Spatial Inefficiencies in Africa's Trade Network

Tilman Graff

University of Oxford

30th April 2018

Motivation

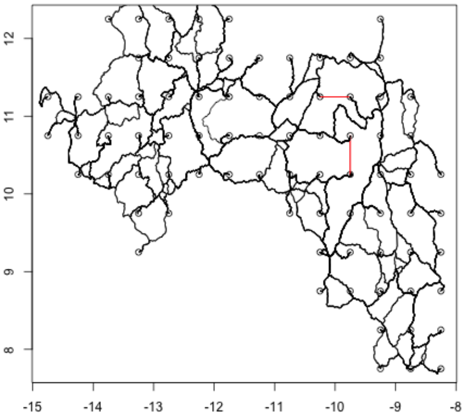


Figure: Road Network Guinea

Motivation

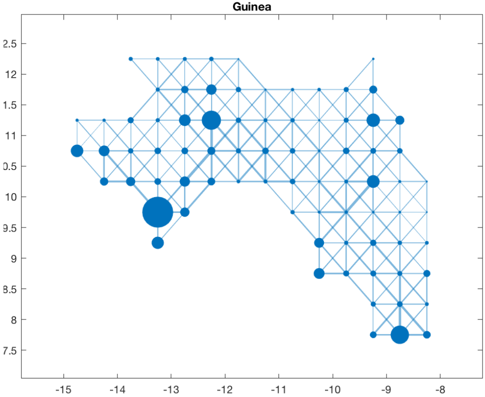


Figure: Road Network Guinea

Motivation

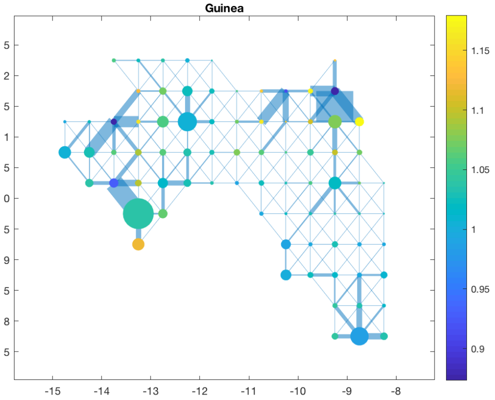


Figure: Optimal Road Network Guinea

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

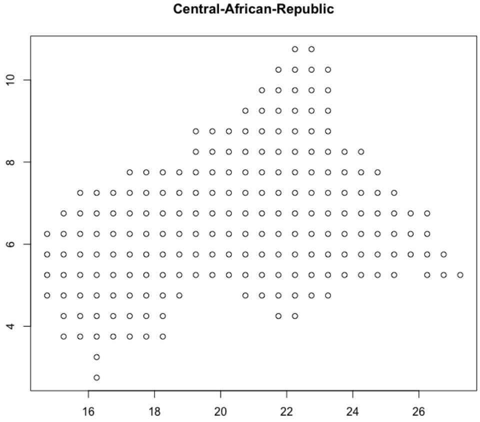
1. Network representation for all African countries
   - Nodes
   - Edges
2. Employ in simple trade model
3. Reshuffle roads to get optimal network
4. Analyse patterns of reshuffling

Network Nodes

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

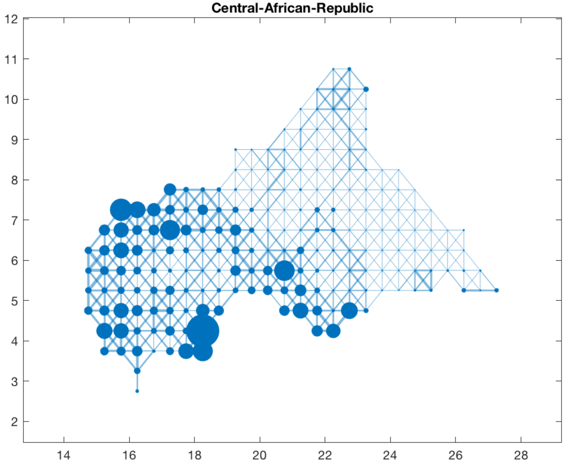
Network Nodes

- Population
- Output (night lights)
- Geography



Network Edges

- Average Speed
- Distance
- Topography



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

Trade Model – see Fajgelbaum & Schaal (2017)

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

Trade Model – see Fajgelbaum & Schaal (2017)

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

- Node i houses L_i and produces Y_i^n of good n
- 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 $c_i = \frac{C_i}{L_i}$
- Can trade with neighbouring nodes $N(i)$
- Occur 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

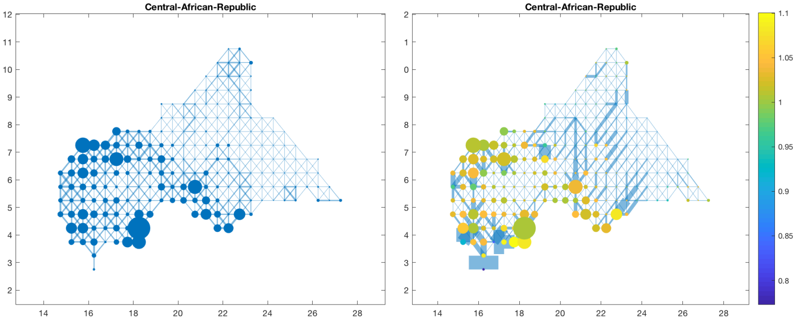
1. Network representation for all African countries
    - Nodes
    - Edges
2. Employ in simple trade model
3. Reshuffle roads to get optimal network
4. Analyse patters of reshuffling

Trade Model – see Fajgelbaum & Schaal (2017)

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

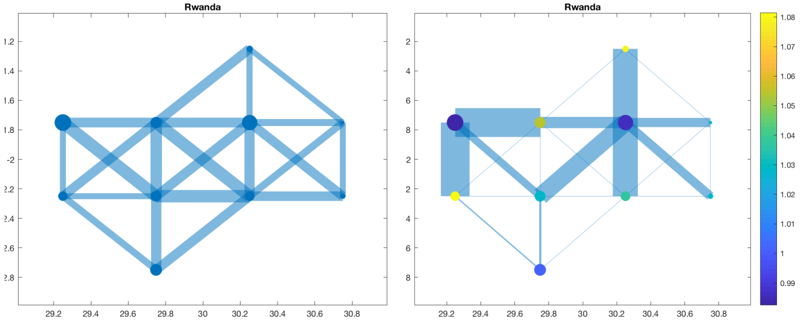
Full Planner's Problem

Network Reallocation



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

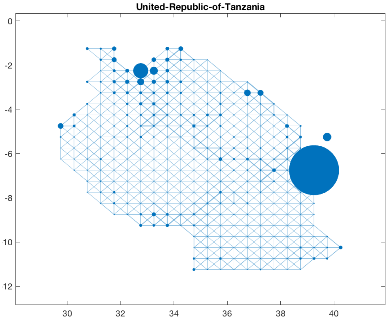
Network Reallocation



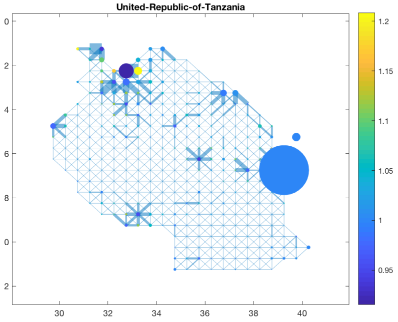
(a) pre reallocation

(b) post reallocation

Network Reallocation



(a) pre reallocation



(b) post reallocation

Welfare gains for entire countries

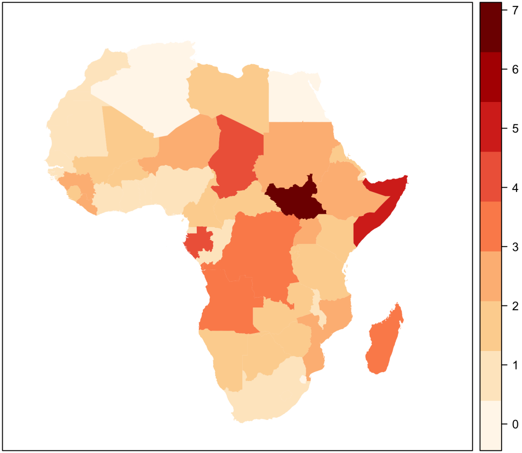
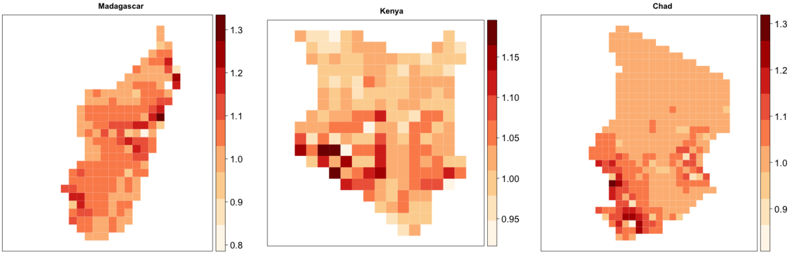


Figure: Percentage welfare gains for all countries in the sample

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

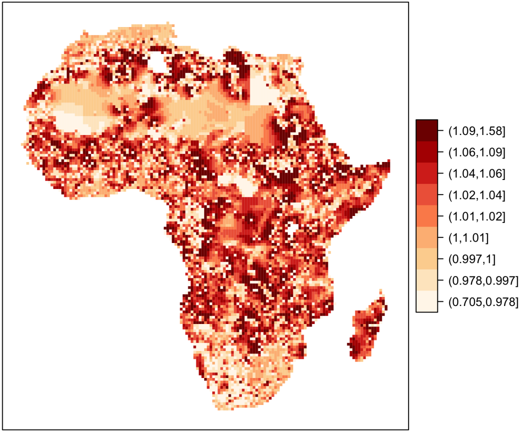


Figure: 10,158 grid cells by Λ_i

Steps

1. Network representation for all African countries
   - Nodes
   - Edges
2. Employ in simple trade model
3. Reshuffle roads to get optimal network
4. Analyse patterns of reshuffling

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

Lasting impact of Colonial Railroads

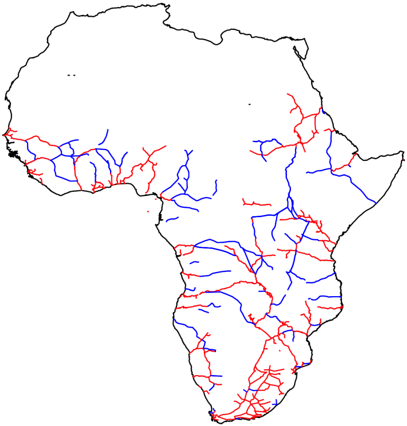


Figure: Colonial Rails (red) and Placebo Rails (blue)

Source: Jedwab & Moradi (2016) and own digitisations

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

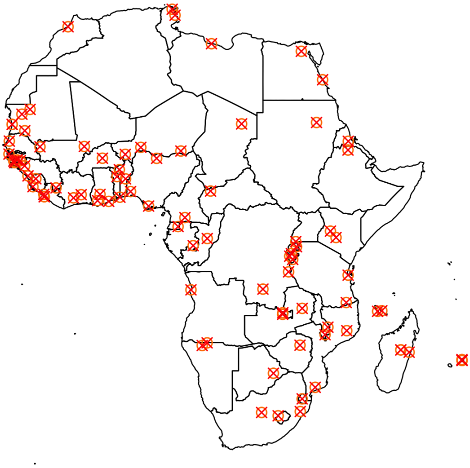


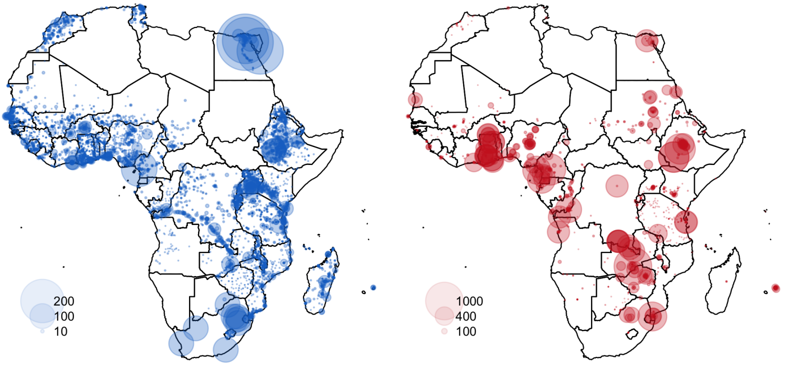
Figure: Birthplaces of African heads of state since 1970

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

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?

	Dependent variable: Local Infrastructure Discrimination Index Λ							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Worldbank Projects								
Total disbursements in million 2011 US dollars	-0.0003^{***} (0.0001)	-0.0004^{***} (0.0001)						
Transport-sector disbursements in million 2011 US dollars			-0.001^{***} (0.0002)	-0.001^{***} (0.0002)				
Number of projects					-0.002^{***} (0.0004)	-0.003^{***} (0.0004)		
Number of transport projects							-0.003^{***} (0.001)	-0.004^{***} (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
Panel B: Chinese Development Projects								
Total commitments in million 2011 US dollars	-0.0001^{***} (0.00004)	-0.0001^{***} (0.00004)						
Transport-sector commitments in million 2011 US dollars			-0.0003^{**} (0.0001)	-0.0003^{**} (0.0001)				
Number of projects					-0.003^{***} (0.001)	-0.004^{***} (0.001)		
Number of transport projects							-0.013^{***} (0.004)	-0.014^{***} (0.005)
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	0.123	0.125	0.123	0.125	0.124	0.126	0.123	0.125

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

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

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

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

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

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

Back