.2        | 0.9 | 1.0  | 1.2  | 1.3  | 1.4  |
|               | Urban Cores | 0.9  | 0.2        | 0.7 | 0.8  | 0.9  | 1.0  | 1.1  |

**Notes:** Urban areas. Cities, Towns, Urban Cores indicate the geographical level for which the statistics are computed. *Area elasticity*: Elasticity of area with respect to population. *Built elasticity*: Elasticity of builtup with respect to population. *Pop. P75/P25*: Interquartile ratio for population. *Pop. Sh. Larg*: Population share of the most populated unit. *Pop Sh. Cap.*: Population share of the capital city. *Zipf's coef.*: Zipf's coefficient for the unit's population distribution. PXX corresponds to the XXth percentile in the cross-country distribution.

## Annex 2. Urbanization characteristics by country

Table A3

Delineated areas' characteristics by country

|                                       |             | Official Urban. | Pop. share | Area share | Relative dens. | Mean pop. | Mean area | Mean dens. | Number units | Area elas. | Built elas. | Pop. P75/P25 | Capital Pop. sh. | Lar. pop. Pop. sh | Zipf |
|---------------------------------------|-------------|-----------------|------------|------------|----------------|-----------|-----------|------------|--------------|------------|-------------|--------------|------------------|-------------------|------|
| Angola (25.6; 1258.0) (20.4)          | Urban Areas |                 | 84.3       | 2.7        | 31.4           | 2322      | 3.6       | 238        | 9312         | 0.9        | 1.2         | 3.2          |                  | 29.8              | 0.7  |
|                                       | Cities      | 67.5            | 64.8       | 0.8        | 77.4           | 96,545    | 61.2      | 867        | 172          | 0.7        | 1.2         | 4.2          | 29.8             | 29.8              | 0.8  |
|                                       | Towns       |                 | 19.6       | 1.9        | 10.6           | 549       | 2.5       | 226        | 9140         | 1.0        | 1.1         | 3.1          |                  | 0.2               | 1.2  |
|                                       | Urban       |                 | 56.3       | 0.2        | 245.2          | 62,996    | 12.6      | 2846       | 229          | 0.9        | 1.4         | 5.8          |                  | 27.8              | 1.0  |
|                                       | Cores       |                 |            |            |                |           |           |            |              |            |             |              |                  |                   |      |
| Benin (10.8; 117.4) (91.9)            | Urban Areas |                 | 73.6       | 6.3        | 11.7           | 6498      | 6.0       | 650        | 1222         | 0.9        | 1.5         | 3.8          |                  | 29.0              | 0.9  |
|                                       | Cities      | 49.0            | 60.0       | 4.1        | 14.6           | 65,302    | 48.7      | 1065       | 99           | 0.9        | 1.0         | 2.5          | 29.0             | 29.0              | 0.8  |
|                                       | Towns       |                 | 13.7       | 2.2        | 6.2            | 1314      | 2.3       | 614        | 1123         | 1.0        | 1.5         | 3.2          |                  | 0.2               | 1.3  |
|                                       | Urban       |                 | 38.6       | 0.9        | 44.2           | 24,762    | 6.1       | 3240       | 168          | 1.0        | 1.3         | 3.5          |                  | 15.3              | 0.9  |
|                                       | Cores       |                 |            |            |                |           |           |            |              |            |             |              |                  |                   |      |
| Botswana (2.2; 582.9) (3.7)           | Urban Areas |                 | 84.8       | 1.5        | 55.0           | 1916      | 9.3       | 84         | 967          | 0.7        | 1.1         | 17.5         |                  | 21.5              | 0.8  |
|                                       | Cities      | 71.6            | 75.8       | 1.0        | 72.3           | 9528      | 35.1      | 215        | 174          | 0.8        | 1.5         | 3.1          | 21.5             | 21.5              | 0.9  |
|                                       | Towns       |                 | 8.9        | 0.5        | 18.2           | 246       | 3.6       | 55         | 793          | 0.8        | 1.0         | 8.0          |                  | 0.2               | 0.8  |
|                                       | Urban       |                 | 60.8       | 0.3        | 233.7          | 5961      | 6.8       | 710        | 223          | 0.9        | 1.5         | 5.3          |                  | 10.4              | 0.5  |
|                                       | Cores       |                 |            |            |                |           |           |            |              |            |             |              |                  |                   |      |
| Burkina Faso (19.0; 276.7) (68.6)     | Urban Areas |                 | 67.2       | 7.9        | 8.5            | 2412      | 4.2       | 404        | 5287         | 0.9        | 1.4         | 4.4          |                  | 15.4              | 0.9  |
|                                       | Cities      | 31.2            | 41.0       | 3.0        | 13.8           | 19,798    | 21.0      | 602        | 393          | 0.9        | 1.5         | 3.0          | 15.4             | 15.4              | 1.1  |
|                                       | Towns       |                 | 26.2       | 5.0        | 5.3            | 1016      | 2.8       | 388        | 4894         | 1.0        | 1.1         | 3.8          |                  | 0.1               | 1.1  |
|                                       | Urban       |                 | 29.6       | 0.7        | 41.5           | 13,055    | 4.6       | 1777       | 431          | 1.0        | 1.7         | 4.2          |                  | 14.6              | 1.0  |
|                                       | Cores       |                 |            |            |                |           |           |            |              |            |             |              |                  |                   |      |
| Burundi (9.8; 27.5) (355.0)           | Urban Areas |                 | 42.1       | 10.3       | 4.1            | 7908      | 5.5       | 1149       | 521          | 0.9        | 1.6         | 5.3          |                  | 11.1              | 0.9  |
|                                       | Cities      | 14.1            | 29.4       | 5.9        | 5.0            | 53,234    | 30.2      | 1792       | 54           | 1.0        | 1.0         | 3.6          | 11.1             | 11.1              | 0.9  |
|                                       | Towns       |                 | 12.7       | 4.4        | 2.9            | 2667      | 2.6       | 1074       | 467          | 1.0        | 1.5         | 4.4          |                  | 0.8               | 1.0  |
|                                       | Urban       |                 | 15.8       | 1.0        | 16.1           | 21,431    | 3.7       | 4522       | 72           | 1.0        | 1.5         | 3.7          |                  | 7.2               | 0.8  |
|                                       | Cores       |                 |            |            |                |           |           |            |              |            |             |              |                  |                   |      |
| Cabo Verde (0.5; 4.6) (112.3)         | Urban Areas |                 | 53.2       | 6.2        | 8.6            | 4258      | 4.4       | 718        | 64           | 0.9        | 1.1         | 4.7          |                  | 22.4              | 0.6  |
|                                       | Cities      | 67.1            | 42.2       | 4.2        | 10.1           | 30,858    | 27.1      | 1244       | 7            | 1.1        | 1.3         | 12.3         | 22.4             | 22.4              | 0.6  |
|                                       | Towns       |                 | 11.0       | 2.0        | 5.4            | 991       | 1.6       | 654        | 57           | 1.0        | 0.6         | 4.1          |                  | 0.9               | 1.0  |
|                                       | Urban       |                 | 25.5       | 1.0        | 26.5           | 13,055    | 4.4       | 2627       | 10           | 0.9        | 1.5         | 4.0          |                  | 17.3              | 0.7  |
|                                       | Cores       |                 |            |            |                |           |           |            |              |            |             |              |                  |                   |      |
| Cameroon (23.9; 471.3) (50.6)         | Urban Areas |                 | 85.6       | 4.7        | 18.4           | 5248      | 5.6       | 505        | 3892         | 0.9        | 1.3         | 4.1          |                  | 15.0              | 0.8  |
|                                       | Cities      | 58.1            | 65.4       | 2.4        | 27.7           | 68,114    | 48.6      | 970        | 229          | 0.9        | 1.2         | 3.6          | 15.0             | 15.0              | 0.8  |
|                                       | Towns       |                 | 20.2       | 2.3        | 8.8            | 1318      | 2.9       | 476        | 3663         | 1.0        | 1.2         | 3.5          |                  | 0.3               | 1.1  |
|                                       | Urban       |                 | 47.2       | 0.4        | 116.1          | 38,998    | 6.6       | 3320       | 289          | 0.9        | 1.3         | 3.9          |                  | 14.3              | 0.9  |
|                                       | Cores       |                 |            |            |                |           |           |            |              |            |             |              |                  |                   |      |
| Central African R. (4.9; 626.4) (7.8) | Urban Areas |                 | 91.5       | 2.4        | 38.2           | 1588      | 5.3       | 151        | 2805         | 0.7        | 1.0         | 7.2          |                  | 19.2              | 1.0  |
|                                       | Cities      | 42.6            | 67.2       | 0.9        | 72.1           | 10,384    | 18.5      | 436        | 315          | 0.7        | 1.2         | 3.3          | 19.2             | 19.2              | 1.1  |
|                                       | Towns       |                 | 24.3       | 1.5        | 16.6           | 475       | 3.7       | 115        | 2490         | 0.8        | 0.9         | 5.3          |                  | 0.2               | 1.0  |
|                                       | Urban       |                 | 54.9       | 0.2        | 345.8          | 6799      | 2.5       | 1994       | 393          | 1.0        | 1.6         | 3.2          |                  | 18.7              | 0.7  |
|                                       | Cores       |                 |            |            |                |           |           |            |              |            |             |              |                  |                   |      |
| Chad (13.8; 1275.0) (10.8)            | Urban Areas |                 | 82.9       | 3.6        | 22.8           | 1095      | 4.5       | 186        | 10,407       | 0.9        | 1.2         | 4.1          |                  | 9.9               | 1.2  |
|                                       | Cities      | 23.8            | 56.5       | 1.8        | 30.8           | 6340      | 19.1      | 285        | 1226         | 0.9        | 1.3         | 3.0          | 9.9              | 9.9               | 1.1  |
|                                       | Towns       |                 | 26.3       | 1.8        | 14.6           | 395       | 2.5       | 173        | 9181         | 1.0        | 0.6         | 3.1          |                  | 0.1               | 1.3  |

(continued on next page)

Table A3 (continued)

|                                          |                | Official<br>Urban. | Pop.<br>share | Area<br>share | Relative<br>dens. | Mean<br>pop. | Mean<br>area | Mean<br>dens. | Number<br>units | Area<br>elas. | Built<br>elas. | Pop.<br>P75/<br>P25 | Capital<br>Pop.<br>sh. | Lar.<br>pop.<br>Pop.<br>sh | Zipf |
|------------------------------------------|----------------|--------------------|---------------|---------------|-------------------|--------------|--------------|---------------|-----------------|---------------|----------------|---------------------|------------------------|----------------------------|------|
| Comoros (0.7; 1.9)<br>(398.3)            | Urban<br>Cores |                    | 37.5          | 0.3           | 108.7             | 2783         | 2.4          | 961           | 1854            | 1.0           | 1.4            | 2.8                 |                        | 9.3                        | 0.9  |
|                                          | Urban<br>Areas |                    | 67.3          | 5.9           | 11.5              | 12,901       | 2.8          | 3437          | 39              | 0.8           | 0.7            | 4.0                 |                        | 24.8                       | 0.9  |
|                                          | Cities         | 29.6               | 35.7          | 1.9           | 18.8              | 66,783       | 8.9          | 6953          | 4               | 0.9           | 1.5            | 4.9                 | 17.0                   | 24.8                       | 0.8  |
|                                          | Towns          |                    | 31.6          | 4.0           | 8.0               | 6743         | 2.1          | 3035          | 35              | 0.9           | 0.8            | 3.4                 |                        | 17.0                       | 0.9  |
|                                          | Urban<br>Cores |                    | 31.2          | 0.8           | 38.3              | 38,909       | 2.6          | 14,067        | 6               | 0.9           | 1.6            | 1.8                 |                        | 19.3                       | 0.7  |
| Congo Brazzaville<br>(3.5; 345.3) (10.3) | Urban<br>Areas |                    | 93.9          | 1.8           | 53.0              | 1989         | 3.7          | 161           | 1672            | 0.8           | 0.9            | 4.5                 |                        | 36.2                       | 0.7  |
|                                          | Cities         | 68.3               | 75.6          | 0.5           | 145.4             | 46,133       | 30.9         | 815           | 58              | 0.7           | 1.4            | 3.9                 | 36.2                   | 36.2                       | 0.8  |
|                                          | Towns          |                    | 18.3          | 1.3           | 14.7              | 402          | 2.7          | 137           | 1614            | 0.9           | 0.8            | 4.2                 |                        | 0.2                        | 1.1  |
|                                          | Urban<br>Cores |                    | 67.5          | 0.1           | 485.9             | 37,344       | 7.5          | 3311          | 64              | 0.9           | 1.6            | 4.6                 |                        | 35.2                       | 0.8  |
|                                          | Cities         |                    |               |               |                   |              |              |               |                 |               |                |                     |                        |                            |      |
| Congo RDC (89.1;<br>2350.1) (37.9)       | Urban<br>Areas |                    | 87.5          | 4.2           | 21.0              | 3588         | 4.5          | 462           | 21,726          | 0.9           | 1.2            | 4.3                 |                        | 7.6                        | 1.0  |
|                                          | Cities         | 46.2               | 60.9          | 1.7           | 36.3              | 36,234       | 26.4         | 1075          | 1497            | 0.8           | 1.1            | 3.5                 | 7.6                    | 7.6                        | 1.0  |
|                                          | Towns          |                    | 26.6          | 2.5           | 10.7              | 1172         | 2.9          | 416           | 20,229          | 1.0           | 1.2            | 3.6                 |                        | 0.1                        | 1.2  |
|                                          | Urban<br>Cores |                    | 46.0          | 0.3           | 152.4             | 20,640       | 3.6          | 3877          | 1984            | 1.0           | 1.5            | 3.5                 |                        | 7.4                        | 0.9  |
|                                          | Cities         |                    |               |               |                   |              |              |               |                 |               |                |                     |                        |                            |      |
| Côte d'Ivoire (23.3;<br>325.9) (71.4)    | Urban<br>Areas |                    | 81.2          | 4.2           | 19.1              | 3837         | 2.8          | 799           | 4921            | 0.9           | 1.6            | 3.3                 |                        | 20.6                       | 0.9  |
|                                          | Cities         | 52.2               | 52.9          | 1.4           | 37.8              | 35,778       | 13.2         | 1520          | 344             | 0.7           | 1.3            | 2.5                 | 1.1                    | 20.6                       | 1.1  |
|                                          | Towns          |                    | 28.3          | 2.8           | 9.9               | 1436         | 2.0          | 745           | 4577            | 1.1           | 1.7            | 2.9                 |                        | 0.1                        | 1.4  |
|                                          | Urban<br>Cores |                    | 44.4          | 0.4           | 100.5             | 28,858       | 4.0          | 5407          | 358             | 1.0           | 1.4            | 4.0                 |                        | 19.7                       | 1.1  |
|                                          | Cities         |                    |               |               |                   |              |              |               |                 |               |                |                     |                        |                            |      |
| Eritrea (3.9; 123.3)<br>(31.3)           | Urban<br>Areas |                    | 70.4          | 3.6           | 19.4              | 2993         | 4.9          | 449           | 907             | 0.9           | 1.1            | 5.0                 |                        | 11.7                       | 0.9  |
|                                          | Cities         | 42.0               | 46.9          | 1.6           | 29.0              | 16,732       | 18.4         | 975           | 108             | 0.8           | 1.5            | 3.4                 | 11.7                   | 11.7                       | 1.0  |
|                                          | Towns          |                    | 23.5          | 2.0           | 11.7              | 1136         | 3.1          | 378           | 799             | 1.0           | 0.1            | 4.0                 |                        | 0.7                        | 1.1  |
|                                          | Urban<br>Cores |                    | 34.0          | 0.3           | 100.5             | 9166         | 2.9          | 2643          | 143             | 1.0           | 1.8            | 4.4                 |                        | 9.0                        | 0.9  |
|                                          | Cities         |                    |               |               |                   |              |              |               |                 |               |                |                     |                        |                            |      |
| Ethiopia (90.9;<br>1139.3) (79.8)        | Urban<br>Areas |                    | 74.4          | 10.9          | 6.8               | 5350         | 9.8          | 448           | 12,653          | 0.9           | 1.2            | 4.6                 |                        | 15.7                       | 1.0  |
|                                          | Cities         | 22.2               | 62.1          | 8.3           | 7.5               | 39,009       | 65.1         | 751           | 1447            | 1.0           | 1.1            | 4.3                 | 4.5                    | 15.7                       | 0.9  |
|                                          | Towns          |                    | 12.4          | 2.7           | 4.7               | 1004         | 2.7          | 409           | 11,206          | 1.0           | 0.8            | 3.6                 |                        | 0.0                        | 1.1  |
|                                          | Urban<br>Cores |                    | 28.4          | 0.9           | 30.6              | 9139         | 3.7          | 1964          | 2822            | 0.9           | 1.6            | 4.0                 |                        | 3.8                        | 0.8  |
|                                          | Cities         |                    |               |               |                   |              |              |               |                 |               |                |                     |                        |                            |      |
| Gabon (2.5; 268.2)<br>(9.1)              | Urban<br>Areas |                    | 94.4          | 1.4           | 68.7              | 2709         | 4.3          | 194           | 855             | 0.7           | 1.1            | 4.1                 |                        | 32.8                       | 0.7  |
|                                          | Cities         | 90.4               | 79.3          | 0.6           | 145.3             | 38,154       | 28.7         | 802           | 51              | 0.7           | 1.2            | 3.8                 | 32.8                   | 32.8                       | 0.8  |
|                                          | Towns          |                    | 15.1          | 0.8           | 18.2              | 461          | 2.8          | 156           | 804             | 0.9           | 1.0            | 3.7                 |                        | 0.4                        | 1.2  |
|                                          | Urban<br>Cores |                    | 70.2          | 0.2           | 397.2             | 30,739       | 8.5          | 2723          | 56              | 0.9           | 1.2            | 5.6                 |                        | 31.5                       | 0.8  |
|                                          | Cities         |                    |               |               |                   |              |              |               |                 |               |                |                     |                        |                            |      |
| Gambia (2.0; 11.3)<br>(176.7)            | Urban<br>Areas |                    | 77.9          | 7.1           | 11.0              | 7760         | 4.0          | 1239          | 200             | 0.9           | 1.8            | 3.2                 |                        | 50.0                       | 0.5  |
|                                          | Cities         | 63.2               | 56.9          | 3.7           | 15.4              | 189,127      | 69.7         | 2687          | 6               | 0.9           | 1.1            | 1.7                 | 50.0                   | 50.0                       | 0.5  |
|                                          | Towns          |                    | 20.9          | 3.4           | 6.2               | 2151         | 2.0          | 1194          | 194             | 1.0           | 2.0            | 3.0                 |                        | 1.2                        | 1.4  |
|                                          | Urban<br>Cores |                    | 40.0          | 1.2           | 32.6              | 79,705       | 13.8         | 4521          | 10              | 0.9           | 0.9            | 10.6                |                        | 32.5                       | 1.0  |
|                                          | Cities         |                    |               |               |                   |              |              |               |                 |               |                |                     |                        |                            |      |
| Ghana (27.8; 241.9)<br>(115.1)           | Urban<br>Areas |                    | 71.5          | 5.6           | 12.8              | 7651         | 5.2          | 824           | 2601            | 0.9           | 1.5            | 4.1                 |                        | 17.3                       | 0.8  |
|                                          | Cities         | 58.0               | 55.2          | 3.1           | 17.7              | 90,905       | 44.6         | 1308          | 169             | 0.9           | 1.1            | 3.6                 | 17.3                   | 17.3                       | 0.9  |
|                                          | Towns          |                    | 16.3          | 2.5           | 6.6               | 1866         | 2.5          | 790           | 2432            | 1.0           | 1.7            | 3.4                 |                        | 0.2                        | 1.2  |
|                                          | Urban<br>Cores |                    | 36.8          | 0.8           | 48.9              | 42,731       | 7.6          | 3810          | 240             | 1.0           | 1.1            | 4.0                 |                        | 13.7                       | 0.9  |
|                                          | Cities         |                    |               |               |                   |              |              |               |                 |               |                |                     |                        |                            |      |
| Guinea (10.8; 248.5)<br>(43.4)           | Urban<br>Areas |                    | 76.1          | 4.8           | 15.8              | 1901         | 2.8          | 418           | 4320            | 0.9           | 1.4            | 2.8                 |                        | 20.2                       | 0.8  |
|                                          | Cities         | 37.3               | 48.3          | 1.4           | 33.9              | 33,432       | 22.7         | 858           | 156             | 0.8           | 1.3            | 3.9                 | 20.2                   | 20.2                       | 0.8  |
|                                          | Towns          |                    | 27.8          | 3.4           | 8.2               | 719          | 2.0          | 402           | 4164            | 1.0           | 1.4            | 2.6                 |                        | 0.3                        | 1.4  |
|                                          | Urban<br>Cores |                    | 41.0          | 0.4           | 90.9              | 25,759       | 6.5          | 2807          | 172             | 1.0           | 1.4            | 3.9                 |                        | 19.4                       | 1.1  |
|                                          | Cities         |                    |               |               |                   |              |              |               |                 |               |                |                     |                        |                            |      |
| Guinea-Bissau (1.7;<br>35.7) (46.5)      | Urban<br>Areas |                    | 72.0          | 4.3           | 16.7              | 1863         | 2.4          | 468           | 642             | 0.9           | 1.4            | 2.6                 |                        | 30.3                       | 0.7  |
|                                          | Cities         | 44.6               | 46.0          | 1.4           | 34.1              | 36,446       | 23.0         | 885           | 21              | 0.7           | 1.1            | 2.8                 | 30.3                   | 30.3                       | 0.8  |
|                                          | Towns          |                    | 25.9          | 3.0           | 8.8               | 694          | 1.7          | 454           | 621             | 0.9           | 1.3            | 2.5                 |                        | 0.4                        | 1.5  |
|                                          | Urban<br>Cores |                    | 37.7          | 0.4           | 97.9              | 27,216       | 6.0          | 2624          | 23              | 0.9           | 1.2            | 3.4                 |                        | 27.8                       | 1.2  |
|                                          | Cities         |                    |               |               |                   |              |              |               |                 |               |                |                     |                        |                            |      |
| Kenya (46.6; 588.8)<br>(79.2)            | Urban<br>Areas |                    | 83.4          | 9.0           | 9.3               | 16,067       | 21.9         | 562           | 2418            | 0.8           | 1.1            | 5.2                 |                        | 33.2                       | 0.9  |
|                                          | Cities         | 28.5               | 78.1          | 8.0           | 9.8               | 97,895       | 126.3        | 1155          | 372             | 0.9           | 1.1            | 3.8                 | 24.2                   | 33.2                       | 0.8  |
|                                          | Towns          |                    | 5.2           | 1.0           | 5.2               | 1189         | 2.9          | 455           | 2047            | 1.0           | 0.8            | 3.6                 |                        | 0.2                        | 1.1  |

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Table A3 (continued)

|                                    |                | Official<br>Urban. | Pop.<br>share | Area<br>share | Relative<br>dens. | Mean<br>pop. | Mean<br>area | Mean<br>dens. | Number<br>units | Area<br>elas. | Built<br>elas. | Pop.<br>P75/<br>P25 | Capital<br>Pop.<br>sh. | Lar.<br>pop.<br>Pop.<br>sh | Zipf |
|------------------------------------|----------------|--------------------|---------------|---------------|-------------------|--------------|--------------|---------------|-----------------|---------------|----------------|---------------------|------------------------|----------------------------|------|
| Lesotho (1.9; 30.9)<br>(60.8)      | Urban<br>Cores |                    | 33.9          | 0.7           | 47.7              | 18,344       | 4.9          | 2734          | 861             | 0.9           | 1.4            | 4.0                 |                        | 9.8                        | 0.8  |
|                                    | Urban<br>Areas |                    | 73.4          | 11.2          | 6.6               | 2112         | 5.3          | 319           | 653             | 1.0           | 1.3            | 4.0                 |                        | 17.7                       | 0.6  |
|                                    | Cities         | 29.5               | 50.8          | 6.4           | 7.9               | 25,832       | 53.6         | 403           | 37              | 0.9           | 1.5            | 8.8                 | 17.7                   | 17.7                       | 0.4  |
|                                    | Towns          |                    | 22.5          | 4.8           | 4.7               | 688          | 2.4          | 314           | 616             | 1.0           | 1.1            | 3.7                 |                        | 0.4                        | 1.1  |
|                                    | Urban<br>Cores |                    | 28.2          | 1.3           | 22.3              | 7807         | 5.8          | 936           | 68              | 0.8           | 1.5            | 7.3                 |                        | 14.5                       | 0.9  |
| Liberia (4.1; 97.6)<br>(41.6)      | Urban<br>Areas |                    | 75.6          | 3.6           | 21.2              | 2376         | 2.7          | 482           | 1293            | 1.0           | 1.4            | 2.7                 |                        | 33.4                       | 0.7  |
|                                    | Cities         | 52.6               | 52.5          | 1.3           | 41.8              | 39,556       | 22.7         | 929           | 54              | 0.8           | 1.7            | 4.5                 | 33.4                   | 33.4                       | 0.9  |
|                                    | Towns          |                    | 23.0          | 2.3           | 10.0              | 756          | 1.8          | 463           | 1239            | 1.1           | 1.4            | 2.5                 |                        | 0.3                        | 1.6  |
|                                    | Urban<br>Cores |                    | 44.5          | 0.4           | 101.4             | 31,231       | 7.4          | 3164          | 58              | 1.0           | 1.6            | 5.9                 |                        | 31.4                       | 1.1  |
|                                    | Urban<br>Areas |                    | 75.2          | 8.2           | 9.2               | 1915         | 5.3          | 271           | 9222            | 0.9           | 1.0            | 3.6                 |                        | 18.0                       | 1.0  |
| Madagascar (23.5;<br>598.1) (39.3) | Cities         | 39.2               | 52.0          | 4.3           | 12.0              | 22,030       | 46.6         | 436           | 555             | 1.0           | 1.0            | 3.7                 | 18.0                   | 18.0                       | 0.9  |
|                                    | Towns          |                    | 23.1          | 3.9           | 6.0               | 627          | 2.7          | 260           | 8667            | 1.0           | 0.8            | 3.1                 |                        | 0.2                        | 1.2  |
|                                    | Urban<br>Cores |                    | 30.3          | 0.6           | 55.3              | 7308         | 3.4          | 1535          | 973             | 1.0           | 1.2            | 3.0                 |                        | 11.1                       | 0.9  |
|                                    | Urban<br>Areas |                    | 63.5          | 10.8          | 5.9               | 5578         | 7.2          | 681           | 1809            | 1.0           | 1.3            | 4.2                 |                        | 19.0                       | 0.9  |
|                                    | Cities         | 17.7               | 47.5          | 7.4           | 6.4               | 41,493       | 49.3         | 854           | 182             | 1.0           | 1.2            | 5.2                 | 8.6                    | 19.0                       | 0.9  |
| Malawi (15.9; 120.9)<br>(131.5)    | Towns          |                    | 16.0          | 3.4           | 4.7               | 1560         | 2.5          | 661           | 1627            | 1.0           | 1.1            | 3.5                 |                        | 0.1                        | 1.2  |
|                                    | Urban<br>Cores |                    | 21.1          | 1.0           | 21.3              | 9824         | 3.5          | 2120          | 342             | 0.9           | 1.6            | 3.3                 |                        | 5.0                        | 0.9  |
|                                    | Urban<br>Areas |                    | 80.3          | 2.0           | 40.2              | 1621         | 2.7          | 385           | 9190            | 0.9           | 1.4            | 3.4                 |                        | 16.4                       | 1.2  |
|                                    | Cities         | 44.7               | 44.7          | 0.5           | 93.8              | 13,609       | 9.9          | 804           | 610             | 0.7           | 1.5            | 2.2                 | 16.4                   | 16.4                       | 1.2  |
|                                    | Towns          |                    | 35.5          | 1.5           | 23.4              | 769          | 2.2          | 355           | 8580            | 1.0           | 1.4            | 3.0                 |                        | 0.1                        | 1.4  |
| Mali (18.6; 1261.9)<br>(14.7)      | Urban<br>Cores |                    | 39.0          | 0.1           | 291.8             | 11,096       | 2.6          | 3172          | 653             | 1.0           | 1.7            | 2.3                 |                        | 14.1                       | 1.2  |
|                                    | Urban<br>Areas |                    | 72.8          | 0.7           | 97.8              | 1090         | 3.1          | 199           | 2507            | 0.8           | 0.8            | 3.8                 |                        | 19.0                       | 0.9  |
|                                    | Cities         | 56.1               | 47.3          | 0.2           | 236.5             | 11,524       | 13.6         | 657           | 154             | 0.8           | 1.0            | 3.0                 | 19.0                   | 19.0                       | 1.0  |
|                                    | Towns          |                    | 25.5          | 0.5           | 46.8              | 407          | 2.4          | 169           | 2353            | 1.0           | 0.2            | 3.3                 |                        | 0.1                        | 1.3  |
|                                    | Urban<br>Cores |                    | 40.3          | 0.1           | 798.9             | 8592         | 3.0          | 1821          | 176             | 0.9           | 1.4            | 4.3                 |                        | 19.0                       | 1.0  |
| Mauritania (3.8;<br>1046.8) (3.6)  | Urban<br>Areas |                    | 76.9          | 14.6          | 5.3               | 21,459       | 7.1          | 2402          | 45              | 0.9           | 1.1            | 4.2                 |                        | 43.8                       | 0.6  |
|                                    | Cities         | 40.8               | 62.2          | 10.8          | 5.7               | 60,021       | 18.2         | 2765          | 13              | 1.0           | 1.1            | 2.0                 | 43.8                   | 43.8                       | 0.8  |
|                                    | Towns          |                    | 14.8          | 3.8           | 3.9               | 5793         | 2.6          | 2254          | 32              | 1.0           | 0.9            | 2.7                 |                        | 1.8                        | 1.5  |
|                                    | Urban<br>Cores |                    | 36.0          | 3.4           | 10.6              | 25,112       | 4.1          | 5546          | 18              | 0.9           | 1.1            | 6.6                 |                        | 21.3                       | 0.9  |
|                                    | Urban<br>Areas |                    | 74.2          | 5.6           | 13.2              | 2632         | 6.1          | 275           | 7346            | 0.9           | 1.0            | 5.1                 |                        | 8.9                        | 0.9  |
| Mozambique (26.1;<br>795.7) (32.8) | Cities         | 37.6               | 57.1          | 3.2           | 18.0              | 20,541       | 34.9         | 579           | 725             | 0.9           | 1.1            | 4.1                 | 8.9                    | 8.9                        | 0.9  |
|                                    | Towns          |                    | 17.0          | 2.4           | 7.0               | 671          | 2.9          | 242           | 6621            | 1.0           | 0.8            | 3.9                 |                        | 0.2                        | 1.1  |
|                                    | Urban<br>Cores |                    | 39.5          | 0.5           | 78.7              | 10,951       | 4.2          | 1831          | 941             | 0.9           | 1.4            | 4.0                 |                        | 8.3                        | 0.8  |
|                                    | Urban<br>Areas |                    | 82.5          | 3.5           | 23.5              | 466          | 7.3          | 31            | 3981            | 0.8           | 1.0            | 3.3                 |                        | 28.1                       | 0.7  |
|                                    | Cities         | 53.0               | 72.3          | 2.3           | 31.2              | 15,610       | 185.4        | 294           | 104             | 0.8           | 1.1            | 7.7                 | 15.9                   | 28.1                       | 0.7  |
| Namibia (2.2; 831.1)<br>(2.7)      | Towns          |                    | 10.2          | 1.2           | 8.6               | 59           | 2.5          | 24            | 3877            | 1.0           | 0.9            | 3.0                 |                        | 0.1                        | 1.1  |
|                                    | Urban<br>Cores |                    | 42.5          | 0.1           | 405.7             | 4615         | 4.2          | 537           | 207             | 0.8           | 1.3            | 4.1                 |                        | 15.7                       | 0.9  |
|                                    | Urban<br>Areas |                    | 78.6          | 2.8           | 28.4              | 2067         | 4.5          | 395           | 7352            | 0.9           | 1.2            | 3.8                 |                        | 7.8                        | 1.3  |
|                                    | Cities         | 16.8               | 52.1          | 1.5           | 35.9              | 10,400       | 17.9         | 587           | 969             | 0.9           | 1.1            | 2.9                 | 7.0                    | 7.8                        | 1.1  |
|                                    | Towns          |                    | 26.5          | 1.3           | 20.2              | 802          | 2.5          | 366           | 6383            | 1.0           | 1.2            | 2.9                 |                        | 0.1                        | 1.4  |
| Niger (19.3; 1191.8)<br>(16.2)     | Urban<br>Cores |                    | 32.9          | 0.2           | 134.7             | 4652         | 2.1          | 1833          | 1368            | 1.0           | 1.4            | 2.5                 |                        | 6.0                        | 1.0  |
|                                    | Urban<br>Areas |                    | 76.8          | 6.5           | 11.8              | 12,475       | 5.3          | 1590          | 11,412          | 0.9           | 1.5            | 3.9                 |                        | 6.6                        | 0.9  |
|                                    | Cities         | 52.7               | 60.9          | 4.1           | 14.9              | 85,455       | 28.4         | 2642          | 1321            | 0.9           | 1.2            | 3.3                 | 1.2                    | 6.6                        | 1.0  |
|                                    | Towns          |                    | 15.9          | 2.4           | 6.5               | 2921         | 2.2          | 1453          | 10,091          | 1.0           | 1.5            | 2.9                 |                        | 0.0                        | 1.4  |
|                                    | Urban<br>Cores |                    | 41.0          | 1.0           | 40.9              | 41,282       | 5.0          | 7626          | 1840            | 1.0           | 1.4            | 3.8                 |                        | 5.9                        | 0.9  |
| Nigeria (185.3; 918.7)<br>(201.7)  | Urban<br>Areas |                    | 49.9          | 14.5          | 3.4               | 9053         | 5.9          | 1324          | 634             | 1.0           | 1.4            | 4.4                 |                        | 10.4                       | 0.9  |
|                                    | Cities         | 17.6               | 34.1          | 8.6           | 4.0               | 60,289       | 34.5         | 1567          | 65              | 1.0           | 1.4            | 3.6                 | 10.4                   | 10.4                       | 0.7  |
|                                    | Towns          |                    | 15.8          | 5.8           | 2.7               | 3199         | 2.7          | 1296          | 569             | 1.0           | 1.3            | 3.5                 |                        | 0.5                        | 1.2  |

(continued on next page)

Table A3 (continued)

|                                             |                | Official<br>Urban. | Pop.<br>share | Area<br>share | Relative<br>dens. | Mean<br>pop. | Mean<br>area | Mean<br>dens. | Number<br>units | Area<br>elas. | Built<br>elas. | Pop.<br>P75/<br>P25 | Capital<br>Pop.<br>sh. | Lar.<br>pop.<br>Pop.<br>sh | Zipf |
|---------------------------------------------|----------------|--------------------|---------------|---------------|-------------------|--------------|--------------|---------------|-----------------|---------------|----------------|---------------------|------------------------|----------------------------|------|
| Sao Tome and Principe<br>(0.2; 1.1) (167.0) | Urban<br>Cores |                    | 16.5          | 1.7           | 9.9               | 18,028       | 4.1          | 3478          | 105             | 0.9           | 1.5            | 4.1                 |                        | 7.9                        | 0.9  |
|                                             | Urban<br>Areas |                    | 77.9          | 6.3           | 12.3              | 14,718       | 7.2          | 1342          | 10              | 0.8           | .              | 7.2                 |                        | 66.2                       | 0.5  |
|                                             | Cities         | 75.1               | 69.8          | 5.2           | 13.5              | 65,921       | 29.3         | 2128          | 2               | 1.0           | .              | 18.6                | 66.2                   | 66.2                       | 0.4  |
|                                             | Towns          |                    | 8.1           | 1.1           | 7.0               | 1918         | 1.6          | 1146          | 8               | 0.9           | .              | 2.3                 |                        | 3.4                        | 1.2  |
|                                             | Urban<br>Cores |                    | 44.6          | 1.3           | 34.5              | 28,063       | 4.9          | 5264          | 3               | 0.9           | .              | 24.4                |                        | 40.5                       | 0.6  |
| Senegal (14.3; 199.9)<br>(71.4)             | Urban<br>Areas |                    | 79.1          | 4.1           | 19.2              | 4387         | 3.2          | 714           | 2572            | 0.9           | 1.3            | 3.0                 |                        | 24.1                       | 0.8  |
|                                             | Cities         | 48.6               | 56.8          | 1.6           | 35.1              | 72,940       | 29.1         | 1442          | 111             | 0.8           | 1.5            | 2.8                 | 24.1                   | 24.1                       | 0.9  |
|                                             | Towns          |                    | 22.3          | 2.5           | 8.9               | 1295         | 2.0          | 681           | 2461            | 1.0           | 1.3            | 2.7                 |                        | 0.2                        | 1.4  |
|                                             | Urban<br>Cores |                    | 45.6          | 0.4           | 101.0             | 46,459       | 6.4          | 4683          | 140             | 1.0           | 1.5            | 4.5                 |                        | 21.4                       | 1.0  |
|                                             | Cities         |                    | 76.7          | 8.4           | 9.1               | 7208         | 6.7          | 812           | 10              | 0.9           | 1.3            | 11.7                |                        | 65.9                       | 0.3  |
| Seychelles (0.1; 0.8)<br>(117.9)            | Urban<br>Areas |                    | 76.7          | 8.4           | 9.1               | 7208         | 6.7          | 812           | 10              | 0.9           | 1.3            | 11.7                |                        | 65.9                       | 0.3  |
|                                             | Cities         | 58.0               | 66.0          | 6.9           | 9.6               | 31,024       | 27.4         | 914           | 2               | 0.9           | 1.2            | 475.3               | 65.9                   | 65.9                       | 0.2  |
|                                             | Towns          |                    | 10.7          | 1.5           | 7.0               | 1253         | 1.5          | 787           | 8               | 0.9           | 1.3            | 7.8                 |                        | 2.8                        | 0.7  |
|                                             | Urban<br>Cores |                    | 32.8          | 1.9           | 17.2              | 10,280       | 5.1          | 1587          | 3               | 0.8           | 1.4            | 196.9               |                        | 27.3                       | 0.5  |
|                                             | Cities         |                    | 76.8          | 3.8           | 20.1              | 1667         | 5.5          | 187           | 4472            | 0.8           | 0.9            | 4.8                 |                        | 15.2                       | 1.0  |
| Sierra Leone (6.2; 73.7) (84.0)             | Urban<br>Areas |                    | 66.5          | 4.5           | 14.9              | 2817         | 2.3          | 839           | 1461            | 1.0           | 1.6            | 2.5                 |                        | 15.9                       | 0.8  |
|                                             | Cities         | 43.4               | 41.3          | 1.4           | 29.0              | 44,114       | 18.1         | 1525          | 58              | 0.8           | 1.4            | 3.8                 | 15.9                   | 15.9                       | 0.9  |
|                                             | Towns          |                    | 25.2          | 3.0           | 8.3               | 1110         | 1.6          | 810           | 1403            | 1.2           | 1.7            | 2.3                 |                        | 0.3                        | 1.6  |
|                                             | Urban<br>Cores |                    | 34.6          | 0.5           | 72.1              | 33,501       | 5.5          | 4681          | 64              | 1.0           | 1.5            | 3.9                 |                        | 14.2                       | 1.2  |
|                                             | Cities         |                    | 76.8          | 3.8           | 20.1              | 1667         | 5.5          | 187           | 4472            | 0.8           | 0.9            | 4.8                 |                        | 15.2                       | 1.0  |
| Somalia (9.7; 640.2)<br>(15.2)              | Urban<br>Areas |                    | 76.8          | 3.8           | 20.1              | 1667         | 5.5          | 187           | 4472            | 0.8           | 0.9            | 4.8                 |                        | 15.2                       | 1.0  |
|                                             | Cities         | 46.7               | 56.9          | 1.8           | 31.7              | 15,610       | 32.4         | 560           | 354             | 0.9           | 1.2            | 3.1                 | 15.2                   | 15.2                       | 0.9  |
|                                             | Towns          |                    | 19.9          | 2.0           | 9.8               | 469          | 3.1          | 155           | 4119            | 0.9           | 0.8            | 4.0                 |                        | 0.7                        | 1.0  |
|                                             | Urban<br>Cores |                    | 41.3          | 0.2           | 177.9             | 8371         | 3.1          | 1813          | 479             | 0.9           | 1.4            | 3.3                 |                        | 13.3                       | 0.8  |
|                                             | Cities         |                    | 89.5          | 3.5           | 25.7              | 10,594       | 9.2          | 495           | 4661            | 0.8           | 1.5            | 6.8                 |                        | 20.8                       | 0.8  |
| South Africa (55.1; 1228.4) (44.9)          | Urban<br>Areas |                    | 89.5          | 3.5           | 25.7              | 10,594       | 9.2          | 495           | 4661            | 0.8           | 1.5            | 6.8                 |                        | 20.8                       | 0.8  |
|                                             | Cities         | 67.8               | 73.8          | 1.9           | 38.8              | 87,726       | 50.3         | 1228          | 464             | 0.9           | 1.2            | 4.6                 | 20.8                   | 20.8                       | 0.9  |
|                                             | Towns          |                    | 15.7          | 1.6           | 9.9               | 2066         | 4.6          | 414           | 4197            | 0.9           | 1.4            | 5.1                 |                        | 0.2                        | 0.9  |
|                                             | Urban<br>Cores |                    | 55.9          | 0.5           | 104.2             | 41,076       | 8.8          | 3740          | 751             | 0.9           | 1.1            | 6.1                 |                        | 7.4                        | 0.7  |
|                                             | Cities         |                    | 87.5          | 6.6           | 13.2              | 2754         | 11.1         | 177           | 3750            | 0.9           | 0.9            | 6.0                 |                        | 6.5                        | 0.9  |
| South Sudan (11.8; 630.3) (18.7)            | Urban<br>Areas |                    | 87.5          | 6.6           | 13.2              | 2754         | 11.1         | 177           | 3750            | 0.9           | 0.9            | 6.0                 |                        | 6.5                        | 0.9  |
|                                             | Cities         | 20.5               | 73.2          | 4.6           | 15.8              | 16,429       | 55.4         | 355           | 526             | 0.9           | 0.8            | 5.6                 | 2.9                    | 6.5                        | 0.8  |
|                                             | Towns          |                    | 14.3          | 2.0           | 7.1               | 522          | 3.9          | 148           | 3224            | 1.0           | 0.8            | 3.6                 |                        | 0.4                        | 1.0  |
|                                             | Urban<br>Cores |                    | 43.4          | 0.8           | 55.8              | 5068         | 4.8          | 935           | 1011            | 0.9           | 1.1            | 4.2                 |                        | 2.4                        | 0.7  |
|                                             | Cities         |                    | 88.6          | 3.5           | 25.2              | 2695         | 5.4          | 277           | 12,209          | 0.8           | 1.1            | 4.9                 |                        | 16.9                       | 1.0  |
| Sudan (37.2; 1859.4)<br>(20.0)              | Urban<br>Areas |                    | 88.6          | 3.5           | 25.2              | 2695         | 5.4          | 277           | 12,209          | 0.8           | 1.1            | 4.9                 |                        | 16.9                       | 1.0  |
|                                             | Cities         | 35.6               | 69.0          | 1.8           | 37.5              | 18,004       | 24.0         | 555           | 1423            | 0.8           | 1.3            | 3.1                 | 16.9                   | 16.9                       | 1.0  |
|                                             | Towns          |                    | 19.6          | 1.7           | 11.7              | 676          | 2.9          | 240           | 10,786          | 1.0           | 0.9            | 3.6                 |                        | 0.0                        | 1.2  |
|                                             | Urban<br>Cores |                    | 53.9          | 0.4           | 119.4             | 9194         | 3.9          | 1923          | 2176            | 1.0           | 1.4            | 3.5                 |                        | 13.3                       | 0.8  |
|                                             | Cities         |                    | 63.2          | 13.8          | 4.6               | 2361         | 8.5          | 204           | 285             | 0.9           | 1.2            | 8.4                 |                        | 24.7                       | 0.6  |
| Swaziland (1.1; 17.6)<br>(60.5)             | Urban<br>Areas |                    | 63.2          | 13.8          | 4.6               | 2361         | 8.5          | 204           | 285             | 0.9           | 1.2            | 8.4                 |                        | 24.7                       | 0.6  |
|                                             | Cities         | 24.4               | 43.4          | 7.7           | 5.7               | 21,997       | 64.2         | 284           | 21              | 1.0           | 0.8            | 4.2                 | 24.7                   | 24.7                       | 0.8  |
|                                             | Towns          |                    | 19.8          | 6.2           | 3.2               | 799          | 4.1          | 198           | 264             | 1.0           | 1.0            | 7.5                 |                        | 0.7                        | 0.8  |
|                                             | Urban<br>Cores |                    | 22.0          | 1.4           | 16.4              | 6509         | 6.6          | 639           | 36              | 0.9           | 1.3            | 8.7                 |                        | 10.7                       | 0.7  |
|                                             | Cities         |                    | 73.0          | 7.0           | 10.5              | 4397         | 7.8          | 355           | 8544            | 0.9           | 1.1            | 5.7                 |                        | 11.0                       | 0.9  |
| Tanzania (51.5; 949.9)<br>(54.2)            | Urban<br>Areas |                    | 73.0          | 7.0           | 10.5              | 4397         | 7.8          | 355           | 8544            | 0.9           | 1.1            | 5.7                 |                        | 11.0                       | 0.9  |
|                                             | Cities         | 36.0               | 56.2          | 4.1           | 13.8              | 33,484       | 44.6         | 680           | 864             | 1.0           | 1.1            | 3.5                 | 0.6                    | 11.0                       | 0.9  |
|                                             | Towns          |                    | 16.8          | 2.9           | 5.8               | 1125         | 3.6          | 319           | 7680            | 0.9           | 1.0            | 4.7                 |                        | 0.1                        | 1.0  |
|                                             | Urban<br>Cores |                    | 34.8          | 0.6           | 59.3              | 13,951       | 4.3          | 2167          | 1283            | 1.0           | 1.5            | 3.7                 |                        | 10.2                       | 0.8  |
|                                             | Cities         |                    | 68.0          | 5.6           | 12.2              | 7322         | 4.8          | 809           | 673             | 0.9           | 1.3            | 3.6                 |                        | 31.8                       | 0.7  |
| Togo (7.3; 58.0)<br>(124.9)                 | Urban<br>Areas |                    | 68.0          | 5.6           | 12.2              | 7322         | 4.8          | 809           | 673             | 0.9           | 1.3            | 3.6                 |                        | 31.8                       | 0.7  |
|                                             | Cities         | 43.4               | 53.1          | 3.0           | 17.7              | 104,132      | 47.0         | 1449          | 37              | 0.8           | 0.9            | 5.0                 | 31.8                   | 31.8                       | 0.8  |
|                                             | Towns          |                    | 14.8          | 2.6           | 5.7               | 1690         | 2.4          | 772           | 636             | 1.0           | 1.2            | 3.2                 |                        | 0.3                        | 1.2  |
|                                             | Urban<br>Cores |                    | 39.9          | 0.9           | 43.2              | 60,316       | 11.2         | 3747          | 48              | 1.0           | 1.0            | 5.0                 |                        | 28.2                       | 0.9  |
|                                             | Cities         |                    | 61.0          | 11.4          | 5.3               | 6743         | 8.6          | 639           | 3246            | 1.0           | 1.2            | 4.3                 |                        | 10.9                       | 0.9  |
| Uganda (35.9; 244.4)<br>(146.9)             | Urban<br>Areas |                    | 61.0          | 11.4          | 5.3               | 6743         | 8.6          | 639           | 3246            | 1.0           | 1.2            | 4.3                 |                        | 10.9                       | 0.9  |
|                                             | Cities         | 25.6               | 49.5          | 8.4           | 5.9               | 64,338       | 74.2         | 902           | 276             | 1.1           | 1.0            | 4.2                 | 10.9                   | 10.9                       | 0.8  |
|                                             | Towns          |                    | 11.5          | 3.0           | 3.8               | 1390         | 2.5          | 614           | 2970            | 1.0           | 1.2            | 3.5                 |                        | 0.2                        | 1.1  |

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Table A3 (continued)

|                                  |                | Official<br>Urban. | Pop.<br>share | Area<br>share | Relative<br>dens. | Mean<br>pop. | Mean<br>area | Mean<br>dens. | Number<br>units | Area<br>elas. | Built<br>elas. | Pop.<br>P75/<br>P25 | Capital<br>Pop.<br>sh. | Lar.<br>pop.<br>Pop.<br>sh | Zipf |
|----------------------------------|----------------|--------------------|---------------|---------------|-------------------|--------------|--------------|---------------|-----------------|---------------|----------------|---------------------|------------------------|----------------------------|------|
| Zambia (15.5; 758.4)<br>(20.4)   | Urban<br>Cores |                    | 22.6          | 1.1           | 20.4              | 15,361       | 5.1          | 2292          | 528             | 1.0           | 1.5            | 3.9                 |                        | 9.5                        | 0.8  |
|                                  | Urban<br>Areas |                    | 73.0          | 3.4           | 21.7              | 2058         | 4.6          | 192           | 5497            | 0.9           | 1.1            | 4.3                 |                        | 16.6                       | 0.7  |
|                                  | Cities         | 45.2               | 55.1          | 1.3           | 42.4              | 47,964       | 55.3         | 547           | 178             | 0.7           | 1.4            | 5.5                 | 16.6                   | 16.6                       | 0.8  |
|                                  | Towns          |                    | 17.9          | 2.1           | 8.7               | 521          | 2.9          | 180           | 5319            | 1.0           | 0.9            | 4.0                 |                        | 0.2                        | 1.0  |
|                                  | Urban<br>Cores |                    | 45.6          | 0.3           | 141.4             | 27,002       | 9.3          | 1822          | 262             | 0.9           | 1.4            | 8.0                 |                        | 15.2                       | 0.9  |
| Zimbabwe (13.5;<br>394.2) (34.3) | Urban<br>Areas |                    | 53.9          | 4.6           | 11.8              | 1587         | 3.9          | 202           | 4596            | 0.9           | 1.0            | 3.8                 |                        | 18.7                       | 0.6  |
|                                  | Cities         | 32.3               | 38.3          | 1.6           | 24.0              | 72,969       | 88.6         | 555           | 71              | 0.7           | 1.1            | 6.7                 | 18.7                   | 18.7                       | 0.7  |
|                                  | Towns          |                    | 15.6          | 3.0           | 5.3               | 467          | 2.6          | 196           | 4525            | 1.0           | 0.9            | 3.7                 |                        | 0.2                        | 1.0  |
|                                  | Urban<br>Cores |                    | 31.8          | 0.5           | 67.0              | 46,255       | 20.1         | 1418          | 93              | 0.9           | 1.2            | 12.5                |                        | 17.2                       | 0.9  |

**Notes:** Besides the country's name appears its population in million, land area in '000 km<sup>2</sup> and mean population density in persons per km<sup>2</sup>. Urban areas. Cities, Towns, Urban Cores indicate the geographical level for which the statistics are computed. *Official urban:* Official urban share of population; *Pop. share (Area share, resp.):* Population (area, resp.) share of urban, cities, towns and cores within the country. *Relative density:* Average population density relative to the whole country. *Mean pop. (area, dens. resp.):* mean population (area, density, resp.) of the units, in persons (km<sup>2</sup> and persons per km<sup>2</sup>, resp.). *Number of units:* Number of units delineated. *Area elas.:* Elasticity of area with respect to population. *Built elas.:* Elasticity of builtup with respect to population. *Pop. P75/P25:* Interquartile ratio for population. *Capital Pop.sh:* Population share of the capital city. *Lar.pop. Pop.sh:* Population share of the most populated unit. *Zipf:* Zipf's coefficient for the unit's population distribution.

### Annex 3. Characteristics of capital and extended cities

Table A4

Characteristics of capital cities

| Country               | City         | Pop.<br>(million) | Off. Pop.<br>(million) | Population<br>share (%) | Land area<br>'000s km <sup>2</sup> | Land area<br>share (%) | Capital<br>= Largest | Number of<br>Centers | Within-city<br>Gradient | Within-city<br>R2 |
|-----------------------|--------------|-------------------|------------------------|-------------------------|------------------------------------|------------------------|----------------------|----------------------|-------------------------|-------------------|
| Angola                | Luanda       | 7.64              | 7.77                   | 29.8                    | 1.81                               | 0.14                   | 1                    | 7                    | -2.03***                | 0.33              |
| Benin                 | Cotonou      | 3.13              | 0.69                   | 29.0                    | 1.63                               | 1.39                   | 1                    | 15                   | -1.17***                | 0.17              |
| Botswana              | Gaborone     | 0.47              | 0.27                   | 21.5                    | 1.42                               | 0.24                   | 1                    | 17                   | -0.84***                | 0.08              |
| Burkina Faso          | Ouagadougou  | 2.91              | 2.53                   | 15.4                    | 0.87                               | 0.31                   | 1                    | 3                    | -1.96***                | 0.30              |
| Burundi               | Bujumbura    | 1.08              | 0.90                   | 11.1                    | 0.44                               | 1.62                   | 1                    | 5                    | -0.72***                | 0.20              |
| Cabo Verde            | Praia        | 0.11              | 0.17                   | 22.4                    | 0.07                               | 1.55                   | 1                    | 1                    | -1.67***                | 0.25              |
| Cameroon              | Yaounde      | 3.58              | 3.66                   | 15.0                    | 0.57                               | 0.12                   | 1                    | 1                    | -2.51***                | 0.42              |
| Central African R.    | Bangui       | 0.94              | 0.85                   | 19.2                    | 0.28                               | 0.05                   | 1                    | 1                    | -2.48***                | 0.37              |
| Chad                  | N'Djamena    | 1.36              | 1.32                   | 9.9                     | 0.78                               | 0.06                   | 1                    | 1                    | -2.00***                | 0.33              |
| Comoros               | Moroni       | 0.13              | 0.06                   | 17.0                    | 0.04                               | 2.00                   | 0                    | 1                    | -0.40***                | 0.04              |
| Congo Brazzaville     | Brazzaville  | 1.28              | 2.23                   | 36.2                    | 0.28                               | 0.08                   | 1                    | 1                    | -2.55***                | 0.54              |
| Congo RDC             | Kinshasa     | 6.76              | 13.17                  | 7.6                     | 0.68                               | 0.03                   | 1                    | 2                    | -2.30***                | 0.34              |
| Côte d'Ivoire         | Yamoussoukro | 0.25              | 0.23                   | 1.1                     | 0.12                               | 0.04                   | 0                    | 2                    | -1.11***                | 0.10              |
| Eritrea               | Asmara       | 0.45              | 0.90                   | 11.7                    | 0.24                               | 0.19                   | 1                    | 5                    | -1.85***                | 0.20              |
| Ethiopia              | Addis Ababa  | 4.09              | 4.40                   | 4.5                     | 1.35                               | 0.12                   | 0                    | 8                    | -1.28***                | 0.21              |
| Gabon                 | Libreville   | 0.80              | 0.81                   | 32.8                    | 0.32                               | 0.12                   | 1                    | 2                    | -1.92***                | 0.40              |
| Gambia                | Banjul       | 1.00              | 0.44                   | 50.0                    | 0.35                               | 3.13                   | 1                    | 3                    | -0.95***                | 0.26              |
| Ghana                 | Accra        | 4.83              | 2.44                   | 17.3                    | 1.56                               | 0.64                   | 1                    | 8                    | -1.23***                | 0.32              |
| Guinea                | Conakry      | 2.18              | 1.84                   | 20.2                    | 0.51                               | 0.21                   | 1                    | 1                    | -1.43***                | 0.30              |
| Guinea-Bissau         | Bissau       | 0.50              | 0.56                   | 30.3                    | 0.16                               | 0.45                   | 1                    | 1                    | -1.57***                | 0.26              |
| Kenya                 | Nairobi      | 11.28             | 4.39                   | 24.2                    | 11.24                              | 1.91                   | 0                    | 83                   | -0.34***                | 0.05              |
| Lesotho               | Maseru       | 0.33              | 0.20                   | 17.7                    | 0.36                               | 1.15                   | 1                    | 2                    | -1.26***                | 0.19              |
| Liberia               | Monrovia     | 1.36              | 1.42                   | 33.4                    | 0.42                               | 0.43                   | 1                    | 1                    | -1.31***                | 0.21              |
| Madagascar            | Antananarivo | 4.23              | 3.06                   | 18.0                    | 5.15                               | 0.86                   | 1                    | 17                   | -0.73***                | 0.10              |
| Malawi                | Lilongwe     | 1.37              | 1.03                   | 8.6                     | 0.96                               | 0.79                   | 0                    | 7                    | -1.03***                | 0.11              |
| Mali                  | Bamako       | 3.05              | 2.45                   | 16.4                    | 0.77                               | 0.06                   | 1                    | 6                    | -2.06***                | 0.27              |
| Mauritania            | Nouakchott   | 0.71              | 1.21                   | 19.0                    | 0.09                               | 0.01                   | 1                    | 3                    | -0.29***                | 0.03              |
| Mauritius             | Port Louis   | 0.55              | 0.15                   | 43.8                    | 0.15                               | 6.64                   | 1                    | 3                    | -0.32***                | 0.02              |
| Mozambique            | Maputo       | 2.32              | 1.10                   | 8.9                     | 0.98                               | 0.12                   | 1                    | 3                    | -1.55***                | 0.28              |
| Namibia               | Windhoek     | 0.36              | 0.40                   | 15.9                    | 0.20                               | 0.02                   | 0                    | 1                    | -1.79***                | 0.17              |
| Niger                 | Niamey       | 1.35              | 1.21                   | 7.0                     | 0.84                               | 0.07                   | 0                    | 2                    | -1.34***                | 0.26              |
| Nigeria               | Abuja        | 2.31              | 2.92                   | 1.2                     | 0.85                               | 0.09                   | 0                    | 24                   | -0.15***                | 0.00              |
| Rwanda                | Kigali       | 1.20              | 1.06                   | 10.4                    | 0.40                               | 1.53                   | 1                    | 2                    | -0.95***                | 0.17              |
| Sao Tome and Principe | Sao Tome     | 0.13              | 0.08                   | 66.2                    | 0.06                               | 4.88                   | 1                    | 2                    | -1.10***                | 0.28              |
| Senegal               | Dakar        | 3.43              | 2.98                   | 24.1                    | 0.62                               | 0.31                   | 1                    | 2                    | -1.89***                | 0.39              |
| Seychelles            | Victoria     | 0.06              | 0.03                   | 65.9                    | 0.05                               | 6.86                   | 1                    | 2                    | -0.31***                | 0.04              |
| Sierra Leone          | Freetown     | 0.99              | 1.14                   | 15.9                    | 0.18                               | 0.25                   | 1                    | 1                    | -1.58***                | 0.40              |
| Somalia               | Mogadishu    | 1.47              | 2.08                   | 15.2                    | 1.18                               | 0.18                   | 1                    | 1                    | -1.70***                | 0.34              |
| South Africa          | Pretoria     | 11.45             | 2.38                   | 20.8                    | 3.66                               | 0.30                   | 1                    | 65                   | -0.34***                | 0.01              |
| South Sudan           | Juba         | 0.34              | 0.37                   | 2.9                     | 0.52                               | 0.08                   | 0                    | 4                    | -1.17***                | 0.22              |

(continued on next page)

Table A4 (continued)

| Country   | City     | Pop.<br>(million) | Off. Pop.<br>(million) | Population<br>share (%) | Land area<br>'000s km <sup>2</sup> | Land area<br>share (%) | Capital<br>= Largest | Number of<br>Centers | Within-city<br>Gradient | Within-city<br>R2 |
|-----------|----------|-------------------|------------------------|-------------------------|------------------------------------|------------------------|----------------------|----------------------|-------------------------|-------------------|
| Sudan     | Khartoum | 6.29              | 5.53                   | 16.9                    | 3.87                               | 0.21                   | 1                    | 56                   | −1.24***                | 0.13              |
| Swaziland | Mbabane  | 0.26              | 0.07                   | 24.7                    | 0.51                               | 2.90                   | 1                    | 4                    | −0.35***                | 0.03              |
| Tanzania  | Dodoma   | 0.29              | 0.26                   | 0.6                     | 0.24                               | 0.03                   | 0                    | 3                    | −1.23***                | 0.26              |
| Togo      | Lome     | 2.31              | 1.75                   | 31.8                    | 0.61                               | 1.06                   | 1                    | 2                    | −1.03***                | 0.30              |
| Uganda    | Kampala  | 3.93              | 2.99                   | 10.9                    | 1.55                               | 0.63                   | 1                    | 15                   | −1.47***                | 0.31              |
| Zambia    | Lusaka   | 2.57              | 2.52                   | 16.6                    | 1.21                               | 0.16                   | 1                    | 4                    | −2.25***                | 0.39              |
| Zimbabwe  | Harare   | 2.53              | 1.52                   | 18.7                    | 1.63                               | 0.41                   | 1                    | 10                   | −1.33***                | 0.17              |

**Notes:** Population (land, resp.) share refers to the capital city's share in national population (land area). Off. Pop. is the official population of capital cities from [United Nations \(2018\)](#) Capital=Largest takes a value of 1 if the capital city is also a country's most populous city. Number of centers is the number of (sub-)centers in the capital city. Within-city gradient is the estimated slope of the within-city population gradient from the barycenter of the city's largest center. Within-city R2 is the R<sup>2</sup> value estimated with the regression used to estimate the within-city gradient.

Table A5

Characteristics of extended cities

| Country      | City          | Land area<br>'000s km <sup>2</sup> | Area ratio<br>/Capital city | Population<br>(million inhab.) | Pop. ratio<br>/Capital city | Number of<br>Centers | Ratio Centers<br>/Capital city | Within-city<br>Gradient | Within-city<br>R2 |
|--------------|---------------|------------------------------------|-----------------------------|--------------------------------|-----------------------------|----------------------|--------------------------------|-------------------------|-------------------|
| Kenya        | Kisumu        | 25.54                              | 2.27                        | 15.48                          | 1.37                        | 471                  | 5.7                            | −0.12***                | 0.01              |
| Ethiopia     | Shashamane    | 24.34                              | 18.02                       | 14.28                          | 3.49                        | 421                  | 52.6                           | −0.43***                | 0.04              |
| Namibia      | Oshakati      | 14.84                              | 72.82                       | 0.63                           | 1.77                        | 214                  | 214.0                          | −0.67***                | 0.09              |
| Kenya        | Nairobi       | 11.24                              | 1.00                        | 11.28                          | 1.00                        | 83                   | 1.0                            | −0.34***                | 0.05              |
| Ethiopia     | Harar         | 7.62                               | 5.65                        | 4.31                           | 1.05                        | 277                  | 34.6                           | −0.21***                | 0.01              |
| South Sudan  | Aweil         | 5.61                               | 10.88                       | 0.77                           | 2.23                        | 192                  | 48.0                           | −0.10***                | 0.00              |
| Madagascar   | Antananarivo  | 5.15                               | 1.00                        | 4.23                           | 1.00                        | 17                   | 1.0                            | −0.73***                | 0.10              |
| Nigeria      | Onitsha       | 4.78                               | 5.61                        | 11.17                          | 4.83                        | 85                   | 3.5                            | −0.30***                | 0.02              |
| Niger        | Magaria       | 4.48                               | 5.32                        | 1.52                           | 1.12                        | 278                  | 139.0                          | 0.02                    | 0.00              |
| Congo RDC    | Bunia         | 4.22                               | 6.19                        | 2.59                           | 0.38                        | 141                  | 70.5                           | −0.07***                | 0.00              |
| Ethiopia     | Jimma         | 4.19                               | 3.10                        | 1.89                           | 0.46                        | 106                  | 13.3                           | −0.19***                | 0.01              |
| Malawi       | Blantyre      | 4.12                               | 4.30                        | 3.02                           | 2.21                        | 54                   | 7.7                            | −0.33***                | 0.03              |
| Uganda       | Mbale         | 3.95                               | 2.56                        | 2.90                           | 0.74                        | 103                  | 6.9                            | −0.27***                | 0.02              |
| Sudan        | Khartoum      | 3.87                               | 1.00                        | 6.29                           | 1.00                        | 56                   | 1.0                            | −1.24***                | 0.13              |
| Uganda       | Jinja         | 3.72                               | 2.41                        | 2.63                           | 0.67                        | 91                   | 6.1                            | −0.25***                | 0.01              |
| South Africa | Pretoria      | 3.66                               | 1.00                        | 11.45                          | 1.00                        | 65                   | 1.0                            | −0.34***                | 0.01              |
| Ethiopia     | Asella        | 2.86                               | 2.12                        | 1.20                           | 0.29                        | 58                   | 7.3                            | −0.24***                | 0.01              |
| Tanzania     | Arusha        | 2.76                               | 11.35                       | 2.28                           | 7.86                        | 33                   | 11.0                           | −0.13***                | 0.01              |
| Ethiopia     | Bechena       | 2.46                               | 1.82                        | 1.00                           | 0.25                        | 82                   | 10.3                           | 0.08***                 | 0.00              |
| Nigeria      | Uyo           | 1.94                               | 2.27                        | 3.16                           | 1.37                        | 57                   | 2.4                            | −0.39***                | 0.03              |
| Congo RDC    | Rubaya        | 1.91                               | 2.81                        | 1.13                           | 0.17                        | 62                   | 31.0                           | 0.14***                 | 0.00              |
| Tanzania     | Bariadi       | 1.85                               | 7.62                        | 0.51                           | 1.74                        | 67                   | 22.3                           | −0.16***                | 0.01              |
| Ethiopia     | Burie         | 1.84                               | 1.36                        | 0.82                           | 0.20                        | 46                   | 5.8                            | −0.00                   | −0.00             |
| Ethiopia     | Ambo          | 1.82                               | 1.35                        | 0.80                           | 0.20                        | 26                   | 3.3                            | −0.11***                | 0.00              |
| Angola       | Luanda        | 1.81                               | 1.00                        | 7.64                           | 1.00                        | 7                    | 1.0                            | −2.03***                | 0.33              |
| Cameroon     | Bafoussam     | 1.77                               | 3.10                        | 1.12                           | 0.31                        | 23                   | 23.0                           | −0.48***                | 0.06              |
| Somalia      | Hargeysa      | 1.76                               | 1.49                        | 0.55                           | 0.37                        | 15                   | 15.0                           | −0.79***                | 0.14              |
| Congo RDC    | Bukavu        | 1.71                               | 2.50                        | 1.83                           | 0.27                        | 19                   | 9.5                            | −0.68***                | 0.05              |
| Tanzania     | Dar es-Salaam | 1.67                               | 6.90                        | 5.67                           | 19.49                       | 8                    | 2.7                            | −1.56***                | 0.40              |
| South Africa | Durban        | 1.64                               | 0.45                        | 3.43                           | 0.30                        | 13                   | 0.2                            | −0.63***                | 0.05              |
| Zimbabwe     | Harare        | 1.63                               | 1.00                        | 2.53                           | 1.00                        | 10                   | 1.0                            | −1.33***                | 0.17              |
| Benin        | Cotonou       | 1.63                               | 1.00                        | 3.13                           | 1.00                        | 15                   | 1.0                            | −1.17***                | 0.17              |
| Mozambique   | Milange       | 1.63                               | 1.66                        | 0.40                           | 0.17                        | 33                   | 11.0                           | −0.24***                | 0.01              |
| Ethiopia     | Mizan Teferi  | 1.58                               | 1.17                        | 0.67                           | 0.16                        | 63                   | 7.9                            | −0.25***                | 0.01              |
| Ghana        | Accra         | 1.56                               | 1.00                        | 4.83                           | 1.00                        | 8                    | 1.0                            | −1.23***                | 0.32              |
| Uganda       | Kampala       | 1.55                               | 1.00                        | 3.93                           | 1.00                        | 15                   | 1.0                            | −1.47***                | 0.31              |
| Nigeria      | Lagos         | 1.51                               | 1.77                        | 12.28                          | 5.31                        | 7                    | 0.3                            | −1.25***                | 0.25              |

**Notes:** Area ratio/Capital city refers to the ratio of the extended city's land area to that of the country's capital city. Pop. Ratio/Capital city to the corresponding ratio for population. Number of Centers to the number of population (sub-)centers within the extended city. Ratio Centers/Capital city to the ratio of the number of (sub-)centers in the extended city compared to the corresponding number in the capital city. Within-city gradient is the estimated slope of the within-city population gradient from the barycenter of the city's largest center. Within-city R2 is the R<sup>2</sup> value estimated with the regression used to estimate the within-city gradient. Cities are ranked by their land area when above 1,500 km<sup>2</sup>, our definition of extended cities, capital cities being those where the ratio to the capital city area or population is equal to 1.00.

## Annex 4. City center statistics over all SSA countries and by country

Table A6

Characteristics of city centers over 47 SSA countries

|                    | Mean  | Std. Error | P10  | P25  | P50  | P75   | P90    |
|--------------------|-------|------------|------|------|------|-------|--------|
| #centers           | 1.68  | 0.59       | 1.07 | 1.23 | 1.51 | 1.89  | 2.59   |
| Share 1 cen.       | 0.77  | 0.12       | 0.62 | 0.71 | 0.80 | 0.85  | 0.91   |
| Share 2 cen.       | 0.12  | 0.10       | 0.03 | 0.06 | 0.09 | 0.14  | 0.19   |
| Elas. #cen. pop.   | 0.23  | 0.13       | 0.04 | 0.12 | 0.24 | 0.33  | 0.41   |
| #centers Capital   | 8.89  | 16.85      | 1.00 | 2.00 | 3.00 | 7.00  | 17.00  |
| #centers lar. pop. | 40.98 | 103.42     | 1.00 | 2.00 | 3.00 | 15.00 | 192.00 |
| Share pop. largest | 0.65  | 0.11       | 0.46 | 0.60 | 0.66 | 0.73  | 0.77   |
| lar/2nd pop.       | 22.82 | 76.78      | 3.24 | 4.73 | 6.36 | 10.51 | 32.78  |
| Zipf centers       | 0.58  | 0.17       | 0.37 | 0.51 | 0.60 | 0.70  | 0.77   |

**Notes:** # centers: Number of centers per city. *Share 1 cen.*: Share of cities with one center. *Share 2 cen.*: Share of cities with two centers. *Elas. #cen. pop.*: elasticity of the number of centers in the city with respect to its population. #centers Capital: Number of centers in the capital city. #centers lar. pop.: Number of centers in the most populous city. *Share pop. largest.*: City population share of the largest center. *Lar/2nd pop.*: Relative population of the largest over the second largest center in a city. *Zipf centers*: Within city population Zipf's coefficient for city centers (i.e., log rank population rule for centers controlling for city fixed effects). Statistics are computed over the cross-section of 47 SSA countries PX corresponds to the  $X^{\text{th}}$  percentile of the distribution.

Table A7

Characteristics of city centers by country

|                       | #centers | Share 1 cen. | Share 2 cen. | Elas. #cen./pop. | #centers Capital | #centers lar. pop. | Sh. pop. largest | lar/2nd pop. | Zipf centers |
|-----------------------|----------|--------------|--------------|------------------|------------------|--------------------|------------------|--------------|--------------|
| Angola                | 1.55     | 0.81         | 0.09         | 0.21             | 7                | 7                  | 0.72             | 32.8         | 0.42         |
| Benin                 | 1.89     | 0.80         | 0.13         | 0.39             | 15               | 15                 | 0.64             | 5.3          | 0.60         |
| Botswana              | 1.32     | 0.83         | 0.09         | 0.22             | 17               | 17                 | 0.78             | 15.0         | 0.50         |
| Burkina Faso          | 1.22     | 0.89         | 0.06         | 0.16             | 3                | 3                  | 0.62             | 10.5         | 0.54         |
| Burundi               | 1.50     | 0.83         | 0.02         | 0.33             | 5                | 5                  | 0.52             | 2.7          | 0.58         |
| Cabo Verde            | 1.29     | 0.57         | 0.14         | 0.01             | 1                | 1                  | 0.38             | 5.2          | 0.68         |
| Cameroon              | 1.76     | 0.79         | 0.11         | 0.28             | 1                | 1                  | 0.66             | 9.4          | 0.56         |
| Central African R.    | 1.44     | 0.81         | 0.09         | 0.18             | 1                | 1                  | 0.76             | 3.2          | 0.90         |
| Chad                  | 1.76     | 0.72         | 0.16         | 0.41             | 1                | 1                  | 0.65             | 3.7          | 0.81         |
| Comoros               | 1.00     | 0.80         | 0.00         | 0.00             | .                | 1                  | 0.61             | .            | 0.00         |
| Congo Brazzaville     | 1.12     | 0.88         | 0.12         | 0.04             | 1                | 1                  | 0.82             | 46.7         | 0.31         |
| Congo RDC             | 1.60     | 0.81         | 0.12         | 0.25             | 2                | 2                  | 0.73             | 4.7          | 0.72         |
| Côte d'Ivoire         | 1.07     | 0.94         | 0.05         | 0.08             | 2                | 5                  | 0.77             | 6.8          | 0.51         |
| Eritrea               | 1.32     | 0.83         | 0.05         | 0.22             | 5                | 5                  | 0.66             | 6.3          | 0.66         |
| Ethiopia              | 2.46     | 0.76         | 0.09         | 0.41             | 8                | 421                | 0.60             | 3.7          | 0.74         |
| Gabon                 | 1.14     | 0.90         | 0.06         | 0.06             | 2                | 2                  | 0.78             | 29.3         | 0.37         |
| Gambia                | 1.33     | 0.83         | 0.00         | 0.30             | 3                | 3                  | 0.61             | 14.3         | 0.45         |
| Ghana                 | 1.54     | 0.71         | 0.17         | 0.30             | 8                | 8                  | 0.60             | 16.9         | 0.45         |
| Guinea                | 1.13     | 0.90         | 0.06         | 0.09             | 1                | 1                  | 0.77             | 11.8         | 0.40         |
| Guinea-Bissau         | 1.05     | 0.95         | 0.05         | -0.00            | 1                | 1                  | 0.71             | 7.2          | 0.56         |
| Kenya                 | 2.94     | 0.84         | 0.05         | 0.37             | 83               | 471                | 0.70             | 6.2          | 0.71         |
| Lesotho               | 2.43     | 0.62         | 0.11         | 0.18             | 2                | 2                  | 0.55             | 13.5         | 0.60         |
| Liberia               | 1.07     | 0.96         | 0.02         | 0.02             | 1                | 1                  | 0.73             | 8.0          | 0.54         |
| Madagascar            | 2.18     | 0.67         | 0.15         | 0.46             | 17               | 17                 | 0.54             | 4.6          | 0.68         |
| Malawi                | 2.10     | 0.64         | 0.13         | 0.31             | 7                | 54                 | 0.45             | 5.6          | 0.69         |
| Mali                  | 1.07     | 0.95         | 0.03         | 0.10             | 6                | 6                  | 0.81             | 5.6          | 0.57         |
| Mauritania            | 1.13     | 0.86         | 0.08         | 0.12             | 3                | 3                  | 0.77             | 3.7          | 0.63         |
| Mauritius             | 1.23     | 0.85         | 0.08         | 0.13             | 3                | 3                  | 0.57             | 4.6          | 0.77         |
| Mozambique            | 1.69     | 0.79         | 0.09         | 0.30             | 3                | 3                  | 0.68             | 5.2          | 0.65         |
| Namibia               | 3.84     | 0.74         | 0.08         | 0.27             | 1                | 214                | 0.73             | 7.6          | 0.69         |
| Niger                 | 1.70     | 0.82         | 0.09         | 0.35             | 2                | 278                | 0.67             | 2.8          | 0.93         |
| Nigeria               | 1.46     | 0.82         | 0.10         | 0.27             | 24               | 7                  | 0.69             | 9.2          | 0.56         |
| Rwanda                | 1.72     | 0.62         | 0.18         | 0.23             | 2                | 2                  | 0.41             | 6.8          | 0.59         |
| Sao Tome and Principe | 1.50     | 0.50         | 0.50         | 0.24             | 2                | 2                  | 0.59             | 521.0        | 0.18         |
| Senegal               | 1.32     | 0.85         | 0.11         | 0.16             | 2                | 2                  | 0.72             | 66.5         | 0.46         |
| Seychelles            | 1.50     | 0.50         | 0.50         | 0.11             | 2                | 2                  | 0.70             | 5.3          | 0.66         |
| Sierra Leone          | 1.10     | 0.91         | 0.07         | 0.04             | 1                | 1                  | 0.73             | 2.0          | 0.81         |
| Somalia               | 1.51     | 0.84         | 0.07         | 0.26             | 1                | 1                  | 0.75             | 6.3          | 0.74         |
| South Africa          | 1.88     | 0.72         | 0.15         | 0.35             | 65               | 65                 | 0.67             | 6.7          | 0.53         |
| South Sudan           | 2.65     | 0.63         | 0.18         | 0.43             | 4                | 192                | 0.60             | 5.6          | 0.63         |
| Sudan                 | 1.66     | 0.78         | 0.13         | 0.33             | 56               | 56                 | 0.73             | 4.5          | 0.70         |
| Swaziland             | 2.62     | 0.48         | 0.19         | 0.43             | 4                | 4                  | 0.37             | 1.7          | 0.63         |
| Tanzania              | 2.07     | 0.77         | 0.09         | 0.39             | 3                | 8                  | 0.61             | 6.1          | 0.70         |
| Togo                  | 1.30     | 0.78         | 0.19         | 0.18             | 2                | 2                  | 0.61             | 83.5         | 0.30         |
| Uganda                | 2.59     | 0.71         | 0.13         | 0.44             | 15               | 15                 | 0.46             | 6.7          | 0.70         |
| Zambia                | 1.71     | 0.70         | 0.19         | 0.16             | 4                | 4                  | 0.63             | 8.3          | 0.56         |
| Zimbabwe              | 2.34     | 0.63         | 0.11         | 0.26             | 10               | 10                 | 0.56             | 6.4          | 0.56         |

**Notes:** # centers: Mean number of centers per city. *Share 1 cen.*: Share of cities with one center. *Share 2 cen.*: Share of cities with two centers. *Elas. #cen. pop.*: elasticity of the number of centers in the city with respect to its population. #centers Capital: Number of centers in the capital city. #centers lar. pop.: Number of centers in the

most populous city. *Share pop. largest.*: City population share of the largest center. *Lar/2nd pop.*: Relative population of the largest over the second largest center (missing for Comoros where all 4 cities have a single center). *Zipf centers*: Within city population Zipf's coefficient for city centers (i.e., log rank population rule for centers controlling for city fixed effects).

## Annex 5. Within city gradient statistics over all SSA countries and by country

**Table A8**

Characteristics of within city gradients over 47 SSA countries

|            |          | Mean           | Std. Error     | P10            | P25            | P50            | P75            | P90            |
|------------|----------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Population | R2s      | 0.06/0.18/0.21 | 0.04/0.09/0.09 | 0.03/0.05/0.09 | 0.04/0.10/0.14 | 0.06/0.16/0.21 | 0.09/0.26/0.29 | 0.12/0.30/0.34 |
|            | Share <0 | 0.94           | 0.09           | 0.85           | 0.92           | 0.97           | 1.00           | 1.00           |
|            | Share >0 | 0.00           | 0.00           | 0.00           | 0.00           | 0.00           | 0.00           | 0.00           |
|            | Mean     | -0.91          | 0.46           | -1.52          | -1.16          | -0.91          | -0.56          | -0.36          |
|            | P10      | -2.73          | 0.86           | -3.83          | -3.36          | -2.60          | -2.10          | -1.84          |
|            | P25      | -2.17          | 0.76           | -3.10          | -2.82          | -2.13          | -1.56          | -1.19          |
|            | P50      | -1.52          | 0.62           | -2.20          | -1.93          | -1.50          | -1.11          | -0.55          |
|            | P75      | -0.98          | 0.44           | -1.52          | -1.18          | -1.02          | -0.64          | -0.41          |
|            | P90      | -0.60          | 0.29           | -0.99          | -0.80          | -0.56          | -0.34          | -0.25          |
| Built-up   | R2s      | 0.27/0.46/0.52 | 0.12/0.13/0.13 | 0.10/0.31/0.35 | 0.20/0.40/0.47 | 0.27/0.47/0.53 | 0.34/0.54/0.61 | 0.41/0.59/0.65 |
|            | Share <0 | 0.76           | 0.21           | 0.45           | 0.59           | 0.81           | 0.96           | 0.99           |
|            | Share >0 | 0.02           | 0.02           | 0.00           | 0.00           | 0.01           | 0.03           | 0.04           |
|            | Mean     | -1.23          | 0.40           | -1.80          | -1.62          | -1.19          | -1.00          | -0.71          |
|            | P10      | -2.29          | 0.53           | -2.75          | -2.62          | -2.43          | -2.15          | -1.67          |
|            | P25      | -1.85          | 0.40           | -2.28          | -2.08          | -1.86          | -1.77          | -1.30          |
|            | P50      | -1.40          | 0.32           | -1.71          | -1.61          | -1.46          | -1.31          | -0.89          |
|            | P75      | -1.01          | 0.23           | -1.29          | -1.13          | -1.06          | -0.87          | -0.63          |
|            | P90      | -0.66          | 0.28           | -1.00          | -0.84          | -0.66          | -0.54          | -0.32          |

**Notes:** Row 1 in each part of the table shows the  $R^2$  for the estimation of equations [4] – [6] in the main text for population and built-up density respectively. *Share <0*: Share of cities with significant (10 % threshold) negative density gradient. *Share >0*: Share of cities with significant (10 % threshold) positive density gradient. *PXX*: Density gradient for the city at the XX<sup>th</sup> centile for the gradient value within the country. Statistics are computed over the cross-section of 47 SSA countries. PXX in the header row corresponds to the X<sup>th</sup> percentile of the cross-country distribution.

**Table A9**

Characteristics of within city gradients by country

|                    | Population     |          |          |            |           |           |           |           |           | Built-up       |          |          |           |           |           |           |           |           |
|--------------------|----------------|----------|----------|------------|-----------|-----------|-----------|-----------|-----------|----------------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|
|                    | R2s            | Share <0 | Share >0 | Grad. Mean | Grad. P10 | Grad. P25 | Grad. P50 | Grad. P75 | Grad. P90 | R2s            | Share <0 | Share >0 | Grad. Av. | Grad. P10 | Grad. P25 | Grad. P50 | Grad. P75 | Grad. P90 |
| Angola             | 0.15/0.30/0.34 | 1.00     | 0.00     | -1.28      | -2.60     | -2.22     | -1.63     | -1.17     | -0.75     | 0.22/0.47/0.53 | 0.95     | 0.01     | -1.72     | -2.89     | -2.45     | -1.99     | -1.31     | -0.95     |
| Benin              | 0.04/0.14/0.17 | 0.99     | 0.00     | -0.94      | -2.61     | -2.30     | -1.72     | -1.14     | -0.75     | 0.15/0.31/0.37 | 0.97     | 0.00     | -1.03     | -2.27     | -1.77     | -1.39     | -1.11     | -0.72     |
| Botswana           | 0.04/0.18/0.22 | 0.98     | 0.00     | -1.29      | -3.26     | -2.77     | -2.20     | -1.61     | -0.87     | 0.28/0.42/0.48 | 0.83     | 0.02     | -1.26     | -2.48     | -2.02     | -1.48     | -1.08     | -0.66     |
| Burkina Faso       | 0.10/0.21/0.26 | 0.99     | 0.00     | -0.98      | -2.58     | -2.10     | -1.50     | -0.97     | -0.60     | 0.30/0.57/0.65 | 0.79     | 0.02     | -1.97     | -2.87     | -2.18     | -1.61     | -1.26     | -0.85     |
| Burundi            | 0.03/0.10/0.15 | 0.93     | 0.00     | -0.47      | -2.07     | -1.56     | -1.10     | -0.69     | -0.24     | 0.22/0.45/0.53 | 0.91     | 0.00     | -1.48     | -2.15     | -1.78     | -1.31     | -1.04     | -0.84     |
| Cabo Verde         | 0.05/0.18/0.21 | 0.86     | 0.00     | -0.94      | -1.67     | -1.11     | -0.79     | -0.54     | -0.54     | 0.20/0.57/0.61 | 0.71     | 0.00     | -2.01     | -2.65     | -2.62     | -1.97     | -1.29     | -1.23     |
| Cameroon           | 0.10/0.19/0.23 | 1.00     | 0.00     | -0.83      | -2.58     | -2.11     | -1.42     | -0.90     | -0.58     | 0.26/0.44/0.51 | 0.94     | 0.01     | -1.26     | -2.57     | -2.12     | -1.64     | -1.29     | -0.94     |
| Central African R. | 0.06/0.16/0.24 | 0.91     | 0.00     | -1.02      | -3.83     | -2.89     | -1.86     | -1.05     | -0.64     | 0.34/0.50/0.62 | 0.75     | 0.03     | -1.09     | -2.52     | -1.87     | -1.52     | -1.06     | -0.42     |
| Chad               | 0.05/0.11/0.16 | 0.95     | 0.00     | -0.71      | -3.30     | -2.55     | -1.44     | -0.78     | -0.46     | 0.35/0.50/0.62 | 0.31     | 0.03     | -1.16     | -2.50     | -1.79     | -1.39     | -0.92     | -0.32     |
| Comoros            | 0.03/0.16/0.17 | 1.00     | 0.00     | -0.99      | -1.96     | -1.76     | -1.34     | -0.96     | -0.80     | 0.15/0.51/0.55 | 1.00     | 0.00     | -0.93     | -1.10     | -1.10     | -0.89     | -0.56     | -0.45     |
| Congo Brazzaville  | 0.05/0.35/0.38 | 0.97     | 0.00     | -1.72      | -2.55     | -2.32     | -1.82     | -1.45     | -0.99     | 0.43/0.65/0.69 | 0.91     | 0.02     | -1.80     | -2.60     | -2.29     | -1.67     | -1.30     | -0.79     |
| Congo RDC          | 0.07/0.13/0.20 | 0.96     | 0.00     | -0.82      | -3.91     | -3.12     | -2.01     | -1.12     | -0.62     | 0.41/0.54/0.62 | 0.90     | 0.02     | -1.03     | -2.21     | -1.72     | -1.30     | -0.91     | -0.54     |
| Côte d'Ivoire      | 0.12/0.33/0.38 | 1.00     | 0.00     | -2.01      | -4.13     | -3.51     | -2.69     | -2.11     | -1.39     | 0.27/0.53/0.59 | 0.99     | 0.01     | -1.42     | -2.15     | -1.85     | -1.46     | -1.13     | -0.78     |
| Eritrea            | 0.04/0.13/0.19 | 0.94     | 0.01     | -1.05      | -3.28     | -2.59     | -1.81     | -1.11     | -0.46     | 0.19/0.49/0.54 | 0.29     | 0.00     | -1.66     | -2.37     | -2.20     | -1.68     | -1.29     | -1.04     |
| Ethiopia           | 0.03/0.05/0.09 | 0.93     | 0.00     | -0.38      | -3.66     | -2.84     | -1.62     | -0.64     | -0.28     | 0.23/0.32/0.39 | 0.59     | 0.01     | -0.81     | -2.53     | -1.98     | -1.50     | -1.13     | -0.71     |
| Gabon              | 0.08/0.33/0.35 | 0.96     | 0.00     | -1.52      | -2.50     | -1.86     | -1.47     | -1.12     | -0.80     | 0.23/0.53/0.55 | 0.84     | 0.00     | -1.86     | -2.72     | -2.25     | -1.77     | -1.24     | -1.07     |

(continued on next page)

Table A9 (continued)

|                          | Population         |             |             |               |              |              |              |              |              | Built-up           |             |             |              |              |              |              |              |              |
|--------------------------|--------------------|-------------|-------------|---------------|--------------|--------------|--------------|--------------|--------------|--------------------|-------------|-------------|--------------|--------------|--------------|--------------|--------------|--------------|
|                          | R2s                | Share<br><0 | Share<br>>0 | Grad.<br>Mean | Grad.<br>P10 | Grad.<br>P25 | Grad.<br>P50 | Grad.<br>P75 | Grad.<br>P90 | R2s                | Share<br><0 | Share<br>>0 | Grad.<br>Av. | Grad.<br>P10 | Grad.<br>P25 | Grad.<br>P50 | Grad.<br>P75 | Grad.<br>P90 |
| Gambia                   | 0.03/0.26/<br>0.27 | 1.00        | 0.00        | −0.99         | −2.39        | −1.46        | −1.23        | −1.02        | −0.95        | 0.02/0.35/<br>0.35 | 1.00        | 0.00        | −1.33        | −2.28        | −1.63        | −1.33        | −1.26        | −1.20        |
| Ghana                    | 0.07/0.24/<br>0.27 | 0.99        | 0.00        | −1.00         | −2.12        | −1.55        | −1.24        | −0.83        | −0.55        | 0.26/0.47/<br>0.52 | 0.99        | 0.00        | −1.26        | −2.33        | −1.72        | −1.38        | −0.94        | −0.74        |
| Guinea                   | 0.10/0.28/<br>0.32 | 1.00        | 0.00        | −1.38         | −3.55        | −3.10        | −2.35        | −1.52        | −0.93        | 0.28/0.55/<br>0.60 | 0.99        | 0.00        | −1.68        | −2.71        | −2.09        | −1.61        | −1.30        | −1.00        |
| Guinea-Bissau            | 0.07/0.23/<br>0.26 | 1.00        | 0.00        | −1.23         | −2.05        | −1.84        | −1.50        | −1.20        | −0.45        | 0.10/0.53/<br>0.60 | 1.00        | 0.00        | −1.73        | −2.68        | −2.46        | −1.92        | −1.11        | −0.88        |
| Kenya                    | 0.02/0.05/<br>0.09 | 0.99        | 0.00        | −0.27         | −3.36        | −2.90        | −2.17        | −1.27        | −0.40        | 0.10/0.21/<br>0.29 | 0.45        | 0.00        | −0.82        | −2.62        | −1.92        | −1.48        | −1.04        | −0.66        |
| Lesotho                  | 0.03/0.08/<br>0.10 | 0.73        | 0.00        | −0.57         | −1.39        | −1.19        | −0.52        | −0.41        | −0.34        | 0.26/0.44/<br>0.51 | 0.73        | 0.00        | −1.17        | −2.65        | −1.79        | −1.17        | −0.82        | −0.57        |
| Liberia                  | 0.11/0.29/<br>0.32 | 1.00        | 0.00        | −1.39         | −2.92        | −2.33        | −1.95        | −1.31        | −0.78        | 0.33/0.57/<br>0.61 | 0.96        | 0.02        | −1.39        | −2.15        | −1.90        | −1.41        | −0.87        | −0.62        |
| Madagascar               | 0.03/0.07/<br>0.09 | 0.92        | 0.00        | −0.47         | −2.80        | −1.87        | −0.96        | −0.54        | −0.34        | 0.20/0.34/<br>0.44 | 0.43        | 0.04        | −1.02        | −2.43        | −1.86        | −1.43        | −0.80        | −0.25        |
| Malawi                   | 0.02/0.05/<br>0.08 | 0.85        | 0.00        | −0.41         | −1.98        | −1.46        | −0.69        | −0.41        | −0.24        | 0.18/0.40/<br>0.47 | 0.73        | 0.04        | −1.28        | −2.43        | −1.85        | −1.22        | −0.77        | −0.37        |
| Mali                     | 0.10/0.33/<br>0.39 | 1.00        | 0.00        | −2.19         | −4.86        | −4.13        | −3.28        | −2.20        | −1.27        | 0.33/0.59/<br>0.64 | 0.79        | 0.01        | −1.87        | −2.48        | −1.92        | −1.43        | −1.10        | −0.77        |
| Mauritania               | 0.15/0.27/<br>0.32 | 0.95        | 0.00        | −1.15         | −3.55        | −2.92        | −2.11        | −1.32        | −0.94        | 0.66/0.77/<br>0.85 | 0.53        | 0.03        | −1.19        | −3.03        | −2.08        | −1.55        | −1.24        | −0.81        |
| Mauritius                | 0.04/0.07/<br>0.09 | 0.85        | 0.00        | −0.42         | −1.86        | −1.53        | −0.55        | −0.34        | −0.32        | 0.30/0.41/<br>0.43 | 0.85        | 0.00        | −0.34        | −0.78        | −0.73        | −0.49        | −0.46        | −0.26        |
| Mozambique               | 0.08/0.13/<br>0.19 | 0.98        | 0.00        | −0.68         | −3.73        | −2.92        | −1.81        | −0.94        | −0.52        | 0.45/0.58/<br>0.65 | 0.69        | 0.02        | −1.17        | −2.43        | −1.82        | −1.35        | −0.96        | −0.65        |
| Namibia                  | 0.04/0.12/<br>0.14 | 0.91        | 0.00        | −0.65         | −3.00        | −2.34        | −1.63        | −1.02        | −0.44        | 0.28/0.35/<br>0.41 | 0.63        | 0.05        | −0.71        | −1.99        | −1.80        | −1.35        | −0.92        | −0.55        |
| Niger                    | 0.04/0.08/<br>0.16 | 0.92        | 0.00        | −0.59         | −3.99        | −3.27        | −2.23        | −1.12        | −0.56        | 0.28/0.34/<br>0.46 | 0.59        | 0.03        | −0.60        | −2.10        | −1.62        | −1.26        | −0.90        | −0.54        |
| Nigeria                  | 0.07/0.16/<br>0.23 | 0.99        | 0.00        | −0.86         | −3.56        | −2.82        | −1.93        | −1.18        | −0.65        | 0.46/0.61/<br>0.65 | 0.96        | 0.01        | −1.20        | −2.05        | −1.68        | −1.31        | −0.96        | −0.66        |
| Rwanda                   | 0.03/0.06/<br>0.10 | 0.80        | 0.00        | −0.28         | −1.30        | −0.82        | −0.47        | −0.32        | −0.25        | 0.34/0.45/<br>0.49 | 0.82        | 0.02        | −0.89        | −1.67        | −1.44        | −0.96        | −0.70        | −0.51        |
| Sao Tome and<br>Principe | 0.01/0.28/<br>0.29 | 1.00        | 0.00        | −1.14         | −2.10        | −2.10        | −1.60        | −1.10        | −1.10        | 0.00/0.28/<br>0.28 | 0.50        | 0.00        | −0.87        | −0.87        | −0.87        | −0.87        | −0.87        | −0.87        |
| Senegal                  | 0.09/0.29/<br>0.33 | 1.00        | 0.00        | −1.49         | −2.99        | −2.56        | −2.08        | −1.53        | −1.11        | 0.22/0.51/<br>0.59 | 0.97        | 0.01        | −1.62        | −2.92        | −2.28        | −1.65        | −1.27        | −0.90        |
| Seychelles               | 0.00/0.04/<br>0.04 | 0.50        | 0.00        | −0.30         | −0.31        | −0.31        | −0.31        | −0.31        | −0.31        | 0.00/0.09/<br>0.09 | 0.50        | 0.00        | −0.63        | −0.63        | −0.63        | −0.63        | −0.63        | −0.63        |
| Sierra Leone             | 0.10/0.30/<br>0.33 | 1.00        | 0.00        | −1.53         | −3.15        | −2.36        | −1.85        | −1.47        | −0.89        | 0.39/0.65/<br>0.69 | 1.00        | 0.00        | −1.31        | −2.15        | −1.85        | −1.50        | −1.10        | −0.75        |
| Somalia                  | 0.07/0.19/<br>0.25 | 0.95        | 0.00        | −0.91         | −2.97        | −2.53        | −1.88        | −1.11        | −0.62        | 0.26/0.41/<br>0.52 | 0.51        | 0.01        | −1.18        | −2.75        | −1.93        | −1.48        | −1.12        | −0.60        |
| South Africa             | 0.05/0.10/<br>0.12 | 0.98        | 0.00        | −0.68         | −2.86        | −2.13        | −1.35        | −0.77        | −0.49        | 0.41/0.47/<br>0.53 | 0.81        | 0.08        | −0.65        | −1.71        | −1.30        | −0.90        | −0.50        | −0.20        |
| South Sudan              | 0.12/0.15/<br>0.18 | 0.90        | 0.00        | −0.36         | −2.26        | −1.54        | −0.83        | −0.45        | −0.31        | 0.26/0.41/<br>0.51 | 0.23        | 0.02        | −1.04        | −2.38        | −1.78        | −1.40        | −0.84        | −0.44        |
| Sudan                    | 0.07/0.14/<br>0.20 | 0.97        | 0.00        | −0.82         | −3.59        | −2.96        | −1.98        | −1.09        | −0.63        | 0.28/0.40/<br>0.50 | 0.45        | 0.03        | −1.02        | −2.63        | −1.85        | −1.51        | −1.08        | −0.56        |
| Swaziland                | 0.04/0.05/<br>0.07 | 0.86        | 0.00        | −0.27         | −1.84        | −0.79        | −0.52        | −0.27        | −0.12        | 0.13/0.21/<br>0.28 | 0.76        | 0.14        | −0.72        | −2.15        | −1.83        | −0.83        | −0.52        | 0.34         |
| Tanzania                 | 0.08/0.14/<br>0.20 | 0.98        | 0.00        | −0.56         | −2.57        | −2.05        | −1.40        | −0.76        | −0.39        | 0.37/0.53/<br>0.61 | 0.79        | 0.02        | −1.25        | −2.55        | −2.02        | −1.52        | −1.10        | −0.72        |
| Togo                     | 0.09/0.26/<br>0.29 | 1.00        | 0.00        | −0.91         | −2.04        | −1.77        | −1.32        | −0.89        | −0.70        | 0.29/0.48/<br>0.53 | 0.97        | 0.03        | −1.16        | −2.24        | −1.99        | −1.64        | −1.10        | −0.58        |
| Uganda                   | 0.05/0.08/<br>0.12 | 0.93        | 0.00        | −0.38         | −2.27        | −1.42        | −0.82        | −0.42        | −0.24        | 0.31/0.42/<br>0.47 | 0.81        | 0.01        | −1.00        | −2.53        | −1.94        | −1.48        | −1.04        | −0.68        |
| Zambia                   | 0.08/0.23/<br>0.28 | 0.98        | 0.00        | −1.16         | −2.25        | −1.73        | −1.22        | −0.79        | −0.43        | 0.23/0.50/<br>0.56 | 0.84        | 0.00        | −1.72        | −2.50        | −2.02        | −1.57        | −1.09        | −0.59        |
| Zimbabwe                 | 0.12/0.19/<br>0.24 | 0.97        | 0.00        | −0.77         | −2.21        | −1.67        | −1.11        | −0.63        | −0.25        | 0.35/0.55/<br>0.63 | 0.85        | 0.03        | −1.65        | −2.43        | −2.19        | −1.71        | −0.96        | −0.51        |

**Notes:** R2s in each part of the table show the  $R^2$  for the estimation of equations [4] – [6] in the main text for population and built-up density respectively. *Share* < 0: Share of cities with significant (10 % threshold) negative density gradient. *Share* > 0: Share of cities with significant (10 % threshold) positive density gradient. *Grad. Mean*: mean estimated gradient for the country across its cities. *PXX*: Density gradient for the city at the XX<sup>th</sup> centile for the gradient value.

## Data availability

Data is available on <https://sites.google.com/view/anatomy-of-urbanization-in-ssa>.

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