

# Road Traffic, Access to Demand, and Pollution Exposure for Small Firms in Developing Cities

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  - this health cost is more severe in firms managed by low skilled managers
- ⇒ Highlight one important negative consequence of demand frictions

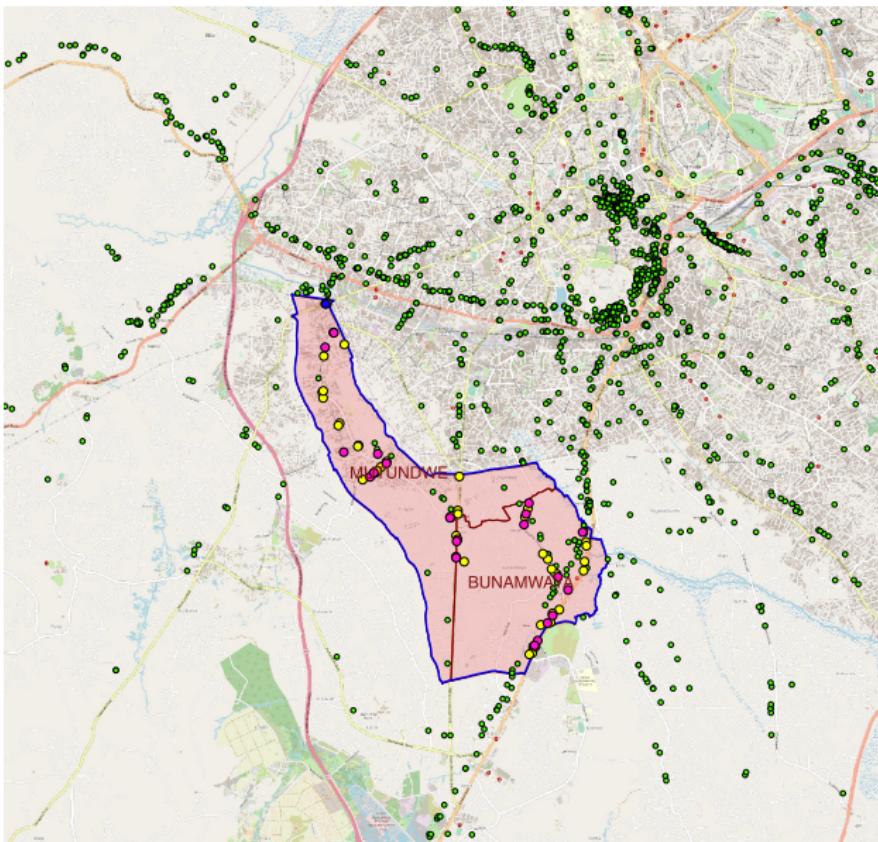
# Our Data

- ▶ We combine together three sources of data
  1. Detailed survey of three manufacturing sectors in urban Uganda
    - location choice, access to demand, pollution perceptions and mitigation
    - representative of urban areas in West, Central, and East regions
    - survey conducted in late 2018-early 2019
  2. Newly collected city block-level measurement of PM 2.5
    - pollution measurements conducted in partnership with AirQo
    - measurements took place in same areas and at same time as survey
    - mobile monitors (moto-taxis) and fixed monitors
  3. Official 2017 census of Ugandan roads, organized by road-type
    - available from the Uganda National Roads Authority

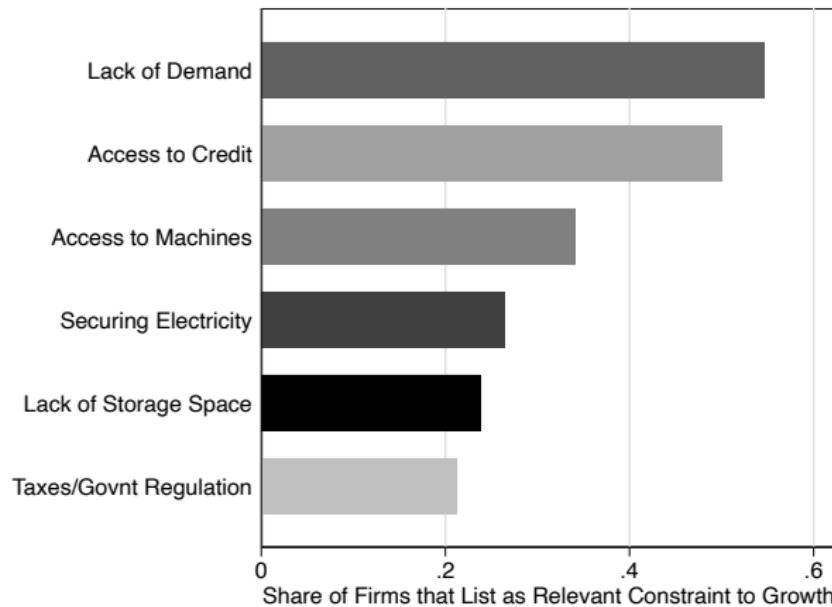
# Data Collection in 52 Urban Areas (Sub-counties)

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Sub-counties are Smaller than Cities (e.g. Silverlake)



## Access to Demand is the Main Constraint

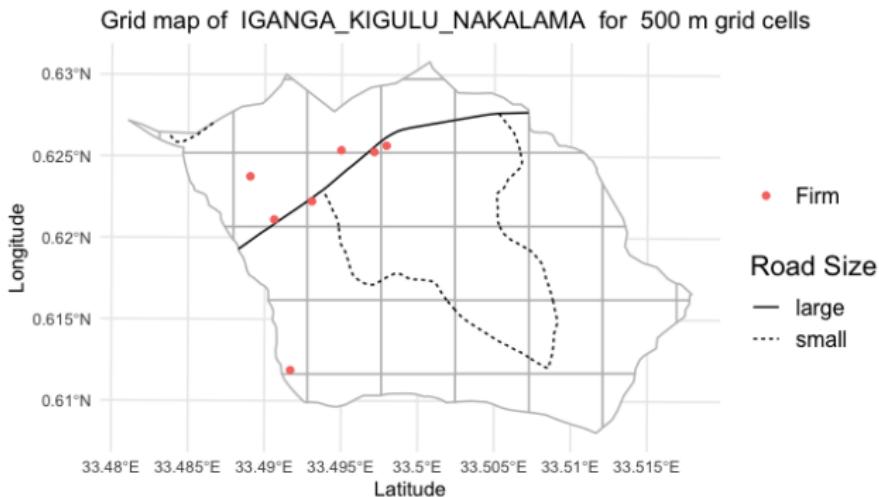


- ▶ Core perceived firm constraint is lack of customer demand

# Location Choice Driven by Customer Access

	Proportion (1)
<i>Panel A: Reasons for location choice (share selected as top 3 out of 18)</i>	
Closeness to customer/market	51.9%
Affordable rent/land price	39.8%
Closeness to a good transportation network	31.5%
Low exposure to air pollution	9.4%
Low exposure to water pollution	2.3%
Low exposure to solid waste pollution	1.4%
<i>Panel B: Marketing strategies and relationships with customers</i>	
(a) Marketing strategies	
I spend money in marketing	6.7%
I talk to the customers when they come to the business	58.1%
I don't do anything in particular	22.8%
(b) Types of customers and orders	
Share of sales to final consumers	92.9%
Orders are placed by walk-in	79.7%
Share of firms selling through shipping to final consumers	15.3%

# Firms Cluster on Major Roads



- ▶ Create measures of firm density and median road size within grid cells

# Firms Cluster on Major Roads

	(1)	(2)	(3)	(4)	(5)
	Firm (Dummy)	Firm (Dummy)	log(firm dens.)	log(firm dens.)	log(firm dens.)
Median Road Size	0.0232* (0.0136)	0.0331** (0.0133)	0.179*** (0.0561)	0.154*** (0.0531)	0.172*** (0.0541)
Avg Man. Score					0.0683 (0.0834)
N	1272	1272	422	422	422
R2	0.116	0.0213	0.166	0.0318	0.229
Fixed Effects	Subcounty		Subcounty		Subcounty
Grid cell length	500m	500m	500m	500m	500m
Level of Observation	Grid Cell	Grid Cell	Grid Cell	Grid Cell	Grid Cell
Clustered SE	No	No	No	No	No

- ▶ Result holds within sub-county, robust to distance to city center
  - In progress: Spatially correlated SEs; Bootstrap grid cells

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  - In progress: Spatially correlated SEs; Bootstrap grid cells
- ⇒ Consistent with firms locating on high traffic roads to access customers

# Pollution Measurement

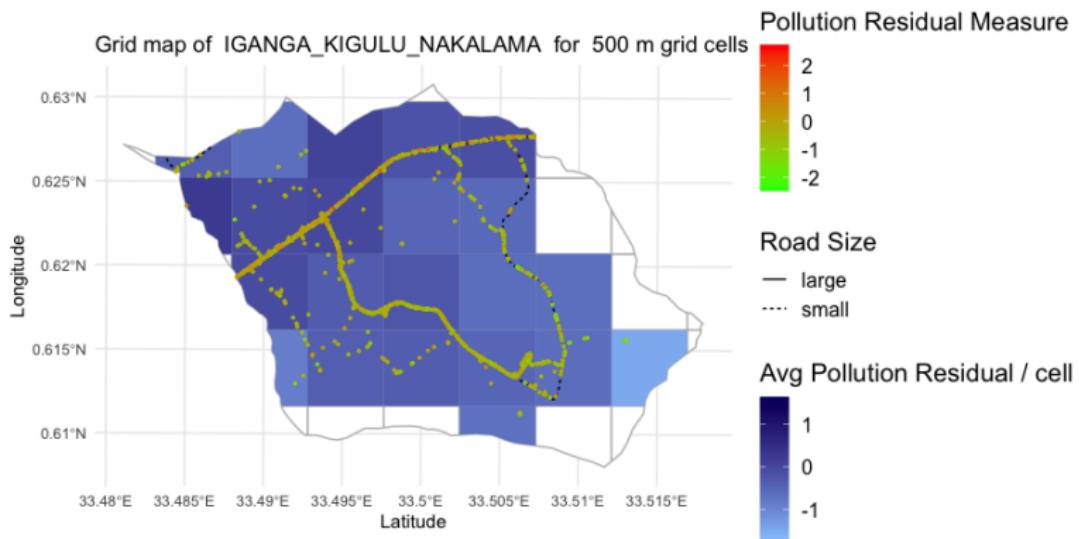


(a) Static Monitor



(b) Mobile Monitor

# Larger Roads are More Polluted



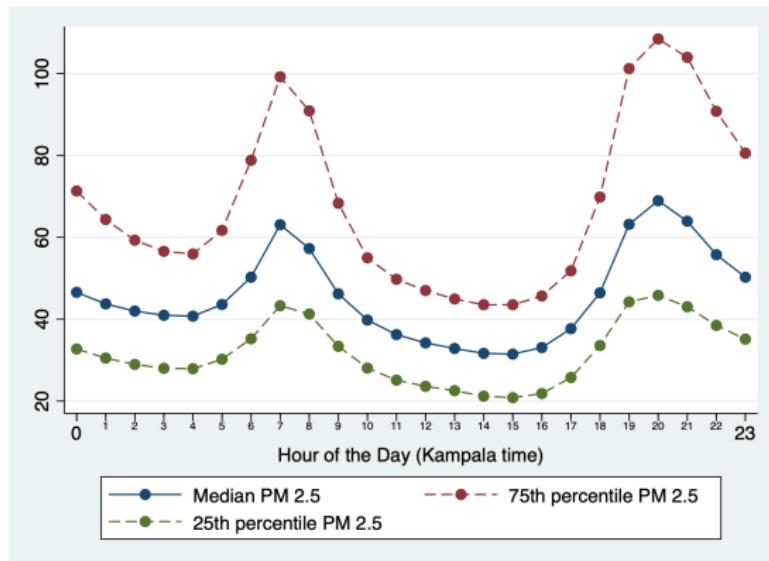
- ▶ Pollution residuals: net out hour and sub-county FE using static monitors

# Larger Roads are More Polluted

	(1) Avg log pollution resid.	(2) Avg log pollution resid.	(3) Residual log Poll	(4) Residual log Poll
Median Road Size	0.0951*** (0.0104)	0.0902*** (0.0109)		
Closest Road Size			0.113*** (0.00883)	0.0577*** (0.00975)
N	1274	1274	151451	151451
R2	0.416	0.255	0.159	0.0115
Fixed Effects	Subcounty		Subcounty	
Grid cell length	500m	500m		
Level of Observation	Grid Cell	Grid Cell	Poll. measure	Poll. measure
Clustered SE	No	No	Date	Date

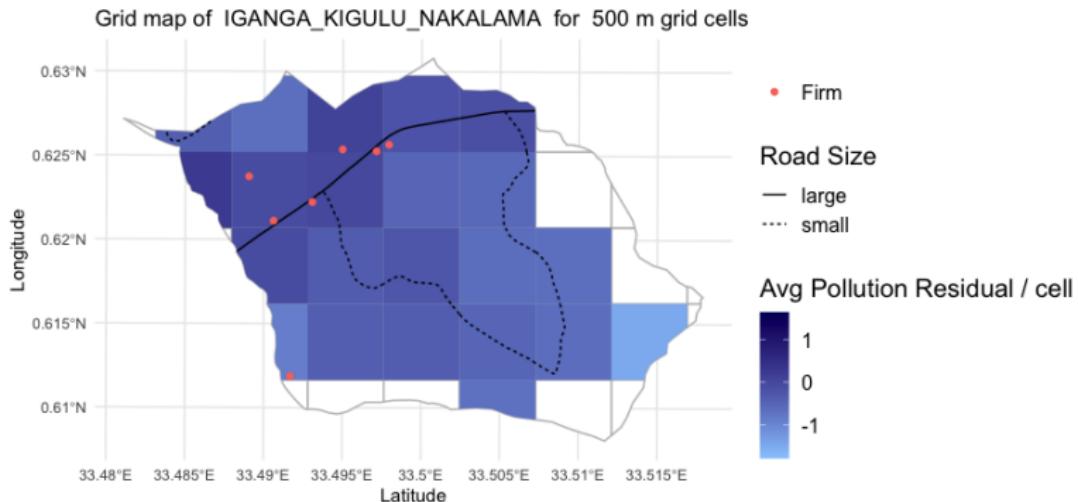
- ▶ Consistent with pollution being caused by road traffic

# Pollution is Generated by Traffic, Not Firms



- ▶ PM2.5 measured in  $\mu\text{g}/\text{m}^3$
- ▶ Use static monitors to estimate hour of day averages

# Firms' Location Exposes them to Pollution



- ▶ Firms cluster in the more polluted parts of town

# Firms' Location Exposes them to Pollution

	(1)	(2)	(3)	(4)	(5)	(6)
	Firm (Dummy)	Firm (Dummy)	log(firm dens.)	log(firm dens.)	log(firm dens.)	Log Firm Density
Median Road Size	0.0139 (0.0140)	0.0229* (0.0136)	0.139** (0.0557)	0.126** (0.0523)	0.133** (0.0536)	
Avg log pollution resid.	0.0979*** (0.0374)	0.113*** (0.0342)	0.706*** (0.162)	0.671*** (0.150)	0.698*** (0.156)	
Avg Man. Score					0.0628 (0.0815)	
Log Pollution Residual						0.156*** (0.0346)
N	1272	1272	422	422	422	91750
R2	0.121	0.0297	0.205	0.0763	0.267	0.614
Fixed Effects	Subcounty		Subcounty		Subcounty	Subcounty
Grid cell length	500m	500m	500m	500m	500m	
Level of Observation	Grid Cell	Grid Cell	Grid Cell	Grid Cell	Grid Cell	Poll. Measure
Clustered SE	No	No	No	No	No	Grid Cell

- ▶ As a byproduct of locating near customers, firms sort into polluted areas

# Benefits of Locating in Polluted Areas

	(1) Log (Rev/worker)	(2) Log(Salary Emp.)	(3) Log(Salary Emp.)	(4) Log(Salary Emp.)	(5) Log (Value Premises)
Avg log pollution resid.	0.331*** (0.121)	0.164 (0.147)	0.155 (0.145)	0.161 (0.149)	0.179 (0.289)
Median Road Size	0.101** (0.0467)	0.00784 (0.0289)	0.00475 (0.0281)	-0.00760 (0.0272)	0.125 (0.0916)
Man. Score	0.167*** (0.0304)	0.0647** (0.0296)	0.0504* (0.0281)	0.0450* (0.0268)	0.101* (0.0589)
Log (Hours worked)			0.316*** (0.0723)	0.302*** (0.0663)	
Log (Size premises)					0.357*** (0.0658)
N	611	1402	1402	1402	442
R2	0.339	0.188	0.214	0.287	0.294
Fixed Effects (1)	Sector	Sector	Sector	Sector	Sector
Fixed Effects (2)	Subcounty	Subcounty	Subcounty	Subcounty	Subcounty
Level of Observation	Firm	Employee	Employee	Employee	Firm
Clustered SE	Grid Cell	Firm	Firm	Firm	Grid Cell
Employee Controls		No	No	Yes	

- ▶ Benefits in terms of revenues are tangible and similar for all firms

# Costs of Locating in Polluted Areas

	(1) Poll Equipment	(2) Flex Commute	(3) Flex Commute	(4) Managers Careful	(5) Managers Careful	(6) Poll Bargaining
Avg log pollution resid.	0.0235 (0.0270)	-0.0501 (0.0575)	-0.0616 (0.0549)	0.00158 (0.0538)	-0.0122 (0.0519)	0.0268 (0.0264)
Median Road Size	-0.00749 (0.00860)	0.0107 (0.0148)	0.0115 (0.0143)	0.0321* (0.0181)	0.0329* (0.0181)	-0.0152 (0.00967)
Man. Score	0.0250** (0.0107)	0.0443*** (0.0157)	0.0411*** (0.0151)	0.0825*** (0.0175)	0.0781*** (0.0173)	-0.0100 (0.00985)
N	586	1246	1246	1210	1210	537
R2	0.0986	0.124	0.149	0.104	0.123	0.131
Fixed Effects (1)	Sector	Sector	Sector	Sector	Sector	Sector
Fixed Effects (2)	Subcounty	Subcounty	Subcounty	Subcounty	Subcounty	Subcounty
Employee Controls		No	Yes	No	Yes	
Level of Observation	Firm	Employee	Employee	Employee	Employee	Firm
Clustered SE	Grid Cell	Firm	Firm	Firm	Firm	Grid Cell
Mean(dependent var)	.06	.103	.103	.188	.188	.047

- ▶ High ability managers adopt mitigating strategies to protect their workers
  - Not driven by sorting or labor market competition for workers
  - Consistent with high ability managers valuing pollution more

# Key Take-Aways (so far)

## Summary

- ▶ Firms locate in polluted areas of town to access customers
- ▶ Health costs of pollution exposure depend on managerial ability

## Implications

- ▶ Pollution exposure as a driver of welfare inequality among workers
- ▶ Role of policy:
  - formal industrial clusters as a policy option
  - managerial training/capacity building for managers