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Research article

Determinants of urban concentration in African countries

Elhadj EZZAHID[1,*], Bouchaib FERRAHI[2] and Oumar El HAMDANI[3]

[1] Faculty of Law and Economics, Laboratory of Applied Economics. University Mohamed V, Rabat, Morocco
[2] LaR2A Laboratory, Faculty of Sciences, Abdelmalek Essaadi University, Tetouan, Morocco
[3] Faculty of Arts and Human Sciences. University Mohamed V, Rabat, Morocco

* **Correspondence:** Email: ezzahidelhadj@gmail.com.

Abstract: Abstract: The knowledge of the potential drivers of urban concentration is of prime importance for policy-makers. This paper examines links between some structural variables and some measures of urban concentration in African countries. Cross-section regressions are used to single out determinants of urban concentration. There are three results worth highlighting. First, huge differences do exist between African countries in terms of the rate of urbanization of their population and the degree of concentration of their urban systems. Second, the countries having the most primal urban systems are the poorest countries according to their per capita GDP. Consequently, the higher the urban population is and the lower the degree of development of a country we have, the higher will be, on average, the degree of its urban concentration. Third, the availability of electricity in rural areas is associated negatively with urban concentration however measured (Prim1, Prim2, *HHI*, and Gini index). This is a rather important result because the availability of electricity in rural areas is informative of the abundance of infrastructures in the country and, henceforth, its even distribution among urban cities and then less concentrated rural migrants' flows.

Keywords: urban concentration; development; primacy; Gini index; Africa

JEL Codes: O18, R12

1. Introduction

Cities are the locus for wealth creation. Scholars discussed many channels through which agglomeration processes and, henceforth, the formation of cities affect positively wealth creation (Bloom et al., 2008). All over the World, the process of growth is associated with an increase in the share of the population living in cities and of the number of these cities.

Many factors explain urbanization's increasing trend. A huge literature discusses the centripetal forces that are likely to produce agglomeration of people and activities in a limited number of points of space. Krugman (1996), Fujita and Thisse (1996), and Moomaw and Shatter (1996) showed that the level of per capita GDP, the extent of industrialization, and the export-orientedness of the economy are positively linked to the rate of urbanization. Bairoch and Goertz (1986) showed that over the 19th century in Europe, economic growth was the key factor behind urbanization. Other researchers claim that many no economic factors push people to migrate toward urban areas (Todaro, 1997).

Generally, the process of urbanization in less developed countries is featured, in its first stages, by its high speed. Therefore, it is likely to produce initially the phenomenon of overconcentration. This phenomenon is caused by "pathological non-economic factors" of urbanization, rather than by economies of agglomeration and higher productivity (Kim, 2008).

In Africa, urbanization was a rather fast process that occurred without a structural change in the economies of these countries (Freire et al., 2014). Furthermore, it appears that the rate of "urbanization in Africa is positively associated with the importance of natural resources' exports in GDP" (Gollin et al., 2013).

There is abundant research about the forces that determine the degree of urban concentration in a country. Indeed, many authors explored the factors that drive concentration in urban systems and others investigated the nature of the relationship between economic development and urban concentration. According to (Henderson, 2005), this interest in urban concentration is legitimate. In fact, the importance of this issue stems from its implications for urban planning, public resources allocation, and for problems created by big cities and population clustering.

Ades and Glaeser explored the factors that drive concentration in urban systems measured by the "average share of urbanised population living in the main city from 1970 to 1985" (Ades & Glaeser, 1995). Their main result is that more dictatorial regimes, high tariffs, high costs of internal trade, and openness to foreign trade increase the degree of concentration. K. Junius investigated the nature of the relationship between economic development and urban concentration. His research aimed to know if the relationship between the two variables takes "the form of an inverted U-curve, where concentration first increases and then decreases in the course of economic development" (Junius, 1997). The author found "evidence for this hypothesis, using different samples of countries. The relationship is conditional on the size of the land area, population density and the density of the transportation system" (Junius, 1997).

William Wheaton and Hisanobu Shishido looked empirially at the determinants of urban concentration in a sample of 38 countries. They found that "the economic variables are highly significant in the nonlinear model, and the explanatory power is surprisingly good. By contrast, the results of the linear model are much less significant. The results suggest that economic theory is a powerful determinant of urban concentration and that the level of development has at first an increasing and then decreasing effect on urban concentration" (Wheaton & Shishido, 1981).

DePaolis (2010) used a general model with multiple specifications, and two groups of countries, to explore the determinants of primacy. The latter is measured by the ratio of the population of the largest city to total population. His empirical results are not systematic. Government effectiveness and economic openness are negatively and significantly correlated to the measure of primacy. Concerning landlockedness of a country, it is correlated positively with the same index (DePaolis, 2010, tables 2, 3, and 4). (Gaviria & Stein, 2000) found that the growth rate and the share of agriculture in GDP are positively and significantly associated with the share of the main city in the urban population. Democracy is negatively but insignificantly correlated with the primacy measure (Gaviria & Stein, 2000). Susanne Frick and Andres Rodriguez-Pose found that "there is no uniform relationship between urban concentration and economic growth. Urban concentration is beneficial for economic growth in high-income countries, while this effect does not hold for developing countries" (Frick & Rodriguez-Pose, 2018).

Mutlu (1989) used a sample of 95 countries to explore the determinants of primacy. His "analysis yields a negative association between primacy and urban concentration and the size of the urban population, the area and population size of the country, and the level of economic development. Income inequality, ethnic homogeneity, the location of the capital functions in the biggest city of the polity, the centralization of administration, and a free-enterprise type of economic and social organization were found to be positively associated with urban concentration and primacy" (Mutlu, 1989).

Alfred M. Wu, Lin Ye and Hui Li used a panel data about Chinese provinces to investigate, over the period 1994–2015, "the theoretical and empirical linkages between political institutions such as fiscal decentralization, socioeconomic factors, and urban geography such as urban agglomeration. Empirical evidence suggests that more decentralized regions (provinces) tend to experience stronger dominance of large cities for the whole study period" (Wu et al., 2019).

Our paper explores the structural determinants of urban concentration in African countries. For this, we measure, in a first step, the extent of this phenomenon in each country by a set of four indicators. The use of more than one measure of urban concentration is to mitigate the shortcomings of each one. In a second step, we attempt to explore the links between these measures and some structural characteristics of African countries. We use a cross section dataset covering African countries by using one observation for the year 2010 or the nearest year for which data are available.

The paper proceeds as follows. In the second section, we present the measures of urban concentration. In the third section, we lay out a descriptive overview of the situation of urban concentration in African countries. In the fourth section, we relate each measure of urban concentration to a bundle of structural variables that may explain the extent of this phenomenon in a large sample of African countries. The last section includes some concluding remarks.

2. Measures of urban concentration

Let $S_i = \{S_{i1}, S_{i2}, \dots, S_{ik^i}\}$ be the set containing the cities' populations of the i^{th} country classified in decreasing order. Remark that in each country *i*, with *i* = 1, 2, 3, . . . , n. There are at most k^i cities in each country *i*. From the data about the population of the different k^i cities in each country *i*, $\{S_{i1}, S_{i2}, \dots, S_{ik^i}\}$, we derive four measures of urban concentration.

One of the most discussed urban concentration features is primacy. "Discussions of primacy- the share of urban population in the country's largest city- often begin with an argument due to Williamson (1965)" (Montgomery et al., 2003). Primacy is indicative of the importance of the population living in the largest city relative to the population of the second largest city or to the total population of the

largest *J* cities (Jefferson, 1939). Rosen and Resnick used "two measures of primacy: the ratio of the largest city to the sum of the top five cities (Primacy I) and the ratio of the largest city to the sum of the population of the top 50 cities (Primacy II)" (Rosen & Resnick, 1980). (Bertinelli & Strobl, 2003) adopt another measure of urban concentration called urban density. It is "defined as the share of the urban population living in cities larger than 75,000 inhabitants" (Bala, 2009). In this paper and for each country *i*, we use the following two measures of primacy.

$$Prim_{1i} = \frac{S_{i1}}{S_{i2}} \tag{1}$$

$$Prim_{2i} = \frac{S_{1i}}{\sum_{j=1}^{j=4} S_{ij}} \tag{2}$$

To measure the degree of concentration in the entire S_{1i} urban system in the i^{th} country, we use also the Hirschman-Herfindahl (*HHI*) and the Gini indices. They are measured as follows:

$$HHI_i = \sum_{j=1}^{k^i} \left(\frac{S_{ij}}{S_i}\right)^2 \; with \; S_i = \sum_{j=1}^{k^i} S_{ij} \tag{3}$$

$$Gini_i = 1 - \left(\frac{1}{k^i} + \frac{2}{k^i s_i} \sum_{j=1}^{j=k^i} \sum_{l=0}^{l=j-1} S_{il}\right) \tag{4}$$

3. Descriptive overview

There are huge differences between African countries with respect to the variables measuring urban concentration and those expected to be their determinants. Among the latter determinants, the one that most varies is population density (persons per one square km of land area). The second most dispersed variable is access to electricity, it ranges from 0.3 % to 100 % (See table 1) Among the variables measuring urban concentration, Prim1 is the most volatile variable. For instance, Liberia's largest city's population is approximately 18 times the population of the second largest city (Appendix Table A1).

According to the ranking of per capita GDP, the poorest country in Africa is Burundi. In 2010, the African countries with the highest urban rate are Gabon (86 %), Djibouti (77 %), and Algeria (68 %). The average rate of urbanization in Africa is 41 % in 2010. Burundi is the less urbanized country in Africa with only 10.64 % of its population living in urban centers. Primacy, measured by the ratio of the population living in the largest city to the population living in the second largest city, attains its peak 17.93 in Liberia and its lowest value (1.02) is observed in Ghana and Malawi.

One of the main consequences of the phenomenon of increasing urbanization is the rise, all over the World, of the number of cities where huge populations are clustered. In Africa, the number of cities with more than one million dwellers (megacity) spectacularly jumped from only 2 in 1950 to 47 in 2010 (See table 2). The majority of African megacities are located in the littoral of the continent (See Appendix Fig. A1).

Table 1. Summary statistics about main variables.

Variable	Abr	Unity	Obs	Min	Max	Mean	Std, Dev,	CV
Primacy 1 [a]	Prim1	Unitless	49	1.02	17.93	4.75	3.75	0.79
Primacy 2 [a]	Prim2	Unitless	49	0.36	5.56	1.62	1.22	0.75
HHI a	*HHI*	Unitless	49	0.02	0.69	0.20	0.14	0.69
Gini a	Gini	Unitless	49	0.35	0.82	0.63	0.12	0.18
Population Density [b]	DD	Inhabitants per Km^2	48	2.66	615.96	91.02	121.60	1.34
Log (GDP per capita) [b]	GDP-p		47	4.99	8.78	6.68	1.01	0.15
Share of urban population in total population [b]	UP	%	49	11	86	41	17	42
Total Population [b]	TP		49	12.05	18.89	16.05	1.46	0.09
Life expectancy at birth [b]	LEB	Years	49	44.83	74.60	57.80	7.30	0.13
Rural degree of elecrifcation [b]	Elec	%	49	0.30	100.00	23.03	29.86	1.30
Share of agriculture in GDP [c]	Agr	%	45	2.63	56.02	23.81	14.95	0.63
Share of industry in GDP [b]	Ind	%	45	8.23	75.38	26.48	14.02	0.53
Openess [b]	Open	%	48	36.98	155.76	75.13	28.28	0.38

Note: b: data from WDI (2015) concern the year 2010; c: data from WDI (2015) concern a year between 2007 and 2010.
Source: a: data from www.citypopulation.de concern one census available in the period (2003–2014);

Table 2. Evolution of the number of megacities across the world.

	1950	1960	1970	1980	1990	2000	2010	2020
Africa	2	3	8	14	24	37	47	58
Europe	19	24	25	28	30	34	37	37
North America	15	22	27	33	36	44	48	51
South America	8	11	17	27	39	48	57	69
Asia	33	48	82	115	166	211	241	291
Australia	2	2	2	3	5	5	5	5
World	79	110	161	220	300	379	435	511

Source: Global Population Project. LandScan 2022. Available from: https://nordpil.com/static/downloads/urbanareas1_1.zip.

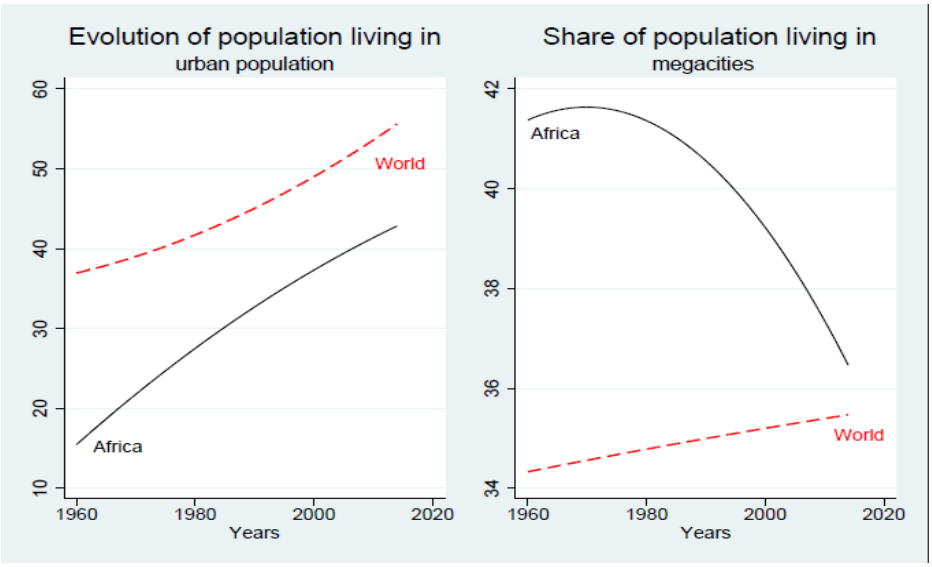

Figure 1. Evolution of UP and of the share of population living in megacities in Africa and in the world.

In Africa, the rate of urbanization increased from less than 20 % in 1960 to more than 40 % in 2014. Notwithstanding this huge increase, Africa's rate of urbanization is still below the average rate of urban population in the World, which is 57.38 % (WDI, 2015) (See figure 1). Urbanization is fuelled by cities organic growth and by the flow of rural migrants attracted by employment opportunities and by other amenities in urban zones.

Table 3. Variables' correlation matrix.

	P rim1	P rim2	*HHI*	Gini	DD	GDP_p	UP	TP	LEB	Elec	Agr	Ind	Open
P rimacy1	1												
P rimacy2	0.88	1											
HHI	0.67	0.72	1										
Gini	0.06	0.16	0.32	1									
Population Density	–0.02	–0.03	0.08	–0.28	1								
Log (GDP per capita)	–0.39	–0.41	–0.33	–0.10	–0.04	1							
Urban Population	–0.06	–0.12	0.08	0.06	–0.27	0.71	1						
Total Population	–0.10	–0.06	–0.42	0.22	–0.24	–0.26	–0.34	1					
Life Exp at Birth	–0.15	–0.11	–0.21	–0.21	0.28	0.42	0.35	–0.15	1				
Electricity	–0.37	–0.42	–0.39	–0.25	0.25	0.68	0.51	–0.03	0.67	1			
Agriculture	0.31	0.27	0.17	0.00	0.06	–0.75	–0.60	0.17	–0.39	–0.48	1		
Industry	–0.29	–0.25	–0.19	0.16	–0.32	0.52	0.46	0.05	0.09	0.20	–0.67	1	
Openess	0.04	0.02	0.14	–0.17	–0.08	0.40	0.37	–0.46	0.06	0.10	–0.57	0.44	1

Source: Data from WDI (2015) and www.citypopulation.de.

The data show that higher is the primacy's measure higher is the degree of an urban system's concentration in a country. *HHI* and Gini indices are, in their turn, positively linked to a higher hierarchization of the urban system. It is expected that the two measures of primacy are positively

correlated with the *HHI* index and with Gini index. Our data show that Prim1 is highly correlated with Prim2. The latter variable is also correlated with *HHI*. Prim1 is a bit less strongly correlated with *HHI* compared to the correlation between Prim2 and *HHI* (See table 3).

Countries in the upper quartile according to the ranking with respect to Prim1 don't belong to the upper quartile according to the ranking with respect to their per capita GDP. Among the group of countries with high Prim1, five countries (Burundi, Ethiopia, Guinea, Liberia, and Madagascar) belong to the lowest quartile according to their per capita GDP. Globally it appears that countries having the most concentrated urban systems according to Prim1 are the poorest countries according to their per capita GDP.

4. Methodology, results, and discussion

In this section, we explore the association between a set of structural variables and urban concentration measured by the above four indicators. The variables that we use to explain the rate of concentration are qualified as structural because they reflect the extent of slow varying phenomena that respond only to long run shifting forces. We run using OLS the following equation:

$$UC_i = \alpha_0 + \sum_{j=1}^{J} \alpha_j x_{ij} + \sum_{m=1}^{M} \alpha_m (x_{im})^2 + \varepsilon_i, \text{for } i = 1,2,3,\ldots,\text{n},. \quad (5)$$

Running Equation 5 over the cross section of African countries implies that we suppose the homogeneity of the relationship between the vector "X" of exogenous variables and each of the four indicators of urban concentration across the units of the sample. Otherwise, we make the hypothesis that across countries, the J ($J \leq 9$) exogenous variables, introduced in each model (for example in table 4 model 2, J = 4), affect in the same manner each of the urban concentration indices (UC_i) in all countries and, henceforth, the absence of country specific effects. We add the quadratic term of some M ($M < J$) explanatory variables to take account of nonlinearities.

Table 4. Determinants of *HHI*.

	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8	Model9	Model10
Share of urban population	0.431**	0.002	0.672***	0.466**	–0.110	0.554***	–0.024	0.602***	0.003	0.616***
	(3.302)	(0.005)	(5.015)	(2.962)	(–0.258)	(4.009)	(–0.057)	(4.288)	(0.006)	(4.311)
Population density	0.000*	0.000*	0.001	0.000	0.000	0.000*	0.000*	0.000*	0.000*	0.000
	(2.447)	(2.269)	(1.249)	(1.319)	(1.149)	(2.478)	(2.266)	(2.502)	(2.351)	(0.247)
Rural degree of electrication	–0,003***	–0.003***	–0.002**	–0.002	–0.002	–0.002*	–0.002*	–0.002*	–0.002*	–0.002*
	(–4.717)	(–4.521)	(–3.447)	(–1.987)	(–1.767)	(–2.564)	(–2.317)	(–2.604)	(–2.195)	(–2.446)
(Share of urban population)2		0.464			0.635		0.637		0.667	
		(0.966)			(1.452)		(1.451)		(1.448)	
(Population density)2			0.000							0.000
			(–0.090)							(0.670)
Log (GDP per capita)			–0.075*	–0.072**	–0.075**	–0.077**	–0.080**	–0.066*	–0.070**	–0.074*
			(–2.408)	(–2.874)	(–3.041)	(–2.969)	(–3.133)	(–2.551)	(–2.744)	(–2.572)
Share of agriculture in GDP			–0.000							

Continued on next page

	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8	Model9	Model10
			(–0.326)							
Total population				–0.023	–0.023					
				(–1.670)	(–1.679)					
Rate of openness						0.001	0.001			
						(1.553)	(1.564)			
Life expectation at birth								0.000	–0.001	0.000
								(–0.001)	(–0.284)	(–0.010)
Constant	0.066	0.150	0.451*	0.872**	1.003**	0.421**	0.556**	0.405	0.595*	0. 468
	(1.177)	(1.446)	(2.047)	(2.785)	(3.116)	(2.967)	(3.307)	(1.810)	(2.316)	(1.917)
R^2	0.340	0.354	0.524	0.477	0.503	0.472	0.498	0.441	0.469	0.447
Vif test	1.56	10.81	5.93	2.39	8.41	2.01	8.10	2.20	8.47	5.43

Source**:** Authors' calculations, t-statistic in parentheses (* p<0.1, ** p<0.05, *** p<0.001).

Table 5. Detreminants of gini index.

	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8	Model9	Model10
Share of urban population	0.168	–0.177	0.231	–0.155	0.153	0.274	–0.247	0.274	0.164	0.156
	(1.528)	(–0.475)	(1.934)	(–0.392)	(1.250)	(1.823)	(–0.567)	(1.841)	(1.321)	(1.232)
Rural degree of electrication	–0.001*	–0.001*	–0.002**	–0.001*	–0.001*	–0.002*	–0.002	–0.002*	–0.001*	–0.001
	(–2.539)	(–2.414)	(–2.754)	(–2.172)	(–2.043)	(–2.035)	(–1.756)	(–2.264)	(–2.091)	(–1.450)
Rate of openness	–0.001*	–0.001*	–0.001	–0.001	–0.001*				–0.001	
	(–2.152)	(–2.194)	(–1.245)	(–1.199)	(–2.146)				(–1.348)	
Share of industry in GDP	0.002	0.002	0.001	0.001	0.002					0.001
	(1.565)	(1.557)	(0.856)	(0.787)	(1.150)					(1.084)
(Share of urban population)2		0.382		0.442			0.569			
		(0.968)		(1.102)			(1.273)			
Total population			0.016	0.018		0.030*	0.030*	0.030*		
			(1.298)	(1.293)		(2.162)	(2.179)	(2.220)		
Population density				0.000	–0.000	0.000	0.000	–0.000		
				(0.097)	(–0.851)	(0.289)	(0.162)	(–0.594)		
(Population density)2					0.000			0.000		
					(0.764)			(0.828)		
Life expectation at birth						0.001	0.000			
						(0.289)	(0.053)			
Log (GDP per capita)									0.009	–0.019
									(0.374)	(–0.716)
Constant	0.646***	0.714***	0.356	0.390	0.684***	0.032	0.171	0.082	0.605***	0.693***
	(14.120)	(8.574)	(1.560)	(1.374)	(10.550)	(0.101)	(0.515)	(0.316)	(4.564)	(4.936)
R^2	0.221	0.240	0.254	0.278	0.236	0.187	0.218	0.198	0.133	0.142
Vif test	1.46	8.68	1.74	7.45	5.01	2.16	8.43	4.91	1.97	2.10

Source: Authors' calculations, t-statistic in parentheses (* p<0.1, ** p<0.05, *** p<0.001).

We use as explanatory variables of urban concentration eight variables that are potentially. The drivers of this process. We are inspired by the available literature that lead with this issue. The squared

variables are chosen after running many regressions and we keep only the simulated regressions where the coefficient attached to a quadratic term is significant.

HHI measures the degree of concentration by using all the information contained in the distribution of the cities according to their size. Thus, it synthetizes the information about the whole distribution. Econometric results show that higher is the rate of urban population higher is the degree of urban concentration measured by *HHI* in Africa. This relationship is robust to changes in the set of exogenous variables. Access of rural areas dwellers to electricity is correlated negatively and significantly with concentration measured by *HHI* (See table 4). This may be due to the fact that if electricity is available in rural areas then the cities in the country are likely to be uniformly endowed with public services and this fact reduces the concentration of population in a limited number of cities especially by diversifying migrants' destinations.

Table 6. Determinants of primacy (Prim1).

	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8	Model9	Model10
Share of urban population	–1.208	5.933	–10.206	–11.193	10.745*	–11.710	10.371*	–8.539	9.672*	–9.175
	(–0.352)	(1.500)	(–0.732)	(–0.885)	(2.670)	(–1.008)	(2.102)	(–0.641)	(2.292)	(–0.716)
Population density	0.002	0.005	0.004	–0.021	0.005	0.004	0.003	0.002	0.003	0.002
	(–0.433)	(0.938)	(0.748)	(–1.636)	(1.189)	(0.879)	(0.494)	(0.312)	(0.642)	(0.414)
Rural degree of electrication		–0.067**	–0.063**	–0.016	–0.035	–0.028	–0.029	–0.022	–0.023	–0.016
		(–3.002)	(–2.807)	(–0.652)	(–1.628)	(–1.313)	(–1.039)	(–0.811)	(–0.909)	(–0.650)
(Share of urban population)2			17.473	25.652		24.316*		20.860		20.760
			(1.207)	(1.925)		(2.051)		(1.524)		(1.555)
(Population density)2				0.000						
				(1.939)						
Log (GDP per capita)				–2.977***	–1.525	–1.507	–2.162**	–2.278**	–2.447**	–2.562**
				(–3.610)	(–1.752)	(–1.802)	(–2.754)	(–2.934)	(–3.101)	(–3.287)
Share of agriculture in GDP					0.027	0.034				
					(0.587)	(0.771)				
Total population							–0.110	–0.104		
							(–0.255)	(–0.244)		
Rate of openness									0.027	0.027
									(1.434)	(1.448)
Constant	5.496**	3.492*	6.684*	25.480***	10.218	14.295*	17.167	21.451*	15.378***	19.762***
	(3.265)	(2.068)	(2.134)	(4.307)	(1.692)	(2.329)	(1.747)	(2.130)	(3.552)	(3.870)
R^2	0.006	0.175	0.202	0.399	0.300	0.369	0.305	0.343	0.337	0.375
Vif test	1.07	1.56	10.81	11.74	2.49	8.69	2.39	8.41	2.01	8.10

Source**:** Authors' calculations, t-statistic in parentheses (* p<0.1, ** p<0.05, *** p<0.001).

Gini index is widely used to measure concentration especially of income among individuals, groups of individuals, or countries. This paper uses Gini index to measure the degree of concentration in an urban system. Results are less systematic compared to those found when we use the *HHI* to approximate the extent of urban concentration (See table 4). The rate of industrialization is linked positively but insignificantly to the value of the Gini index. Electrification of a country is significantly and negatively correlated with the degree of urban concentration measured by the Gini index. The

share of urban population (UP) and the total population (TP) are correlated positively with the Gini index (See table 5).

Availability of electricity in rural areas is associated with a lower Prim1. This is a rather important result because the availability of electricity in rural areas is informative of the abundance of infrastructures in the country and its even distribution among cities. The population of the country is associated negatively with Prim1 whereas the share of agriculture in the GDP is associated positively with this variable. The (log) of per capita GDP is negatively correlated with urban concentration measured by Prim1. GDP is associated positively with this variable. The (log) of per capita GDP is negatively correlated with urban concentration measured by Prim1.

Table 7. Determinants of primacy (Prim2).

	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8	Model9	Model10
Share of urban population	1.561	–2.353	3.016*	–2.686	2.933*	–2.49	–1.721	3.268*	2.609	–2.813
	(–1.23)	(–0.522)	(–2.216)	(–0.638)	(–2.179)	(–0.625)	(–0.390)	(–2.04)	(–1.885)	(–0.666)
Population density	0.001	0.001	0.001	–0.007	0.001	0.001	0.001	–0.005	0.001	–0.006
	(–0.826)	(–0.676)	(–0.645)	(–1.516)	(–1.041)	(–0.801)	(–0.37)	(–1.161)	(–0.537)	(–1.286)
Rural degree of electrication	–0.022**	–0.021**	–0.012	–0.008	–0.013	–0.011	–0.01	–0.01	–0.009	–0.006
	(–3.119)	(–2.946)	(–1.545)	(–0.959)	(–1.796)	(–1.543)	(–1.151)	(–1.112)	(–1.161)	(–0.746)
(Share of urban population)2		4.237		6.643		5.872	5.181			6.42
		(–0.906)		(–1.497)		(–1.443)	(–1.143)			(–1.442)
Log (GDP per capita)			–0.611*	–0.863**	–0.538	–0.533	–0.642*	–0.794**	–0.705**	–0.900**
			(–2.436)	(–3.144)	(–1.847)	(–1.858)	(–2.497)	(–2.831)	(–2.725)	(–3.235)
(Population density)2				0				0		0
				(–1.787)				(–1.495)		(–1.494)
Share of agriculture in GDP					–0.001	0.001				
					(–0.057)	(–0.056)				
Total Population							–0.005	–0.005		
							(–0.037)	(–0.035)		
rate of Openness									0.008	0.006
									(–1.313)	(–0.908)
Constant	1.399*	2.173*	4.681**	7.658***	4.205*	5.189*	5.882	6.109	4.815**	7.495***
	(–2.583)	(–2.146)	(–3.276)	(–3.887)	(–2.081)	(–2.463)	(–1.764)	(–1.861)	(–3.389)	(–3.78)
R^2	0.194	0.209	0.296	0.368	0.292	0.329	0.318	0.333	0.324	0.381
Vif test	1.56	10.81	2.07	11.74	2.49	8.69	8.41	5.58	2.01	10.49

Source**:** Authors' calculations, t-statistic in parentheses (* p<0.1, ** p<0.05, *** p<0.001).

Results about the determinants of Prim2 are similar to those found for Prim1. The (log) of per capita GDP, the degree of rural electrification, and the share of the urban population in the total population are negatively and significantly correlated with urban concentration measured by Prim2. The share of agriculture in GDP and total population affect negatively but insignificantly primacy measured by Prim2. The degree of openness of the country and population density affect positively Prim2 but they are not statistically significant (See table 7).

Scholars believe that the relationship between urban concentration, whatever is measured, and its deep determinants is likely not linear. We introduce a quadratic term in our regressions in order to capture

the potential nonlinearities between urban concentration and its structural drivers. The square of the share of the urban population affects positively *HHI* (insignificantly), Gini index (insignificantly), Prim1 (significantly), and Prim2 (insignificantly). This means that the relationship between the two variables is convex. The effect of the square of the population density on urban concentration is nil.

5. Conclusions

Urbanization is a complex phenomenon shaped by multiple deep operating forces. One of the consequences of an urbanization process is how balanced a country's urban system gets over time and how balanced it is at a point of time compared to other countries. Identification of links between a set of structural variables and the degree of concentration of an urban system is a prerequisite for decision-makers to calibrate their decisions.

Indeed, the knowledge of the most important factors that command the degree of concentration of an urban system is of prime importance for policy-makers that seek to put at place the foundations of a more balanced urban system. As is expected, a higher *HHI* is associated with a higher primacy index. Remark that the two metrics capture different portions of the distribution of cities according to their size. *HHI* gives an idea about concentration over the entire distribution. Prim1 measures only the relative size of the largest city with respect to its followers.

Our empirical investigation shows that in a sample of African countries higher rate of the urban population, lower rate of electrification, higher population density, and a higher population of the largest city contribute to increase the degree of urban concentration measured by *HHI* (this index captures concentration over the whole urban system). On the contrary, the same determinants have weak links with urban concentration measured by Prim1 or by Prim2.

Availability of electricity in rural areas is associated with less concentration in urban systems (lower Prim1, lower Prim2, lower *HHI*, and lower Gini index). This result is frequent in empirical research (Junius, 1997). This is a rather important result because the availability of electricity in rural areas is informative of the abundance of infrastructures in the country and its even distribution along space and, henceforth, between cities. We can conjecture that the availability of electricity in rural areas is informative about deep dynamics that contribute to producing, ceteris paribus, more balanced urban systems. This result conforms to what is widely documented by scholars.

Electricity is one type among many types of infrastructures (roads, bridges, commuting systems, schools, sanitation, and water supply facilities). As stressed by (Freire et al., 2014), people are attracted by cities where there are sufficient basic services among which electricity. Consequently, decision-makers are strongly advised to endow intermediate and small cities with sufficient and diversified infrastructures so that rural migrants have many alternatives to migrate to. This reduces pressure on cities at the top of the urban hierarchy.

Overall, the per capita GDP is negatively and statically correlated with urban concentration. This finding is robust to the index used to gauge the extent of urban concentration and the control variables introduced in the regressions as determinants of this index. This result may indicate that economic growth and development contribute to producing more balanced urban systems.

Conflict of interest

All authors declare no conflicts of interest in this paper.

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