Spatial Inefficiencies in Africa's Trade Network

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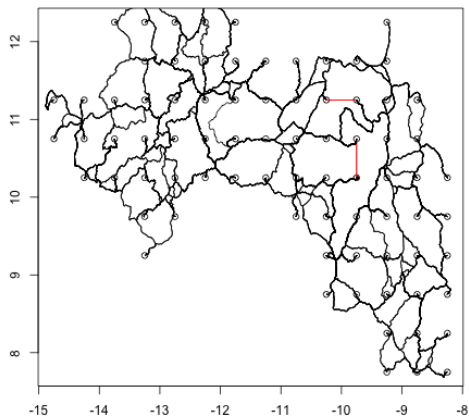# Motivation

Figure: Road Network Guinea
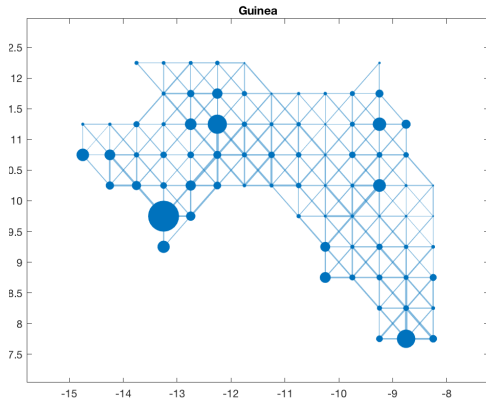
Motivation

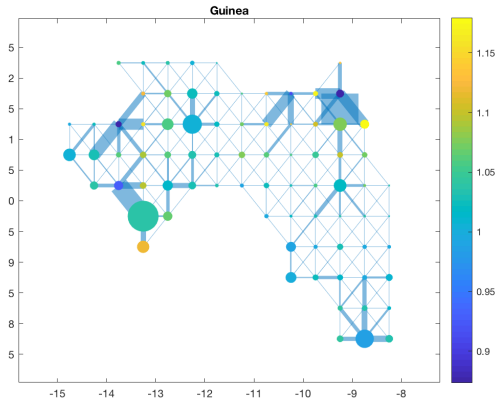
Figure: Road Network Guinea

Motivation

Figure: Optimal Road Network Guinea

Motivation

- Are African roads where they should be?

- Which country has the most efficient trade network?

- Why do some regions have *too* many roads?

Steps

1. Network representation for all African countries

   ▶ Nodes

   ▶ Edges

2. Employ in simple trade model

3. Reshuffle roads to get optimal network

4. Analyse patterns of reshuffling

Steps

1. Network representation for all African countries
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Network Nodes

Figure: 10,167 grid cells (0.5 x 0.5 degrees)

Network Nodes

- Population
- Output (night lights)
- Geography

Central-African-Republic

Network Edges

- Average Speed
- Distance
- Topography
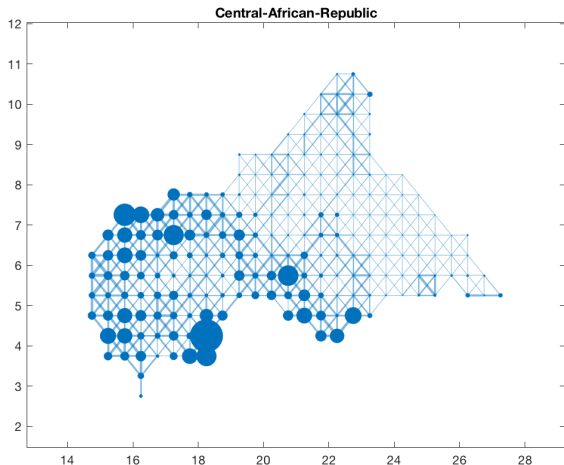
Central-African-Republic

Steps

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   ▸ Nodes

   ▸ Edges

2. Employ in simple trade model

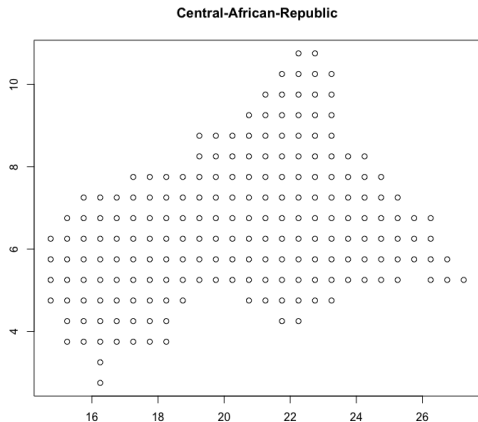3. Reshuffle roads to get optimal network

4. Analyse patterns of reshuffling

Trade Model – see Fajgelbaum & Schaal (2017)

- Node i houses L_i and produces Y_i^n of good n
- Two varieties $n \in \{\mathrm{urban}, \mathrm{rural}\}$

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- Two varieties $n \in \{\text{urban}, \text{rural}\}$

- Consumers in i consume $C_i = \left(\sum_n (C_i^n)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$

- Derive utility $u_i = c_i^{\alpha}$, where $c_i = \frac{C_i}{L_i}$

Trade Model – see Fajgelbaum & Schaal (2017)

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- Can trade with neighbouring nodes $N(i)$

- Incur iceberg trade cost $\tau_{i,k}^n = \delta_{i,k}^\tau \frac{(Q_{i,k}^n)^\beta}{I_{i,k}^\gamma}$

  - costs fall with $I_{i,k}$ (*infrastructure*)

  - costs rise with $Q_{i,k}^n$ (*congestion*)

Steps

1. Network representation for all African countries

   ▶ Nodes

   ▶ Edges

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3. Reshuffle roads to get optimal network

4. Analyse patters of reshuffling
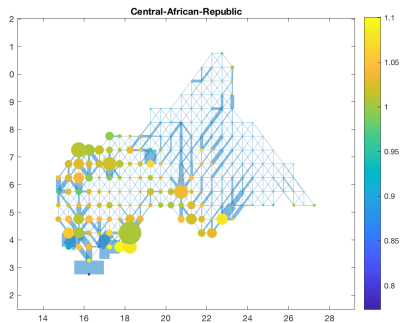
Trade Model – see Fajgelbaum & Schaal (2017)

- Social planner can reallocate infrastructure $I_{i,k}$
- Keeping total infrastructure cost fixed
  - $\sum_i \sum_{k \in N(i)} \delta_{i,k}^I I_{i,k} \leq K$
  - where K = total cost of building the current network

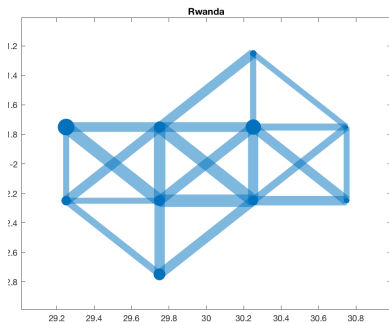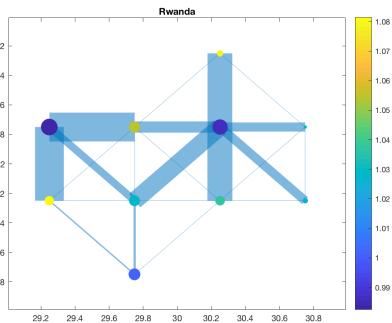Full Planner's Problem

Network Reallocation
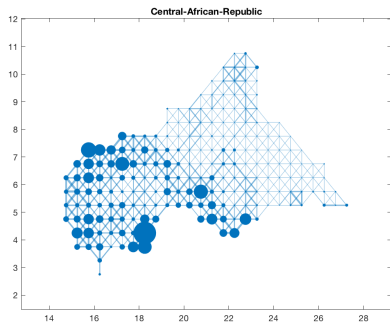
(a) pre reallocation

(b) post reallocation

Network Reallocation

(a) pre reallocation

(b) post reallocation

Network Reallocation
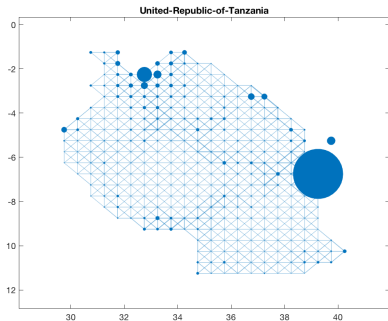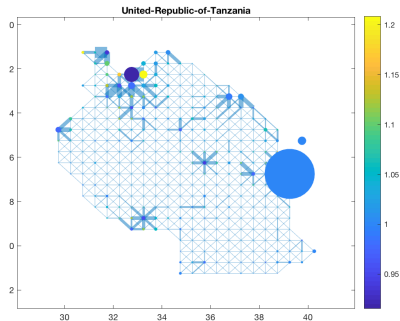
(a) pre reallocation   **(b)** post reallocation

Welfare gains for entire countries
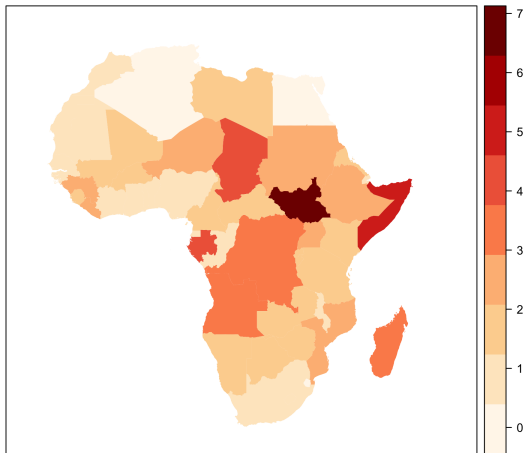
Figure: Percentage welfare gains for all countries in the sample

Local Infrastructure Discrimination Index Λ_i

Figure: Λ_i for sample countries

(a) Madagascar   **(b)** Kenya   **(c)** Chad
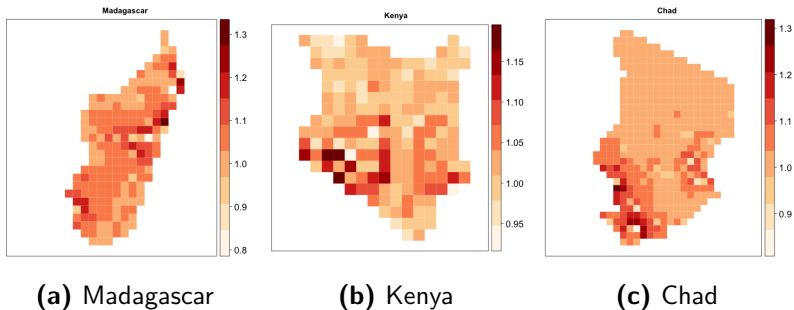
$$\Lambda_i = \frac{\text{Welfare under the optimal Infrastructure}_i}{\text{Welfare under the current Infrastructure}_i}$$

Λ_i for entire sample

Figure: 10,158 grid cells by Λ_i

Steps

1. Network representation for all African countries
   - Nodes
   - Edges
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4. Analyse patterns of reshuffling

Why do some areas have too few roads while others have too many?

Lasting impact of Colonial Railroads
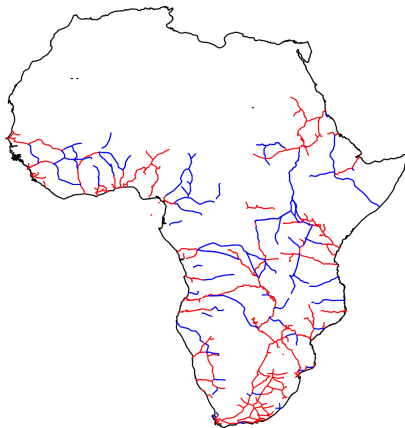
Figure: Colonial Rails (red) and Placebo Rails (blue)

Lasting impact of Colonial Railroads

Table: Colonial Railroads and Local Infrastructure Discrimination Index

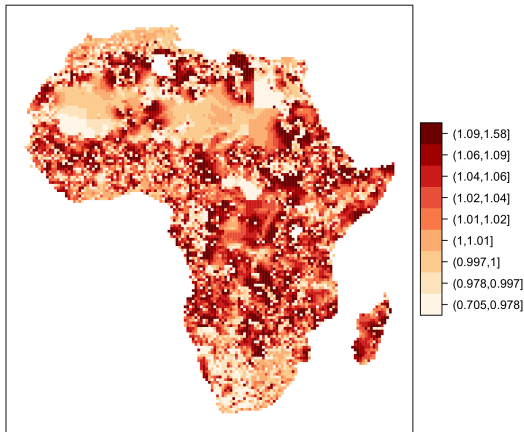|				_Dependent variable:_				
				Local Infrastructure Discrimination Index Λ_i				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
KM of Colonial Railroads	−0.0002***	−0.0001***	−0.0002***	−0.0002***				
	(0.0001)	(0.0001)	(0.0001)	(0.0001)				
KM of Colonial Placebo Railroads					0.00004	−0.0002	−0.0002	−0.0003
					(0.0003)	(0.0003)	(0.0003)	(0.0003)
Country FE		Yes	Yes	Yes		Yes	Yes	Yes
Geographic controls			Yes	Yes			Yes	Yes
Simulation controls				Yes				Yes
Observations	10,158	10,158	10,158	10,158	10,158	10,158	10,158	10,158
R^2	0.001	0.099	0.124	0.126	0.00000	0.098	0.122	0.124

Note: *p<0.1; **p<0.05; ***p<0.01

Regional Favoritism

Figure: Birthplaces of African heads of state since 1970

Regional Favoritism

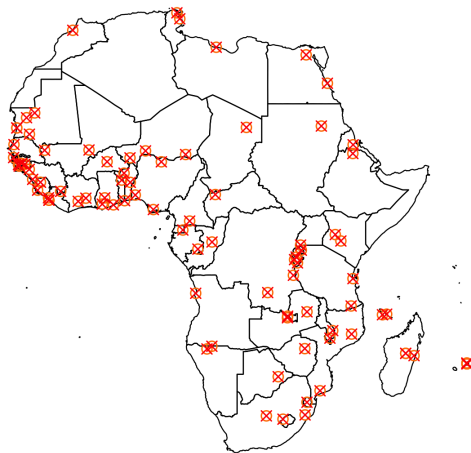|	Dependent variable: Local Infrastructure Discrimination Index Λ							
	Full Sample					Excluding Capitals		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Years in Power	−0.001***	−0.001***	−0.001***			−0.001***	−0.001**	
	(0.0003)	(0.0002)	(0.0004)			(0.0003)	(0.0004)	
Years in Power × Democracy			−0.0001				−0.0002	
			(0.001)				(0.001)	
In Power Dummy				−0.024***	−0.025***			−0.026***
				(0.006)	(0.006)			(0.007)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Simulation controls		Yes	Yes		Yes	Yes	Yes	Yes
Observations	10,066	10,066	10,066	10,066	10,066	10,019	10,019	10,019
R^2	0.124	0.125	0.125	0.124	0.126	0.128	0.128	0.128

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$
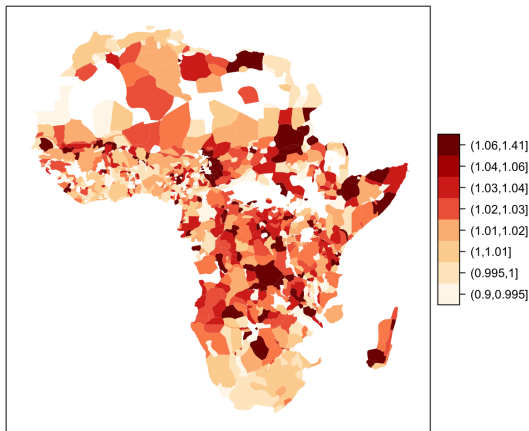
Ethnic Relations

Figure: Λ_h over ethnic homelands

Ethnic Relations

Table: Null Effect of Ethnic Discrimination

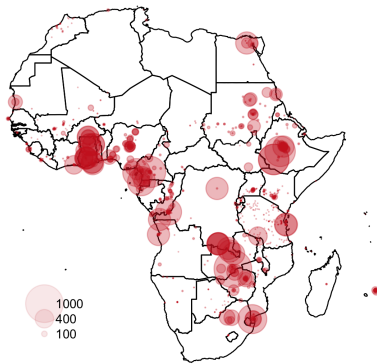|	Dependent variable: Local Infrastructure Discrimination Index Λ_h							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ethnicity discriminated against 1960–2010	−0.001 (0.008)	−0.001 (0.007)						
Ethnicity excluded from the central government 1960–2010			−0.006 (0.005)	−0.005 (0.005)				
Ethnicity involved in an ethnic war 1960–2010					0.002 (0.008)	0.002 (0.008)		
Ethnicity split by colonial borders							−0.002 (0.004)	−0.002 (0.004)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Simulation controls		Yes		Yes		Yes		Yes
Observations	496	496	496	496	496	496	932	932
R^2	0.156	0.166	0.158	0.168	0.156	0.167	0.164	0.167

Note: $^*p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Does Aid go into the right locations?

Figure: Spatial Distribution of Development Aid Projects
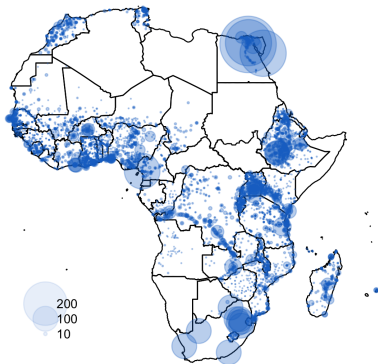
(a) World Bank Aid   **(b)** Chinese Aid

Does Aid go into the right locations?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Local Infrastructure Discrimination Index Λ							
Panel A: Worldbank Projects								
Total disbursements	−0.0003***	−0.0004***						
in million 2011 US dollars	(0.0001)	(0.0001)						
Transport-sector disbursements			−0.001***	−0.001***				
in million 2011 US dollars			(0.0002)	(0.0002)				
Number of projects					−0.002***	−0.003***		
					(0.0004)	(0.0004)		
Number of transport projects							−0.003***	−0.004***
							(0.001)	(0.001)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Simulation controls		Yes		Yes		Yes		Yes
Observations	10,158	10,158	10,158	10,158	10,158	10,158	10,158	10,158
R^2	0.125	0.128	0.125	0.127	0.127	0.131	0.126	0.129

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Concerns

- Identification
- Non-linearity of model
- ...

Backup: full planner's problem

$$\max_{\substack{\left\{ C_i^n, \{Q_{i,k}^n\}_{k\in N(i)} \right\}_n, \\ c_i, \left\{ I_{i,k} \right\}_{k\in N(i)}}} \quad \sum_i L_i u(c_i)$$

subject to

$$L_i c_i \le \left(\sum_{n=1}^{N} (C_i^n)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

$$C_i^n + \sum_{k\in N(i)} Q_{i,k}^n (1 + \tau_{i,k}^n(Q_{i,k}^n, I_{i,k})) \le Y_i^n + \sum_{j\in N(i)} Q_{j,i}^n$$

$$\sum_i \sum_{k\in N(i)} \delta_{i,k}^i I_{i,k} \le K$$

$$I_{i,k} = I_{k,i} \text{ for all } i \in \mathcal{I}, k \in N(i)$$

$$C_i^n, c_i, Q_{i,k}^n \ge 0 \text{ for all } i \in \mathcal{I}, n \in \mathcal{N}, k \in N(i).$$