From Samurai to Skyscrapers: How Transaction Costs Shape Tokyo

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Motivation

- City is the center of economic activities.
- Efficient use of the scarce land in the CBD can have a sizable impact on the functioning of the economy.
- Land ownership should be continuously allocated to the best usage at that time.
- One key type of land transaction is to change lot size by split or assembly. But, transaction costs might exist:
  - Land assembly will also be costly because negotiation with multiple landowners is needed.
  - Land split will also be costly because demolishing the buildings and finding multiple buyers to sell split land are necessary.

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- If transaction costs > benefit of optimal land use
  → lot size can persist and affect urban development in the long run (Coase, 1960)
- Lot size persistence
  - Rural/agricultural settings: lot size persistence disappears in 150 years (Bleakley and Ferrie, 2014; Smith, 2020; Finley et al., 2021)
  - Can we expect the same pattern in cities?
    - Benefit of optimal land use ↑ → Weaker persistence?
    - Transaction costs ↑ → Stronger persistence?
- Urban development
  - Consequence of lot size persistence for urban development is understudied and can be different in space and time
    - Once tall buildings become available: tall buildings require large footprints and generate agglomeration benefits → premia

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Our study: History of Tokyo as a laboratory

- This study examines how the initial lot size affects urban development in the long run, in the context of central Tokyo.
- Natural experiment: **release of local lords' estates** (*daimyo yashiki*) to the private market after 1868
  - Local lords (*daimyo*) are the chiefs of about 300 regional domains in Japan. They owned estates in Tokyo.
  - Local lords' estates are much larger than other lots.
  - → They lost their estates and the private sector took over them after 1868
  - → Supply shock of larger lots to Tokyo.
  - Spread across Tokyo + a zoning episode for RD

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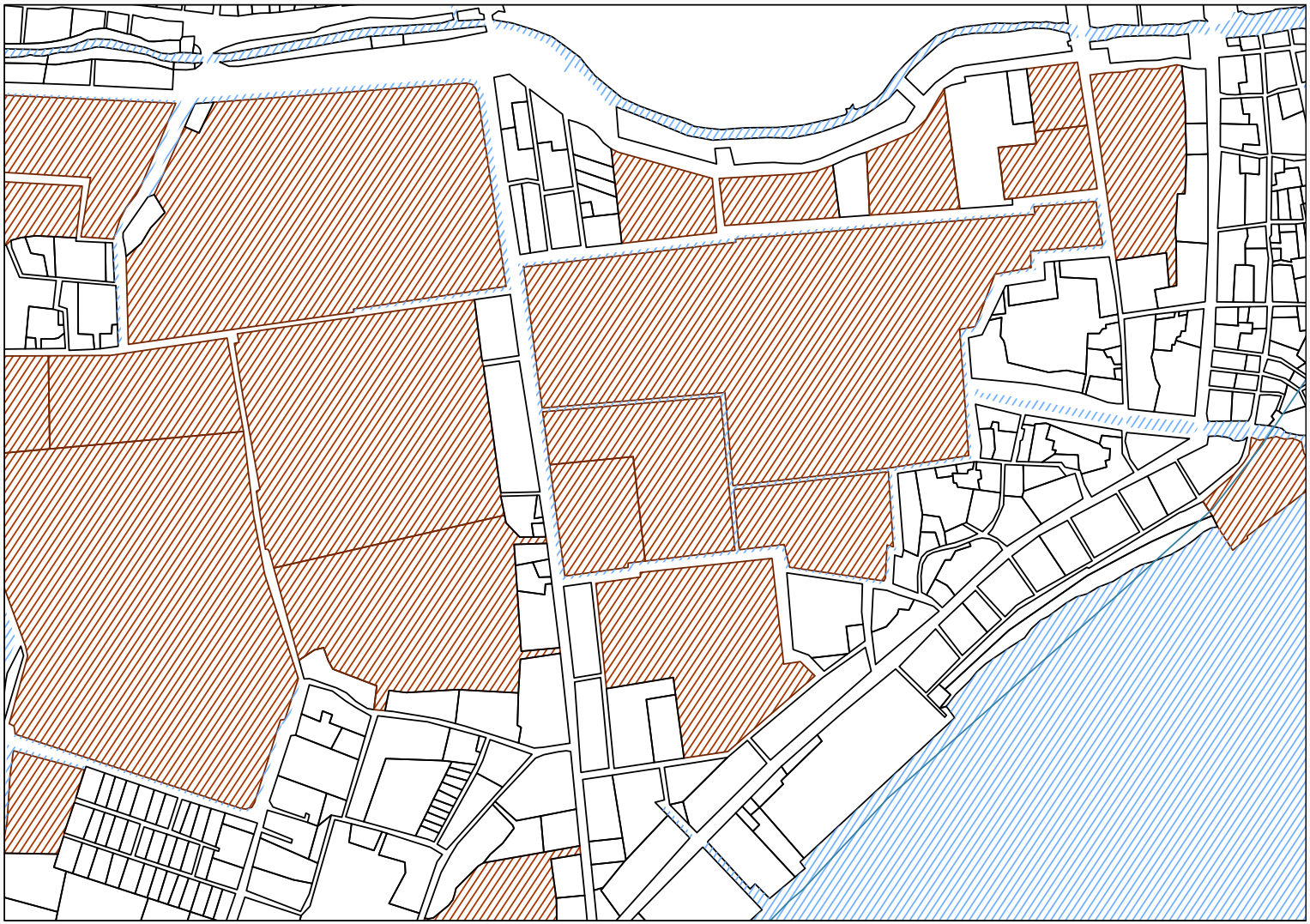
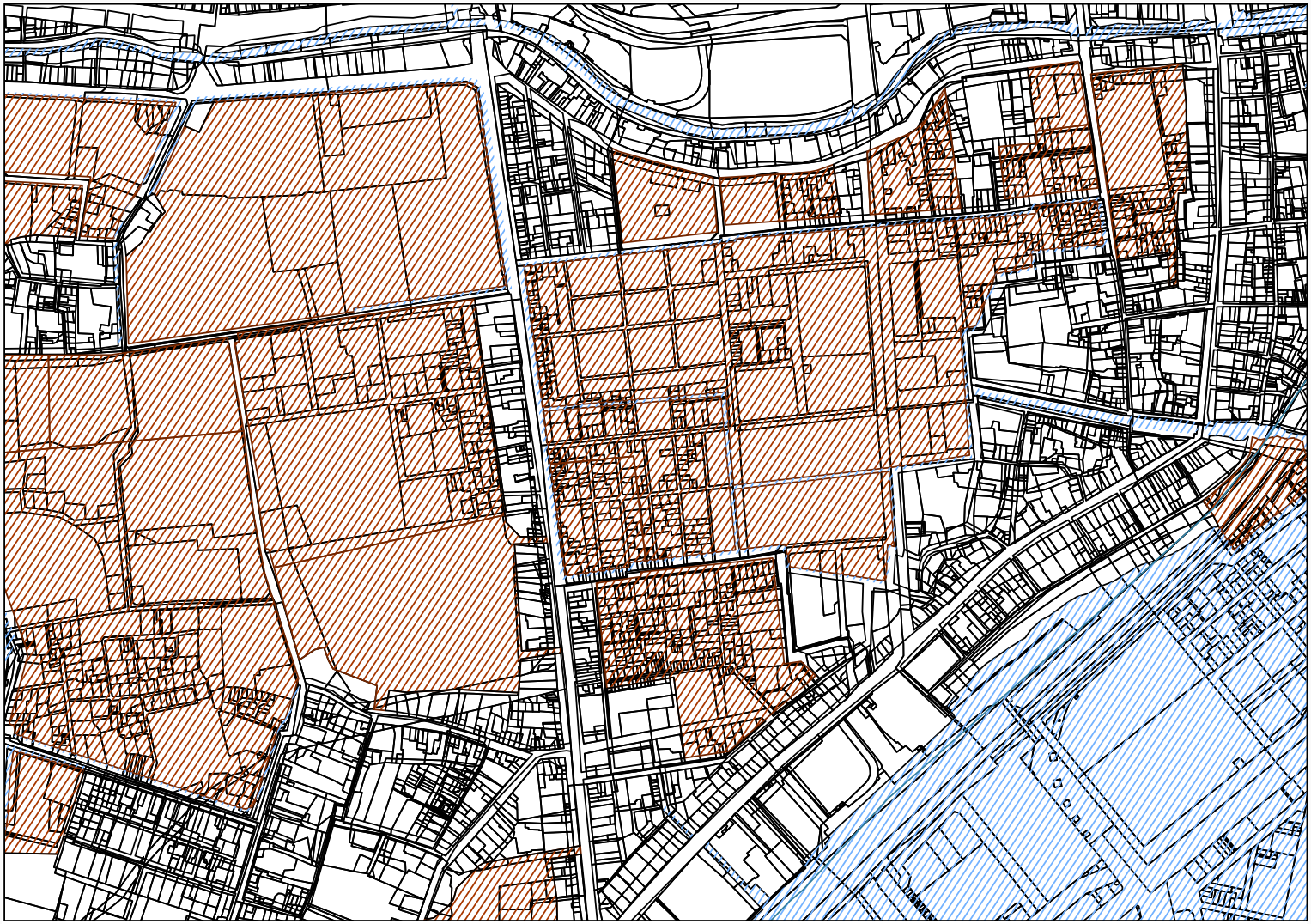
One example from a map in 1850s: Tamachi Station

松平
修理大夫
松平隠岐守
三田
一丁目
島津
淡路守
西徳寺町
水野壱岐守
松平
長八郎
仁賀保
主税助
三田二丁目
三田四丁目
三田四国町
同町
同町
同

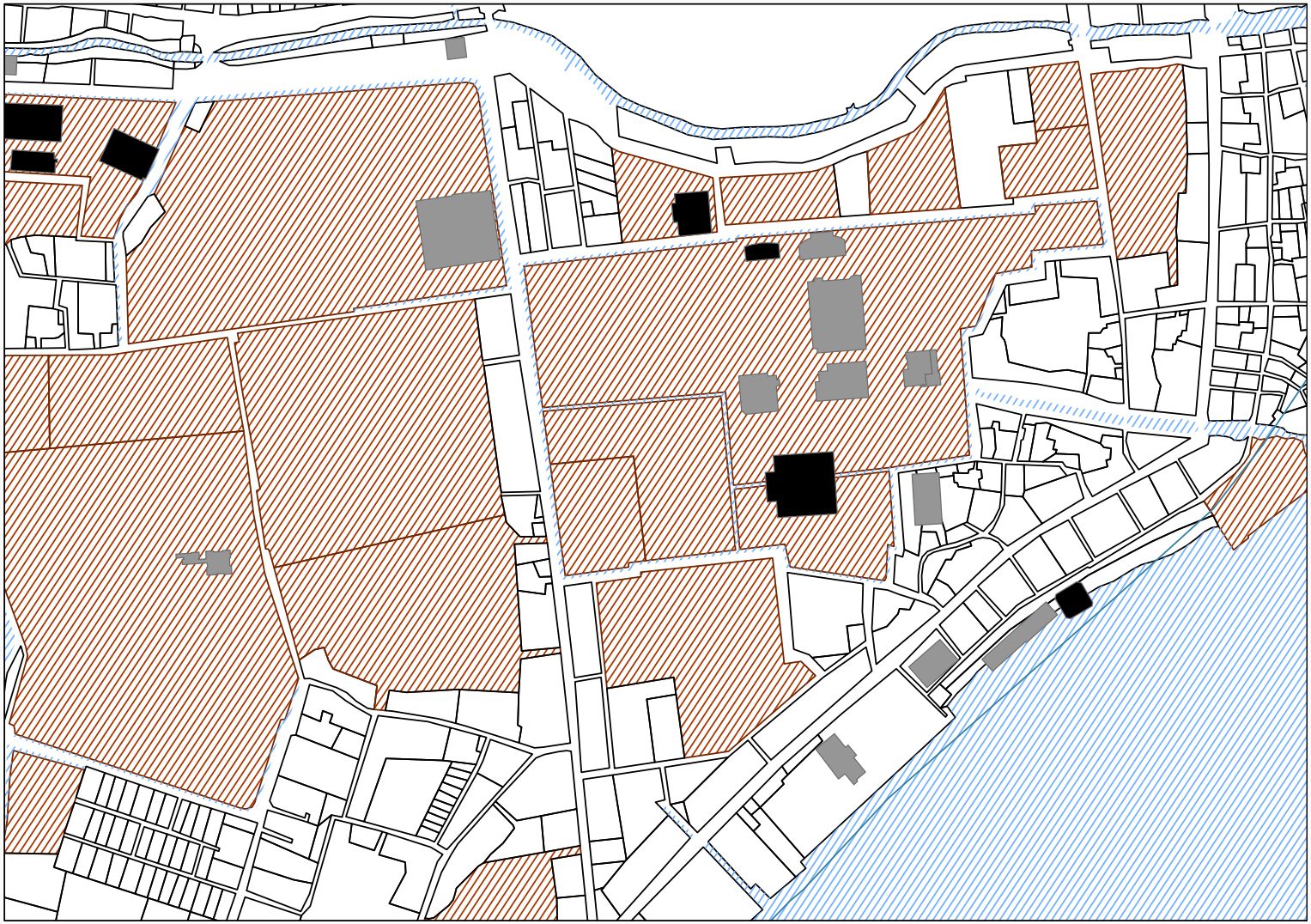
Local lords’ estates are less-fragmented (1850s)



Those lots are less fragmented even today (2010)



And tall buildings (> 15 or > 30 stories) are there (2011)



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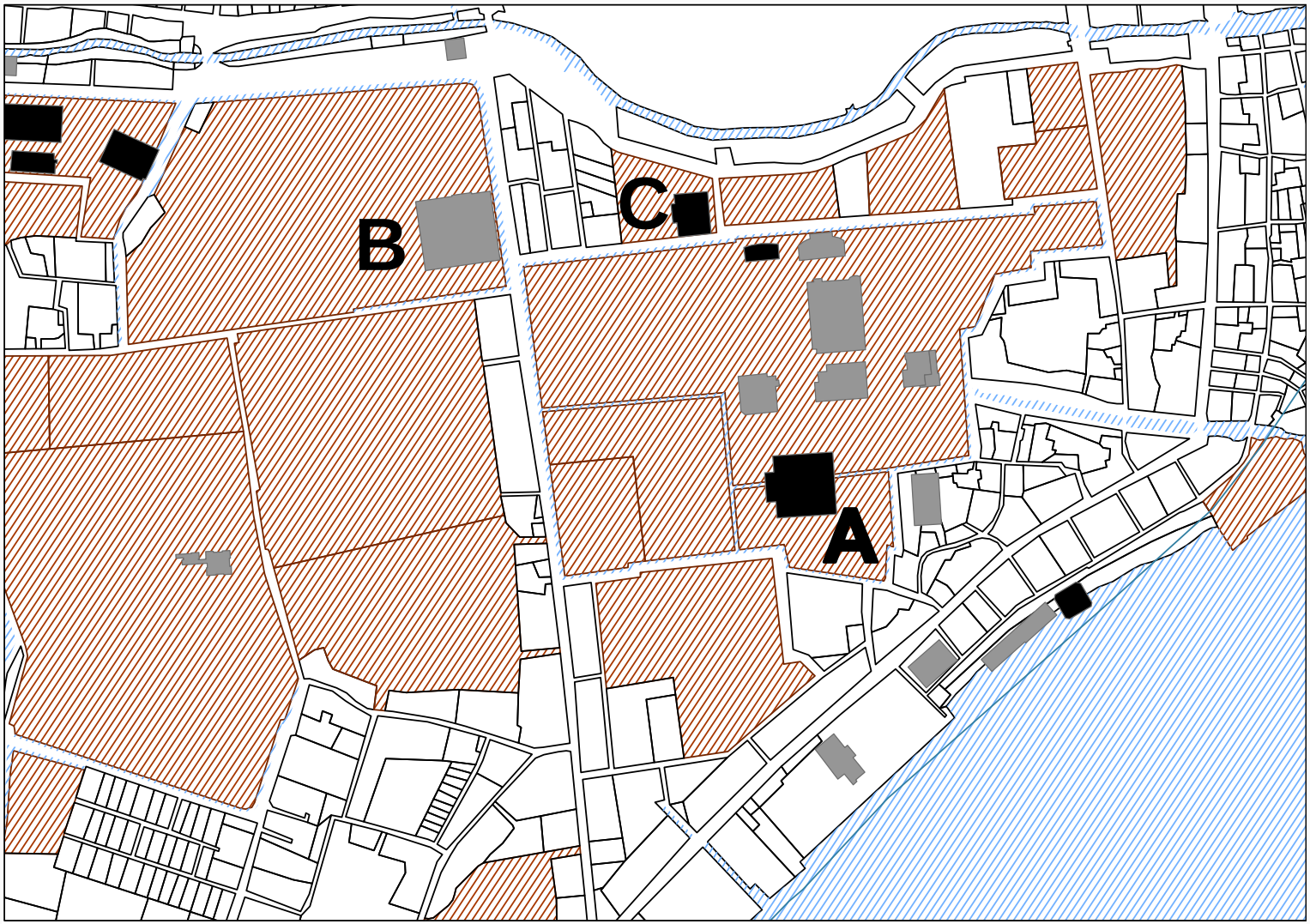
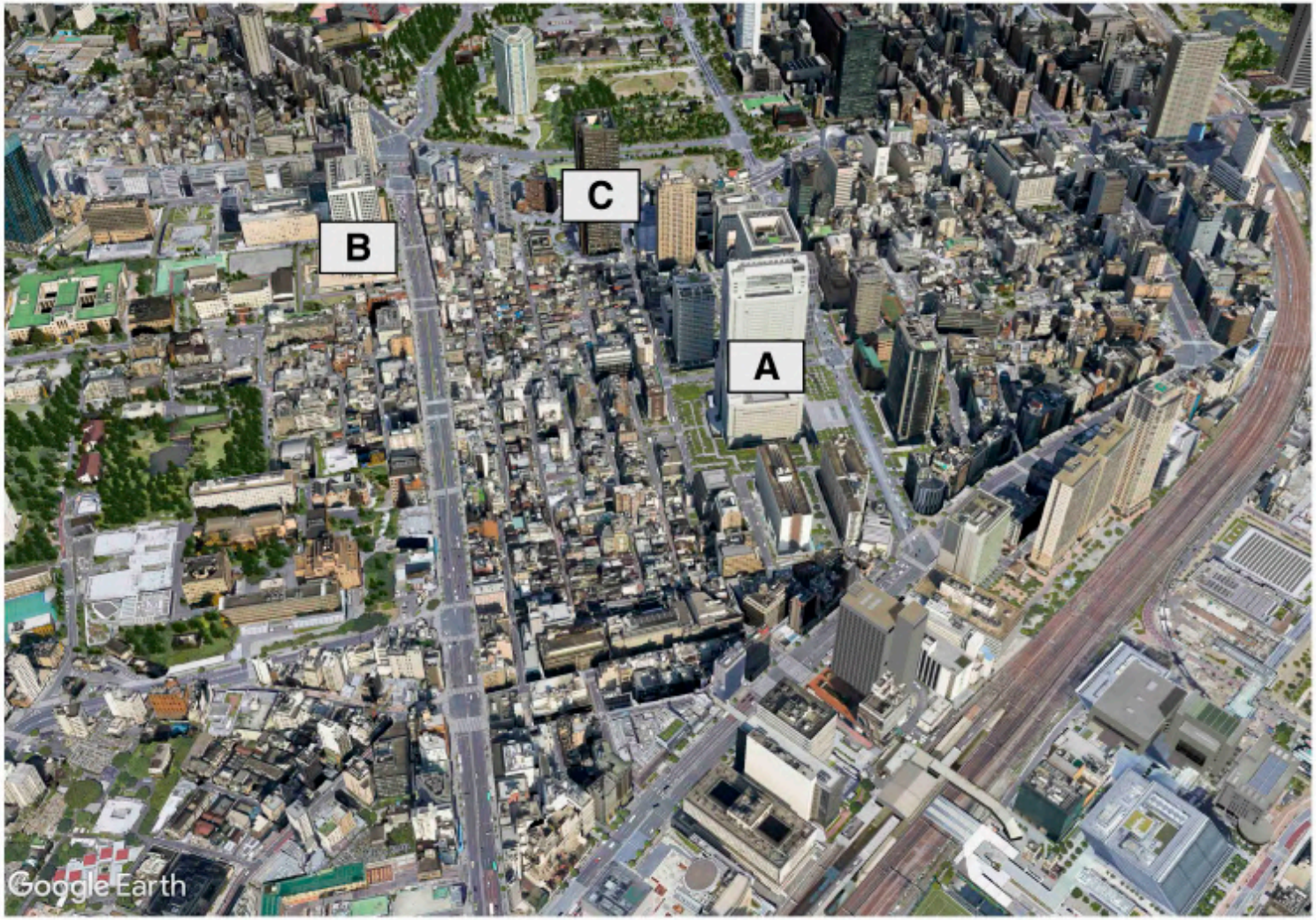


Large variation of building heights in a small area suggesting high land assembly costs



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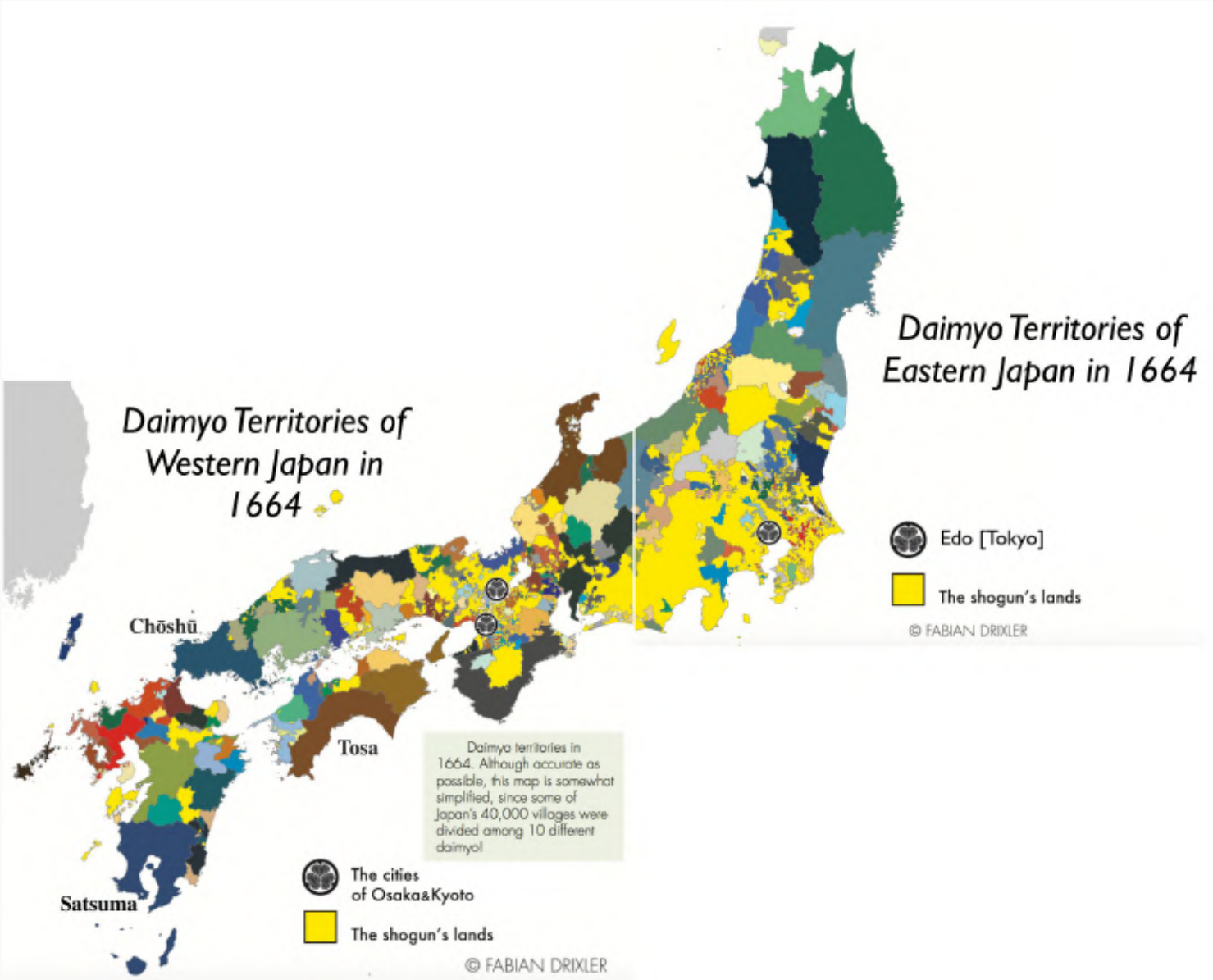
Very brief summary of history

- 1600: *Shogun* started to construct a city in a marsh.
- During the pre-modern era (1600–1868): 250-300 local feudal lords
- Local lords typically had three estates (Larger lots)
  - Wives and kids stayed in Tokyo as hostages
  - "Alternate Attendance System": Lords had to come to Tokyo once a two years and stay for a year
  - Vassals stayed in Tokyo as well
- 1868: Two estates were expropriated → mostly released to the private market
- After WWII: heavy asset tax rate so that they had to sell the remaining one

Local lords as chiefs of local domains



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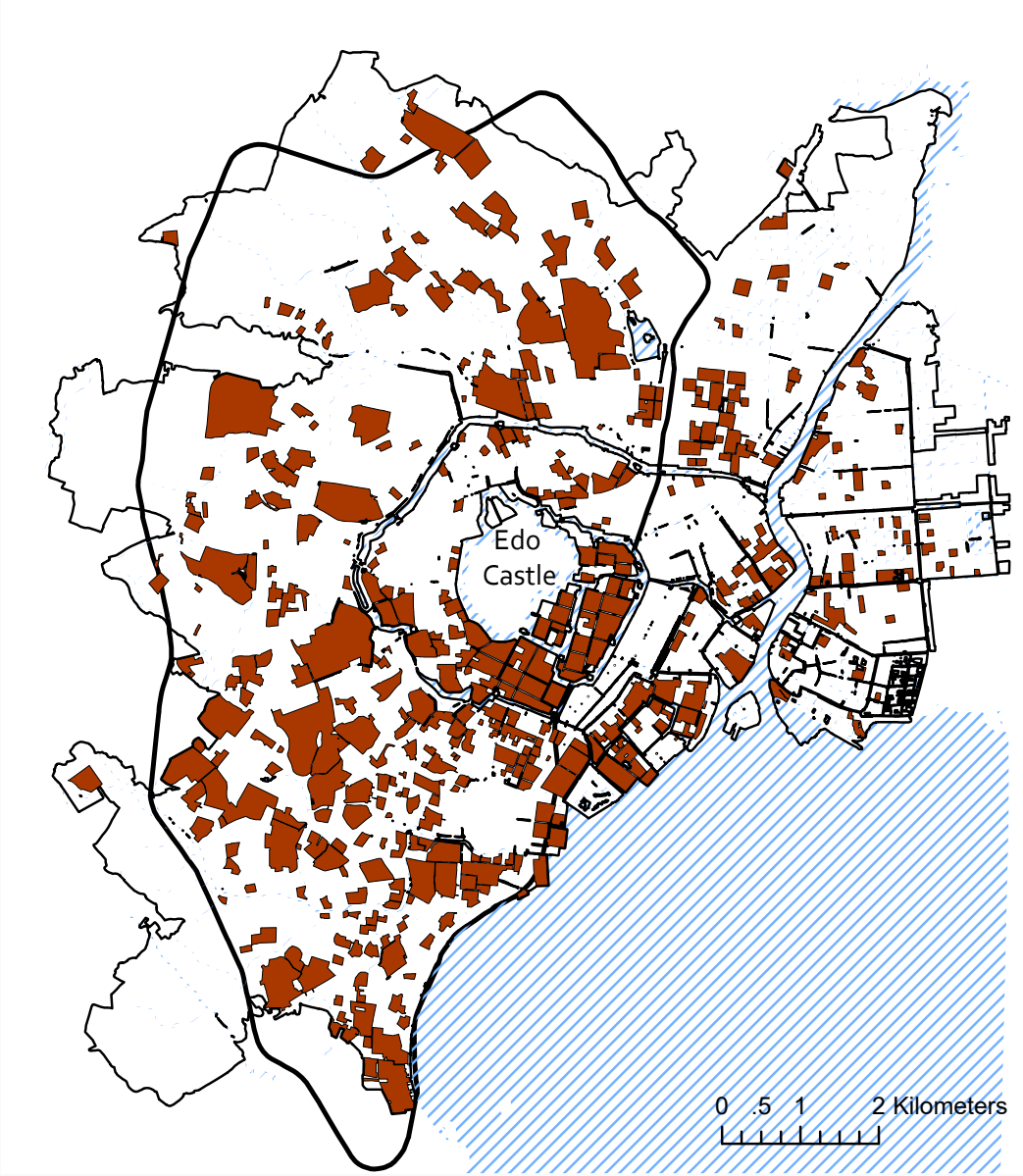
Local lords owned estates in Tokyo (Map in the 1850s)



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Urbanization of old Tokyo

- Business activities increased in old Tokyo after WWII.
- After WWII, daytime population increased from 3M to 4.7M.
  - Residential population did not increase so much.
- Tall buildings increased.
  - No skyscrapers before 1965
  - Kasumigaseki building in 1965 = 36 stories, 147 m
  - Over-30-stories buildings: 32 in 1990, 86 in 2000, 260 in 2010, and 357 in 2020

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Data spanning 150 years

- Various data sources including digitizing new data
  - Local lords' estates in the 1850s
  - Lot fragmentation in 1873, 1912, 1931–35, and 2008–2011.
  - Land price in 1876, 1912, 1931-1935, 1972, 1983, 2010s.
  - Buildings of today (shape, height, sector, ..)
- We aggregate all of these information at the 100 m*100 m cell level.

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Various Identification Strategies

- OLS conditional on geographical controls
- Higher local lords' estates share → In 2011, less lot fragmentation, more tall buildings, and higher land prices.
  - When local lords' estates share increases from zero to one, land price increases by 17–30 %.
- **RD using zoning policy**

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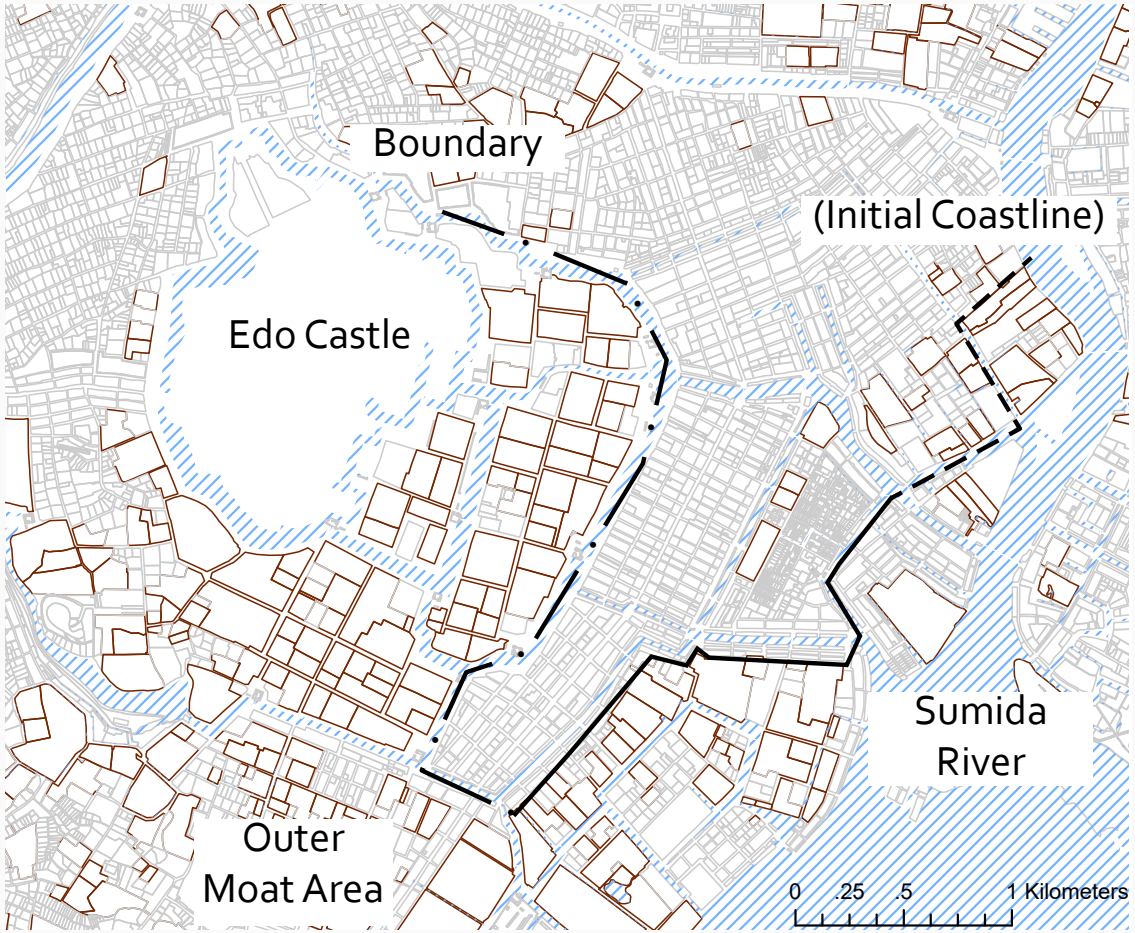
- **RD using zoning policy**

RD using the Tokugawa's Planning using the left and center zones.

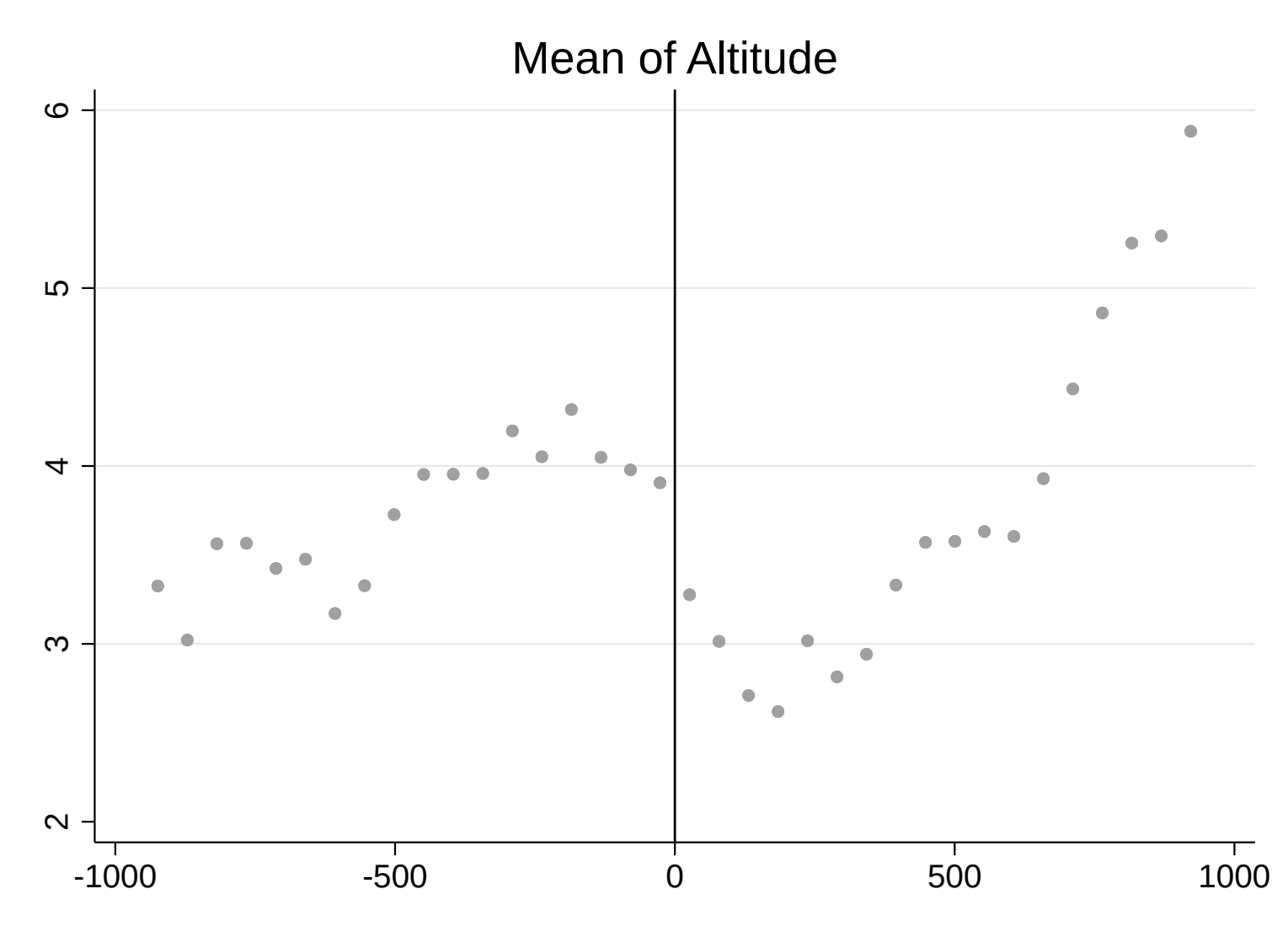
▸ Result



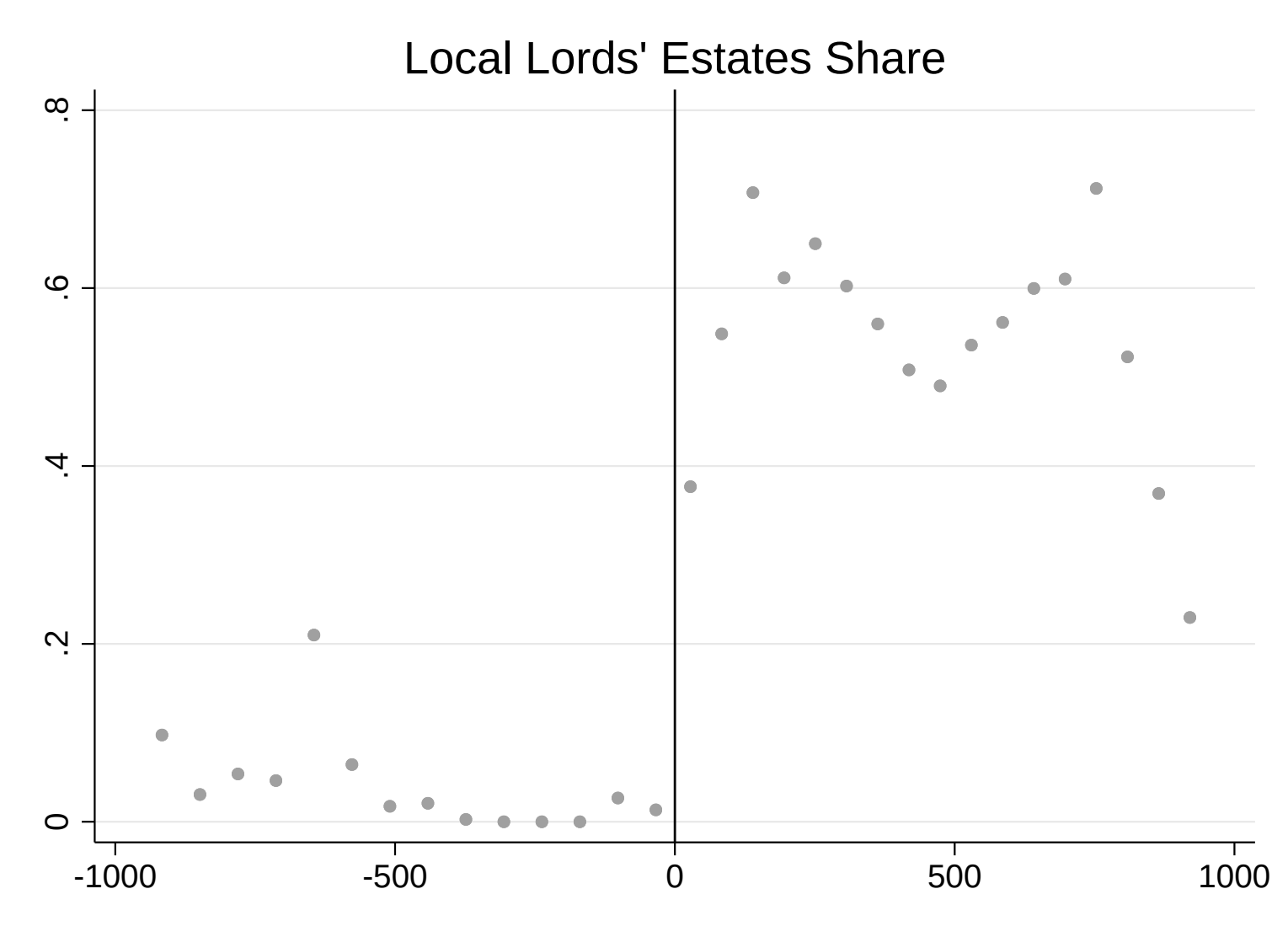
The left and center area were initially developed. The right zone was developed later.

RD results (Balancing Test)

go back



RD results



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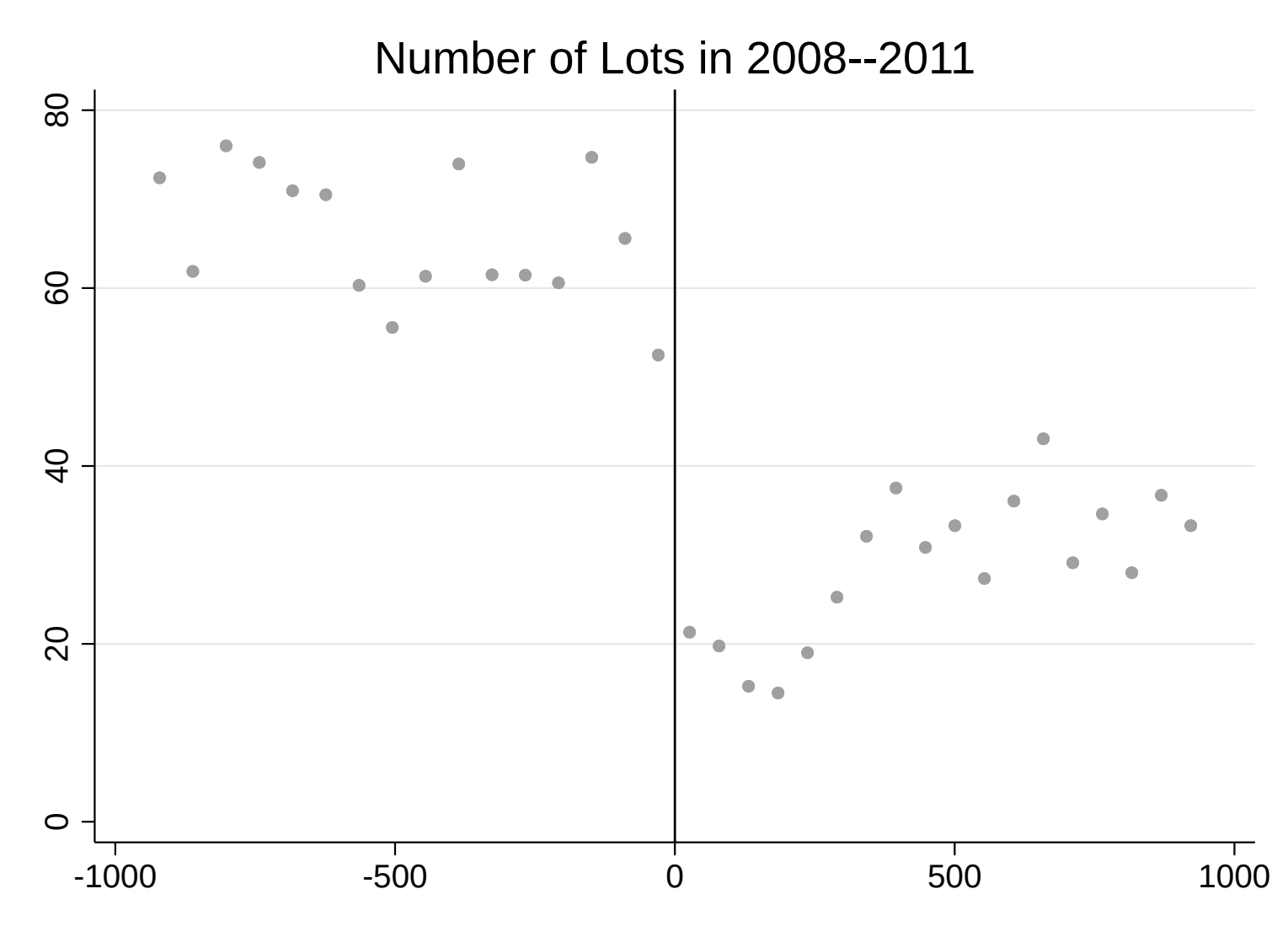

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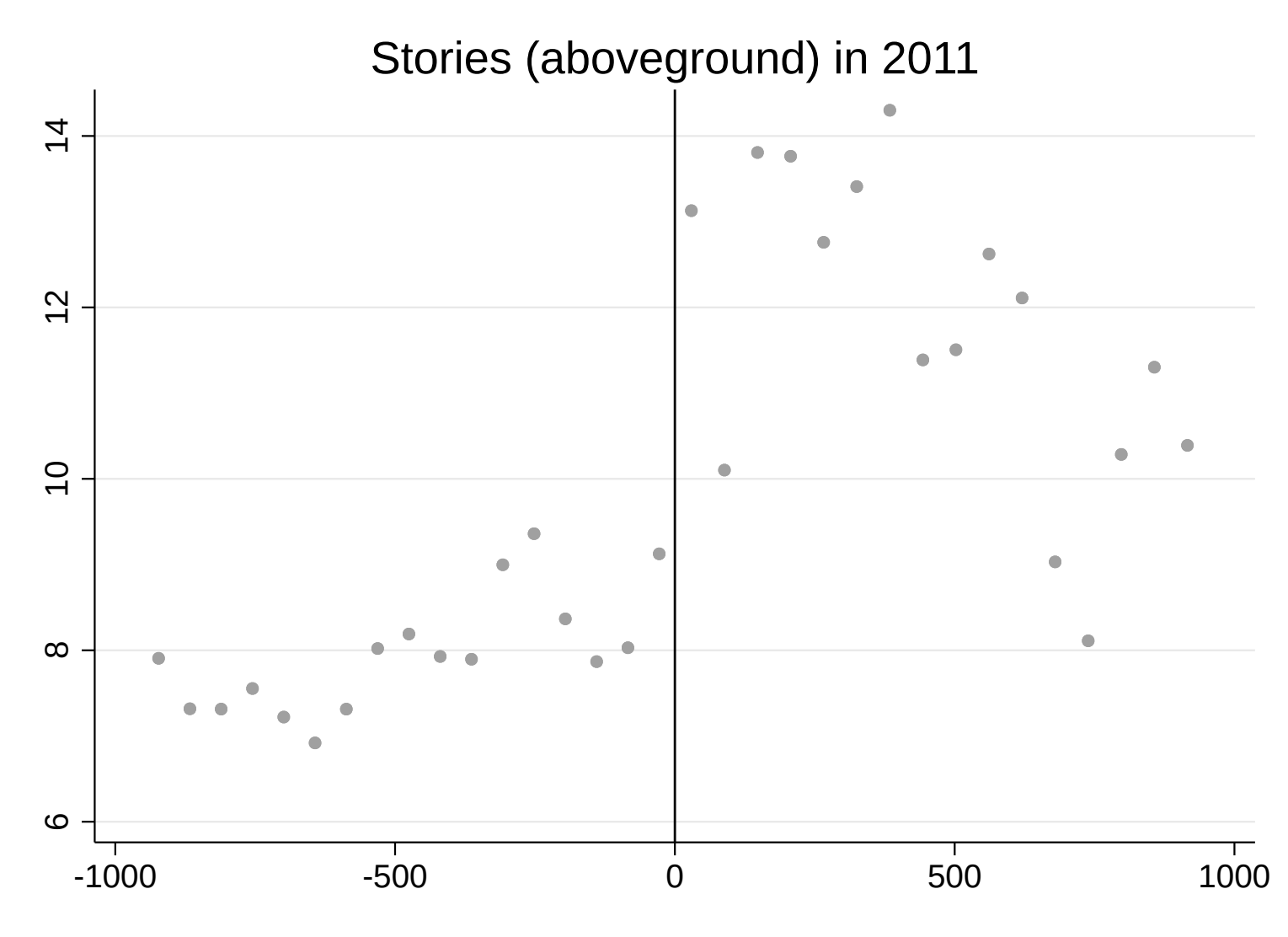

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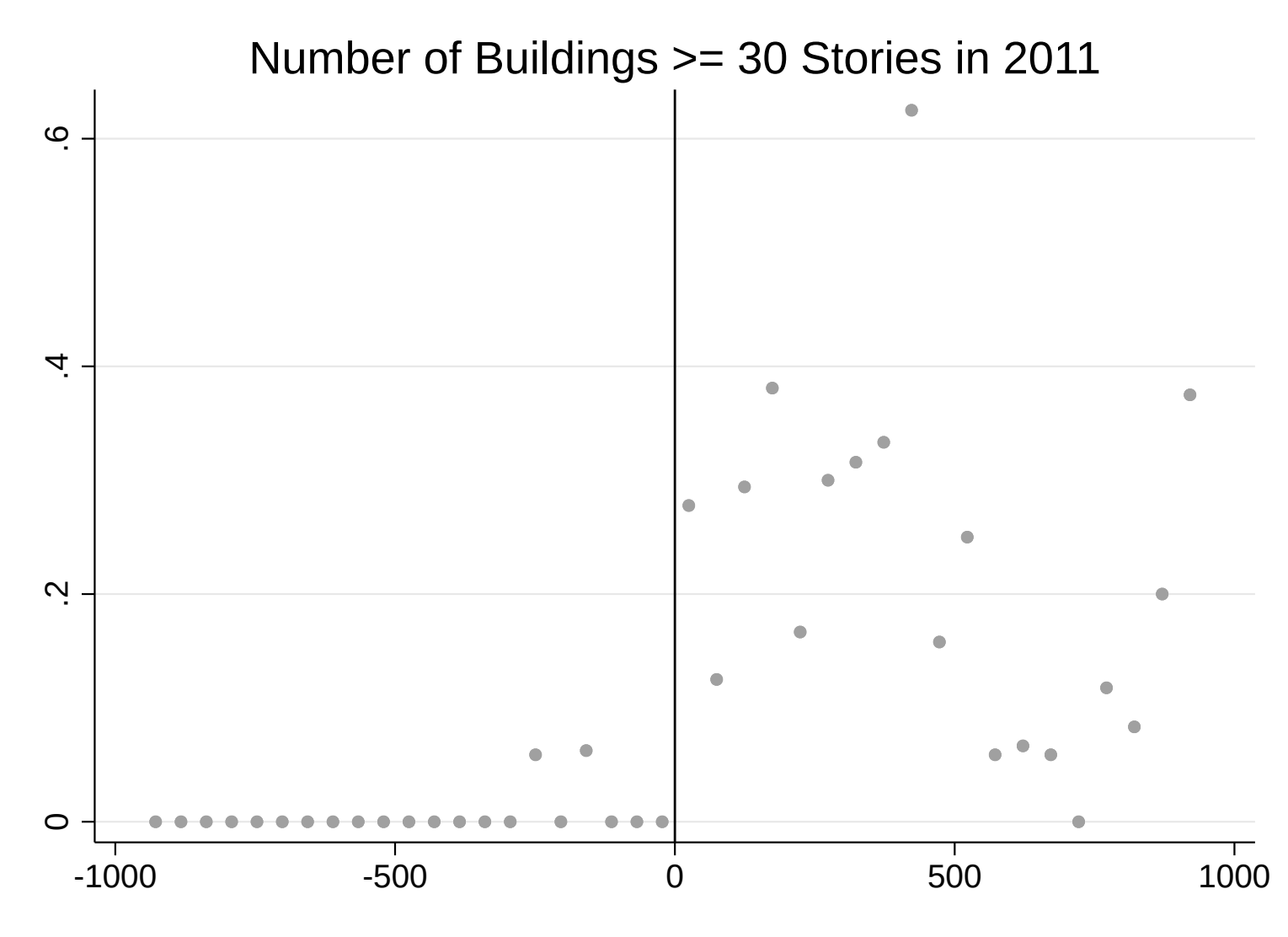
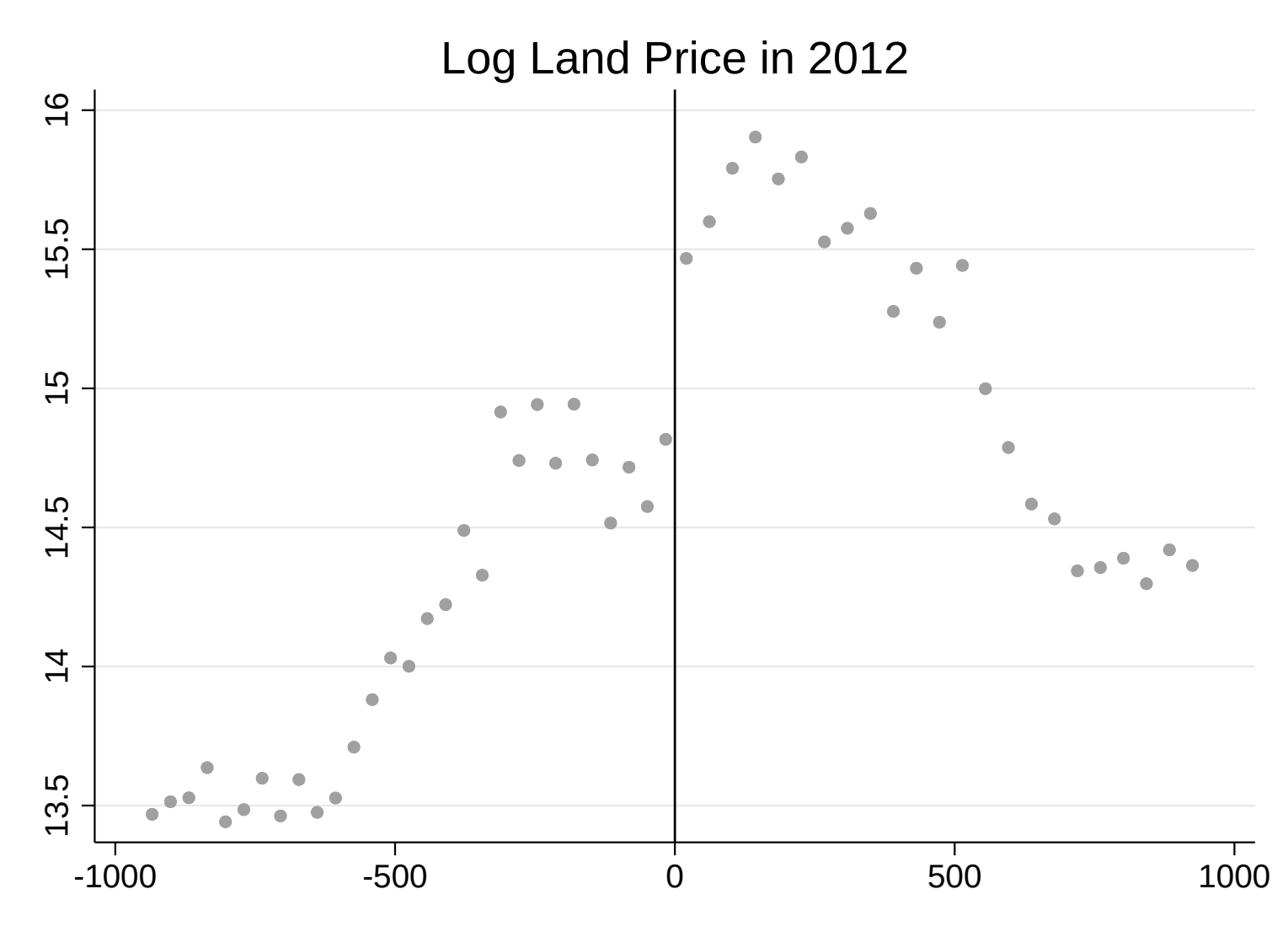

Number of Buildings >= 30 Stories in 2011
0
.2
.4
.6
-1000
-500
0
500
1000

RD results



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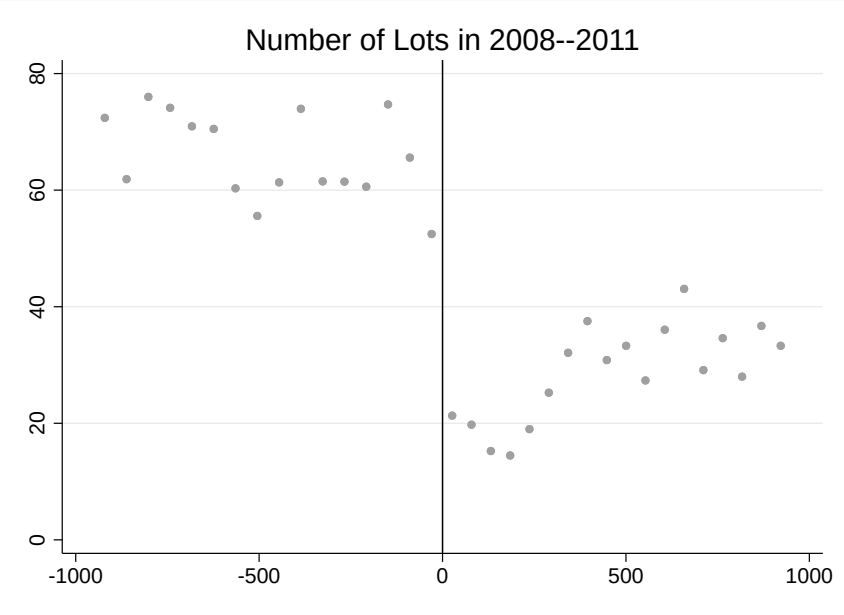
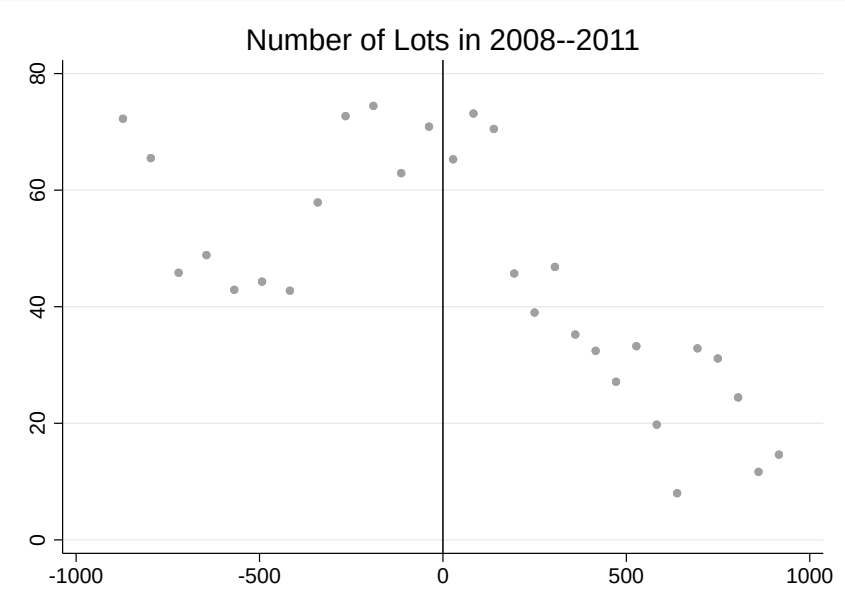


Core



Non-Core

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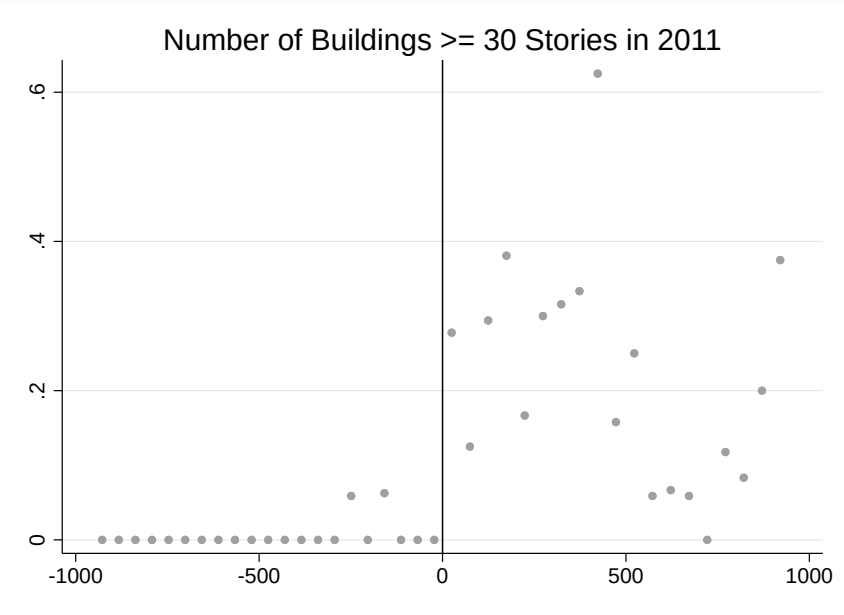

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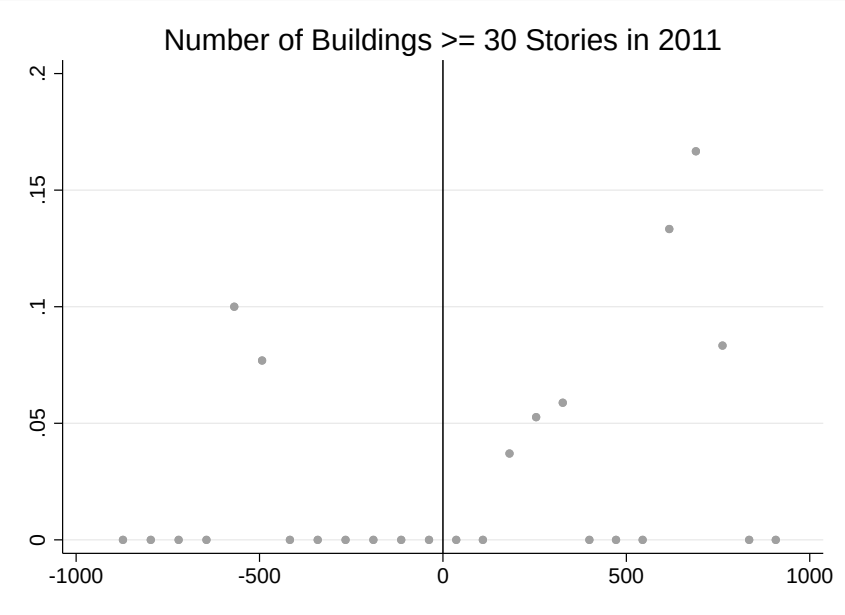

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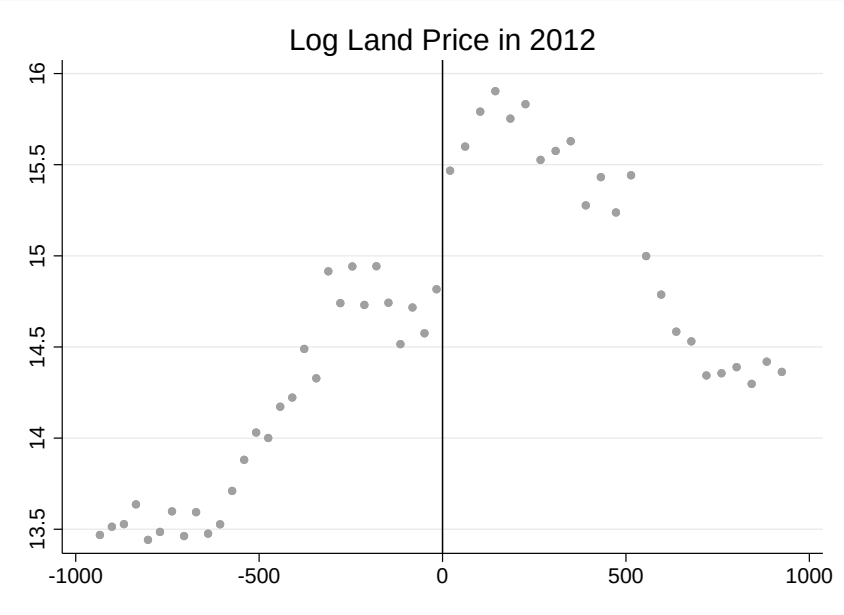

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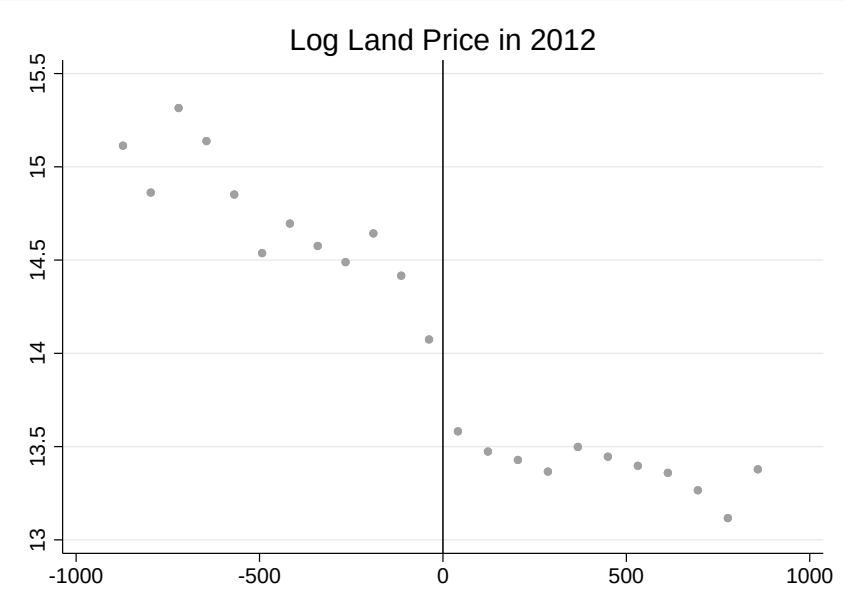

Non-Core

Core vs Non-core

- Persistence in spite of high economic potential in the core area: high transaction costs
  - higher potential gain may endogenously intensify landowner' strategic behavior in their negotiation (the hold-out problem, (Miceli and Sirmans, 2007; Brooks and Lutz, 2016; Grossman et al., 2019)
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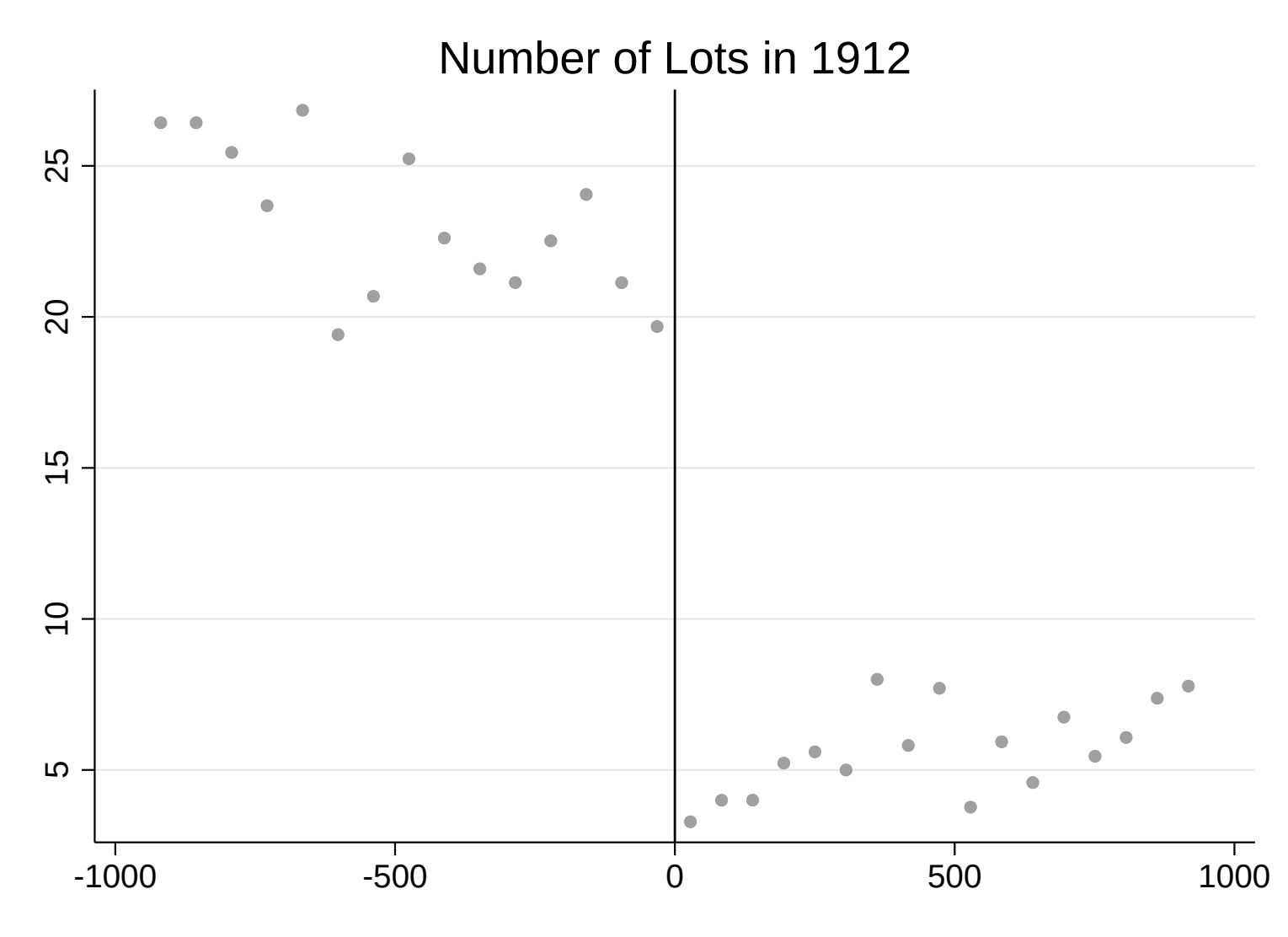
Before the age of skyscraper: Lots were larger



But land price was lower

Reverse of fortune: pre-skyscraper age

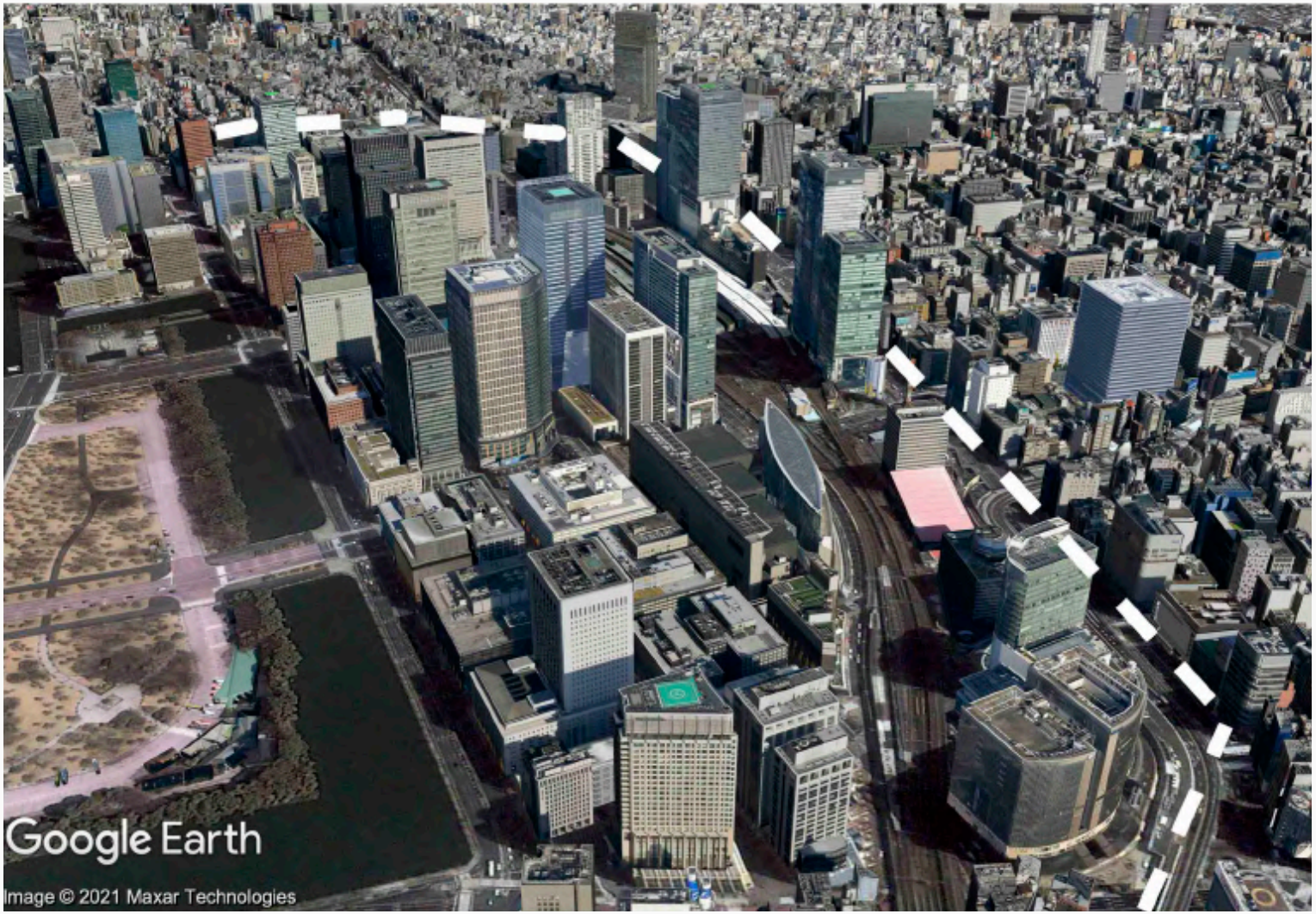
Reverse of fortune: dawn of skyscraper age

Reverse of fortune: dawn of skyscraper age

Reverse of fortune: skyscraper age

In 1970

In 2011



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Firm-level micro data to investigate agglomeration benefits

- Local lords' estates → skyscrapers (→ agglomeration benefits for firms) → higher land price
- Firm-level data collected by a major Japanese credit research company (Teikoku Databank).
  - Cover most of the Japanese firms
  - Revenue per worker (proxy of TFP)
  - Location of HQ
- Selection vs Agglomeration
  - Selection will affect the lower tail of productivity, while agglomeration will shift the distribution or make the upper tail ticker (Combes et al., 2012).

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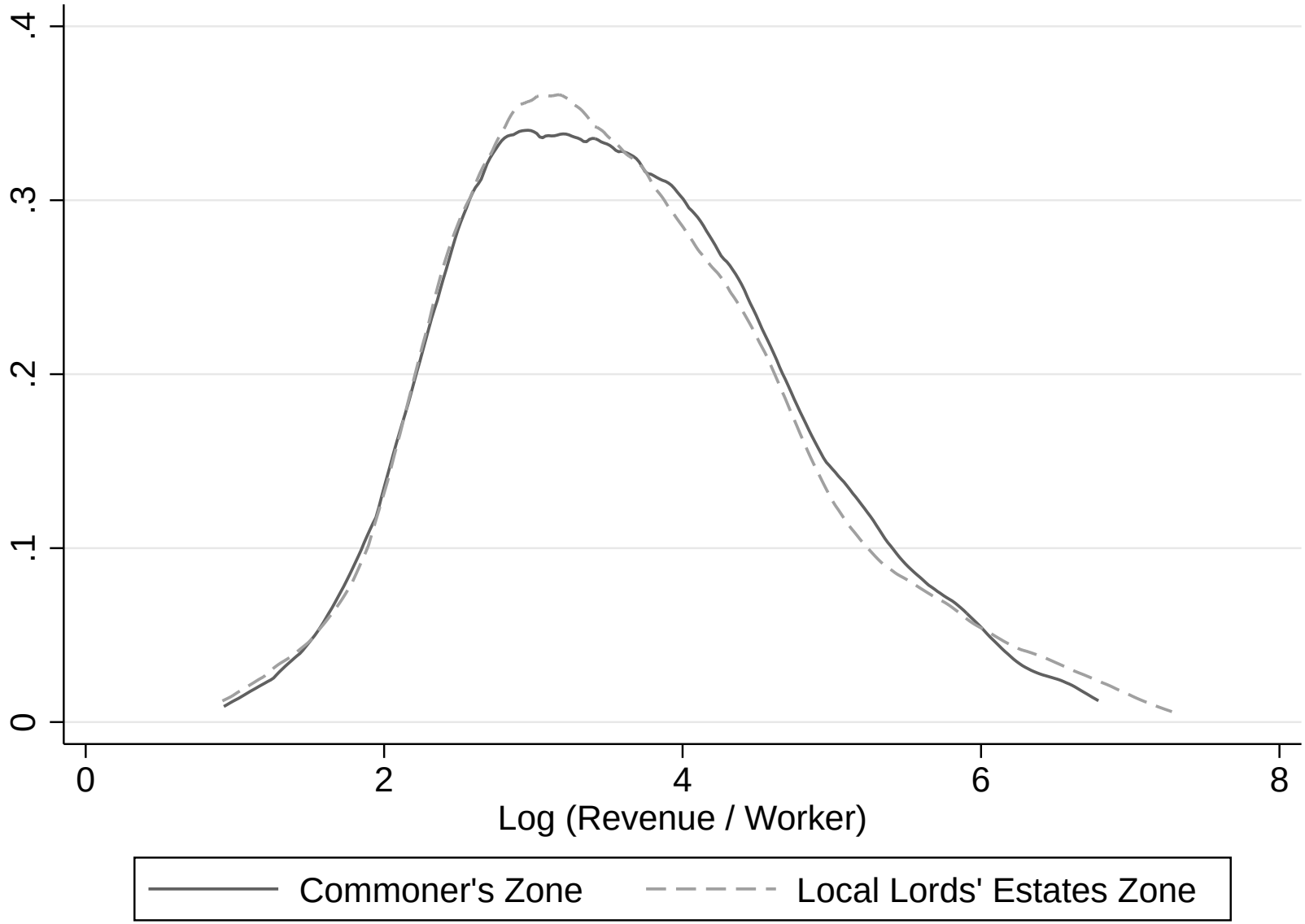
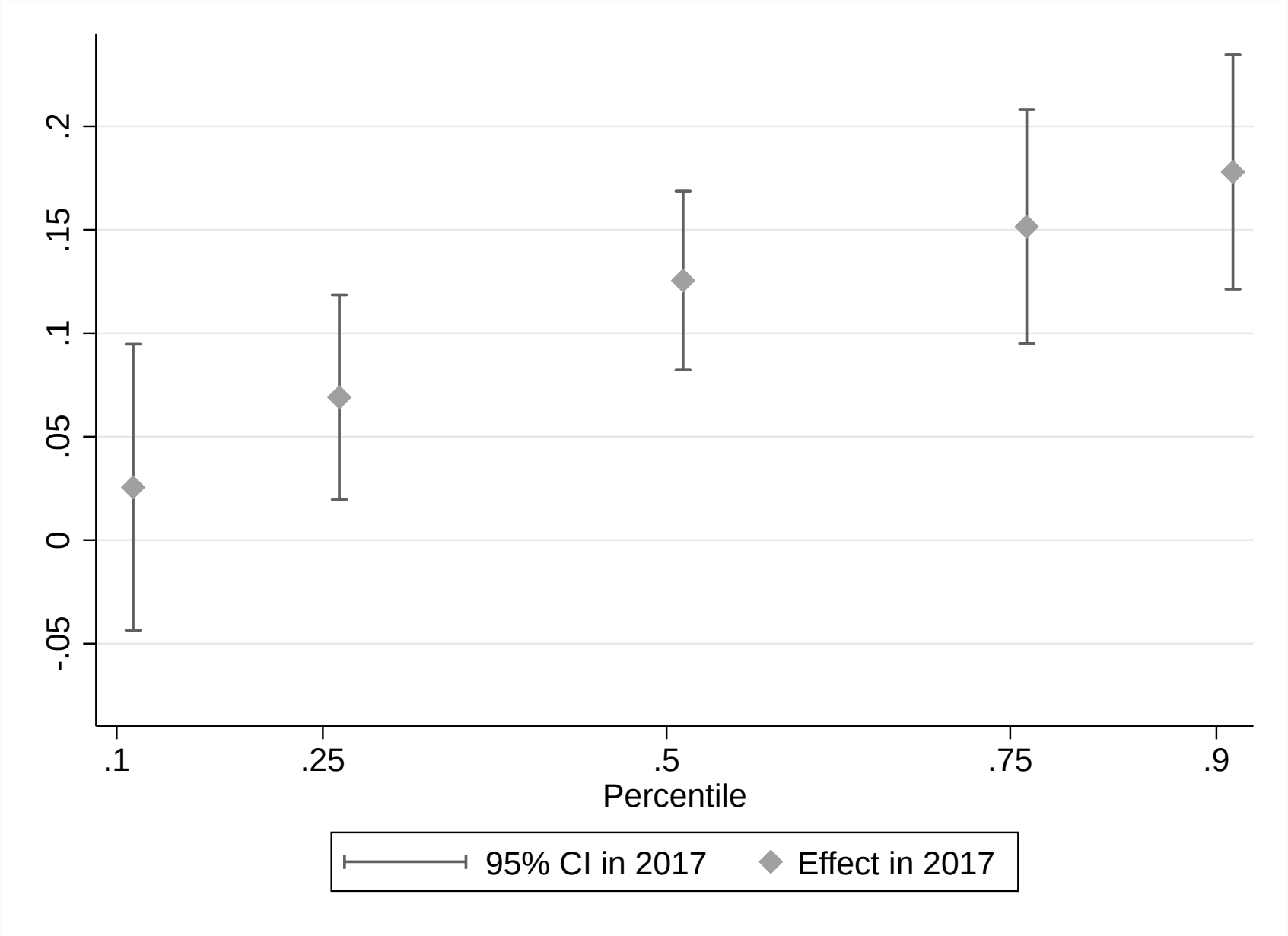
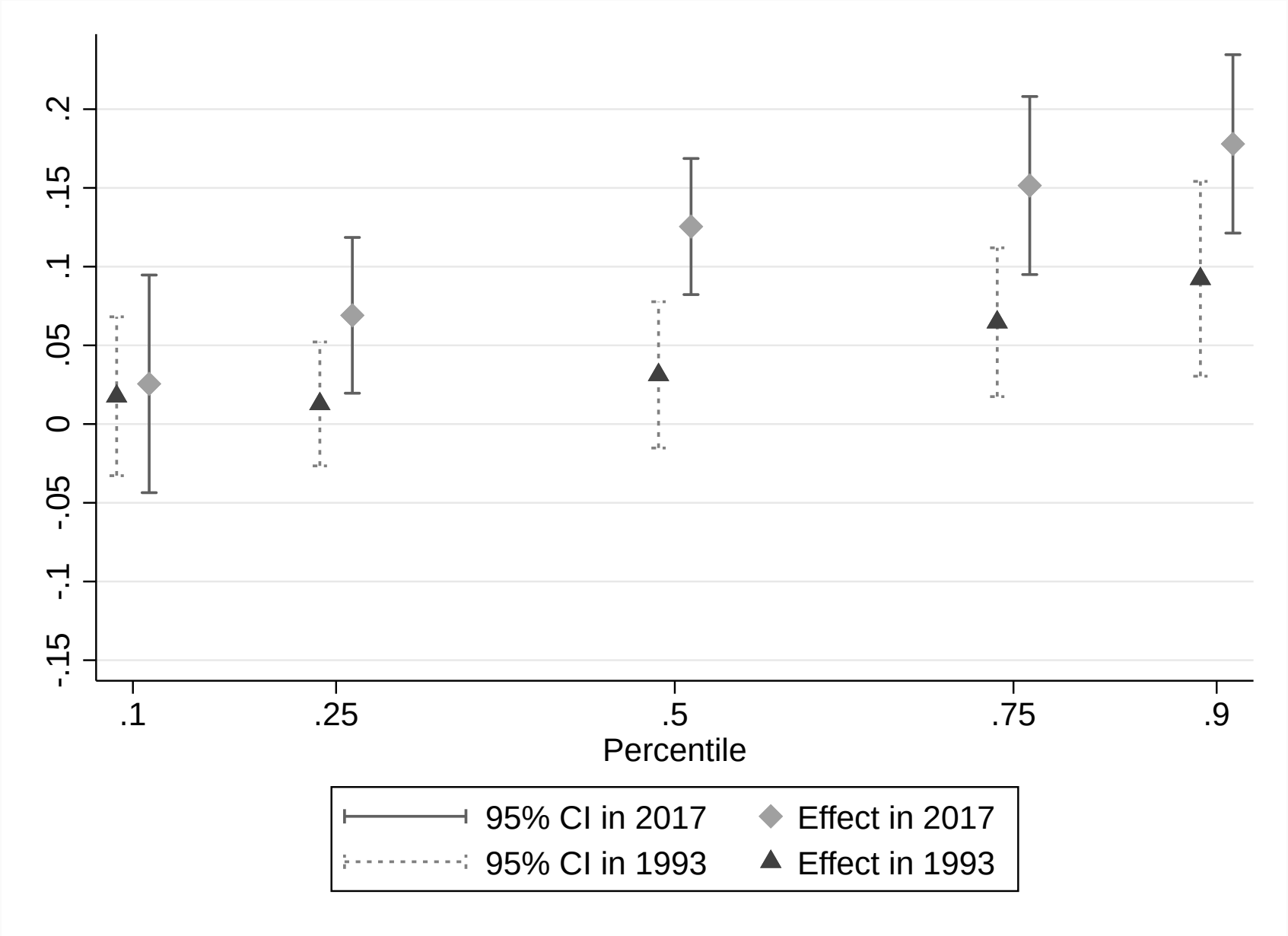
The upper tail is thicker and the lower tail does not show clear cutoff



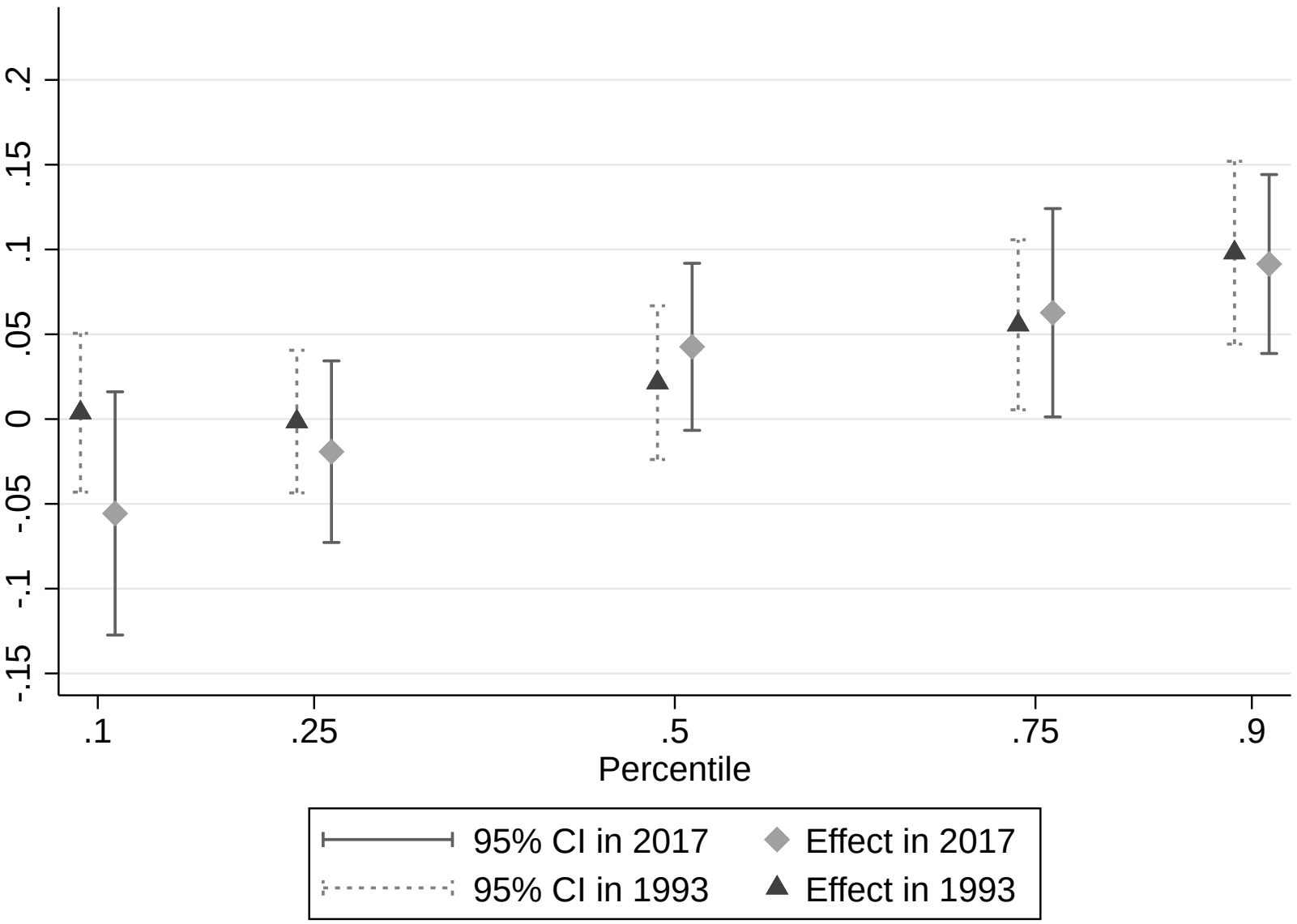
Larger impacts in the upper tail using 2017



Impacts are smaller in 1993 when buildings were shorter



Impacts become similar when controlling for stories



Robustness Checks

- Main results: Local loads estates → Larger lot size → Skyscrapers → Higher land price
  - Public infrastructure, not skyscrapers? → Table A.14 and A.15 in the paper
  - Block size, not lot size? → Table A.16 and A.17
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  - Coefficient stability analysis → Table A.5 and A.8
- Construction technology and office economy after WWII → Larger lots are more valued
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Summary

- Local lords' estates at the end of the 1850s → larger lots in 1917, 1931, and even 2011(OLS and Local randomization) .
  - Lot size persistence only in the core area, suggesting high transaction costs in the core area.
- Local lords' estates at the end of the 1850s → taller buildings, and higher land prices today.
  - Negative effect on land price (split cost) before WWII
  - It turned to positive around the 1970s
  - Positive effect on firm productivity by tall buildings.
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  - Weak property rights in slums (Field, 2005; Galiani and Schargrodsky, 2010; Harari and Wong, 2019; Michaels et al., 2021; Henderson et al., 2021)
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- (3) Land assembly and urban development (Miceli and Sirmans, 2007; Brooks and Lutz, 2016).
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Land assembly is hard in big cities

Barcelona residents face eviction as Sagrada Familia Basilica completion approaches

Source: Euronews

RD results

	(1)	(2)	(3)
Panel I: Local Lords' Estates Share (N: 351)			
Local Lords' Estates Zone	0.411***	0.351***	0.351***
	(0.0579)	(0.0590)	(0.0592)
Panel A: Number of Lots in 1872 (N: 350)			
Local Lords' Estates Zone	-12.14***	-10.79***	-10.79***
	(1.896)	(2.055)	(2.059)
Panel B: Number of Lots in 2008–2011 (N: 352)			
Local Lords' Estates Zone	-23.74***	-22.32***	-22.22***
	(7.128)	(6.472)	(6.297)
Panel C: Number of Buildings in 2011 (N: 351)			
Local Lords' Estates Zone	-10.06**	-10.64***	-10.60***
	(4.446)	(3.723)	(3.656)
Panel D: Stories (aboveground) in 2011 (N: 351)			
Local Lords' Estates Zone	2.159***	2.045**	2.020**
	(0.746)	(0.882)	(0.873)
Panel E: Number of Buildings >= 30 Stories in 2011 (N: 351)			
Local Lords' Estates Zone	0.114**	0.126**	0.124***
	(0.0452)	(0.0513)	(0.0469)
Panel F: Log Land Price in 2012 (N: 341)			
Local Lords' Estates Zone	0.179	0.348	0.343*
	(0.333)	(0.219)	(0.202)
Distance from the Center (Castle)	No	Yes	Yes
Mean of Altitude	No	Yes	Yes
S.D. of Altitude	No	Yes	Yes
Locational Controls	No	Yes	Yes
Earthquake Risk	No	No	Yes

Standard errors allowing within-300 m correlation are in parentheses. $^{+}$ p<0.10, * p<0.05, ** p<0.01, *** p<0.001. N shows the maximum sample size. Sample size varies across the outcome variables.

FAR / Block Size / Road Width (Local Randomization)

	(1)	(2)	(3)
Panel I: Local Lords' Estates Share			
Local Lords' Estates Zone	0.351***	0.361***	0.299***
	(0.0592)	(0.0589)	(0.0619)
Panel A: Number of Lots in 1872			
Local Lords' Estates Zone	-10.79***	-10.90***	-10.13***
	(2.059)	(2.083)	(2.058)
Panel B: Number of Lots in 2008–2011			
Local Lords' Estates Zone	-22.22***	-21.60***	-18.52***
	(6.297)	(6.234)	(6.298)
Panel C: Number of Buildings in 2011			
Local Lords' Estates Zone	-10.60***	-10.43***	-8.680**
	(3.656)	(3.645)	(3.433)
Panel D: Stories (aboveground) in 2011			
Local Lords' Estates Zone	2.020**	2.082**	2.038**
	(0.873)	(0.862)	(0.837)
Panel E: Number of Buildings >= 30 Stories in 2011			
Local Lords' Estates Zone	0.124***	0.120***	0.121**
	(0.0469)	(0.0456)	(0.0476)
Panel F: Log Land Price in 2012			
Local Lords' Estates Zone	0.343*	0.323	0.177
	(0.202)	(0.203)	(0.136)
Panel G: Log Land Price in 2012			
Local Lords' Estates Zone (Core)	0.827***	0.806***	0.464**
	(0.228)	(0.236)	(0.186)
Local Lords' Estates Zone (Non-core)	-0.237	-0.241	-0.141
	(0.275)	(0.278)	(0.175)
Block Size	No	Yes	No
FAR Regulation	No	No	Yes
Distance from the Center (Castle)	Yes	Yes	Yes
Mean of Altitude	Yes	Yes	Yes
S.D. of Altitude	Yes	Yes	Yes
Locational Controls	Yes	Yes	Yes
Earthquake Risk	Yes	Yes	Yes

Standard errors are in parentheses. We allow a within-300 m correlation in error terms. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. *Block Size* is the average area of blocks (land surrounded by roads). *Road Width* consists of the average road width and the proportion of roads more than 12 m wide.

Controlling for Public Infrastructure (Local Randomization)

	(1)	(2)	(3)	(4)	(5)
Panel I: Local Lords' Estates Share					
Local Lords' Estates Zone	0.351***	0.318***	0.355***	0.347***	0.313***
	(0.0592)	(0.0642)	(0.0572)	(0.0555)	(0.0604)
Panel A: Number of Lots in 1872					
Local Lords' Estates Zone	-10.79***	-9.935***	-10.76***	-10.69***	-9.602***
	(2.059)	(2.042)	(2.040)	(2.165)	(2.099)
Panel B: Number of Lots in 2008–2011					
Local Lords' Estates Zone	-22.22***	-16.16***	-22.03***	-22.48***	-15.80***
	(6.297)	(5.523)	(6.256)	(5.649)	(5.022)
Panel C: Number of Buildings in 2011					
Local Lords' Estates Zone	-10.60***	-7.362**	-10.52***	-11.11***	-7.559***
	(3.656)	(3.154)	(3.622)	(3.246)	(2.825)
Panel D: Stories (aboveground) in 2011					
Local Lords' Estates Zone	2.020**	1.897**	2.048**	1.975**	1.797**
	(0.873)	(0.766)	(0.890)	(0.852)	(0.727)
Panel E: Number of Buildings >= 30 Stories in 2011					
Local Lords' Estates Zone	0.124***	0.120***	0.126***	0.117**	0.112**
	(0.0469)	(0.0462)	(0.0473)	(0.0479)	(0.0454)
Panel F: Log Land Price in 2012					
Local Lords' Estates Zone	0.343*	0.173	0.354*	0.366*	0.199
	(0.202)	(0.168)	(0.201)	(0.193)	(0.166)
Panel G: Log Land Price in 2012					
Local Lords' Estates Zone (Core)	0.827***	0.544**	0.836***	0.700***	0.428**
	(0.228)	(0.212)	(0.233)	(0.215)	(0.194)
Local Lords' Estates Zone (Non-core)	-0.237	-0.227	-0.225	-0.0477	-0.0603
	(0.275)	(0.264)	(0.268)	(0.274)	(0.250)
Road Width	No	Yes	No	No	Yes
Hospital, University, and Parks Share	No	No	Yes	No	Yes
Distance to Nearest Station in 2018 and 1950	No	No	No	Yes	Yes
Distance from the Center (Castle)	Yes	Yes	Yes	Yes	Yes
Mean of Altitude	Yes	Yes	Yes	Yes	Yes
S.D. of Altitude	Yes	Yes	Yes	Yes	Yes
Locational Controls	Yes	Yes	Yes	Yes	Yes
Earthquake Risk	Yes	Yes	Yes	Yes	Yes

Standard errors are in parentheses. We allow a within-300 m correlation in the error terms. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

U.S. Army Air Force bombing in WWII

Physical Capital Plays Little Role (Local Randomization)

	(1)	(2)	(3)
Panel I: Local Lords' Estates Share (N: 351)			
Local Lords' Estates Zone (Core)	0.400***	0.324***	0.317***
	(0.0740)	(0.0723)	(0.0718)
Local Lords' Estates Zone (Non-core)	0.418***	0.383***	0.393***
	(0.0966)	(0.0933)	(0.100)
Panel A: Number of Lots in 1872 (N: 350)			
Local Lords' Estates Zone (Core)	-13.77***	-9.973***	-10.97***
	(1.351)	(1.962)	(1.791)
Local Lords' Estates Zone (Non-core)	-5.923***	-8.602***	-7.354***
	(2.019)	(2.479)	(2.346)
Panel B: Number of Lots in 2008–2011 (N: 352)			
Local Lords' Estates Zone (Core)	-40.04***	-33.98***	-33.55***
	(6.403)	(6.653)	(6.919)
Local Lords' Estates Zone (Non-core)	3.812	-5.343	-5.884
	(7.729)	(7.655)	(8.041)
Panel C: Number of Buildings in 2011 (N: 351)			
Local Lords' Estates Zone (Core)	-20.70***	-18.97***	-19.38***
	(3.238)	(3.092)	(3.542)
Local Lords' Estates Zone (Non-core)	6.893	0.576	1.083
	(5.586)	(5.456)	(5.476)
Panel D: Stories (aboveground) in 2011 (N: 351)			
Local Lords' Estates Zone (Core)	3.306***	3.357**	2.840*
	(1.048)	(1.513)	(1.577)
Local Lords' Estates Zone (Non-core)	-0.423	-0.232	0.415
	(0.634)	(0.789)	(0.754)
Panel E: Number of Buildings >= 30 Stories in 2011 (N: 351)			
Local Lords' Estates Zone (Core)	0.174***	0.221***	0.192***
	(0.0591)	(0.0697)	(0.0704)
Local Lords' Estates Zone (Non-core)	-0.0320*	-0.0333	0.00214
	(0.0191)	(0.0376)	(0.0354)
Panel F: Log Land Price in 2012 (N: 341)			
Local Lords' Estates Zone (Core)	0.933***	1.012***	0.888***
	(0.326)	(0.228)	(0.248)
Local Lords' Estates Zone (Non-core)	-0.868***	-0.362	-0.210
	(0.301)	(0.299)	(0.272)
WWII Destruction	Yes	Yes	Yes
Distance from the Center (Castle)	No	Yes	Yes
Mean of Altitude	No	Yes	Yes
S.D. of Altitude	No	Yes	Yes
Locational Controls	No	Yes	Yes
Earthquake Risk	No	No	Yes

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Controlling for Block Size or FAR (OLS)

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Acknowledgement

- We all belong to TDB-CAREE and thank Teikoku Databank for providing us access to their dataset.
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