ONLINE APPENDIX

(For the World Bank Research Observer article by Baccini, Fiorini, Hoekman and Sanfilippo: Services, Jobs and Economic Development in Africa)

Appendix A

Table A1: Full results by main sectors based on equation (1)

	(1) Agriculture	(2) Mining	(3) Manufacturing	(4) Utilities	(5) Construction	(6) Tertiary
ntl_pc	-2.100***	0.198*	0.604***	0.00982	0.416***	0.881***
	(0.354)	(0.106)	(0.129)	(0.0151)	(0.0643)	(0.251)
ntl_pc^2	1.016***	-0.0535	-0.202*	0.0429***	-0.202***	-0.556***
	(0.321)	(0.0488)	(0.119)	(0.0112)	(0.0297)	(0.189)
pop	0.353***	0.0636	-0.0258	-0.0368***	-0.0758***	-0.314***
	(0.129)	(0.0697)	(0.0427)	(0.00591)	(0.0229)	(0.0890)
pop^2	-0.0190***	-0.00209	0.00192	0.00168***	0.00362***	0.0155***
	(0.00539)	(0.00281)	(0.00179)	(0.000256)	(0.000968)	(0.00374)
post_2000	-0.0656***	-0.00436***	0.000364	0.000494**	0.00993***	0.0597***
	(0.00657)	(0.00169)	(0.00182)	(0.000238)	(0.00120)	(0.00508)
Constant	-0.876	-0.442	0.0956	0.203***	0.415***	1.802***
	(0.780)	(0.427)	(0.254)	(0.0342)	(0.135)	(0.538)
Observations	3,135	3,135	3,135	3,135	3,135	3,135
R-squared	0.971	0.920	0.913	0.881	0.899	0.969

Notes: Estimates are based on equation (1). NTL_pc is the value of nighttime lights per capita. pop is the log of population. The squared term of both the former variables is included. Post_2000 is the variable of interest, a dummy taking 1 if the year of the census is successive to 2000. All regressions include district fixed effects. Robust standard errors in parenthesis. District. *** p<0.01, ** p<0.05, * p<0.1

Table A2: Full results by industries within services based on equation (1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
VARIABLES	trade	accommodation	transport	finance	public	business	education	health	private_hh	other_services	unspec_servic
ntl_pc	-0.0465	0.430***	-0.0739	0.0608***	-0.145	-0.0843**	0.256***	0.148***	-0.219***	0.625***	-0.0792***
	(0.104)	(0.0654)	(0.255)	(0.0149)	(0.110)	(0.0371)	(0.0560)	(0.0435)	(0.0790)	(0.0874)	(0.0242)
ntl_pc^2	-0.0776	-0.162***	-0.215	-0.0228**	0.148*	0.0553***	-0.0416	-0.0990***	0.108**	-0.307***	0.0143
	(0.0615)	(0.0235)	(0.144)	(0.00950)	(0.0860)	(0.0191)	(0.0351)	(0.0273)	(0.0503)	(0.0617)	(0.0127)
pop	-0.206***	-0.0286	-0.0670***	-0.00998*	0.256***	-0.00127	0.0597***	-0.0951***	-0.0949***	-0.111***	0.0222
	(0.0585)	(0.0226)	(0.0259)	(0.00530)	(0.0361)	(0.0186)	(0.0217)	(0.0232)	(0.0240)	(0.0239)	(0.0358)
pop^2	0.00812***	0.00195**	0.00328***	0.000562***	-0.0115***	0.000198	-0.00201**	0.00441***	0.00456***	0.00585***	-0.00167
	(0.00251)	(0.000958)	(0.00104)	(0.000216)	(0.00159)	(0.000790)	(0.000933)	(0.000918)	(0.00107)	(0.00102)	(0.00162)
post_2000	0.0337***	0.00562***	0.00919***	-0.000309	-0.0108***	0.00561***	0.00784***	0.00505***	0.00162*	0.00762***	-0.00591***
	(0.00242)	(0.00126)	(0.00135)	(0.000292)	(0.00150)	(0.000809)	(0.00102)	(0.00134)	(0.000829)	(0.00111)	(0.00106)
Constant	1.371***	0.0721	0.357**	0.0444	-1.362***	-0.00209	-0.386***	0.519***	0.510***	0.499***	-0.0234
	(0.343)	(0.135)	(0.163)	(0.0326)	(0.205)	(0.109)	(0.127)	(0.144)	(0.135)	(0.141)	(0.197)
Observations	3,135	3,135	3,135	3,135	3,135	3,135	3,135	3,135	3,135	3,135	3,135
R-squared	0.904	0.647	0.910	0.921	0.901	0.796	0.941	0.859	0.907	0.716	0.466

Notes: Estimates are based on equation (1). NTL_pc is the value of nighttime lights per capita. pop is the log of population. The squared term of both the former variables is included.
Post_2000 is the variable of interest, a dummy taking 1 if the year of the census is successive to 2000.
All regressions include district fixed effects. Robust standard errors in parenthesis. District. *** p<0.01, ** p<0.05, * p<0.1

Table A3: Correlations between changes in sectoral employment and type of occupation

VARIABLES	(1) Agriculture	(2) Manufacturing	(3) Services
Goods (tangible) occupations	0.751***	0.180	-0.412**
	(0.245)	(0.129)	(0.186)
Services (intangible) occupations	-0.310	0.232*	0.523***
	(0.247)	(0.129)	(0.189)
Constant	-0.0396***	0.00844***	0.0211***
	(0.00204)	(0.00123)	(0.00125)
Observations	1,528	1,520	1,529
R-squared	0.712	0.210	0.867

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Notes: Each column reports a regression linking the first difference in the share of employment in one of the three sectors (agriculture, manufacturing, services) against the first difference in the share of workers classified into goods (tangible) or services (intangible) types of occupations according to the definition by Duernecker and Herrendorf (2020). The latter refers only to those employed within a specific sector. In order to compute the first difference in an homogenous manner, the estimation sample includes the two most recent waves for each country.

Appendix B

Table B1 Main analysis

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS					
	Nightlight *per capita*					
Secondary sector	-0.000	0.006***	0.005***	-0.002	0.006***	0.006***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Tertiary sector	0.010***	0.003**	-0.000	0.012***	-0.001	-0.001
	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Constant	0.018***	0.019***	0.020***	0.017***	0.020***	0.019***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Admin FE	No	Yes	Yes	No	Yes	Yes
Wave FE	No	No	Yes	No	No	Yes
Controls	No	No	No	Yes	Yes	Yes
Observations	3,214	3,213	3,213	2,982	2,909	2,909
R-squared	0.075	0.962	0.963	0.188	0.965	0.965

Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADMN and wave fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Table B2 Macro service clusters

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS					
	Nightlight *per capita*					
Mining	0.009***	0.004***	0.004***	-0.119***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.027)	(0.002)	(0.002)
Manufacturing	-0.001	0.004***	0.003***	0.010	0.003*	0.003**
	(0.002)	(0.001)	(0.001)	(0.066)	(0.001)	(0.001)
Construction	0.003***	0.004***	0.003*	0.113*	0.003*	0.003*
	(0.001)	(0.001)	(0.001)	(0.059)	(0.001)	(0.001)
Utilities	0.003	-0.000	-0.001	0.063	-0.001	-0.001
	(0.002)	(0.001)	(0.001)	(0.059)	(0.001)	(0.001)
Other industry	-0.000	0.000	-0.000	0.041	-0.009	-0.009
	(0.001)	(0.000)	(0.000)	(0.215)	(0.010)	(0.010)
High-skill services	0.011***	0.008***	0.007***	0.353***	0.005**	0.005**
	(0.002)	(0.003)	(0.003)	(0.072)	(0.002)	(0.002)
Low-skill services	-0.002	-0.002	-0.003	-0.090	-0.004**	-0.004**
	(0.001)	(0.002)	(0.002)	(0.061)	(0.002)	(0.002)
Constant	0.017***	0.018***	0.019***	0.519***	0.017***	0.015***
	(0.001)	(0.001)	(0.001)	(0.045)	(0.002)	(0.003)
Admin FE	No	Yes	Yes	No	Yes	Yes
Wave FE	No	No	Yes	No	No	Yes
Controls	No	No	No	Yes	Yes	Yes
Observations	3,214	3,213	3,213	2,982	2,909	2,909
R-squared	0.175	0.964	0.964	0.172	0.968	0.968

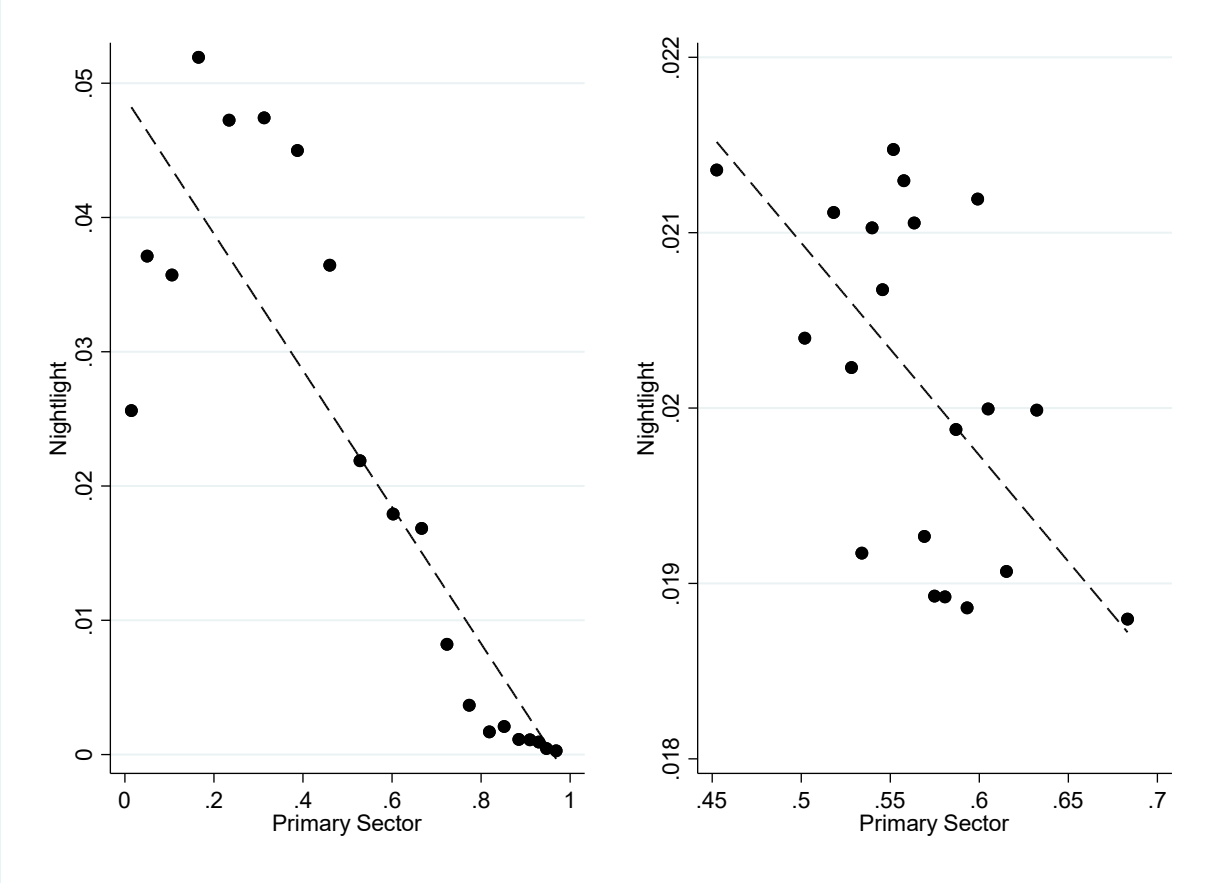
Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADMN and wave fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Table B3 Individual service industries

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS					
	Nightlight *per capita*					
Mining	0.008***	0.004**	0.003**	-0.096***	0.004**	0.004**
	(0.001)	(0.001)	(0.001)	(0.021)	(0.002)	(0.002)
Manufacturing	-0.003*	0.003***	0.003***	0.047	0.003**	0.003**
	(0.002)	(0.001)	(0.001)	(0.058)	(0.001)	(0.001)
Construction	0.002	0.003***	0.003***	0.116**	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.058)	(0.001)	(0.001)
Utilities	0.003*	-0.000	-0.001	0.013	-0.001	-0.001
	(0.002)	(0.001)	(0.001)	(0.058)	(0.001)	(0.001)
Other industry	-0.001	-0.001	-0.001	0.053	-0.005	-0.005
	(0.001)	(0.000)	(0.000)	(0.188)	(0.008)	(0.008)
Accommodation	0.001	0.002***	0.002***	0.095**	0.001**	0.001**
	(0.001)	(0.001)	(0.001)	(0.039)	(0.000)	(0.001)
Private household	0.004***	-0.002***	-0.002***	-0.243***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.038)	(0.001)	(0.001)
Transport	0.009***	-0.009*	-0.010**	-0.164***	-0.011**	-0.011**
	(0.003)	(0.005)	(0.005)	(0.060)	(0.005)	(0.005)
Trade	-0.011***	0.002**	-0.000	0.187***	-0.001	-0.001
	(0.002)	(0.001)	(0.001)	(0.066)	(0.001)	(0.001)
Business	0.005***	0.003**	0.002**	-0.026	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.051)	(0.001)	(0.001)
Education	-0.003*	0.002	0.001	0.251***	0.001	0.002
	(0.002)	(0.001)	(0.001)	(0.066)	(0.001)	(0.001)
Finance	-0.006***	0.001	0.001	-0.010	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.060)	(0.001)	(0.001)
Health	0.004***	0.004***	0.003***	0.102	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.063)	(0.001)	(0.001)
Other services	0.005***	0.002***	0.001	-0.151**	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.061)	(0.001)	(0.001)
Public	0.005***	0.002**	0.003***	0.191*	0.002**	0.002**
	(0.002)	(0.001)	(0.001)	(0.105)	(0.001)	(0.001)
Unspecified services	0.001***	0.001***	0.000*	-0.023	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.019)	(0.000)	(0.000)
Constant	0.018***	0.019***	0.021***	0.513***	0.018***	0.016***
	(0.001)	(0.001)	(0.001)	(0.037)	(0.002)	(0.002)
Admin FE	No	Yes	Yes	No	Yes	Yes
Wave FE	No	No	Yes	No	No	Yes
Controls	No	No	No	Yes	Yes	Yes
Observations	3,214	3,213	3,213	2,982	2,909	2,909
R-squared	0.256	0.968	0.969	0.230	0.972	0.972

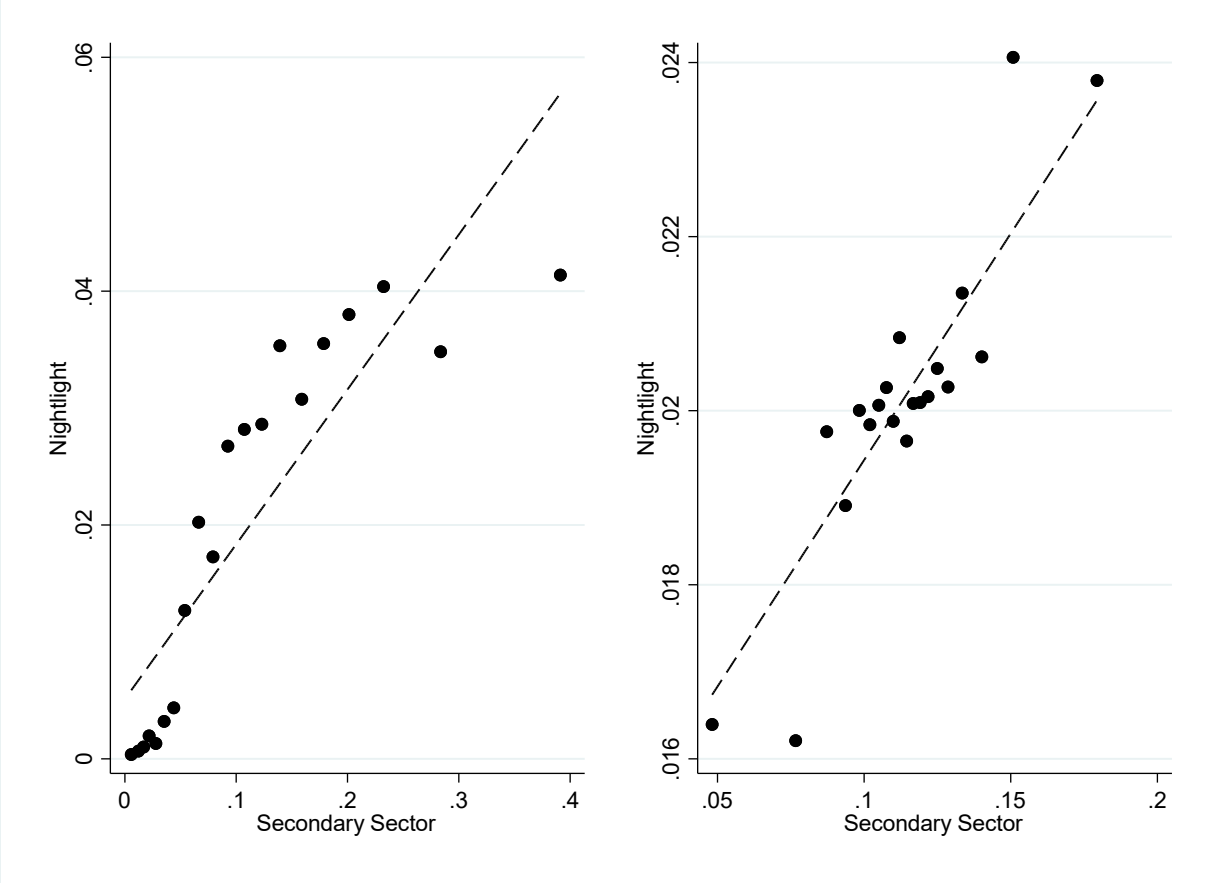
Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADMIN and wave fixed effects. *** p<0.01, ** p<0.05, * p<0.1.

Figure B1 Correlation between nightlight and share of the primary sector



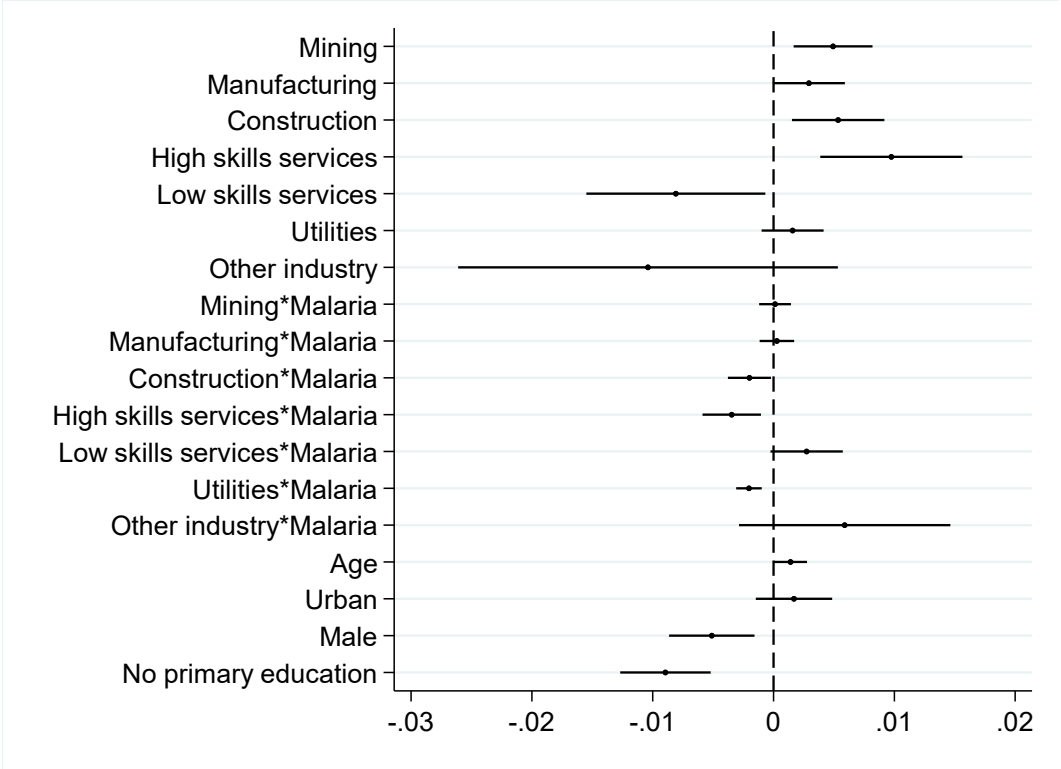
Note: binned scatterplot. The graph on the left shows a simple correlation. The graph of the right shows a correlation accounting for ADMIN and wave fixed effects.

Figure B2 Correlation between nightlight and share of the secondary sector



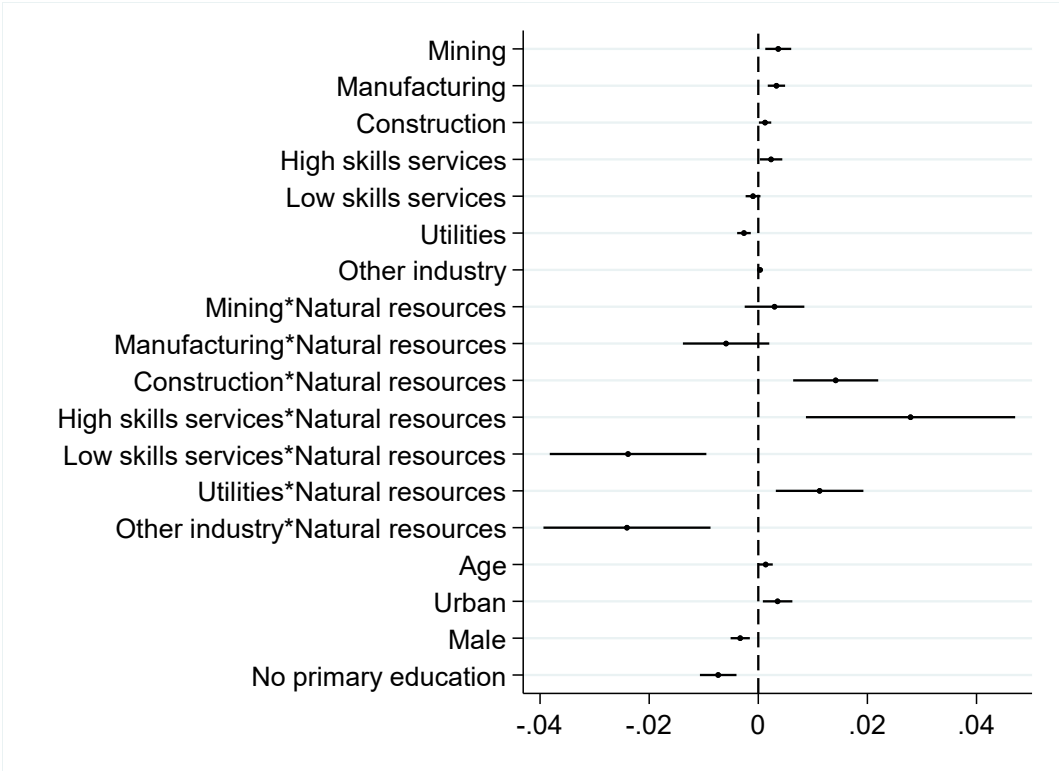
Note: binned scatterplot. The graph on the left shows a simple correlation. The graph of the right shows a correlation accounting for ADMIN and wave fixed effects.

Figure B3 High skills services and growth: The mediating effect of the incidence of malaria



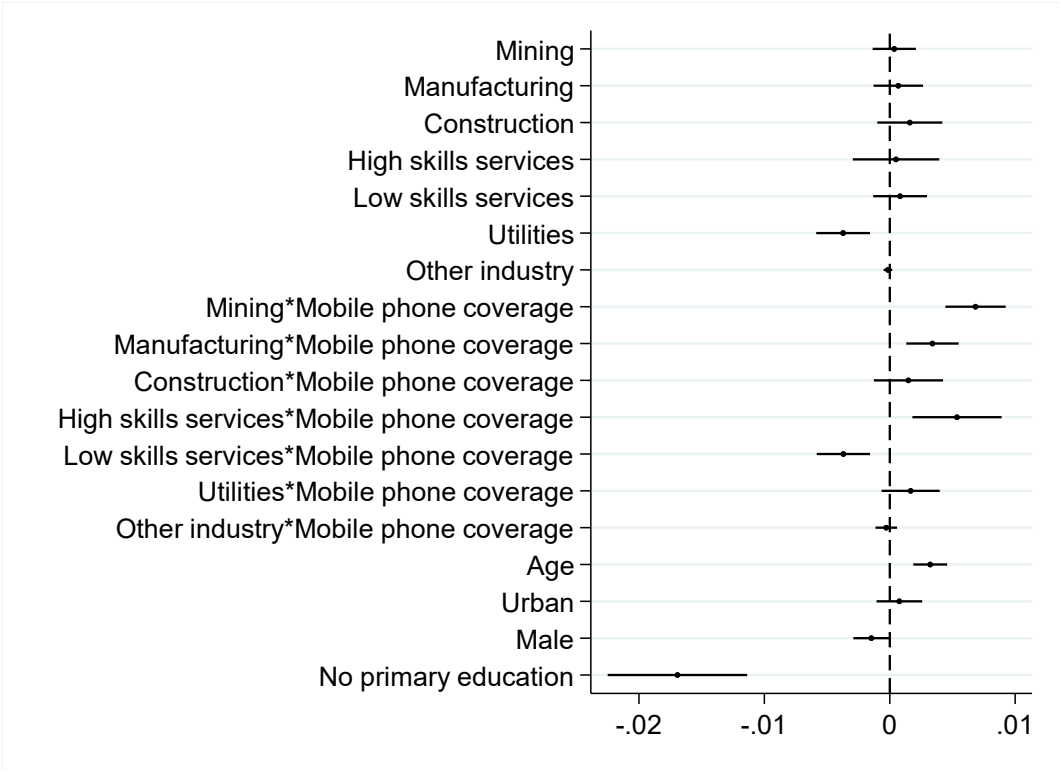
Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADMIN and wave fixed effects. The number of observations is 2,829 and the R^2 is 0.970. 90% C.I.

Figure B4 High skills services and growth: The mediating effect of natural resources



Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADMIN and wave fixed effects. The number of observations is 2,811 and the R^2 is 0.966. 90% C.I.

Figure B5 High skills services and growth: The mediating effect of technology



Note: OLS regression weighted by population with standard errors clustered by ADMIN units. The outcome variable is nightlight *per capita*. The model includes ADMIN and wave fixed effects. The number of observations is 1,958 and the R^2 is 0.975. 90% C.I.

Appendix C

Figure C1. Structural transformation at the sub-national level: Agriculture, manufacturing and services

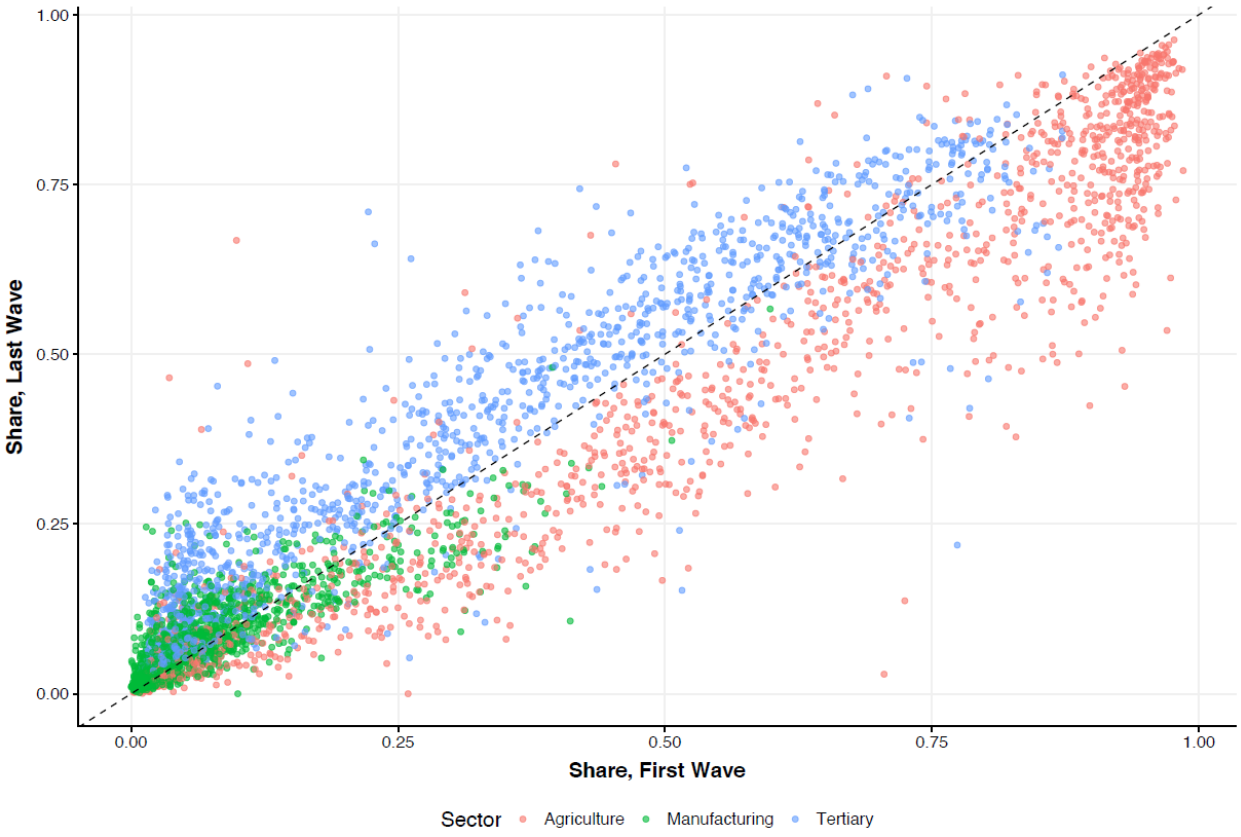
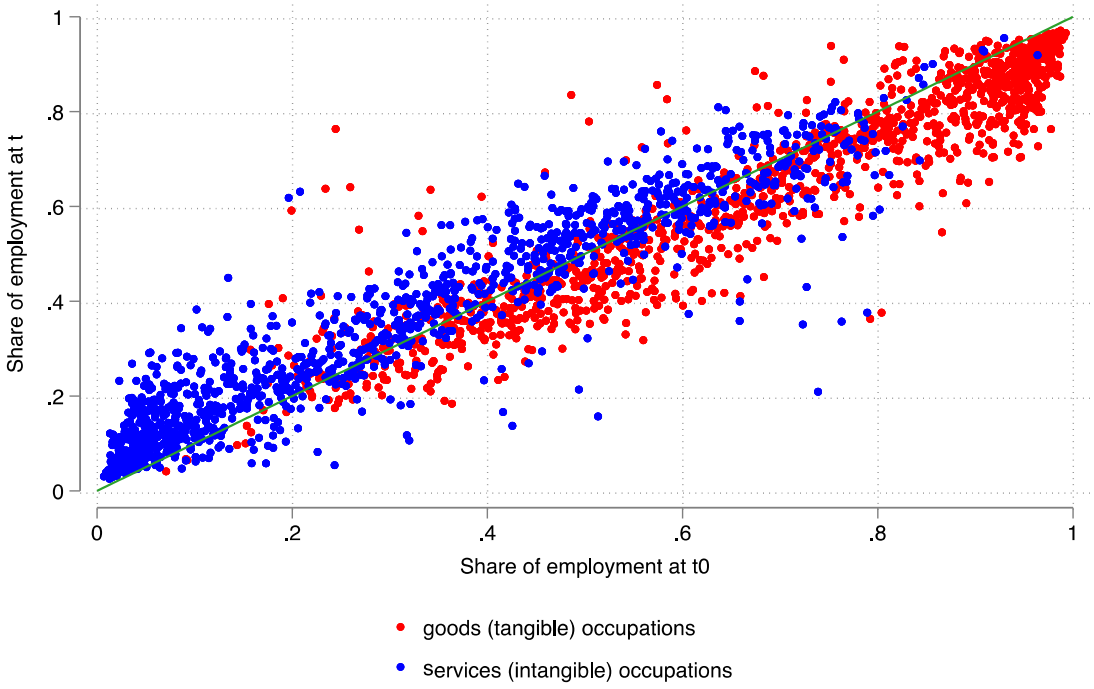


Figure C2. Changes in type of occupations within the manufacturing sector



Notes: Goods and Services occupations are constructed on the basis of the classification of Duernecker and Herrendorf (2020) and relative to those employed in the manufacturing sector only.
Source: Author's elaboration on IPUMS.

Appendix D: Data

1. *Sample selection and data availability*

To obtain temporally and spatially explicit information on employment in Sub-Saharan African (SSA) countries, we collected data on all SSA countries available on the IPUMS International database (Minnesota Population Center, 2020). The IPUMS International database includes employment information for a representative sample of SSA countries' individuals, covering different fractions of each country's total population. Table 1 lists the countries included in our sample, together with information on the year of which data collection, the coverage fraction and the number of surveyed individuals. The country coverage of the sample is determined by the availability of data on the "INDGEN" variable in at least two census waves per country to be able to track the change in the sectoral composition of employment at the administrative unit level. This constraint led to the exclusion of Burkina Faso, Cameroon, Guinea, Kenya, Lesotho, Senegal, Sierra Leone, South Sudan, Sudan, Uganda, and Zimbabwe, as data for the "INDGEN" variable in IPUMS International was reported in only one wave. In addition, Liberia and Togo were excluded due to the extended period between the only two waves included in the IPUMS International database (1974-2008 for Liberia and 1970-2010 for Togo). This left 13 countries: Benin, Botswana, Egypt, Ghana, Malawi, Mali, Mauritius, Morocco, Mozambique, Rwanda, South Africa, Tanzania, and Zambia.

We aggregate individual-level information on sectoral employment to the lowest available administrative unit level[1] (namely, the second administrative level, except for Botswana, for which only the first administrative level is available). The administrative designations in the IPUMS International Database have numerous spatial and temporal inconsistencies, including frequent redistricting by national authorities.

[1] This operation amounts to aggregating data at the second administrative level for most countries, excluding Botswana, for which the sole administrative division available for aggregation is the first. The second-level administrative unit corresponds to Districts in most cases. Exceptions are Benin ("Communes"), Malawi ("Traditional Authorities"), Mali ("Circles"), Mauritius ("Municipal Wards/Village Council Areas"), and Morocco and Rwanda ("Provinces"). Administrative units are roughly comparable in terms of surface, apart from a few rural districts in Egypt, Mali and Morocco, corresponding to sparsely habited and/or desertic areas.

Appendix Table D1: Sample countries, waves, coverage fractions and number of surveyed individuals

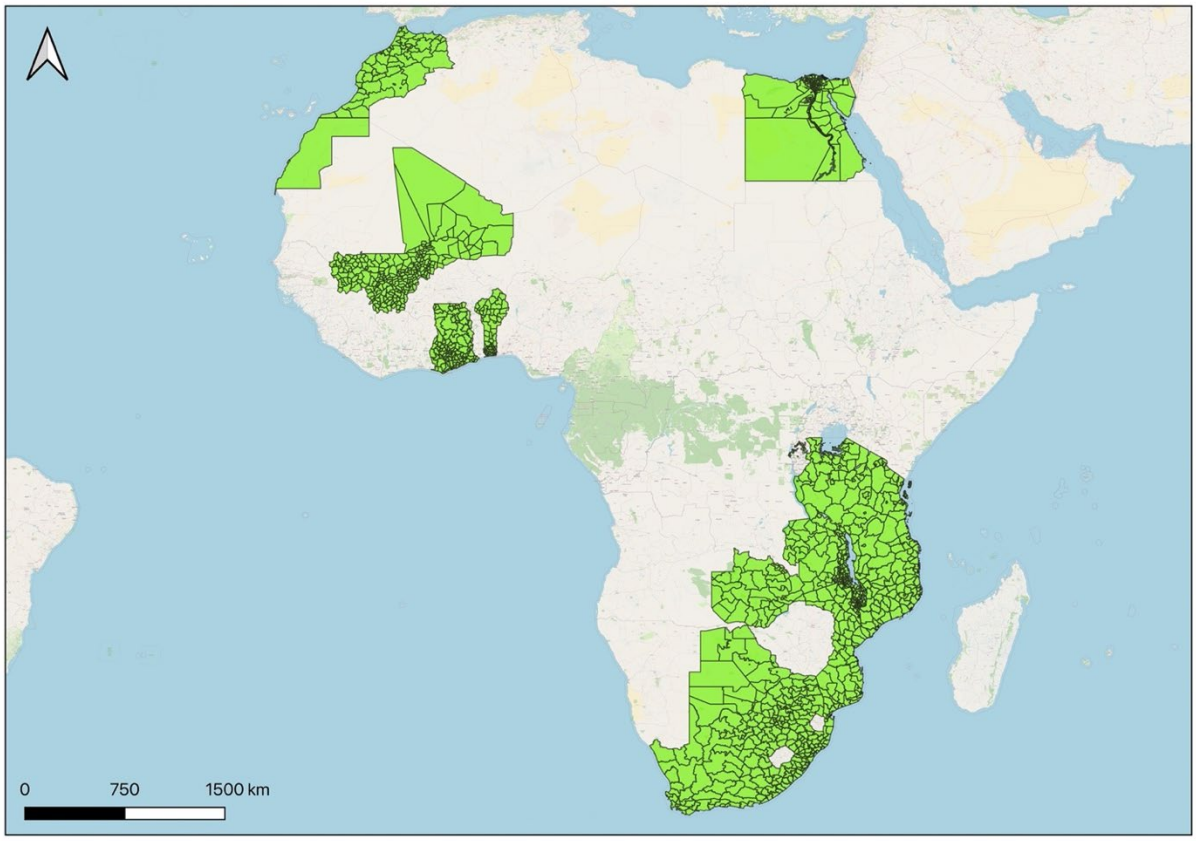
Country	Year	Fraction	N_{obs}
Benin	1992	10.0	498419
Benin	2002	10.0	685467
Benin	2013	10.0	1009693
Botswana	1991	10.0	132623
Botswana	2001	10.0	168676
Botswana	2011	10.0	201752
Egypt	1986	14.1	6787077
Egypt	1996	10.0	5902243
Egypt	2006	10.0	7282434
Ghana	2000	10.0	1012062
Ghana	2010	10.0	1405681
Malawi	1998	10.0	519551
Malawi	2008	10.0	680230
Mali	1987	10.0	785384
Mali	1998	10.0	991330
Mali	2009	10.0	1451856
Mauritius	1990	10.0	106710
Mauritius	2000	10.0	119695
Mauritius	2011	10.0	123189
Morocco	1982	5.0	1012873
Morocco	1994	5.0	1294026
Morocco	2004	5.0	1482720
Mozambique	1997	10.0	1551517
Mozambique	2007	10.0	2047048
Rwanda	1991	10.0	742918
Rwanda	2002	10.0	843392
Rwanda	2012	10.0	1038369
South Africa	2001	10.0	3724723
South Africa	2007	2.0	1047657
Tanzania	2002	10.0	3732735
Tanzania	2012	10.0	4498022
Zambia	1990	10.0	787461
Zambia	2000	10.0	996117
Zambia	2010	10.0	1321973

Source: IPUMS.

In the case of Rwanda, the second-level geographic definer is only available in the last two waves (2002 and 2012), while the first level definition is only available for the first wave (1991), thereby making it impossible to harmonize consecutive surveys at the same administrative level. Given these inconsistencies, we instead obtain temporally and spatially consistent second-level administrative shapefiles from Alesina

et al. (2021), to which we aggregate all variables employed in the report.[2] The Alesina et al. (2021) database does not include spatial designations for Mauritius; we therefore retrieve the IPUMS International shapefiles for Mauritius and aggregate all available data[3] to these geographic delimiters as a second-best solution. Appendix Figure D1 offers a global representation of the 1,546 unique administrative units contained in Alesina et al. (2021).

Appendix Figure D1: Administrative units



Source: Authors' elaboration on IPUMS and Alesina et al. (2021)

2. Employment and Occupation Data

In order to obtain information on sectoral shares defined at the second administrative level for all countries in our final sample, we first need to unpack the INDGEN variable into the 17 levels which constitute its categories: (1) Agriculture, fishing and forestry; (2) Mining and extraction; (3) Manufacturing; (4) Utilities (electricity, gas, water and waste management); (5) Construction; (6) Wholesale and retail trade; (7) Hospitality (hotels and restaurants); (8) Transportation, storage and communications; (9) Financial services

[2] Notably, in the case of Rwanda, the shapefile harmonisation procedure operated by Alesina et al. (2021) results in all IPUMS observations being clustered in a subset of 30 out of 145 Rwandan districts.

[3] Alesina et al. (2021) and Manacorda and Tesei (2020) data sources are unavailable for Mauritius.

and Insurance; (10) Public Administration and Defense; (11) Services, not specified; (12) Business services and real estate; (13) Education; (14) Health and social work; (15) Other services; (16) Private household services; (17) Other industry, not elsewhere classified. We first obtain 17 different binary variables coded as 1 if the individual's survey response belongs to the target category, and 0 if it does not[4]. From these 17 intermediate variables, we calculate each sector's share on overall employment at the second administrative level by collapsing the individual binary indicators to the ADMIN units, weighting each observation by the survey weights provided by IPUMS International.

We also produce coarser definitions of sectoral employment as an alternative to the disaggregated version; here, we lose in terms of granularity what we gain in terms of ability to describe general macro-sectoral trends. We proceed as follows: (1) Agriculture, fishing and forestry, and (2) Mining and extraction are grouped in the Primary sector; (3) Manufacturing, (5) Construction, and (17) Other industry, n.e.c. are aggregated in the Secondary sector; every other sector is considered Tertiary sector. We create individual categorical variables for each macro-sector and we repeat the procedure outlined for disaggregated sectors in order to obtain macro-sectoral shares at the second administrative level.

We proceed similarly for what concerns data on individuals' class of occupation (occupational role), contained in IPUMS International's "OCCISCO" variable. The OCCISCO variable contains detailed information on 11 categories of mansions, coded according to the major categories in the International Standard Classification of Occupations (ISCO) scheme for 1988. For someone with more than one job, the primary occupation is typically the one in which the person had spent the most time or earned the most money. The 11 categories are: (1) Legislators, senior officials and managers; (2) Professionals; (3) Technicians and associate professionals; (4) Clerks; (5) Service workers and shop and market sales; (6) Skilled agricultural and fishery workers; (7) Crafts and related trades workers; (8) Plant and machine operators and assemblers; (9) Elementary occupations; (10) Armed forces; (11) Other occupations, unspecified or not elsewhere classified. Again, we obtain 11 distinct binary variables repeating the procedure used for the sector of employment, and we then proceed to collapse these binary indicators to the desired ADMIN level using IPUMS survey weights in the procedure.

3. Economic and geographic covariates

By leveraging the rich information contained in the IPUMS International dataset, we are able to obtain an ample set of covariates which describe patterns of economic development in each administrative unit that

[4] IPUMS records a non-insignificant percentage of "Not in Universe" (NIU) and missing responses. In order not to distort the resulting sectoral shares, we decide to drop NIU and missing observations from the dataset. Our shares are thus calculated using the total number of individuals having answered the INDGEN survey field at the denominator.

we observe. We cover several categories designed by IPUMS, namely: (1) Group quarters (urban/rural status, residence status, and geo-identifiers for administrative units of levels 1 and 2); (2) Family (number of own children and number of children under 5 years old); (3) Demographics (age, gender, marital status); (4) Fertility (children ever born, children surviving, number of births in the past year, children surviving from births in the past year, mortality status of mother); (5) Ethnicity (religion, ethnicity, language); (6) Education (school attendance, literacy, educational attainment, years of schooling); (7) Occupation (besides the abovementioned variables, we include employment status and labour force par-ticipation), (8) Migration (migration status).

We replicate the procedure described in the previous section in order to calculate ADMIN-level shares for each variable of interest. In particular, where available, we compute:

- Shares of urban and rural residents;
- Average number of own children and of children under five years old;
- Average age;
- Shares of female and male inhabitants;
- Shares of single, married, divorced, and widowed individuals;
- Shares of individuals with zero, one, two, three or more children;
- Shares of individuals with zero, one, two, three or more surviving children;
- Shares of individuals with zero, one, two or three or more newborns in the last year;
- Shares of individuals with zero, one, two or three or more surviving newborns in the last year;
- Mother mortality shares (percentage of individuals' mothers alive or deceased);
- Shares for each major religion in the dataset (shares of individuals with atheist, Buddhist, Hindu, Jewish, Muslim, Christian or other religious beliefs);
- Indices of linguistic and ethnic fractionalization as in Alesina et al. (2003)
    - Calculated as $\Phi_j = 1 - \sum_{i=1}^{N} s_{ij}^2$ where s_{ij} is the share of ethnic or linguistic group $i = \{1, \dots, N\}$ in ADMIN unit j.
    - We calculate the share s_{ij} by dividing the instances of each unique ethnic or linguistic group recorded in each ADMIN unit in the raw dataset by the ADMIN unit's total population.
- Shares of individuals attending, not attending, having attended and having never attended school;
- Literacy and illiteracy rates;
- Shares of individuals with no formal education, or with primary, secondary or university education;
- Average number of school years completed;

- Shares of employed, unemployed and inactive individuals;
- Shares of individuals participating and not participating to the labour force;
- Shares of native and immigrant individuals:
    - the migration variable is not perfectly conformable across different country censuses. As can be inferred from Tables 2-13, an individual may be categorized as a migrant if their previous (according to different temporal criteria) residence is different to their current one. We define "immigrants" those individuals whose previous residence is in the same major but different minor administrative unit, or in a different major administrative unit, or abroad, without further distinction on the time horizon on which "previous residence" is established. Indeed, the definition may vary from the more general "previous residence, unspecified", to "previous residence, 10 years prior [to the survey]", "previous residence, 5 years prior [to the survey]", and "previous residence, 1 year prior [to the survey]". Given the large temporal gaps between each wave of the survey, it is reasonable to expect that these discrepancies in categorizing prior residence do not introduce bias in the classification of migrant and native individuals.

IPUMS International provides information on the uniformity of the educational attainment variables. In particular, for school attendance, the data is largely comparable across waves, with slight differences in the age of the respondents and hence in the composition of the universe. Small differences can also be found with respect to the inclusion of correspondence courses, adult literacy classes, and non-traditional studies. With respect to literacy rates, "samples provide differing criteria with respect to the level of ability that should constitute literacy", hence the standards can vary across samples-waves, based on the abovementioned criteria. For educational attainment, in order to ensure comparability across samples and waves, IPUMS International applies the UN standard 6-3-3 classification (primary, lower secondary, higher secondary schooling). Most countries' school system diverge from this standard, but where applicable, data are recoded to adapt to the 6-3-3 system. For countries reporting only degree rather than grade, the answer is classified to the corresponding category. Finally, concerning years of schooling, this variable is top-coded differently across samples, with a maximum of 18+ years. In our sample, Botswana 1991 is top-coded at 17+, Botswana 2001, all Mauritius and all South Africa at 13+, while the remaining country-wave pairs are all top-coded at the standard 18+. The data is hence not perfectly comparable across country-wave pairs unless the diverging observations are dropped from the panel, since the top coding discrepancies will alter downwards the average number of years of schooling for ADMIN units located in countries with lower top values for this variable. To synthesize the information above, Tables 2-13 present the full list of IPUMS covariates together with their availability on a per-country, per-wave basis.

Appendix Table D2: Data availability, Benin

Variable	Label	Benin 1992	Benin 2002	Benin 2013
RESIDENT	Residence status	x	x	x
URBAN	Urban/Rural status	x	x	x
GEOLEV1	1st subnational admin. level	x	x	x
GEOLEV2	2nd subnational admin. level	x	x	x
NCHILD	Number of children	x	x	x
NCHLT5	Number of children under 5	x	x	x
AGE	Age	x	x	x
SEX	Gender	x	x	x
MARST	Marital Status	x	x	x
CHBORN	Children ever born	x	x	x
CHSURV	Surviving children	x	x	x
BIRTHSLYR	Number of births in the past year	o	x	x
BIRTHSURV	Children surviving births in the past year	o	x	x
MORTMOT	Mortality status of mother	x	x	x
RELIGION	Religion	x	x	x
ETHNICBJ	Ethnicity, Benin	x	x	x
LANGBJ	Primary language spoken, Benin	o	o	x
SCHOOL	School attendance	o	o	x
LIT	Literacy	x	x	x
EDATTAIN	Educational attainment, international recode	x	x	x
YRSCHOOL	Years of schooling	x	x	x
EMPSTAT	Employment Status	x	x	x
LABFORCE	Labour force participation	x	x	x
OCCISCO	Occupation, ISCO general	x	x	x
INDGEN	Industry, general recode	x	x	x
MIGRATEP	Migration status, previous residence	x	x	x

Appendix Table D3: Data availability, Botswana

Variable	Label	Botswana 1991	Botswana 2001	Botswana 2011
RESIDENT	Residence status	x	x	x
URBAN	Urban/Rural status	x	o	o
GEOLEV1	1st subnational admin. level	x	x	x
GEOLEV2	2nd subnational admin. level	o	o	o
NCHILD	Number of children	x	x	x
NCHLT5	Number of children under 5	x	x	x
AGE	Age	x	x	x
SEX	Gender	x	x	x
MARST	Marital Status	x	x	x
CHBORN	Children ever born	x	x	x
CHSURV	Surviving children	x	x	x
BIRTHSLYR	Number of births in the past year	o	x	x
BIRTHSURV	Children surviving births in the past year	o	x	x
MORTMOT	Mortality status of mother	o	x	x
RELIGION	Religion	o	x	x
LANGBW	Primary language spoken, Botswana	o	o	x
SCHOOL	School attendance	o	o	x
LIT	Literacy	x	x	x
EDATTAIN	Educational attainment, international recode	x	x	x
YRSCHOOL	Years of schooling	x	x	x
EMPSTAT	Employment Status	x	x	x
LABFORCE	Labour force participation	x	x	x
OCCISCO	Occupation, ISCO general	x	x	x
INDGEN	Industry, general recode	x	x	x
MIGRATE1	Migration status, 1 year	x	x	x

Appendix Table D4: Data availability, Egypt

Variable	Label	Egypt 1986	Egypt 1996	Egypt 2006
RESIDENT	Residence status	o	o	o
URBAN	Urban/Rural status	x	x	x
GEOLEV1	1st subnational admin. level	x	x	x
GEOLEV2	2nd subnational admin. level	x	x	x
NCHILD	Number of children	x	x	x
NCHLT5	Number of children under 5	x	x	x
AGE	Age	x	x	x
SEX	Gender	x	x	x
MARST	Marital Status	x	x	x
CHBORN	Children ever born	o	o	o
CHSURV	Surviving children	o	o	o
BIRTHSLYR	Number of births in the past year	o	o	o
BIRTHSURV	Children surviving births in the past year	o	o	o
MORTMOT	Mortality status of mother	x	x	x
RELIGION	Religion	x	x	x
SCHOOL	School attendance	o	o	x
LIT	Literacy	x	x	x
EDATTAIN	Educational attainment, international recode	x	x	x
YRSCHOOL	Years of schooling	o	o	o
EMPSTAT	Employment Status	x	x	x
LABFORCE	Labour force participation	x	x	x
OCCISCO	Occupation, ISCO general	x	x	x
INDGEN	Industry, general recode	x	x	x
MIGRATEP	Migration status, previous residence	o	x	x

Appendix Table D5: Data availability, Ghana

Variable	Label	Ghana 2000	Ghana 2010
RESIDENT	Residence status	o	o
URBAN	Urban/Rural status	x	x
GEOLEV1	1st subnational admin. level	x	x
GEOLEV2	2nd subnational admin. level	x	x
NCHILD	Number of children	x	x
NCHLT5	Number of children under 5	x	x
AGE	Age	x	x
SEX	Gender	x	x
MARST	Marital Status	x	x
CHBORN	Children ever born	x	x
CHSURV	Surviving children	x	x
BIRTHSLYR	Number of births in the past year	x	x
BIRTHSURV	Children surviving births in the past year	o	o
MORTMOT	Mortality status of mother	x	x
RELIGION	Religion	x	x
ETHNICGH	Ethnicity, Ghana	x	x
SCHOOL	School attendance	x	x
LIT	Literacy	x	x
EDATTAIN	Educational attainment, international recode	x	x
YRSCHOOL	Years of schooling	x	x
EMPSTAT	Employment Status	x	x
LABFORCE	Labour force participation	x	x
OCCISCO	Occupation, ISCO general	x	x
INDGEN	Industry, general recode	x	x
MIGRATE5	Migration status, 5 years	x	o

Appendix Table D6: Data availability, Malawi

Variable	Label	Malawi 1998	Malawi 2008
RESIDENT	Residence status	o	x
URBAN	Urban/Rural status	x	x
GEOLEV1	1st subnational admin. level	x	x
GEOLEV2	2nd subnational admin. level	x	x
NCHILD	Number of children	x	x
NCHLT5	Number of children under 5	x	x
AGE	Age	x	x
SEX	Gender	x	x
MARST	Marital Status	x	x
CHBORN	Children ever born	x	x
CHSURV	Surviving children	x	x
BIRTHSLYR	Number of births in the past year	x	x
BIRTHSURV	Children surviving births in the past year	x	x
MORTMOT	Mortality status of mother	x	x
RELIGION	Religion	x	x
ETHNICMW	Ethnicity, Malawi	o	x
SCHOOL	School attendance	x	x
LIT	Literacy	x	x
EDATTAIN	Educational attainment, international recode	x	x
YRSCHOOL	Years of schooling	x	x
EMPSTAT	Employment Status	x	x
LABFORCE	Labour force participation	x	x
OCCISCO	Occupation, ISCO general	x	x
INDGEN	Industry, general recode	x	x
MIGRATEP	Migration status, previous residence	o	x

Appendix Table D7: Data availability, Mali

Variable	Label	Mali 1987	Mali 1998	Mali 2009
RESIDENT	Residence status	x	x	o
URBAN	Urban/Rural status	o	x	x
GEOLEV1	1st subnational admin. level	x	x	x
GEOLEV2	2nd subnational admin. level	x	x	x
NCHILD	Number of children	x	x	x
NCHLT5	Number of children under 5	x	x	x
AGE	Age	x	x	x
SEX	Gender	x	x	x
MARST	Marital Status	x	x	x
CHBORN	Children ever born	x	x	x
CHSURV	Surviving children	x	x	x
BIRTHSLYR	Number of births in the past year	o	o	x
BIRTHSURV	Children surviving births in the past year	o	o	o
MORTMOT	Mortality status of mother	x	x	x
RELIGION	Religion	o	o	x
LANGML	Primary language spoken, Mali	x	x	x
SCHOOL	School attendance	o	x	x
LIT	Literacy	x	x	x
EDATTAIN	Educational attainment, international recode	x	x	x
YRSCHOOL	Years of schooling	o	x	x
EMPSTAT	Employment Status	x	x	x
LABFORCE	Labour force participation	x	x	x
OCCISCO	Occupation, ISCO general	x	x	x
INDGEN	Industry, general recode	x	x	x
MIGRATEP	Migration status, previous residence	o	x	x

Appendix Table D8: Data availability, Mauritius

Variable	Label	Mauritius 1990	Mauritius 2000	Mauritius 2011
RESIDENT	Residence status	x	x	x
URBAN	Urban/Rural status	x	x	x
GEOLEV1	1st subnational admin. level	x	x	x
GEOLEV2	2nd subnational admin. level	x	x	x
NCHILD	Number of children	x	x	x
NCHLT5	Number of children under 5	x	x	x
AGE	Age	x	x	x
SEX	Gender	x	x	x
MARST	Marital Status	x	x	x
CHBORN	Children ever born	x	x	x
CHSURV	Surviving children	x	x	x
BIRTHSLYR	Number of births in the past year	o	o	o
BIRTHSURV	Children surviving births in the past year	o	o	o
MORTMOT	Mortality status of mother	o	o	o
RELIGION	Religion	x	x	x
LANGMU	Primary language spoken, Mauritius	x	x	x
SCHOOL	School attendance	o	o	x
LIT	Literacy	x	x	x
EDATTAIN	Educational attainment, international recode	x	x	x
YRSCHOOL	Years of schooling	x	x	x
EMPSTAT	Employment Status	x	x	x
LABFORCE	Labour force participation	x	x	x
OCCISCO	Occupation, ISCO general	x	x	x
INDGEN	Industry, general recode	x	x	x
MIGRATE5	Migration status, 5 years	x	x	x

Appendix Table D9: Data availability, Morocco

Variable	Label	Morocco 1982	Morocco 1994	Morocco 2004
RESIDENT	Residence status	o	o	o
URBAN	Urban/Rural status	o	o	o
GEOLEV1	1st subnational admin. level	x	x	x
GEOLEV2	2nd subnational admin. level	x	x	x
NCHILD	Number of children	x	x	x
NCHLT5	Number of children under 5	x	x	x
AGE	Age	x	x	x
SEX	Gender	x	x	x
MARST	Marital Status	x	x	x
CHBORN	Children ever born	x	x	x
CHSURV	Surviving children	x	x	x
BIRTHSLYR	Number of births in the past year	x	x	x
BIRTHSURV	Children surviving births in the past year	x	x	x
MORTMOT	Mortality status of mother	o	o	o
RELIGION	Religion	o	o	o
LANGMA	Primary language spoken, Morocco	o	x	x
SCHOOL	School attendance	o	o	o
LIT	Literacy	x	x	x
EDATTAIN	Educational attainment, international recode	x	x	x
YRSCHOOL	Years of schooling	x	x	x
EMPSTAT	Employment Status	x	x	x
LABFORCE	Labour force participation	x	x	x
OCCISCO	Occupation, ISCO general	x	x	x
INDGEN	Industry, general recode	x	x	x
MIGRATE5	Migration status, 5 years	o	o	x

Appendix Table D10: Data availability, Rwanda

Variable	Label	Rwanda 1991	Rwanda 2002	Rwanda 2012
RESIDENT	Residence status	x	x	x
URBAN	Urban/Rural status	o	x	x
GEOLEV1	1st subnational admin. level	x	o	o
GEOLEV2	2nd subnational admin. level	o	o	x
NCHILD	Number of children	x	x	x
NCHLT5	Number of children under 5	x	x	x
AGE	Age	x	x	x
SEX	Gender	x	x	x
MARST	Marital Status	x	x	x
CHBORN	Children ever born	x	x	x
CHSURV	Surviving children	x	x	x
BIRTHSLYR	Number of births in the past year	x	x	x
BIRTHSURV	Children surviving births in the past year	x	x	x
MORTMOT	Mortality status of mother	x	x	x
RELIGION	Religion	x	x	x
LANGRW	Primary language spoken, Rwanda	x	x	o
SCHOOL	School attendance	o	x	x
LIT	Literacy	x	x	x
EDATTAIN	Educational attainment, international recode	o	x	x
YRSCHOOL	Years of schooling	o	x	x
EMPSTAT	Employment Status	x	x	x
LABFORCE	Labour force participation	x	x	x
OCCISCO	Occupation, ISCO general	o	x	x
INDGEN	Industry, general recode	o	x	x
MIGRATEP	Migration status, previous residence	x	x	o

Appendix Table D11: Data availability, South Africa

Variable	Label	South Africa 2001	South Africa 2007
RESIDENT	Residence status	o	x
URBAN	Urban/Rural status	x	x
GEOLEV1	1st subnational admin. level	x	x
GEOLEV2	2nd subnational admin. level	x	x
NCHILD	Number of children	x	x
NCHLT5	Number of children under 5	x	x
AGE	Age	x	x
SEX	Gender	x	x
MARST	Marital Status	x	x
CHBORN	Children ever born	x	x
CHSURV	Surviving children	x	x
BIRTHSLYR	Number of births in the past year	x	x
BIRTHSURV	Children surviving births in the past year	x	x
MORTMOT	Mortality status of mother	x	x
LANGZA1	Language spoken at home, SAF	x	o
RELIGION	Religion	x	o
SCHOOL	School attendance	x	o
LIT	Literacy	x	x
EDATTAIN	Educational attainment, international recode	x	x
EMPSTAT	Employment Status	x	x
LABFORCE	Labour force participation	x	x
OCCISCO	Occupation, ISCO general	x	x
INDGEN	Industry, general recode	x	x
MIGRATE5	Migration status, 5 years	x	o
MIGRATEP	Migration status, previous residence	o	x

Appendix Table D12: Data availability, Tanzania

Variable	**Label**	Tanzania 2002	Tanzania 2012
URBAN	Urban/Rural status	x	x
GEOLEV1	1st subnational admin. level	x	x
GEOLEV2	2nd subnational admin. level	x	x
NCHILD	Number of children	x	x
NCHLT5	Number of children under 5	x	x
AGE	Age	x	x
SEX	Gender	x	x
MARST	Marital Status	x	x
CHBORN	Children ever born	x	x
CHSURV	Surviving children	x	x
BIRTHSLYR	Number of births in the past year	x	x
BIRTHSURV	Children surviving births in the past year	o	x
MORTMOT	Mortality status of mother	x	x
SCHOOL	School attendance	x	x
LIT	Literacy	x	x
EDATTAIN	Educational attainment, international recode	x	x
EMPSTAT	Employment Status	x	x
LABFORCE	Labour force participation	x	x
OCCISCO	Occupation, ISCO general	x	x
INDGEN	Industry, general recode	x	x
MIGRATE1	Migration status, 1 year	x	o

Appendix Table D13: Data availability, Zambia

Variable	Label	Zambia 1990	Zambia 2000	Zambia 2010
RESIDENT	Residence status	x	x	x
URBAN	Urban/Rural status	x	x	o
GEOLEV1	1st subnational admin. level	x	x	x
GEOLEV2	2nd subnational admin. level	x	x	x
NCHILD	Number of children	x	x	x
NCHLT5	Number of children under 5	x	x	x
AGE	Age	x	x	x
SEX	Gender	x	x	x
MARST	Marital Status	x	x	x
CHBORN	Children ever born	x	x	x
CHSURV	Surviving children	x	x	x
BIRTHSLYR	Number of births in the past year	x	x	x
BIRTHSURV	Children surviving births in the past year	x	x	x
MORTMOT	Mortality status of mother	o	o	x
RELIGION	Religion	o	x	x
LANGZM1	Primary language spoken, Zambia	x	x	x
SCHOOL	School attendance	o	x	x
LIT	Literacy	x	x	x
EDATTAIN	Educational attainment, international recode	x	x	x
YRSCHOOL	Years of schooling	x	x	x
EMPSTAT	Employment Status	x	x	x
LABFORCE	Labour force participation	x	x	x
OCCISCO	Occupation, ISCO general	x	x	x
INDGEN	Industry, general recode	x	x	x
MIGRATE1	Migration status, 1 yesr	x	x	x

We also aggregate two additional sets of economic and geographic covariates, derived from Manacorda and Tesei, (2020) and Alesina et al., (2021). In particular, the former dataset is constituted of 50 x 50 Km grid cells spanning the whole African continent. We retrieve grid cell-level information on:

- Mobile phone coverage – 2G + 3G and 3G only;
- Internet penetration;
- Number of protests (from the GDELT Database);
- Number of protests (from the ACLED Database);
- GDP growth;
- Number of lightning strikes;
- Rainfall and temperature;
- Distance to the closest border;
- Percentage of a grid cell covered by an oil field;
- Number of cities;
- Percentage of a grid cell covered by forests and mountains;
- Presence of mines and diamond mines;
- Infant mortality rates;

- A dummy "Capital City" indicator, or a distance to the capital city;
- Length of the electric and primary road networks.

Given the grid cell format, we first need to preprocess the data, which is stored as a STATA dataset, in order to resample its information to our desired administrative level. We thus rasterize the grid cells, thereby transforming each 50x50Km square in a stack of raster pixels containing the values of the variables of interest; we then calculate zonal statistics at the ADMIN level for each layer of the raster stack, therefore obtaining distinct variables for each layer, characterized as the mean or the sum (depending on the underlying variable: e.g. average internet penetration, or total lightning strikes) of pixel values contained in an administrative unit. With 50x50Km pixels and ADMIN units varying in size, there are pixels bound to span over the borders of ADMIN units; through the `exactextractr` package in R version 4.0.3, we are able to aggregate pixels to an ADMIN unit using only the exact fraction of a pixel covered by an ADMIN unit polygon shapefile. All variables described above are only available for a subset of years spanned by our master dataset, 1998-2012.

The Alesina et al. (2021) database is instead available at the exact administrative unit level at which we have assembled our master dataset[5], and is therefore immediately conformable to it. We retrieve information on:

- Mean terrain ruggedness;
- Mean stability of malaria transmission;
- Mean agricultural suitability;
- Dummy variables for diamond mines and oil fields contained in the ADMIN unit;
- Distance[6] to capital;
- Distance to border;
- Distance to nearest colonial railroad;
- Distance to nearest catholic mission;
- IPUMS urban shares, birth cohorts 1960 and earlier;
- IPUMS shares of agricultural, manufacturing and services workers for birth cohorts 1960 and earlier.

[5] Which indeed uses the Alesina et al. (2021) georeferenced ADMIN units, as described above.
[6] All distance metrics are calculated from the ADMIN centroid.

4. Geolocalized Indicators of Economic Development

We leverage on a burgeoning literature in the field of Economic Geography, dating back to Henderson et al., (2012), in constructing disaggregated indicators of economic performance based on remotely sensed data, primarily night-time lights (NTLs). NTLs have been shown to be a useful proxy for economic growth and size, especially for developing countries[7]. One frequent caveat against the use of NTLs in longitudinal economic analyses has been retraced in time-series inconsistencies in NTLs trends due to satellite intercalibration issues (Gibson et al., 2021)[8]; however, a recently published dataset by Li et al. (2020) has attempted to mitigate these issues and is therefore viable for timeseries and panel analyses. In particular, the authors employ two generations of satellite instruments, the pioneering DMSP-OLS (which collected data between 1992 and 2013) and its successor, VIIRS (still in orbit), in order to construct a longer data series spanning 1992-2018. Their dataset improves on pre-existing NTL data products on two fronts: first, they intercalibrate the internal 1992-2013 DMSP-OLS time series at the global scale; second, they successfully attempt to reduce discrepancies between the DMSP and VIIRS data series by converting the VIIRS radiance information to DMSP-like NTL data, thereby providing the scientific community with a dataset exhibiting temporal consistency and extending the span of historical DMSP NTL data to 2018, with the trade-off of losing some granularity.[9]

We obtain the full (1992-2018) dataset from Li et al. (2020) and compute zonal statistics at the second administrative level for each of the ADMIN-waves pairs included in our sample, obtaining two main variables: mean NTLs and the Sum of Lights (SoL), which we then divide by each ADMIN's total population to obtain an indicator of nightlights per capita. Appendix Figure D2 provides some descriptive evidence on the sub-national variation of this variable, showing enough variation both between- and within-countries.[10]

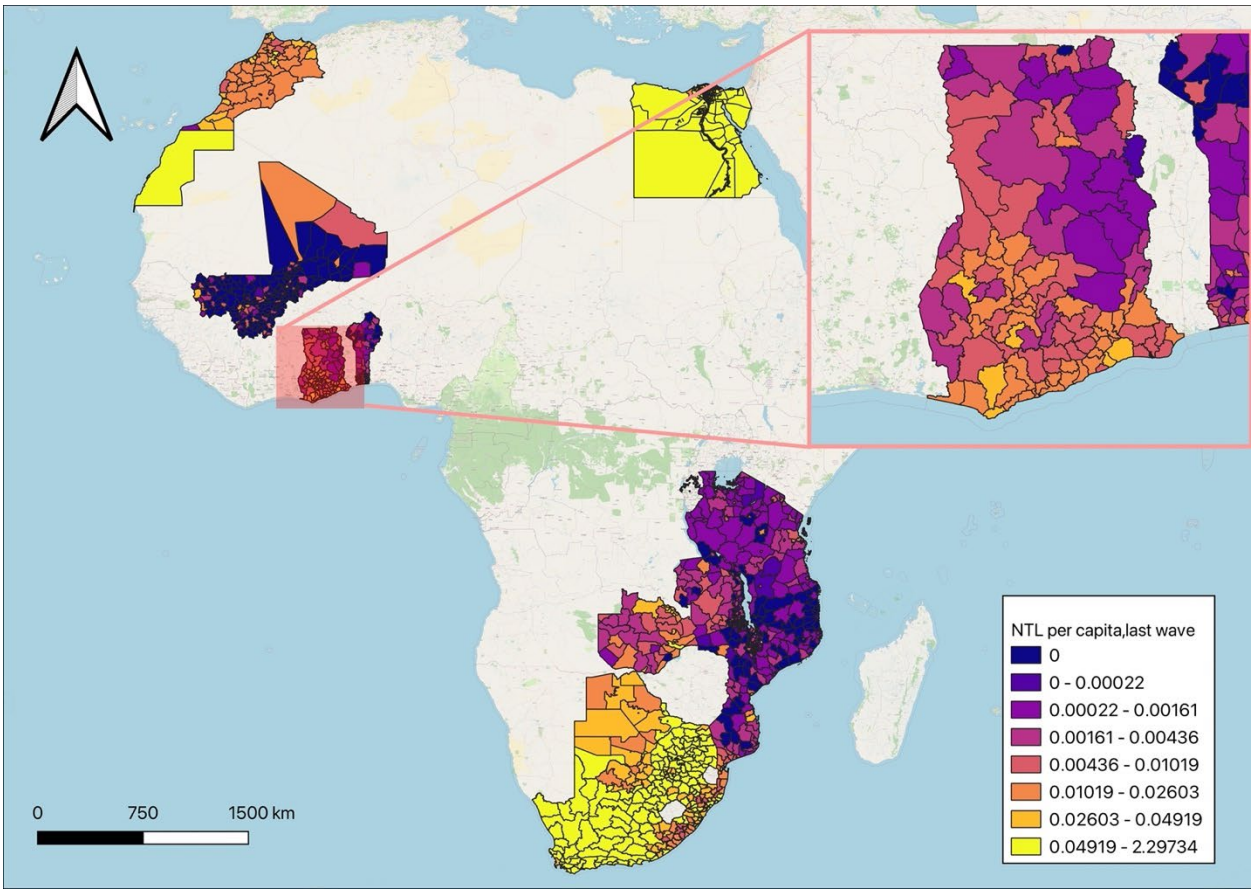
[7] In developed countries, the top-level saturation of the NTLs data due to the widespread presence of night-time illumination masks cross-sectional and temporal heterogeneity, while this effect is less pronounced for developing countries presenting large swaths of unlit territory.

[8] Indeed, DMSP-OLS, the NOAA program which has produced the frequently used 1992-2013 NTLs time series, has launched six individual satellites whose orbits have progressively lowered over time and whose sensors are not perfectly identical, resulting in inconsistencies when employing their measurements across years.

[9] Due to the conversion between VIIRS and DMSP NTL, the target resolution is that of DMSP-OLS, coarser than VIIRS. Some caveats remain, mostly due to uncertainties in NTL pixels with values lower than 10.

[10] The relatively higher values of Western Sahara is due to the fact that it reports—due to its higher area—relatively high values of NTL (which is summed across pixels) and a small population.

Appendix Figure D2. Nightlights per capita, last wave



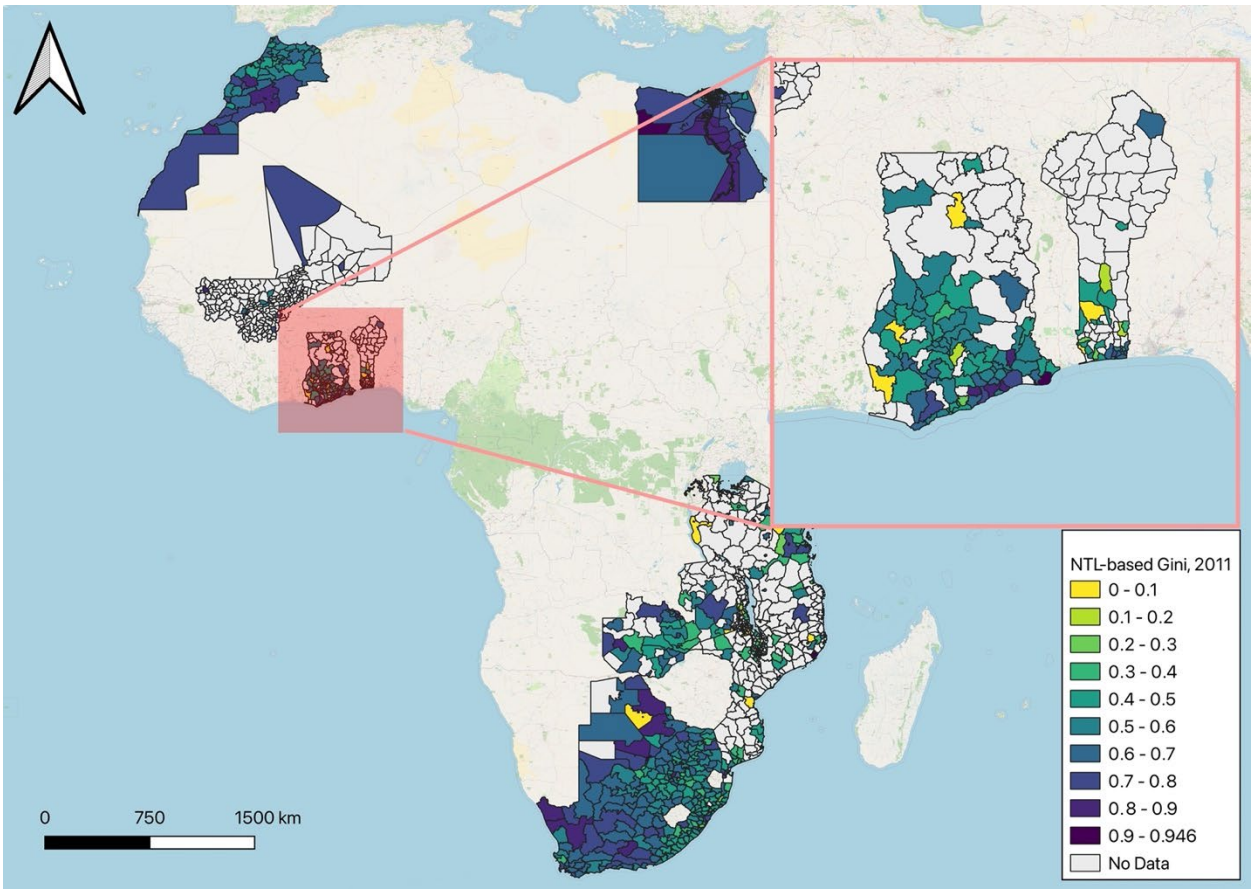
Source: Author's elaboration on Li et al. (2020)

5. Remotely-sensed Spatial Inequality Measurements

Our fourth and final set of variables is represented by measurements of spatial inequality, which represent one of the latest developments in the use of remotely sensed socioeconomic data. In particular, we exploit the Li et al. (2020) harmonized NTLs dataset described in section D.2. in conjunction with the recently released LandScan dataset (Oak Ridge National Laboratory, 2019), a 1Km^2 pixel-level raster population database covering 2000-2018, and the Gridded Population of the World v3 (Center for International Earth Science Information Network-CIESIN-Columbia University) dataset, a 4.6Km^2 pixel-level raster population database for the years 1990 and 1995. We calculate 1Km^2 pixel level NTLs sums for 1992-2018 from the Li et al. (2020) dataset, and population counts for 1990, 1995 and 2000-2018 by leveraging the combination of LandScan and GPW v3; we then calculate population counts for 1992-1994 and 1996-1999 by linearly interpolating population values from 1990 to 1995 and from 1995 to 2000. We thus obtain a pixel-level population and nightlights panel dataset comprising over 10 million observations over the countries in our sample. In order to obtain remotely-sensed measurements of inequality, we employ the

procedure described in Elvidge et al. (2012) and further refined by Mirza et al. (2021) as follows: we first calculate average lights per person (LPP)[11], by dividing pixel-level NTLs by pixel-level population counts; we then calculate inequality in the distribution of LPP for each administrative units by calculating Gini coefficients for the range of pixels contained in each administrative unit in our sample. Appendix Figure D3 provides evidence on the distribution of the inequality measure at the administrative level and for the year corresponding to the last census wave available.

Appendix Figure D3. Spatial Gini indicator based on Mirza et al., (2021)



Source: Author's elaboration on Li et al. (2020), LandScan and GPW v.3.

[11] As in Mirza et al., (2021) we first censor both pixel-level NTLs and population in order to exclude zeroes, an operation which prevents placing excessive weight on uninhabited regions or places without detectable NTLs.

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