Dynamics of Greenfield Development: Evidence from Tanzania

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NOVAFRICA

Motivation: Urban planning in the developing world

- Cities in developing countries largely unplanned
  - Can exacerbate urban informality (slums, weak property rights, etc.)
  - Contrast with HICs, where urban land is:
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- Planning involves a tradeoff
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  - Mitigates coordination failure (crowding road, service access, etc.)
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  - But entails an ex-post rigidity (limits market (re)allocation of land)
- Important to *design plans* effectively from the start
  - opportunity to plan in advance of settlement on urban *periphery* in SSA
    - ∼108mn people added to SSA urban areas between 2010 and 2020
    - ∼15mn of these are on land that was not urban in 2010

Greenfield ('de novo') urban planning

- We study 'greenfield planning' in Dar es Salaam, Tanzania ∼2005
  1. Purchase cheap land on urban fringe (expecting urban expansion)
  2. Partition into formal plots with minimal services (mostly unpaved roads)
  3. People buy plots and build their own homes

- We bring the economist toolkit (theory & data)
  - The Economist as Urban Planner
  - Urban planners & economists should communicate more (Bertaud 2018, Duranton 2017)

Outline

Previous paper: *Economics of Greenfield Urban Planning*

- Planning decisions $\Rightarrow \sim$2020 economic outcomes (15 years after implementation)
  - Outcomes: Land prices, residential development, household sorting, etc
  - Empirical design: Spatial regression discontinuity (RDD), OLS using very local variation

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- Main empirical findings
  - Land value gains from planning: $\sim 100\%$ (plot), $\sim 50\%$ (land)
  - Bare land price per sqm / plot size elasticity ~ -0.5 (misallocation)
  - Strong sorting on education and income

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- Model and counterfactuals (fix total residential area, reallocate plot sizes)
  - Sufficient statistic: (modestly) increasing land price per sqm with plot size
  - Marshallian social planner: should have reduce plot sizes (raises land values + more inclusive toward lower income hh)

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  - Do households randomly populate planned areas or do they cluster?
  - Do they cluster above and beyond locational fundamentals? (may suggest value of proximity to neighbors)

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  - Does residential development follow or precede public services? Both?
  - Does it vary with whether provision of services is private or public?

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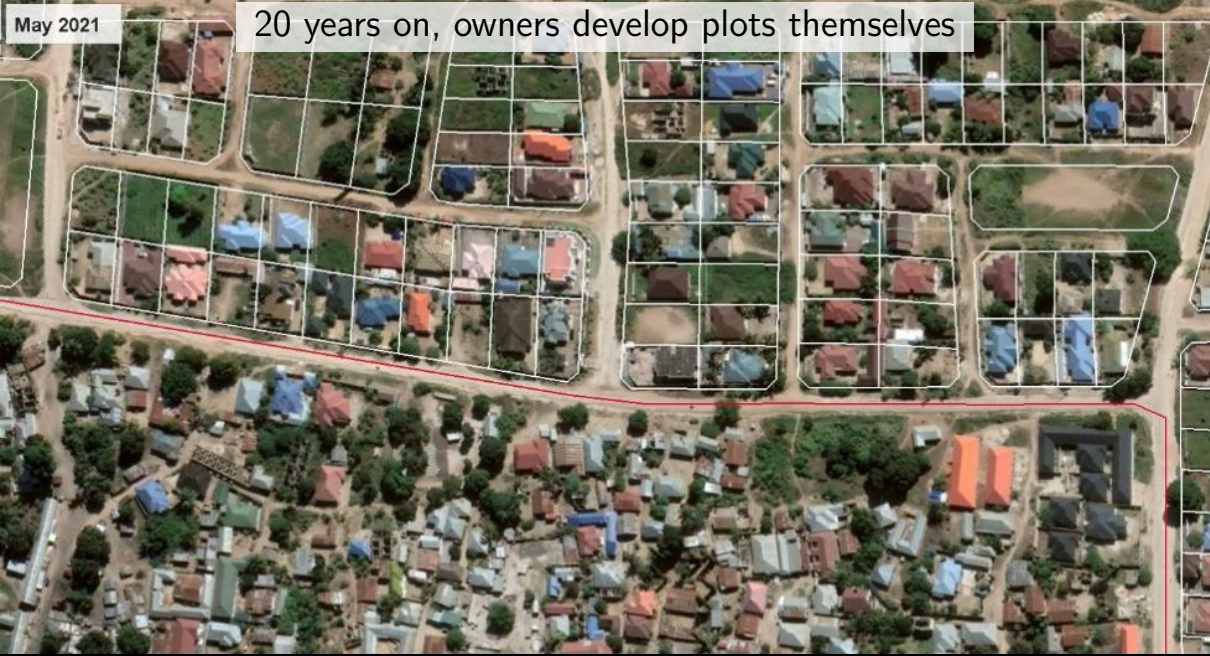
- Pioneers/Early Settlers (WiP)
  - Role of Pioneers
  - Do pioneers differ from later settlers across observable characteristics?

The "20k" project in Dar es Salaam 12 areas, 75km^2, ∼36,000 residential plots in 38km^2

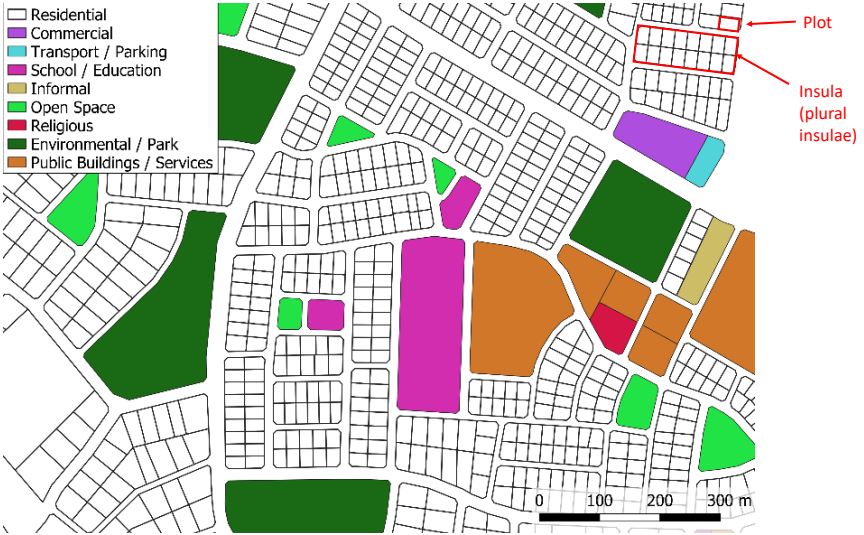

June 2001
Greenfield Site


June 2001
Greenfield Site, land is parcelled and sold


May 2021
20 years on, owners develop plots themselves

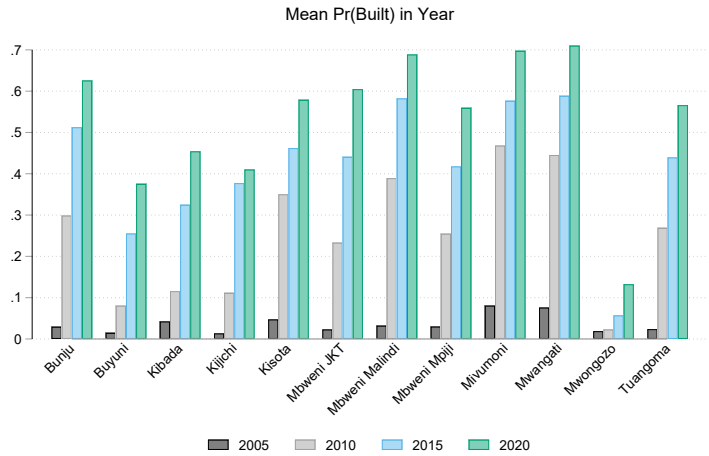
Residential & non-residential plots, and road reserves (Mwbeni Mpiji)

Residential & non-residential plots, and road reserves in Mwbeni Mpiji



Planned non-residential use and road reserves in Mwbeni Mpiji

Aggregate Dynamics of Residential Development



Data collection

- Data sources
  - Town plans and survey drawings ('planning treatments')
  - Satellite imagery, building footprints
  - Primary data:
    - Plot transactions, local real estate agents 43 *madalali*
    - 2022 Survey of residents ∼3,200 households
    - 2025 Survey of residents ∼1,200 households
- Outcomes
  - Built outcomes from satellites, enumeration from field team
- Controls: planned uses and natural amenities
  - Historical paved main roads
  - Digital elevation
  - OpenStreetMap

Residential Clustering & Value of Neighbors

- Do residents cluster or populate planned areas randomly?
- Clustering above and beyond locational fundamentals?
  - Reasons for building near each other: socialization, safety, services proximity

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- Methodology - Burchfield et al. (2006)
  - Idea: Compare actual buildings distribution vs randomized ("dartboard" approach)
  - Randomization needs weighting
    - E.g. Residents may cluster near a major paved road for CBD access
    - Probit with 20k area FE's to assess how fundamentals affect development: main controls from previous study
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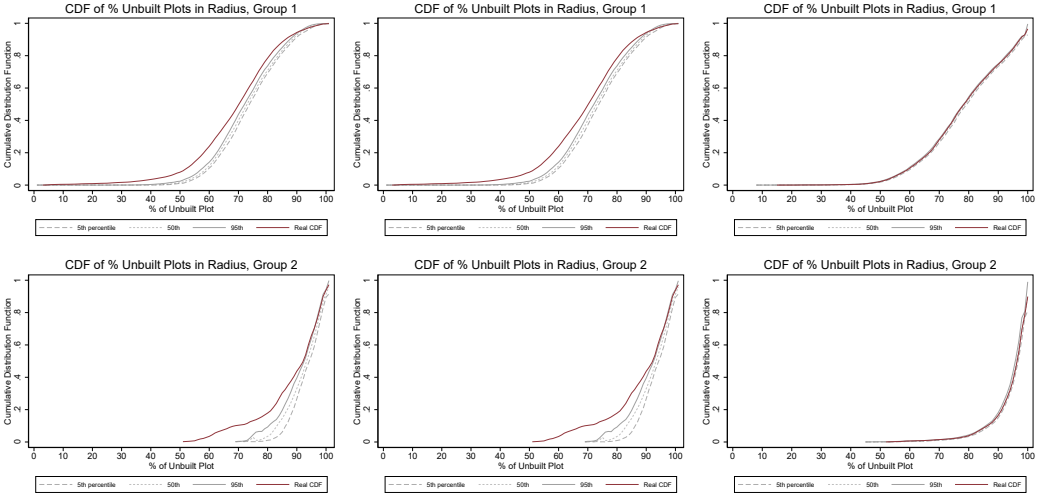
  - Do for 2010 stock, 2020 stock, 2010-2020 flows (2005 $\sim$ no bld implementation)

Probit

	(1) Pr(Built 2010)	(2) Pr(Built 2020))	(3) Δ Built (2010-2020)
main			
Dist (km) paved major road	-0.26	-0.13	-0.077
	(0.013)	(0.0095)	(0.010)
Elevation (m)	0.0045	0.0063	0.0061
	(0.00070)	(0.00059)	(0.00066)
Ruggedness	-0.098	-0.10	-0.093
	(0.013)	(0.0095)	(0.010)
River/stream/water/wetland 100m	-0.46	-0.53	-0.48
	(0.083)	(0.058)	(0.063)
Z-index: 3 Ins. Characteristics	-0.025	0.052	0.070
	(0.012)	(0.0099)	(0.011)
20k edge in 100m	-0.0079	-0.024	-0.031
	(0.022)	(0.018)	(0.020)
Ln plot size	0.065	-0.026	-0.057
	(0.021)	(0.017)	(0.019)
Mean	0.175	0.492	0.406
Observations	35509	36215	29289

Actual vs Counterfactual: Stock 10, Stock 20, Flow 10-20 (by area groups)



Timing of Public Services $\leftrightarrow$ Residential Construction

- Do public services precede or follow residential construction?
  - "Common" view: Empty areas $\rightarrow$ first, build infrastructure + non-res uses $\rightarrow$ residents build
  - Find that public services implementation seems mostly demand-led
  - Caution with interpretation: Non-causal (IV with planned uses?)

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- Public services examined
  - Non-residential services: schools, commercial, religious, etc
  - Local roads: Bulldozed by 2005. Overgrown if not maintained. Can be paved or increase width.

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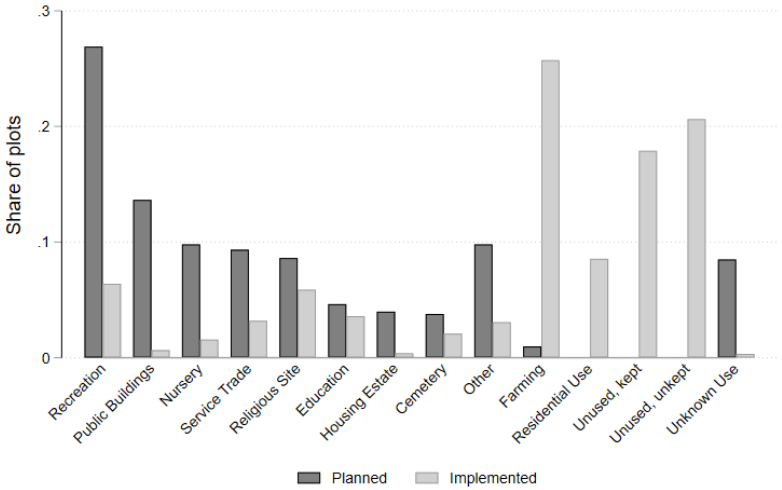
  - Later
    - Geocode electricity stations
    - Geocode government ("supply-led") vs private ("demand-led") provision of public services

Review an important result (Motivation)

- Previous study
  - Planned non-residential uses don't matter for 2020 residential development
  - Very low implementation? Explore?
  - Few implementation uses matter (e.g. commercial, religious). Direction of relationship?

Low implementation of planned non-residential uses



Planned Non-Res Amenities: proximity irrelevant for 2020 development

	(1) Ln Price	(2) Share gridcell built	(3) Plot is built	(4) Log area of buildings	(5) Multiple buildings on plot
Pln. recreation in 100m					
Pln. nursery school in 100m		+			
Pln. religious site in 100m					
Pln. education in 100m	+				
Pln. service trade in 100m					
Pln. housing estate in 100m					
Pln. public building in 100m					
Pln. cemetery in 100m					
Pln. any other non-res in 100m					
N (gridcells)	4074	94789	94789	46465	46465
N (plots)	1446	36215	36215	17822	17822

Note: p-value<0.05 (+/-), <0.01 (++/−)

amenity magnitudes

Implemented Non-Res Amenities

- More development near implemented:
  - commercial, housing estate, recreation and religious
- Less development where unused and unkept
- Direction of relationship?

	(1) Share gridcell built	(2) Plot is built	(3) Log area of buildings	(4) Multiple buildings on plot
Impl. farming in 100m				
Impl. recreation in 100m	+			
Impl. religious site in 100m	+			
Impl. education in 100m				
Impl. cemetery in 100m				
Impl. service trade in 100m	++	++		+
Impl. nursery school in 100m				
Impl. other non-res in 100m				
Impl. public building in 100m				
Impl. housing estate in 100m	++	++		
Impl. unknown non-res in 100m			- -	- -
Unused, kept in 100m				
Unused, unkept in 100m	- -	- -	-	
Impl. as residential in 100m				
N (gridcells)	94789	94789	46465	46465
N (plots)	36215	36215	17822	17822

Note: p-value<0.05 (+/-), <0.01 (++/−)

amenity magnitudes

2010 Non-Residential Implementation → 2010-2020 Res Development

	Built 2010		Built 2020		Cond. Unbuilt 2010	
	(2)	(3)	(5)	(6)	(10)	(11)
paved km	-0.057***	-0.056***	-0.057***	-0.056***	-0.033***	-0.032***
	(0.0044)	(0.0045)	(0.0059)	(0.0060)	(0.0068)	(0.0068)
av elevat	0.00068***	0.00068***	0.0022***	0.0022***	0.0022***	0.0022***
	(0.00026)	(0.00026)	(0.00033)	(0.00033)	(0.00039)	(0.00039)
av rugged	-0.019***	-0.019***	-0.037***	-0.037***	-0.033***	-0.033***
	(0.0032)	(0.0032)	(0.0047)	(0.0047)	(0.0046)	(0.0046)
dist rs wwr 100m	-0.070***	-0.069***	-0.17***	-0.17***	-0.15***	-0.15***
	(0.014)	(0.014)	(0.026)	(0.026)	(0.025)	(0.025)
z index3 chars	-0.0036	-0.0032	0.021***	0.021***	0.026***	0.026***
	(0.0041)	(0.0041)	(0.0053)	(0.0053)	(0.0057)	(0.0058)
dist 20k 100m	-0.0048	-0.0038	-0.0091	-0.0083	-0.0100	-0.0096
	(0.0079)	(0.0078)	(0.0098)	(0.0098)	(0.011)	(0.011)
ln own plot s	0.011	0.013*	-0.0056	-0.0042	-0.016	-0.015
	(0.0070)	(0.0070)	(0.0095)	(0.0095)	(0.011)	(0.011)
educ 2010 200m		0.0065		0.014		0.016
		(0.015)		(0.016)		(0.020)
nurs 2010 200m		-0.018		-0.0024		0.0068
		(0.021)		(0.028)		(0.033)
public 2010 200m		-0.063		-0.024		0.029
		(0.039)		(0.068)		(0.084)
relig 2010 200m		0.096***		0.060***		0.028
		(0.023)		(0.020)		(0.025)
servtrade 2010 200m		0.018		-0.0064		-0.024
		(0.038)		(0.032)		(0.032)
Mean	0.189	0.189	0.526	0.526	0.436	0.436
Observations	32871	32871	33108	33108	26656	26656

2010 Residential Development → 2010-2020 Non-Residential Implementation

- LPM of non-residential use implementation in 2010, 2020, and flows for 2010-2020 (from not built upon in 2010).
  - Units of observation: any planned non-residential plot
  - Implementation - building footprint 30m2 exists.
  - Buildings observed in all time periods. Use observed by surveyors in 2020.
  - Exclude implemented as recreastion or cemetery (also unknown) - no building 30m2.
  - Controls: Non-residential plot characteristics, mtaa-20k area FE's

- Coefficients of interest
  - Fraction of neighboring (with 200m) residential plots that are developed in 2010
  - Fraction of neighboring undeveloped residential plots in 2010 that are developed by 2020.

2010 Residential Development (also 10-20) → 2010-2020 Non-Res Implementation

	Implemented & Built 2010		Implemented & Built 2020		Cond. Unbuilt 2010	
	(1)	(2)	(3)	(4)	(5)	(6)
Dist(km) major paved road	-0.019	-0.019	-0.047**	-0.044**	-0.032*	-0.029*
	(0.0099)	(0.0098)	(0.015)	(0.015)	(0.014)	(0.014)
Elevation	0.0020**	0.0020**	0.0025*	0.0020	0.00089	0.00035
	(0.00066)	(0.00071)	(0.0010)	(0.0011)	(0.00099)	(0.00100)
Ruggedness	-0.0027	-0.0026	-0.031**	-0.028*	-0.027*	-0.024*
	(0.0070)	(0.0070)	(0.011)	(0.012)	(0.011)	(0.012)
River/Stream 100m	-0.023	-0.022	-0.017	-0.00031	0.00090	0.017
	(0.021)	(0.021)	(0.039)	(0.041)	(0.040)	(0.042)
20k Boundary 100m	0.0087	0.0085	0.018	0.014	0.010	0.0060
	(0.017)	(0.017)	(0.027)	(0.027)	(0.026)	(0.026)
Log(Own Plot Size)	0.058***	0.058***	0.069***	0.070***	0.022*	0.023*
	(0.0092)	(0.0092)	(0.011)	(0.011)	(0.0092)	(0.0092)
%Nbr Res Built 200m (2010)	0.15	0.15	0.16	0.24*	0.065	0.15
	(0.082)	(0.087)	(0.11)	(0.11)	(0.10)	(0.10)
% Nbr Res Built-up 200m (2010-2020)		0.0079		0.14		0.13*
		(0.040)		(0.071)		(0.065)
Mean	0.052	0.052	0.128	0.128	0.086	0.086
Observations	1491	1491	1491	1491	1331	1331

Next: Geocoding Education Service in 20k Areas

- 2023 Interview with Mero, retired official from the Ministry of Lands
- Operation, Management and Ownership
  - Privately Provided Schools (33 schools)
    - 31 schools: Operated, managed, and owned by their developers
    - 2 schools: Operated and managed by private sector entities different from the infrastructure builders
    - Demand-led development (developed later)
  - Publicly Provided Schools (21 schools)
    - Municipal Councils responsible for owning, operating, and managing the sites
    - Some cases involve resident committees in operations and management activities
    - Supply-led development (developed early)

2010 Non-Residential Implementation ↔ 2010-2020 Res Development

Count of schools provided per year:		
When provided	Public	Private
2003	1	1
2004	1	0
2005	1	1
2006	7	0
2007	0	1
2008	1	2
2010	0	1
2011	0	1
2012	0	3
2013	0	1
2014	0	2
2015	0	6
2016	0	1
2017	1	0
2018	2	1
2019	0	3
2020	0	1
2021	0	1
2022	1	1
2023	2	2
2024	1	0
Total	20	29

Local Roads ($\sim$ 2010 image)

Grid squares with planned vs. implemented roads (out of 190,000 grid squares)

Table: Width

	Planned	2005	2010	2015	2020
With Road	54796	8833	38120	42047	44902
$\leq$ 4m	0	7372	21845	22977	18968
(4,8]	33822	966	14060	16762	20908
$>$8	20974	495	2215	2308	5026
	Planned	2005	2010	2015	2020
Footpath	0	5392	9728	9798	10330
Dirt	0	2883	27878	31092	32558
Mixed/Paved	0	558	522	1157	2019

2010 Local Roads → 2010-2020 Residential Development

	Built 2010 (1)	Built 2020 (2)	Δ Built (3)
Dist(km) major paved road	-0.045***	-0.044***	-0.021**
	(0.0047)	(0.0069)	(0.0079)
Elevation	0.0015***	0.0031***	0.0030***
	(0.00032)	(0.00042)	(0.00049)
Ruggedness	-0.012***	-0.027***	-0.025***
	(0.0030)	(0.0044)	(0.0044)
River/Stream 100m	-0.029*	-0.12***	-0.11***
	(0.014)	(0.024)	(0.024)
Z index: 3-Ins. Characteristics	-0.0038	0.016**	0.020***
	(0.0041)	(0.0053)	(0.0058)
20k Boundary 100m	-0.011	-0.014	-0.013
	(0.0076)	(0.0096)	(0.011)
Log(Own Plot Size)	0.020**	0.0066	-0.0039
	(0.0070)	(0.0092)	(0.010)
DirtRoad 50m	0.040***	0.026**	0.014
	(0.0064)	(0.0091)	(0.010)
FootPath 50m	0.00040	0.0032	0.0096
	(0.0064)	(0.0081)	(0.0093)
PavedRoad 50m	0.20***	0.11**	0.015
	(0.033)	(0.037)	(0.051)
Mean	0.189	0.526	0.436
N(Plots) Without Road(50m)	7885	8001	7124
Observations	32871	33108	26656

2010 Residential Development → 2010-2020 Local Roads

	Road 2010		Road 2020		Gain Road (2010-2020)		Lose Road (2010-2020)	
	(1)	(2)	(3)	(4)	(5)	(6)		
Dist(km) major paved road	-0.010	-0.011	-0.0077	-0.0029	0.019	0.024	0.016*	0.015*
	(0.0082)	(0.0084)	(0.0075)	(0.0077)	(0.019)	(0.018)	(0.0065)	(0.0068)
Elevation	0.0041***	0.0042***	0.0048***	0.0043***	0.0062***	0.0048***	-0.0014***	-0.0014***
	(0.00047)	(0.00048)	(0.00046)	(0.00046)	(0.00091)	(0.00091)	(0.00040)	(0.00039)
Ruggedness	-0.025***	-0.026***	-0.034***	-0.032***	-0.034***	-0.028***	0.0061	0.0058
	(0.0040)	(0.0040)	(0.0043)	(0.0043)	(0.0049)	(0.0049)	(0.0042)	(0.0042)
River/Stream 100m	-0.023	-0.028	-0.12**	-0.098*	-0.11**	-0.079	0.078*	0.075
	(0.035)	(0.036)	(0.039)	(0.038)	(0.043)	(0.044)	(0.039)	(0.039)
20k Boundary 100m	-0.12***	-0.12***	-0.11***	-0.11***	-0.098***	-0.091***	0.032***	0.032***
	(0.012)	(0.012)	(0.011)	(0.011)	(0.021)	(0.021)	(0.0095)	(0.0095)
% Res. Built (2010), 200m	0.25***	0.23***	0.18***	0.28***	0.21*	0.41***	-0.075	-0.092*
	(0.051)	(0.055)	(0.044)	(0.047)	(0.085)	(0.089)	(0.038)	(0.041)
% Res. Built Up (2010-2020), 200m		-0.053		0.22***		0.46***		-0.034
		(0.046)		(0.042)		(0.068)		(0.042)
Mean Dep.Var.	0.687	0.687	0.791	0.791	0.518	0.518	0.083	0.083
Observations	53308	53308	53908	53908	16668	16668	36605	36605

Note: This table presents OLS regressions of grid-level road building over time. Controls always include 20K*Mtaa FEs and amenities. Standard errors in parentheses are clustered by insula.

Pioneers/Early Settlers (WiP)

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  - How important for initial stages of development?
  - Crucial for the success of **greenfield** development?
    - Importance of early neighbors. But who leads? Subsidizing early settlers?
    - "Lack" of supply-led development
  - What motivates them to move early? 2025 survey asks them directly!
    - Inadequate prior housing?
    - Strategic behavior? Form coalitions?

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  - Temporal Pioneers
- Characteristics of Pioneers
  - Risk loving, social, richer? 2025 survey will also help!

Spatial Pioneer Definition with Relaxed Cutoff (10%)

Category	2005	2010, 2015, 2020
Pioneer	• Plot built in 2005	• Plot built in current period & plot unbuilt in prior period
(X=3)	• Neighboring plots' share built in current period $< 10\%$	• Either: - Nbr plots' share built in prior period $< 10\%$ & Nbr plots' share built in current period $< 10\%$ - OR - Nbr plots' share built in prior period $> 10\%$ & Nbr plots' share built in current period $< 10\%$
Follower	• No followers	• Plot built in current period & plot unbuilt in prior period
(X=1)		• Nbr plots' share built in prior period $> 10\%$ • Nbr plots' share built in current period $> 10\%$
Joiner	• Plot built in 2005	• Plot built in current period & plot unbuilt in prior period
(X=2)	• Neighboring plots' share built in current period $> 10\%$	• Nbr plots' share built in prior period $< 10\%$ • Nbr plots' share built in current period $> 10\%$

Spatial pioneers are no different

	(1) Index Volunteer Type (see Dependent Variables)	(2) Index Labour Contrib (see Dependent Variables)	(3) Index Cash Contrib (see Dependent Variables)	(4) plot_size_sqm	(13) Count of people in target respondent household	(14) education	(15) Target Respondent is retired	(16) Target respondent worked in gov/public/parastatatal 5yrs min	(17) Respondent commutes outside of own mtaa	(18) Target Household's Income (T2S)	(19) Household owns any other Building
Follower	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Joiner	0.098	0.089	0.157*	-90.254*	-0.072	0.336	-0.006	0.043	-0.007	-284734.171	-0.011
	(0.078)	(0.055)	(0.074)	(35.205)	(0.143)	(0.305)	(0.026)	(0.035)	(0.032)	(223684.916)	(0.035)
Pioneer	0.174	0.228*	0.215	31.019	0.147	0.033	-0.062	0.030	-0.028	-805770.493**	0.009
	(0.131)	(0.093)	(0.127)	(55.698)	(0.227)	(0.531)	(0.044)	(0.056)	(0.055)	(310244.445)	(0.056)
Constant	1.732***	0.596***	1.483***	1181.100***	4.803***	13.843***	0.225***	0.433***	0.646***	2690170.141***	0.503***
	(0.052)	(0.034)	(0.048)	(23.849)	(0.097)	(0.210)	(0.018)	(0.023)	(0.021)	(163564.045)	(0.023)
N	1448000	1448000	1448000	1448000	1448000	1438000	1447000	1442000	1440000	1231000	1430000

Temporal Pioneers have lower Income & Education vs Later Settlers

Income & Education of HH head for owner-occupiers in near 20k areas

Year occupy	Income (1000's Sh/m) non- retired in 2020			Education (years)		
	S	M	L	S	M	L
<2011	1711	2299	2008	11.5	13.5	13.6
2011-2015	1831	2718	3183	12.3	14.6	15.0
>2015	2372	2894	2457	13.0	14.7	14.5
N	379	596	196	419	703	244

Conclusion

Key Takeaways

1. **Greenfield Urban Planning** – Key option to address urban informality
2. **Important to understand how these areas develop over time**
3. **Residents cluster near each other** (up to some point)
4. **Public services are mostly demand-driven**
5. **Residents leading development (pioneers) don't seem to differ**

Thank you!

- Feedback very welcome after the talk or over email
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