Colonial Legacies: Shaping African Cities

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Basic idea

- Compared to Anglophone cities, Francophone cities are more ‘compact’
- Two dimensions to compactness
  - Less ‘sprawl’: higher density development overall and smaller spatial extent of city
    - Colonial intensive margin
  - At extensive margin less ‘leapfrogging’: More infill and extension of existing developments and less spatially disconnected developments
    - Leapfrog: new developments that are over some threshold distance (here 300m) from the edge of an existing development
  - [Leapfrogging naturally contributes to low density development/sprawl, but not necessarily vice versa]
- Examine this idea with data on built cover from 1990-2014 for 318 Africa cities in 15 Anglophone and 13 Francophone Sub-Saharan African countries.

Why the difference?

- **Urban planning literature on Africa:**
- **British indirect rule: dual mandate**
  - "Native authorities would continue to govern the native population, while townships, largely based on the cantonment model, accompanied the colonizers ... Land laws distinguished between on the one hand, the plantation estates and townships of the European colonizers, and, on the other hand, indigenous or customary land under the dual mandate approach...." (Home , 2015, p.55, 57).
- French direct (assimilative) rule:
  - Centralized and standardized urban institutions: goal to bring all urban land under one control, replacing native with French institutions and practises (Njoh, 2015)

Francophone

- "Customary land management is not recognized.....In former French colonies, this situation is clearly linked with conception of freehold as defined in the Code Napoleon, and with the French Centralist political model. It is characterised by: (i) state monopoly on land, and state control over land markets and centralized land management system...." (Durand-Lasserve 2004)
- Given a desire to maintain social order and control over the landscape, the French wanted:

Different neighbourhoods *spatially integrated and linked in a lineal pattern so that from one intersection an official could see 2 kms in four directions* (Njoh 2015).

- Francophone more likely to have integrated lineal road systems
    - See also Silva (2015) on French centralisation and standardised grid systems.

Examples: Colonial sections of the city: those nearer the city centre

- Road layout
- Bamako (Mali) and Accra (Ghana): Emerge in colonial era
- Similar sizes in 1920 (16,000 vs 19000) and today (1.8m and 2.3 m)
- Classic French colonial rule: Bamako 1907 ‘Plan d’une cite administrative’
- vs Accra British dual mandate. First plan 1945, applied (but only ex post to European section)

Grey: Open street map
Red: **mid-1960's street map**

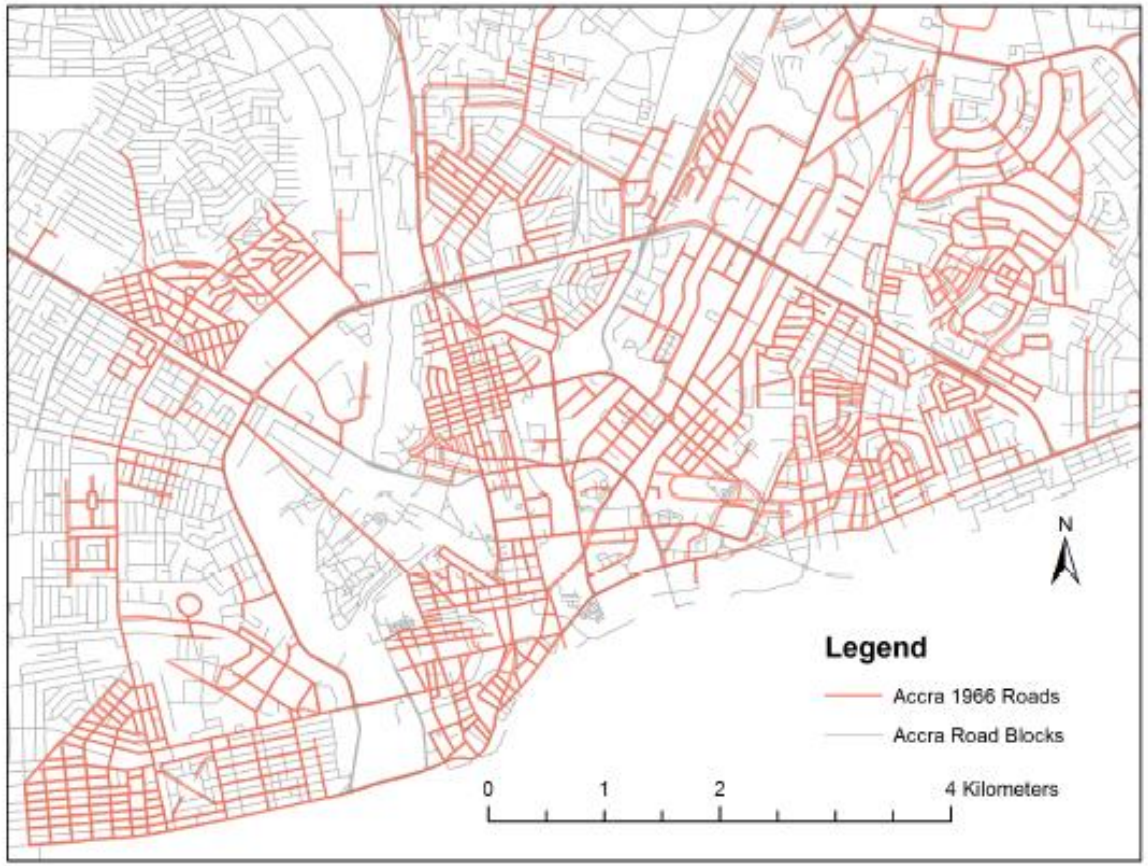


Figure 3a: Persistence of road blocks in Accra

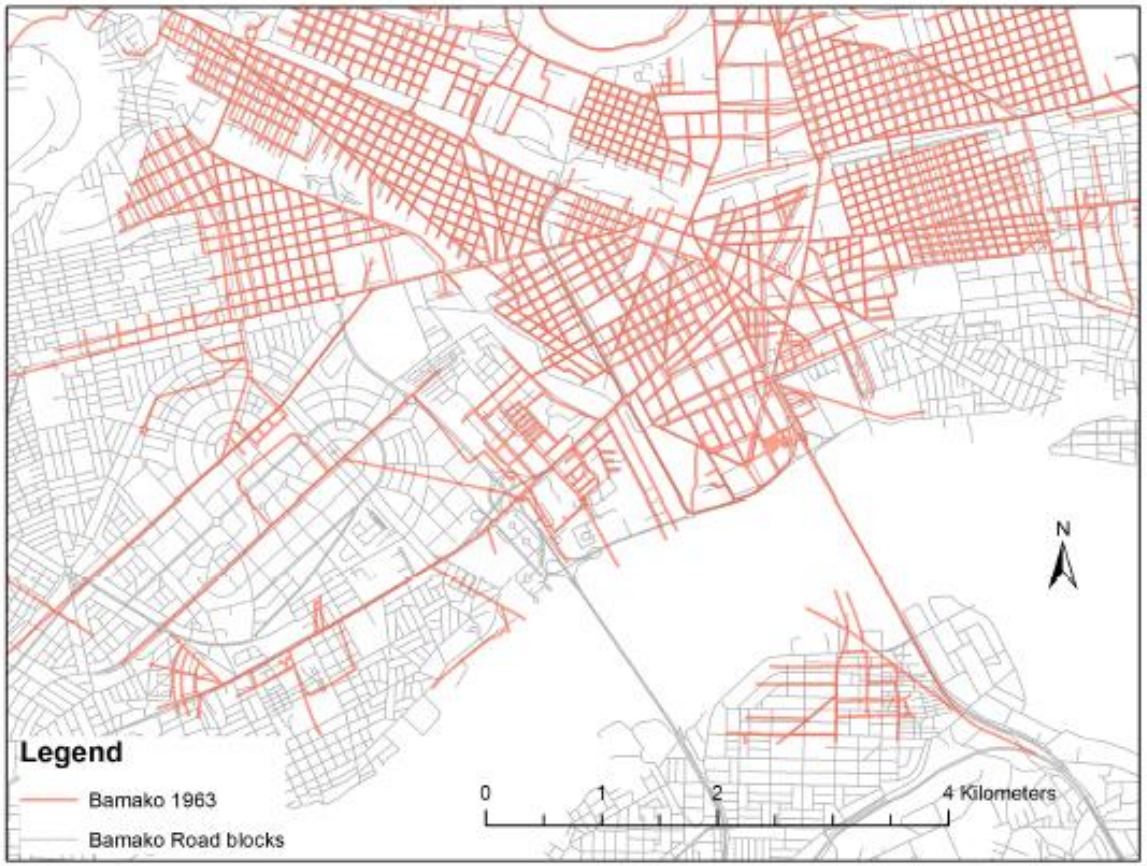
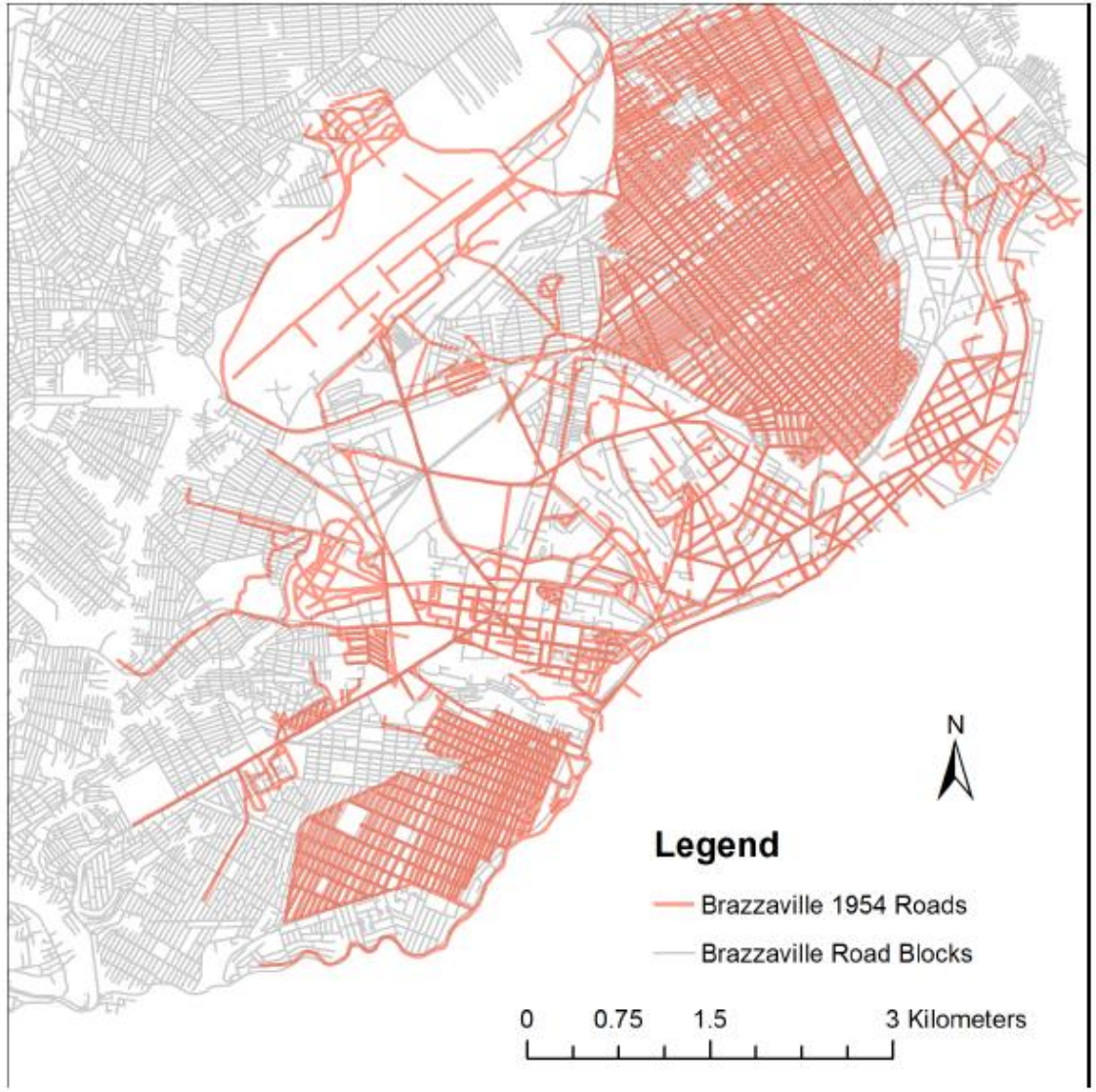


Figure 3b: Persistence of road blocks in Bamako

(c) Harare



(d) Brazzaville

Why does it matter?

- Density and compactness argued to affect
  - Firm (or social) interaction externalities (Rossi-Hansberg 2004)
  - How much we pollute (Glaeser & Kahn, 2010)
  - How much time we spend commuting (Harari, 2017)
  - How we interact socially (Putnam 2000, Burley, 2016)
  - **Cost of providing public services and urban infrastructure outlays**. (Trubka, Newman, Bilsborough 2010)
    - Little solid empirical evidence on this. Exception: Hortas-Rico & Sole-Olle (2010) on cost of infrastructure provision in Spain
- We use Demographic and Health Survey data on utilities in a variety of African cities
  - Do families have worse connections to electricity, phone landlines, piped water, and city sewer systems, if they live in areas of a city which have more leapfrog development and/or openness?

The experiment, part I

- Colonial influence on overall urban structure:
  - In general, ‘random’ allocation of colonial rule for any city Michalopoulos & Papaioannou (2016)
    - Scramble for Africa (Berlin 1884/85 conference)
  - Arbitrary drawing of borders
- Colonial cities laid out differently under the two regimes
- Persistence in physical lay-out in older colonial sections and their extensions
  - Initial lay-out influences future for decades, even centuries
    - Long life of public infrastructure (e.g. roads)
  - If redevelop: follow old roads
    - Rights of ways for roads in intensely developed areas

The experiment, part II

- However have an ***extensive margin*** beyond the colonial physical layout: given by rapid urban growth of post-colonial era:
  - For 111 cities with data, population from 1960-2000 grew by 550%
- At far extensive margin:
  - Institutions and norms governing city planning persist beyond the end of the colonial era. Avenues:
    - Inertia which leaves in place colonial land use regulation rules and procedures
    - Continuation of norms through the training of post-colonial planners and policy makers
    - Persistence of legal philosophies which filter into planning procedures.

Identification

- Even if colonial origin is happenstance, worry in the process that on average cities by colonial origin could have different geographies or pre-colonial histories
- Worry a lot about differential geography in shaping cities (Burchfield et al 2006; Harari, 2017)
- Many controls, but how to deals with unobservables?
- Border experiment matching cities within 100 miles of Francophone-Anglophone borders
  - Only possible in West Africa.

Organization and summary of findings

- **Overall city**:
  - Burchfield et al (2006) measure of sprawl, 'openness', 23% higher in Anglophone cities in 2014
  - Areas are 28% larger in Anglophone cites, ceteris paribus

- Colonial influenced sections:
  - Francophone cities have more gridiron road structures (lineal roads with rectangular blocks)
  - Anglophone: in rings out to 5kms, 39-80% less density land use development

- At extensive margin (beyond the 1990 built cover boundary of the city)
  - Anglophone cities have 61% more leapfrog [LF] patches and a 32% higher ratio of LF to total patches of new development
    - For same growth rate: French more intensive development
      - Fewer patches (29%) and less likely to be LF
    - Implies more intensive development of existing land (e.g. build higher): unobserved

Relevant literatures

- General economics literature on institutions and persistence
  - Banerjee & Iyer2005; Guiso, Sapienza Zingales 2016 on historical institutional accidents
  - Colonialism affects economic development and political stability: Acemoglu Johnson and Robinson, 2004
  - Impose French civil law (vs British common law): Affects regulatory outcomes, banking procedures, property rights enforcement: La Porta, Lopez-de-Silanes and Shleifer 2008
    - Mahoney (2001, p. 505) argues that French civil law is more "comfortable with the centralized activist government."
- Urban theory
  - Centralized control in the face of externalities improves outcomes compared to laissez faire (David & Whinston 1964, Hockman et al). No space
  - Higher density from centralized control (by benevolent ruler (!)) in face of social externalities: Rossi-Hansberg 2004; Helsley & Strange 2007.
  - Leapfrogging on urban fringe more likely if lower density centre: Turner 2007 and Henderson and Mitra 1996

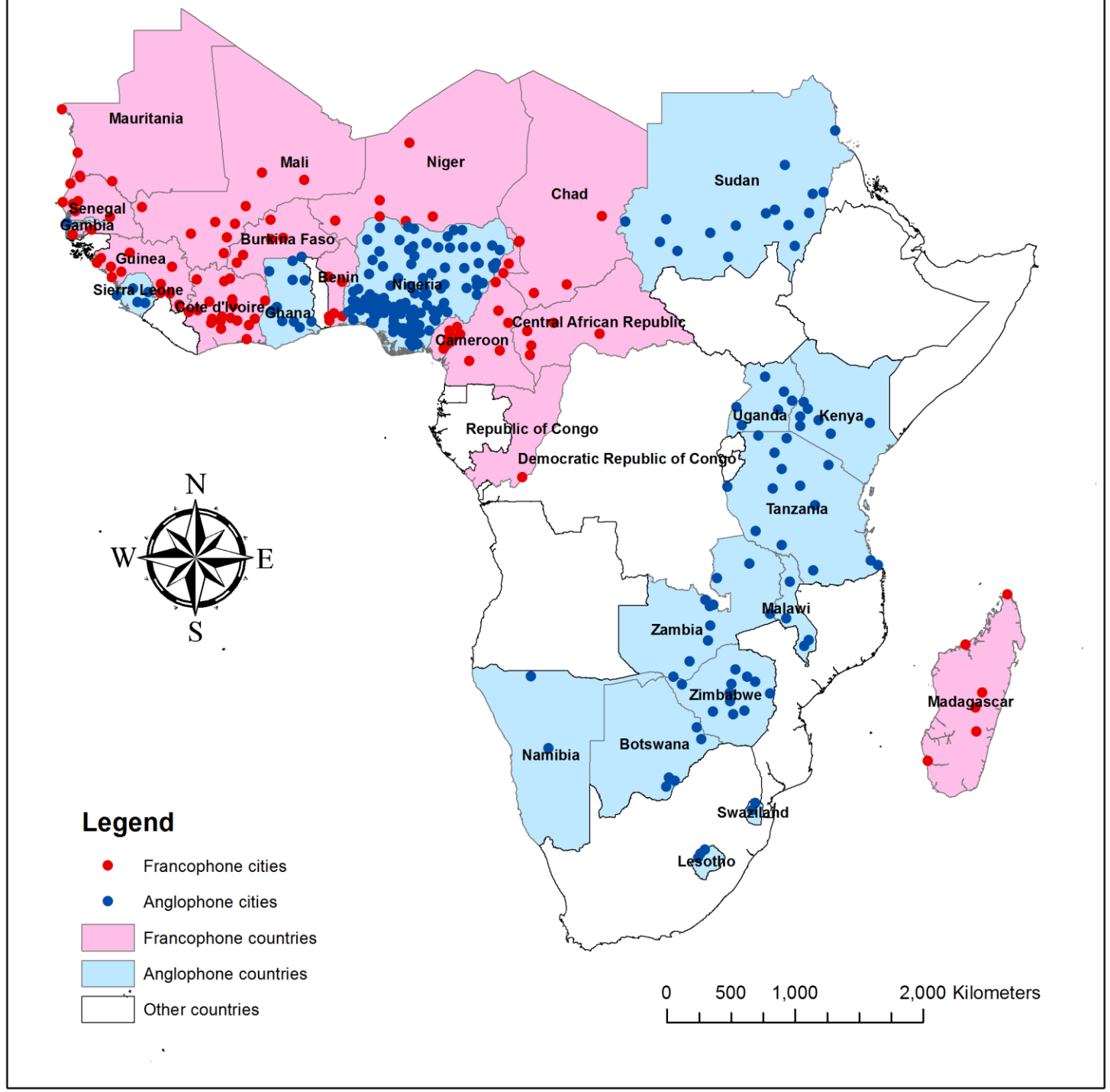
Empirical urban literature

- Land planning matters: Rectangular grid vs metes and bounds. Ohio experiment: later higher land values . Libecap & Lueck (2011)
- Imposing a road grid pattern leads to greater contiguity of the urban spatial structure
  - Aggregation properties of rectangles without gaps or overlaps promotes compactness
  - *O'Grady (2014): for New York City, neighbourhoods with a greater fraction of rectangular grids imposed centrally and historically, then experienced higher future land values and more compactness, or higher density of use*
- *Sprawl and urban shape: Role of geography*
  - Burchfield et al (2006) on geography and history affecting openness
  - Harari (2017) on India: geography affects shape
  - We have many controls

Context

- Figure on colonial countries
  - Issue of reallocation of German colonies (Tanzania, Cameroon)
  - Role of West Africa with only borders

Sample cities



Data

- Land use data: distinguish built cover
  - Global Human Settlement Layer for (1975) 1990, 2000, 2010, 2014 ‘epochs’
    - Based on **Landsat** but updated with information from Modus, Meris, LandScan
    - **38m x 38 m** resolution
  - Stock of built persists: no removal from built to unbuilt. Flows are all non-negative.
- From 333 cities, get 318 relatively cloud free cities over 30,000 population in 1990 with cloud free observations generally in both 2000 or 2014.
  - 2/3 Anglophone
    - 1/3 Nigeria
- OpenStreetMap: 20 Francophone cities over 300,000 in 2012. Match to 20 Anglophone cities (size, growth coastal or not)

Geography and extent of city

- Outer envelop of lit areas around a city (lit for at least 2 of years 2008-2012)
  - Experiment with other thresholds (above 0 lights) and trimming extreme radius cities
- Geography: Nunn & Puga (2012) ruggedness , elevation and range, coastal, distance to coast, kms of coastline, inland water, buffering vegetation, rainfall
- Initial population (1990), lagged country GDP*, city estimated annualized population growth rate 90-12*
- City centre: brightest lit pixel (0.64 sq kms at equator) in night lights in 1992/3

General framework

- General for openness, area and leapfrogging:

$Y_{ijt} = X_{ij}\beta + Z_{ijt}\theta + d_t + \delta \text{Brit}_j + \varepsilon_{ijt}$; country j; city i; time t.

- Y: outcomes:
  - **Stock** 2014: openness, area
  - **Flow** 90-00 and 00-14: leapfrogging

    Count of patches of different types, areas of patches
- X: time invariant city geographic features, base population, pop growth 90-12
- Z: time varying country GDP; d_t : time dummy;
- δ: differential for British colonies

Robust errors clustered by city

Sprawl: Overall patterns

- **Openness index for 2014 (Burchfield et al, 2006) overall for a city**
  - For each pixel: fraction of unbuilt pixels in 1km around it.
- Pdf's for pixels and regs for city averages
- Report here just on 2014 stock

- **Look at land area of city**;
  - Defined by night lights
    - Not smoothed cover: bias

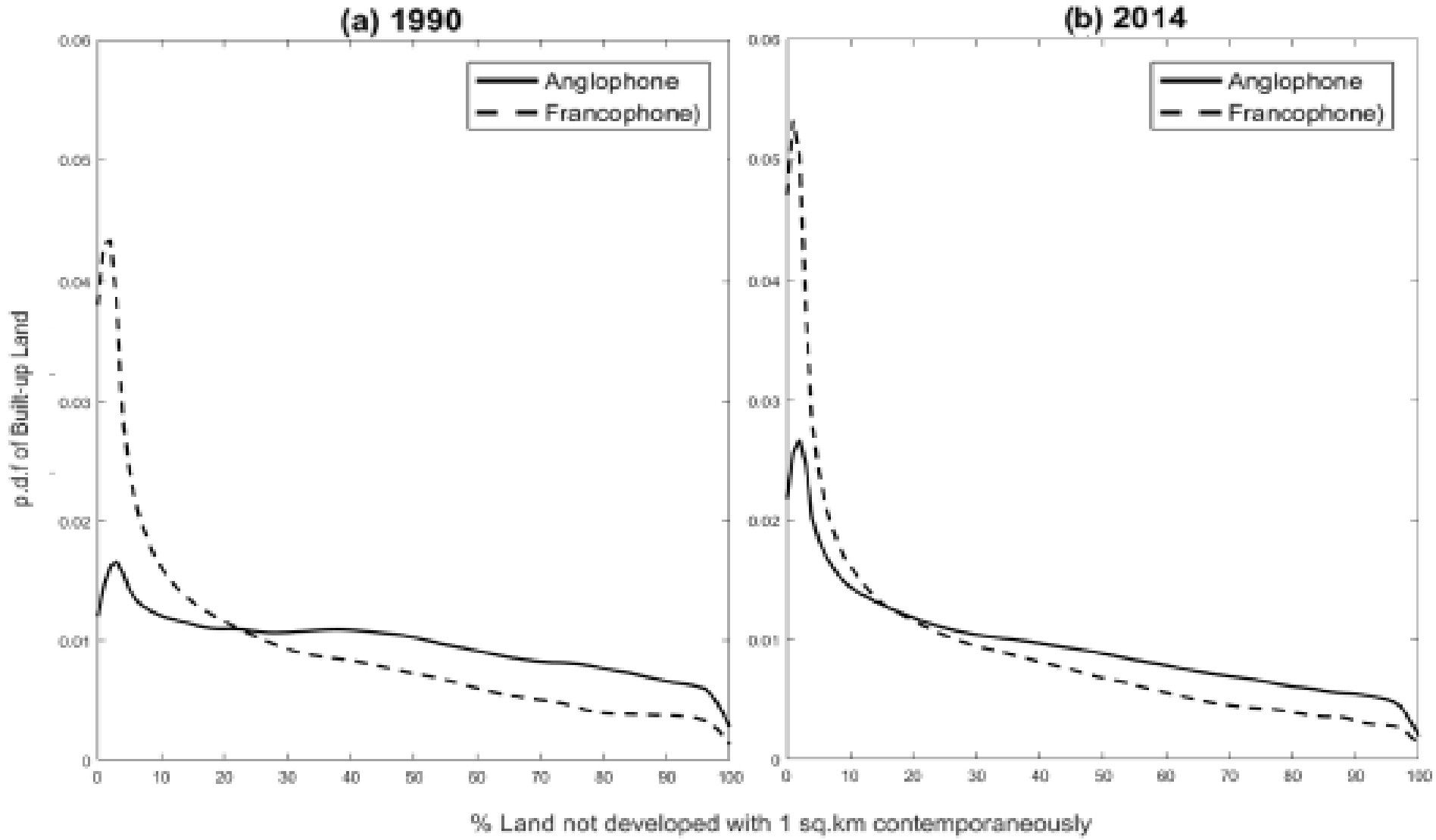


Figure 2: Probability function of Anglophone and Francophone built-up land across areas with different degrees of sprawl for (a) 1990 and (b) 2014

Pdf for all pixels in all cities

Results on overall openness and area

	Ln (Openness, 2014)		Ln(Lights area of city, 2014)	
Anglophone Dummy	0.229***	0.231***	0.355**	0.277***
	(0.045)	(0.047)	(0.151)	(0.089)
Controls for geography and country and city conditions	No	Yes	No	Yes
Observations	307	307	307	307
R-squared	0.077	0.37	0.014	0.77

- Can trim top 5% and bottom 5 % by lights area

Geography controls include ln ruggedness, ln rainfall, ln elevation range, coast dummy, interaction of ln coast length with coast dummy, interaction of ln distance to coast with non-coastal dummy, fraction of river area, fraction of lake area. Fringe geography controls include fraction of forest, fraction of shrubs, fraction of crops, fraction of wetlands and water, fraction of sparse vegetables and bare land (base is grasslands).
Country and city: ln GDP pc t-1, city 1990 population, annualized city pop growth rate from circa 1990 to circa 2012

For typical city with separate regs by colonial origin, effects are 28% and 37% respectively

Older colonial sections of city (or immediate extensions)

- Road layouts
- After eyeballing, rigorously define measures characterising road layout
- Francophone cities propensity score matched to 20 Anglophone.

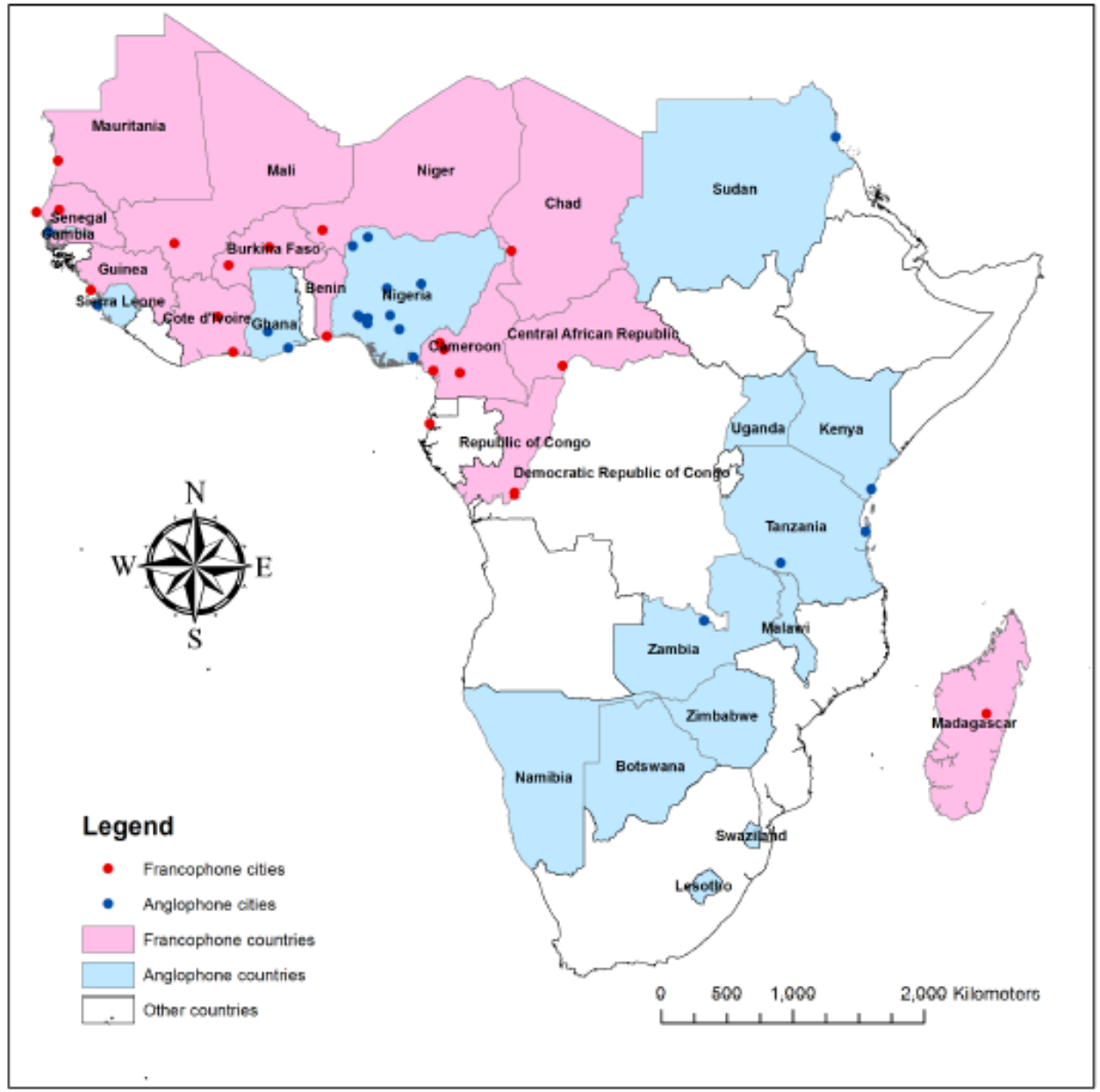


Figure 1b: Spatial distribution of 40 sample cities

Gridiron blocks

- 20 Francophone; 20 Anglophone matched (out of 68)
  - 1990 population, rainfall, coastal, elevation. Estimated pop growth 92-12
    - (Mahalanobis distance without replacement)
  - Balanced
- Look within 3 and 5 kms of centre: more colonial and better info from Open StreetMaps
- Define extent of **gridiron blocks**: *rectangular, no dangles, connected to neighbours by 4 way intersections.*
  - Rectangularity: area of block/area of minimum bounding rectangle ≤ 1
  - Fraction within 3 or 5 kms of all blocks
- Dangles: Roads off regular network which dead-end or end at a T-intersection
  - Fraction of all blocks having a dangle

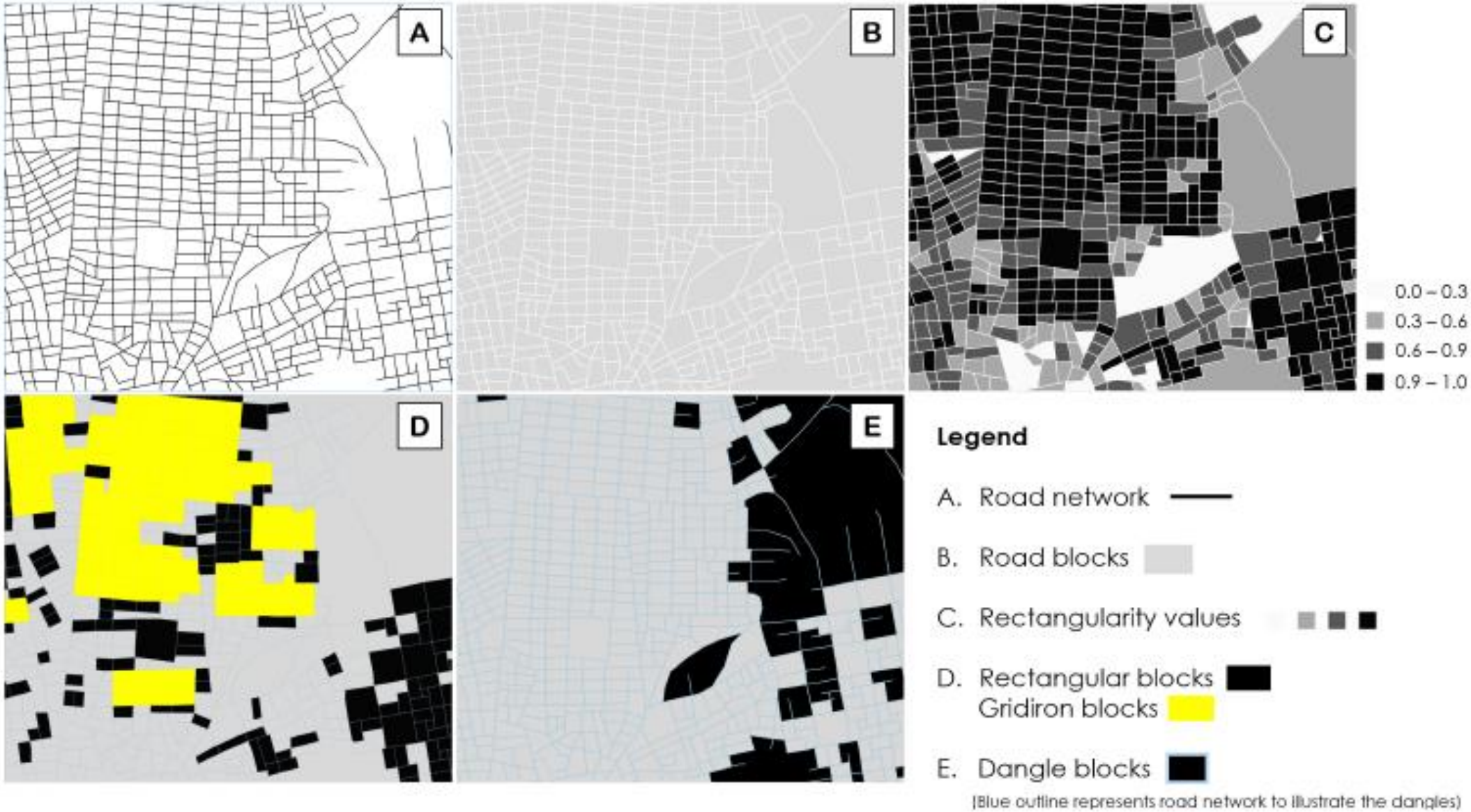


Figure 5: Road blocks and rectangularity

Rectangularity: Zunic et al 2012, Rosin 1999

Gridiron share within 5km of center

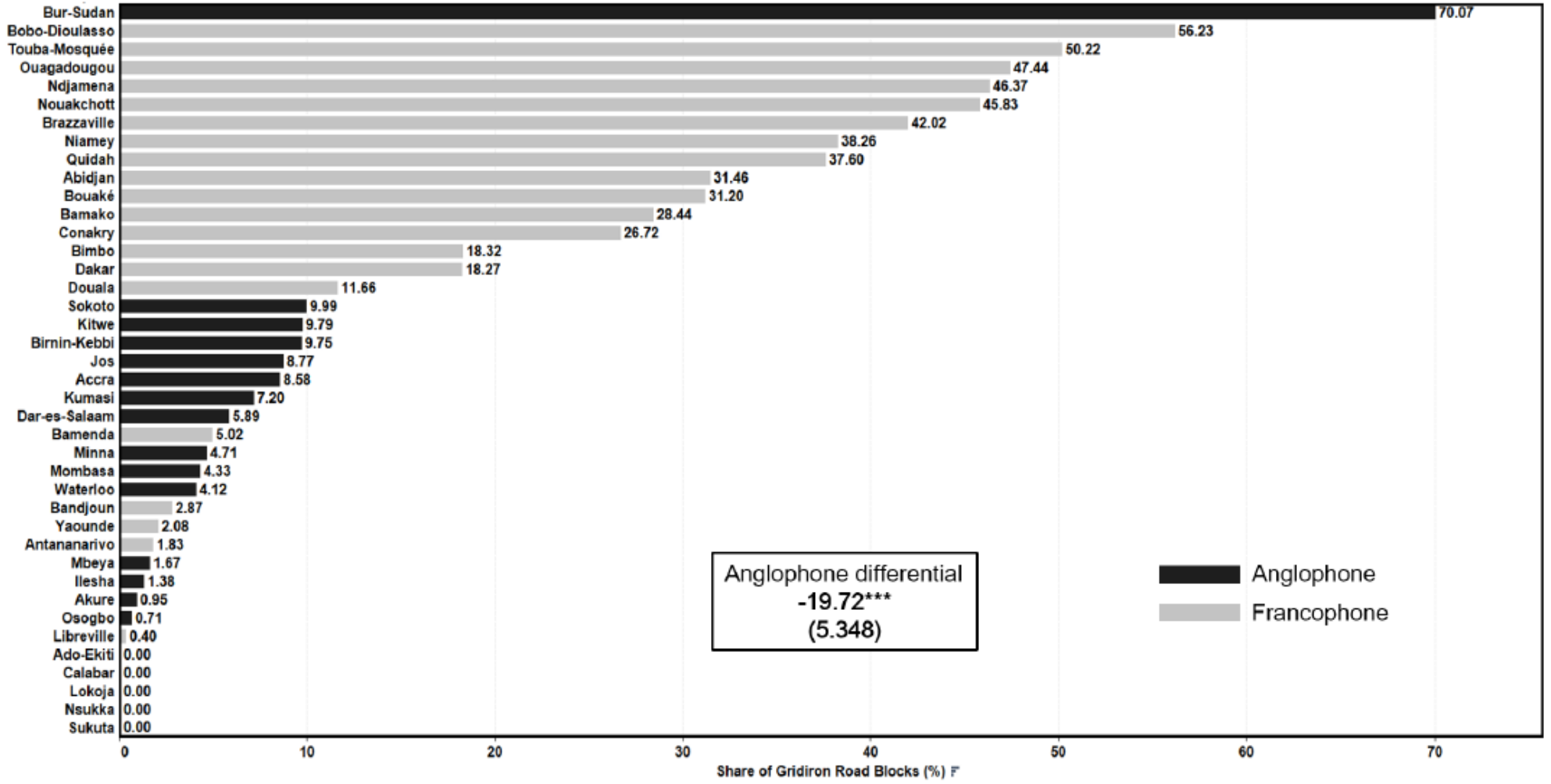


Figure 5: Share of gridiron road blocks within contemporary 5km

Mean: 17

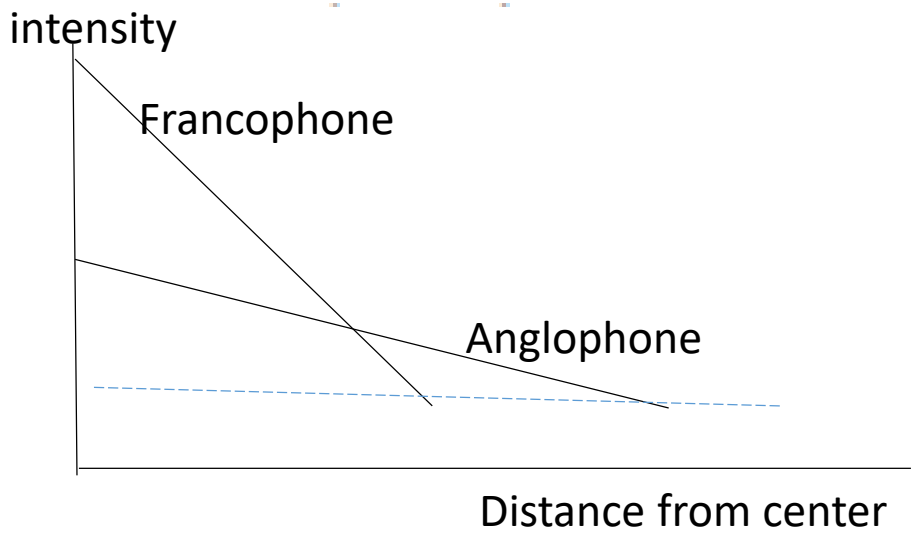
- Dur Sudan (port Sudan): set up as a ‘planned’ city.
- British 3.5% more dangles from mean of 10.7; but only significant at 10% level

Intensity in old colonial section (ln(count of built pixels))

Table 2: Intensity by rings in 1990

	(1) 1km	(2) 2km	(3) 3km	(4) 4km	(5) 5km	(6) 6km
Anglophone Dummy	-0.389**	-0.658***	-0.804***	-0.781***	-0.420*	-0.075
	(0.165)	(0.164)	(0.194)	(0.229)	(0.241)	(0.263)
Ln ring total pixel	1.070***	0.534	-0.017	0.274*	0.546***	0.421***
	(0.355)	(0.465)	(0.211)	(0.164)	(0.167)	(0.145)
Anglophone mean	1.313	2.654	2.526	2.245	2.138	2.185
Francophone mean	1.684	3.329	2.877	2.522	2.373	2.424
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.200	0.287	0.395	0.477	0.511	0.429
N	312	316	307	283	254	218

- **Note: Not clear how to compare intensity at city fringe** (beyond colonial influences portions).
- **Three issues**
  - French cities much smaller area, because more intense.
  - Not just counts, but developed pixels more intensely developed (2014)
  - *Less intense land cover in centre could be compensated for with higher buildings: No information*
- **Turn to Leapfrog**



Intensity of already developed pixels, 2014

	1km	2km	3km	4km	5km	6km
Anglophone Dummy	-0.174***	-0.265***	-0.433***	-0.365***	-0.415***	-0.204
	(0.058)	(0.058)	(0.088)	(0.124)	(0.140)	(0.154)
Ln ring built pixel	1.487***	1.334***	1.361***	1.381***	1.327***	1.317***
	(0.060)	(0.043)	(0.050)	(0.055)	(0.044)	(0.046)
Anglophone mean	1.196	2.514	2.539	2.425	2.229	2.299
Francophone mean	1.463	3.153	3.024	2.569	2.586	2.501
Geographic and other controls	Yes	Yes	Yes	Yes	Yes	Yes
Rsq	0.911	0.934	0.926	0.925	0.930	0.917
N	283	285	279	259	236	209

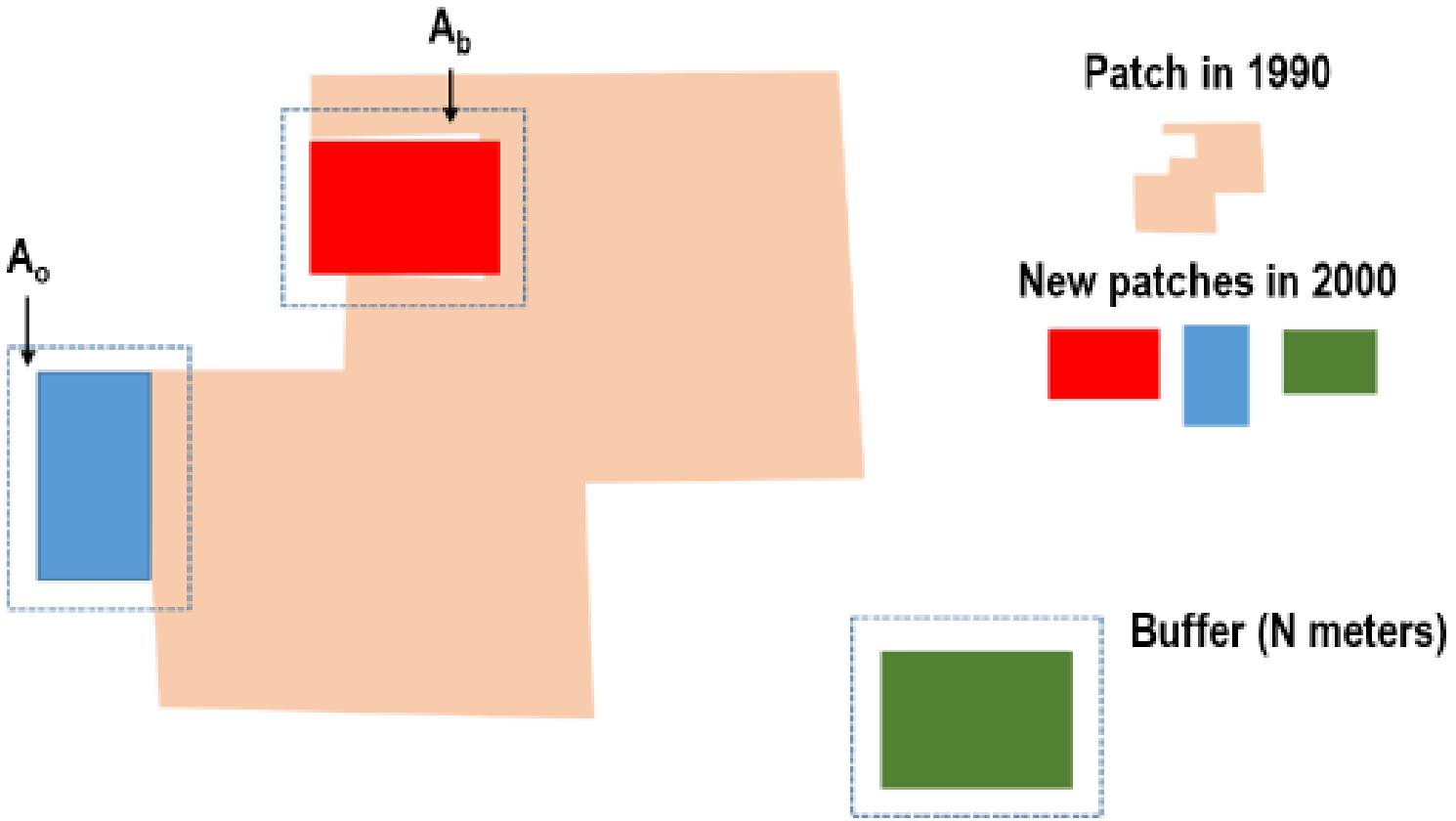
Share of grid square that is built *area. log of total built area in each ring

Extensive margin and leapfrog

- Outcomes
  - Ln(count of leapfrog developments in a city)
    - Essentially no leapfrog developments within the 1990 smoothed cover boundary. All extensive margin
  - Ln (ratio of LF to total (new) development patches)
  - Ln(avg LF area).
    - So it is not bigger but fewer (or more) patches for example
  - Two time periods (90-00 & 00-14, with time dummy)
- How to define leapfrog:

Extensive margin and leapfrogging

What is a leapfrog development?



- Buffer is 300 m:

5 minutes walk or so

- LF no intersection of *buffer* with existing development

- **Landscape Expansion Index (LEI): area of buffer with existing development /buffer area**
  - LF: LEI =0

Figure 6: Illustration of using the landscape expansion index for defining leapfrog patches

Main results

Table 3: Leapfrogging

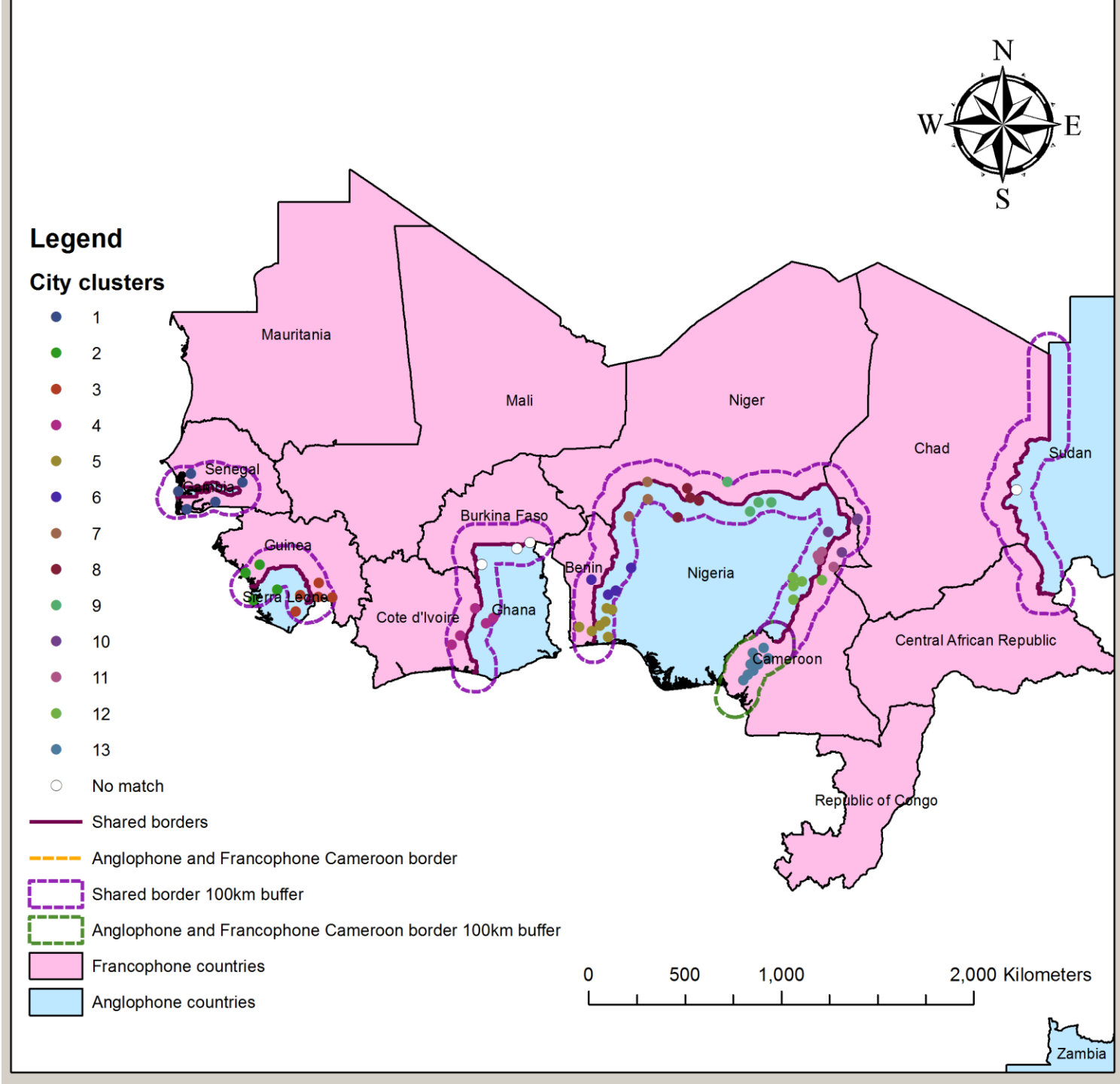
	Ln count of LF				Ln LF minus ln total patches				Ln avg. LF area
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Anglophone dummy	0.907***	0.700***	0.642***	0.607***	0.339***	0.282***	0.246**	0.319***	-0.046
	(0.139)	(0.140)	(0.135)	(0.163)	(0.099)	(0.104)	(0.101)	(0.119)	(0.064)
Ln initial cover 1990	0.656***	0.572***	0.553***	0.278***	-0.081**	-0.126***	-0.143***	-0.311***	0.014
	(0.049)	(0.048)	(0.048)	(0.063)	(0.033)	(0.033)	(0.033)	(0.040)	(0.021)
Year dummy 2014	0.517***	0.508***	0.504***	0.491***	0.119**	0.121**	0.118**	0.119**	0.140***
	(0.065)	(0.065)	(0.066)	(0.068)	(0.053)	(0.054)	(0.055)	(0.056)	(0.034)
Lag t-1 ln country GDP per capita				-0.229				-0.146	0.067
				(0.147)				(0.111)	(0.051)
Ln annual population growth 90 to 12				10.760***				5.222**	1.989
				(3.198)				(2.413)	(1.226)
Ln projected city population 1990				0.730***				0.467***	0.049
				(0.099)				(0.067)	(0.034)
Internal geography	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Fringe geography	No	No	Yes	Yes	No	No	Yes	Yes	Yes
R^2	0.446	0.502	0.517	0.586	0.053	0.099	0.126	0.231	0.117
N	606	606	606	551	606	606	606	551	525

- Geographic controls do matter.
- Implies Anglophone 29% more total patches

If separate regs by colonial origin and pick typical city: differences are 71% and 29% on columns 4 and 8 respectively

Identification

- City geographic characteristics across countries not completely balanced.
  - Modestly impact outcomes (but goes both ways)
  - Worry about unobservables
- Border experiment
  - No waterways on borders
  - 100 km buffer (same if 150km). Part of Cameroon under British control: Remove
    - 35 Anglophone and 23 Francophone cities over 2 time periods
  - **14 'natural clusters' (cluster fixed effects): Algorithm**
    - Match Anglophone cities to nearest Francophone city
    - Assign unmatched Francophone to nearest cluster
  - Balance across 11 key geographic covariates



Shared borders

Identification with border sample:

Table 4: Identification based on border sample

	(1) Ln count of LF	(2) Ln LF minus ln total patches	(3) Ln avg. LF area
Basic controls			
Anglophone dummy	0.952*	0.763**	-0.118
	(0.496)	(0.340)	(0.162)
City cluster FE's			
Anglophone dummy	0.789***	0.537***	-0.210
	(0.290)	(0.178)	(0.135)
R^2	0.673	0.431	0.271
N	108	108	103

Note: Controls include ln initial cover 1990, year dummy 2014, lag t-1 ln country GDP per capita, ln annual population growth 90 to 12, ln projected city population in 1990, ln average ruggedness, and coast dummy. Standard errors are clustered at city level.

* p <0.1, ** p <0.05, *** p <0.01. Standard errors in parentheses.

25% more total patches

Sample size of 56 due to cloud cover effects of openness measure vs lights measure.

Robustness, illustrated with leap-frogging

Table 5: Leapfrogging: Robustness

	(1) Base	(2) No single pixel patches	(3) 60 meter buffer	(4) Trim	(5) No German colonies	(6) No Nigeria	(7) Colonial origin	(8) Non colonial origin	(9) 40 cities
Ln count of LF									
Anglophone	0.607***	0.555***	0.526***	0.420***	0.492**	0.670***	1.079*	0.629***	0.646***
dummy	(0.163)	(0.165)	(0.138)	(0.161)	(0.197)	(0.217)	(0.606)	(0.179)	(0.229)
Ln ratio of LF									
Anglophone	0.319***	0.279**	0.237***	0.227*	0.175	0.336**	0.150	0.362***	0.292
dummy	(0.119)	(0.126)	(0.073)	(0.120)	(0.142)	(0.159)	(0.319)	(0.128)	(0.218)
Ln avg. LF area									
Anglophone	-0.046	-0.034	-0.088**	-0.026	-0.168**	-0.042	0.141	-0.029	0.136
dummy	(0.064)	(0.056)	(0.044)	(0.059)	(0.081)	(0.070)	(0.142)	(0.071)	(0.113)
R^2	0.586	0.582	0.679	0.515	0.606	0.556	0.698	0.550	0.596
N	551	551	551	505	489	330	69	502	49

Trim top and bottom 5% by max distance from center to lights boundary.
No German: Tanzania, Cameroon, Namibia, Togo)

Effect on public utilities

- DHS: 44500 households in 193 cities (60 Francophone) cities in 18 countries.
- **Not looking at colonial effects per se** (could be many other colonial influences on provision of public goods)
- Looking at effect of extent of cover and LF
  - Within 2km buffer (neighbourhood of cluster) at
    - Extent of ground (fraction built pixels)
    - Number of LF developments
    - ***GPS location of cluster randomized within 2 kms: measurement error***
- Outcomes: connection to electricity network, piped water supply, flush toilet connected to city sewer, land line
- Have city FE's. Identify off within city variation

Table 6: Public utility connection

	Has electricity		Has piped water		Has flush toilet		Has phone land line	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Count of LF	-0.0033**	-0.0026*	-0.0002	0.0008	-0.0045***	-0.0031***	-0.0019**	-0.0020**
	(0.0014)	(0.0014)	(0.0013)	(0.0014)	(0.0010)	(0.0010)	(0.0008)	(0.0009)
Share of built cover in buffer		0.0526*		0.0797**		0.1168***		-0.0026
		(0.0298)		(0.0364)		(0.0266)		(0.0128)
Ln buffer center distance	-0.0727***	-0.0666***	-0.0700***	-0.0608***	-0.0383***	-0.0248***	-0.0124***	-0.0127***
	(0.0066)	(0.0075)	(0.0088)	(0.0096)	(0.0062)	(0.0073)	(0.0035)	(0.0038)
Ln buffer ruggedness	0.0553***	0.0507***	0.0565***	0.0495**	-0.0054	-0.0157	-0.0012	-0.0010
	(0.0165)	(0.0171)	(0.0204)	(0.0210)	(0.0120)	(0.0124)	(0.0062)	(0.0064)
Buffer has river of lake	0.0209	0.0232	0.0361	0.0395	-0.0057	-0.0007	0.0041	0.0040
	(0.0214)	(0.0214)	(0.0272)	(0.0270)	(0.0174)	(0.0175)	(0.0122)	(0.0121)
Household size	0.0086***	0.0086***	0.0024***	0.0024***	0.0026***	0.0026***	0.0069***	0.0069***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Sex of household head: Male	-0.0075	-0.0076	-0.0092*	-0.0094**	-0.0159***	-0.0161***	-0.0096***	-0.0096***
	(0.0050)	(0.0050)	(0.0047)	(0.0047)	(0.0041)	(0.0040)	(0.0028)	(0.0028)
Highest educational level of head: Primary	0.0367***	0.0374***	0.0117	0.0128*	-0.0052	-0.0036	0.0126***	0.0126***
	(0.0072)	(0.0072)	(0.0073)	(0.0073)	(0.0045)	(0.0045)	(0.0034)	(0.0034)
Highest educational level of head: Secondary	0.1739***	0.1740***	0.0519***	0.0521***	0.0407***	0.0410***	0.0424***	0.0424***
	(0.0070)	(0.0070)	(0.0071)	(0.0071)	(0.0047)	(0.0047)	(0.0038)	(0.0038)
Highest educational level of head: Higher	0.2877***	0.2877***	0.0578***	0.0577***	0.1652***	0.1652***	0.1124***	0.1124***
	(0.0088)	(0.0088)	(0.0094)	(0.0094)	(0.0089)	(0.0089)	(0.0072)	(0.0072)
Highest educational level of head: Unknown	0.1417***	0.1417***	0.0457**	0.0457**	0.0124	0.0124	0.0027	0.0026
	(0.0247)	(0.0247)	(0.0225)	(0.0225)	(0.0165)	(0.0165)	(0.0150)	(0.0150)
Period dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.320	0.321	0.436	0.437	0.255	0.259	0.126	0.126
N	44517	44517	44561	44561	44500	44500	42748	42748
Base fraction	**74%**		**63**		**13**		**6**	

Note: Period dummies control the difference between the DHS survey years with year 2000 and 2014 when satellite data is available. Period dummies include 1 year before dummy, 1 year after dummy, 2 years before dummy, and 2 years after dummy. Standard errors are clustered at DHS cluster level.

1 sd increase in built cover increases likelihood of connection by 0.016, 0.025, 0.036 for electricity, water and sewer respectively

Conclusions

- Francophone cities more compact than Anglophone
- Overall less openness and smaller spatial extent of city
- Old colonial and their immediate connected sections of the city
  - French urban planning
    - More gridiron road structures
    - More intense development near the centre
- Extensive margin: persistence of norms
  - Less leapfrog, or disconnected development
- So what question

LEI distribution: Anglophone vs Francophone