Exploring the Impact of Urban Green Spaces on the Housing Market

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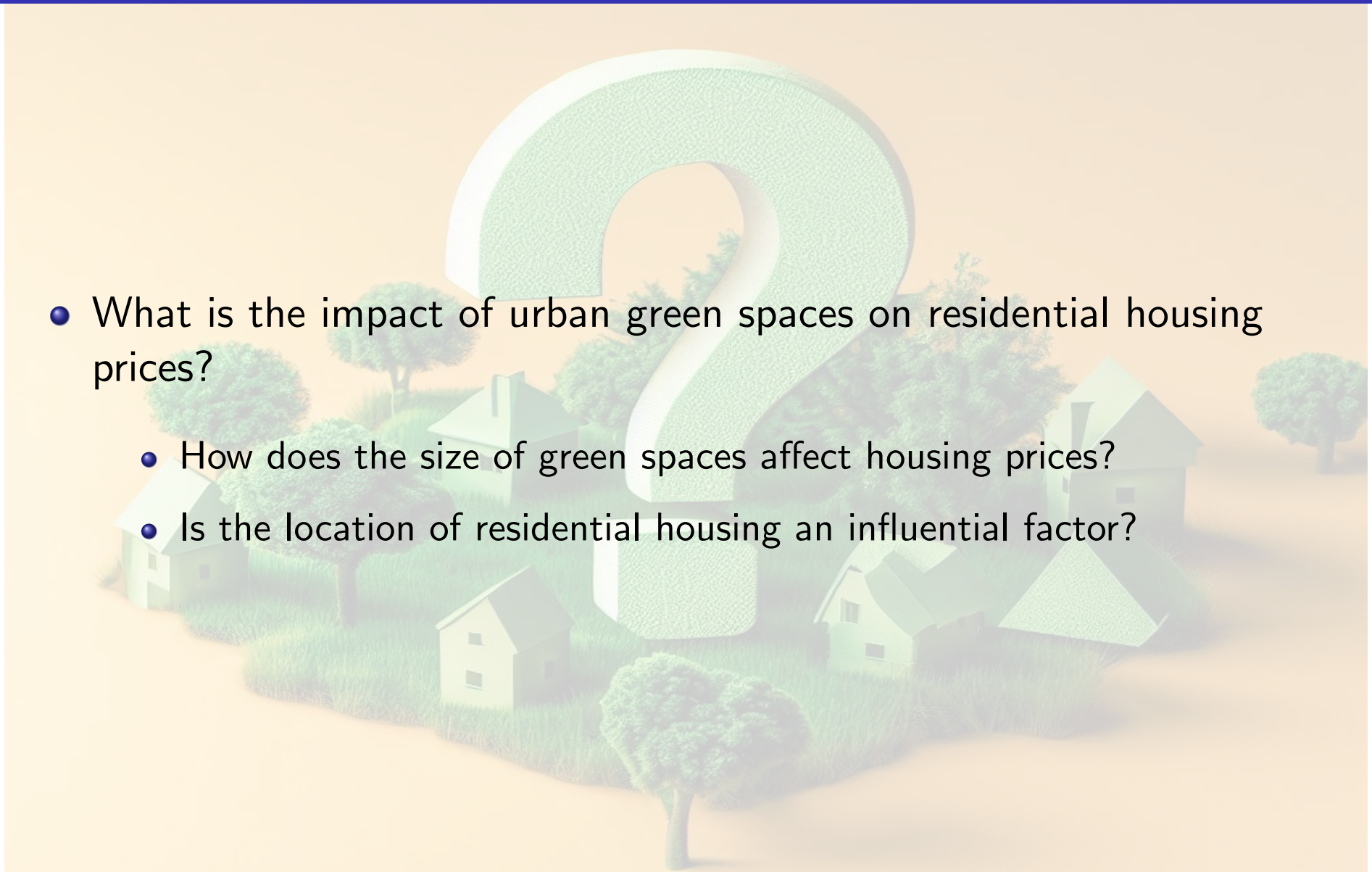
Tehran Institute for Advanced Studies

EEA Congress

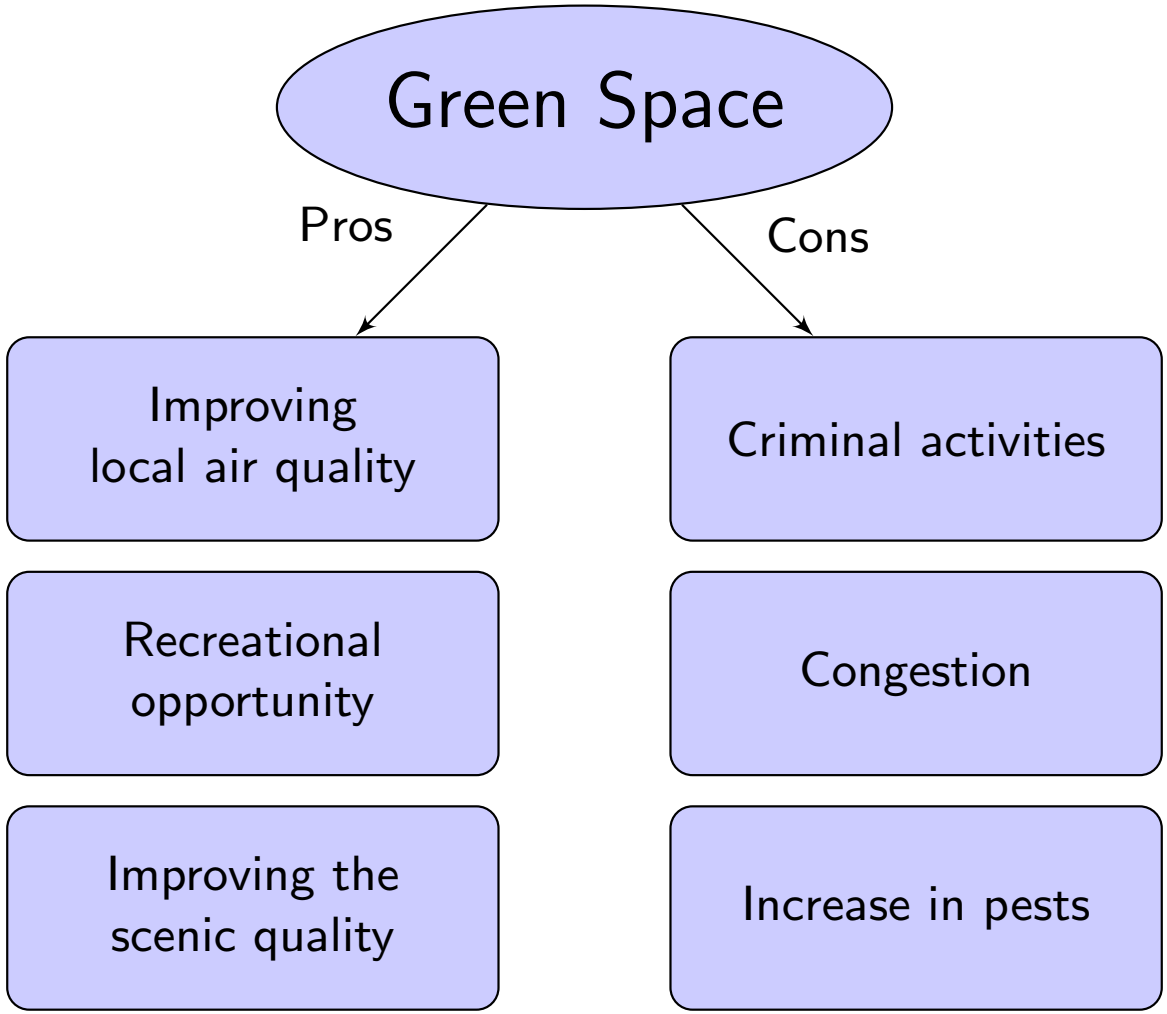
August 26, 2024

Research Question

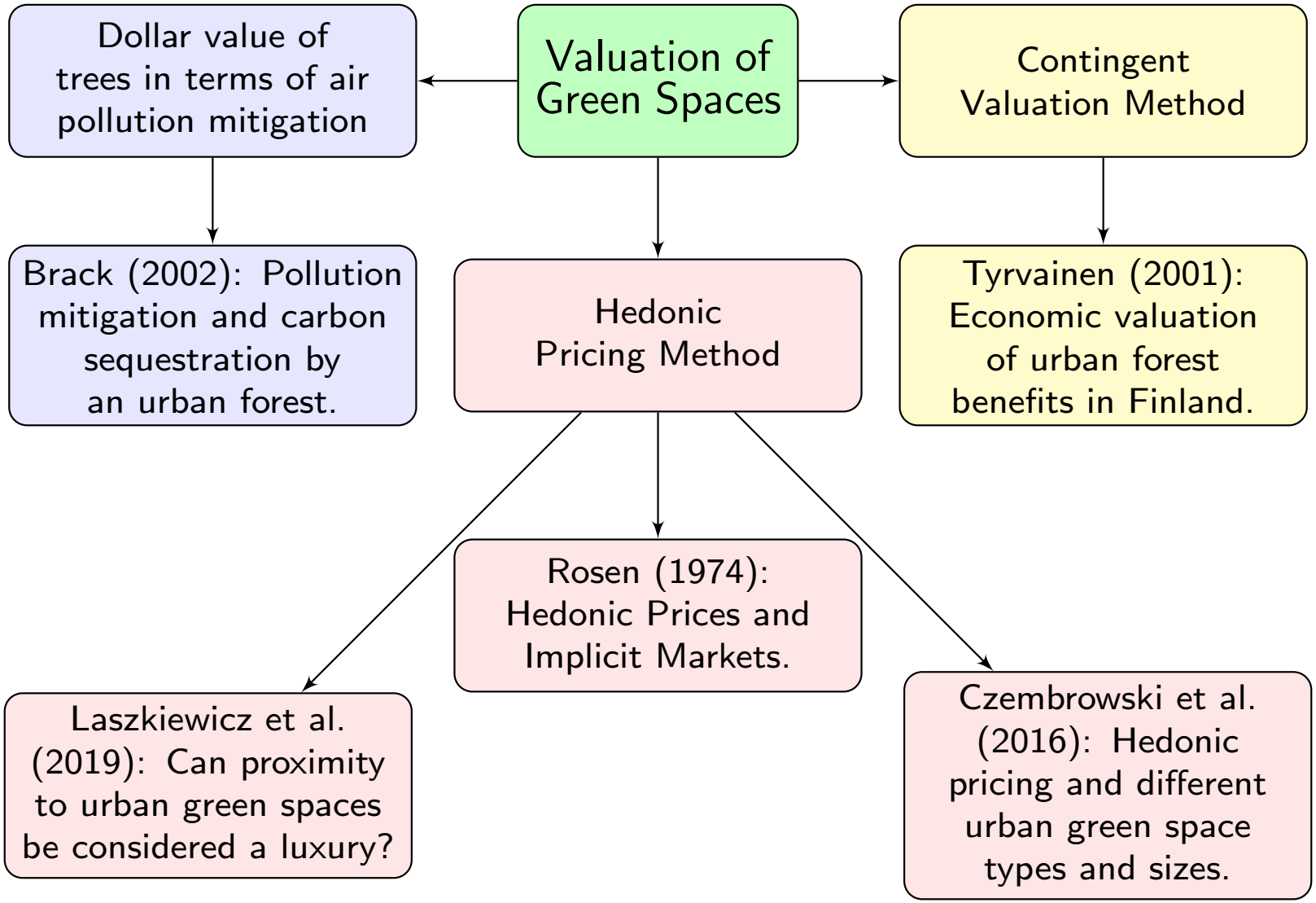


- What is the impact of urban green spaces on residential housing prices?
  - How does the size of green spaces affect housing prices?
  - Is the location of residential housing an influential factor?

Introduction



Related Literature



Hedonic Pricing Method

- **Model:**

$$Ln\ P_{it} = S_{it}\ \beta_1 + WS_{it}\gamma + N_{it}\ \beta_2 + E_{it}\ \beta_3 + time\ FE\ \delta_1 + region\ FE\ \delta_2 + (time\ FE.region\ FE)\ \delta_3 + u_{it}$$

  - P: Price per square meter
  - S: House characteristics:
    - Area, Age, ...
  - N: Neighborhood variables:
    - Distance to the nearest metro station and expressway
  - E: Environmental variables:
    - Distance to the nearest green space

HPM- Spatial Autocorrelation

- The First Law of Geography: *"everything is related to everything else, but near things are more related than distant things."*
- To correct spatial autocorrelation, we use independent variables of neighborhood:

$$Ln\ P_{it} = S_{it}\ \beta_1 + WS_{it}\gamma + N_{it}\ \beta_2 + E_{it} + u_{it}$$

- Where WS_{it} represent average age and average area of the houses that are sold in the same quarter with the first 6 digits of the postal code in common.

Data- House Characteristics

- All the house transactions during 2010-18 in Iran are publicly shared by the Ministry of Roads and Urban Development.
- The variables are consisted of:
  - Price per square meter
  - Date of transaction
  - Age
  - Area
  - Frame type
  - District
  - 10-digit postal code
- We had access to the first six digits of the traded properties, which divide Tehran into 15016 polygons that the property is located inside them.

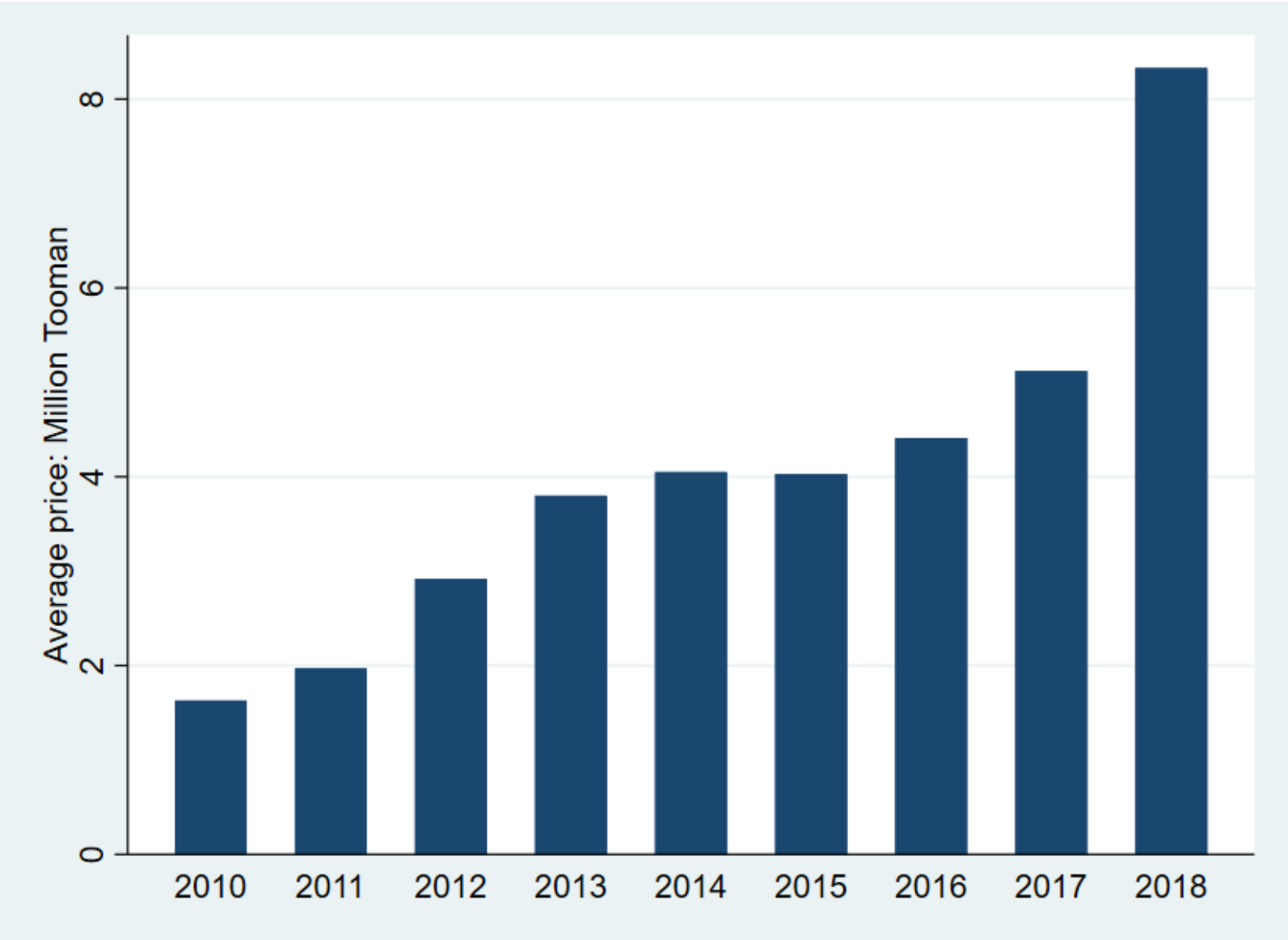
House Characteristics- Summary Stats

Variables	No. Obs.	Mean	Std. dev.	Min	Max
Price (Mil. IRT)	1099488	3.97	2.95	0.08	54.81
Price (USD)*	1099488	937.21	520.22	72.72	4567.50
AdjustedPrice** (Mil. IRT)	1099488	36.65	18.65	1.48	276.64
Age (year)	1099488	8.60	8.42	0	49
Area (m^2)	1099488	83.72	36.84	35.38	380

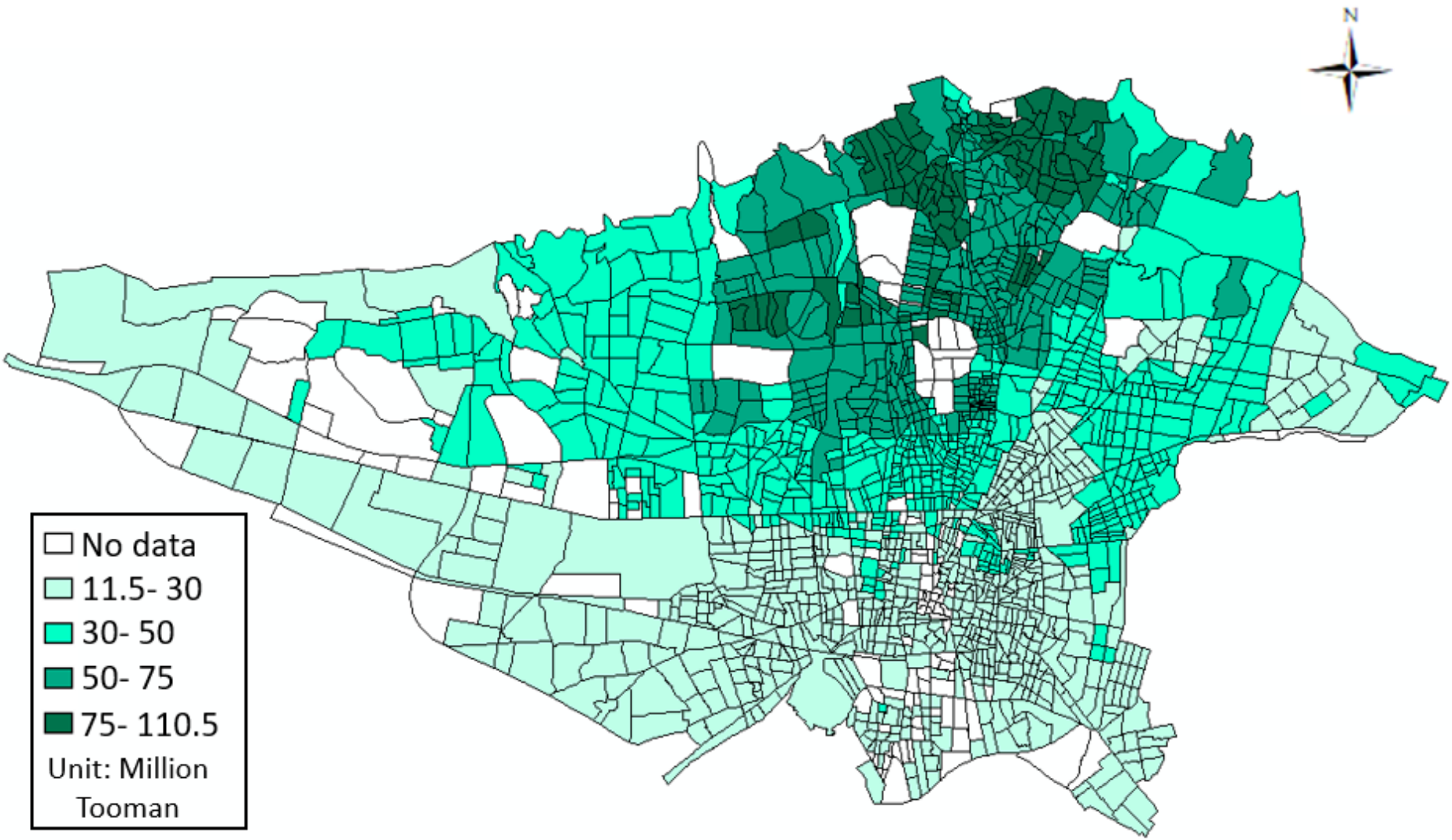
* USD/IRT changes in different years. In 2010 each Dollar was averagely 1100 Toomans and in 2018 it grows up to 12000 Toomans in the market.

** House prices are adjusted with housing inflation to the winter of 2022 (Statistical Center of Iran).

Average Price by Year



Adjusted House Prices: 2010-18



Data- Environmental Variables

- Parks' characteristics obtained from Tehran Parks and Green Spaces Organization.
- The shape file were created by using google earth and google map.
- Green spaces are classified based on their area:

Type	Explanation	No. of parks-end of 2009	No. of parks-end of 2018	Average distance
1- Very small	Smaller than $2550m^2$	552	801	416 m
2- Small	Between $2550m^2$ and $10200m^2$	649	824	408 m
3- Midsize	Between $10200m^2$ and $25500m^2$	258	319	709 m
4- Big	Between $25500m^2$ and $102000m^2$	127	155	1220 m
5- Very big	Greater than $102000m^2$	38	51	2063 m
Total	All the parks	1624	2150	218 m

- Distance to the nearest park of each type, are used as the environmental variables.

Description of Distance Calculation

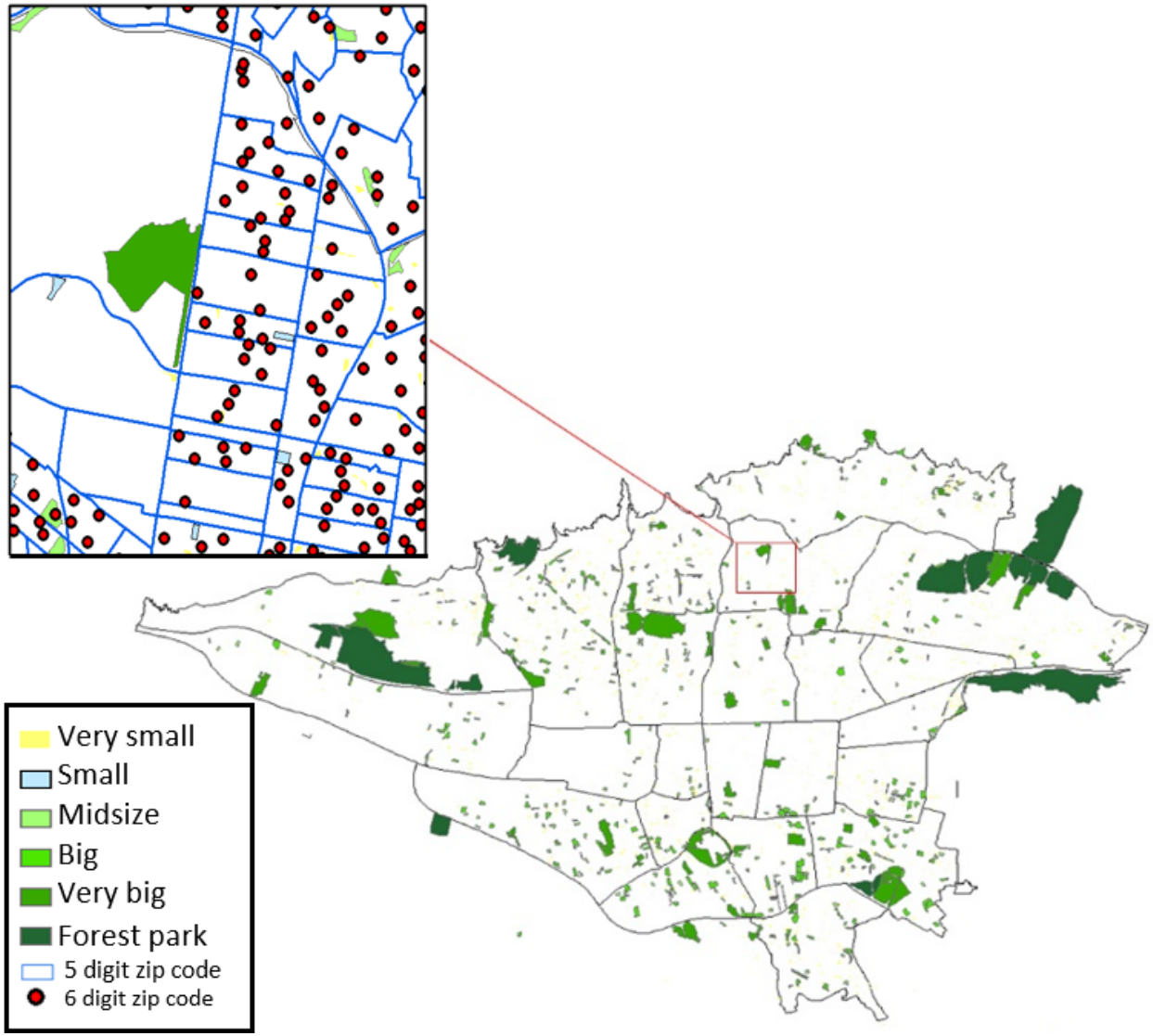


Figure: Tehran Green Spaces and Houses Geographical Coordinates- 2018

Greenery Distribution around the City

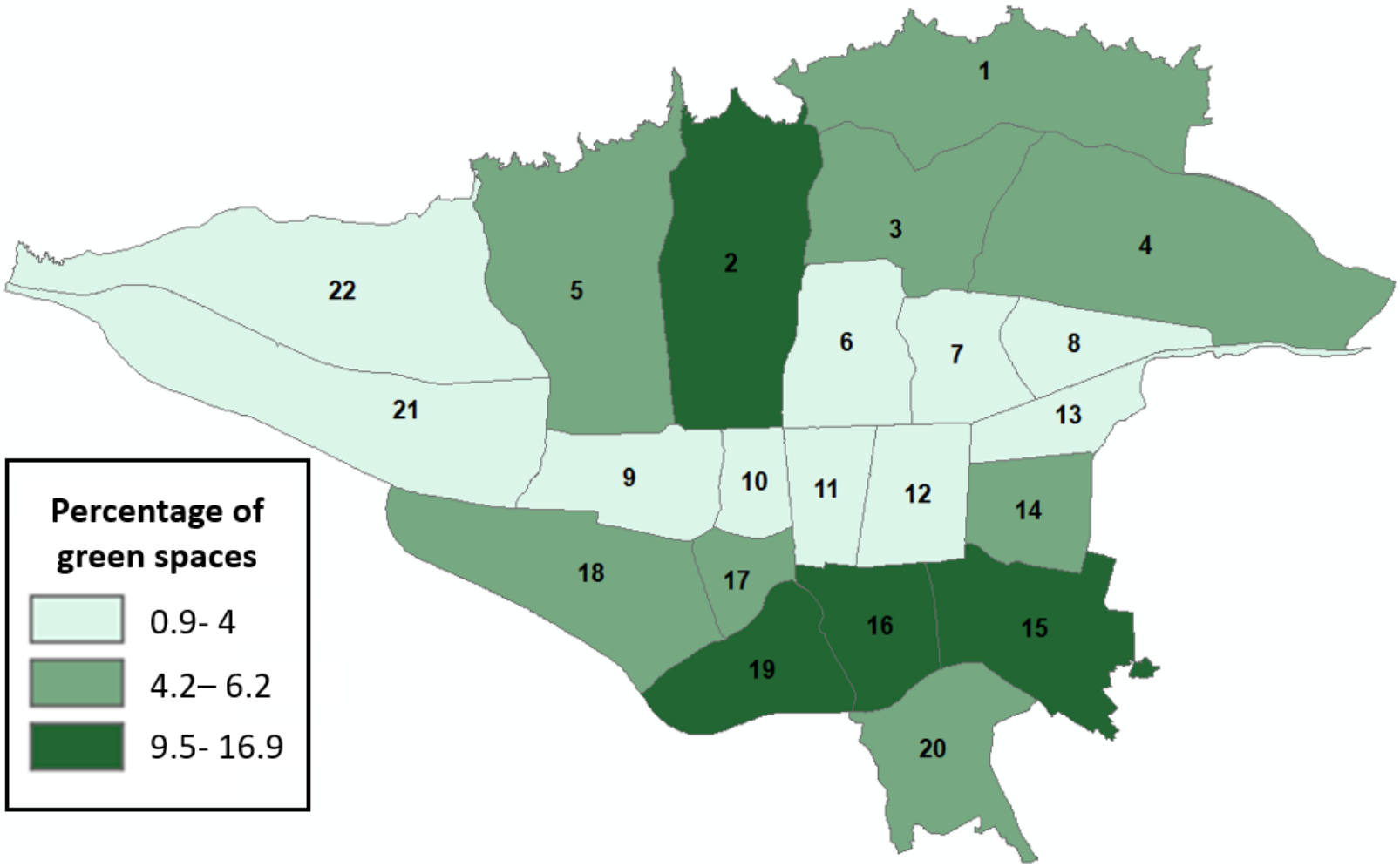


Figure: Share of green spaces in each urban district- 2018: The numbers within the polygons represent the name of that urban district, and Forest parks have been excluded.

Data- Neighborhood Variables

- Metro stations:
  - The time of the inauguration of the metro station
  - The geographic coordinates of the metro station
  - The total number of active stations in Tehran was 66 at the beginning of the study which increased to 112.
  - Classification of distance to metro:

$$Metrogroup = \begin{cases} 1 & less\ than\ 400\ m \\ 2 & more\ than\ 400\ m \end{cases}$$

- Expressways:
  - The shape file of the expressways is available on the website of OpenStreetMap that is a free map of the whole world.

Result: Distance to the Nearest Park

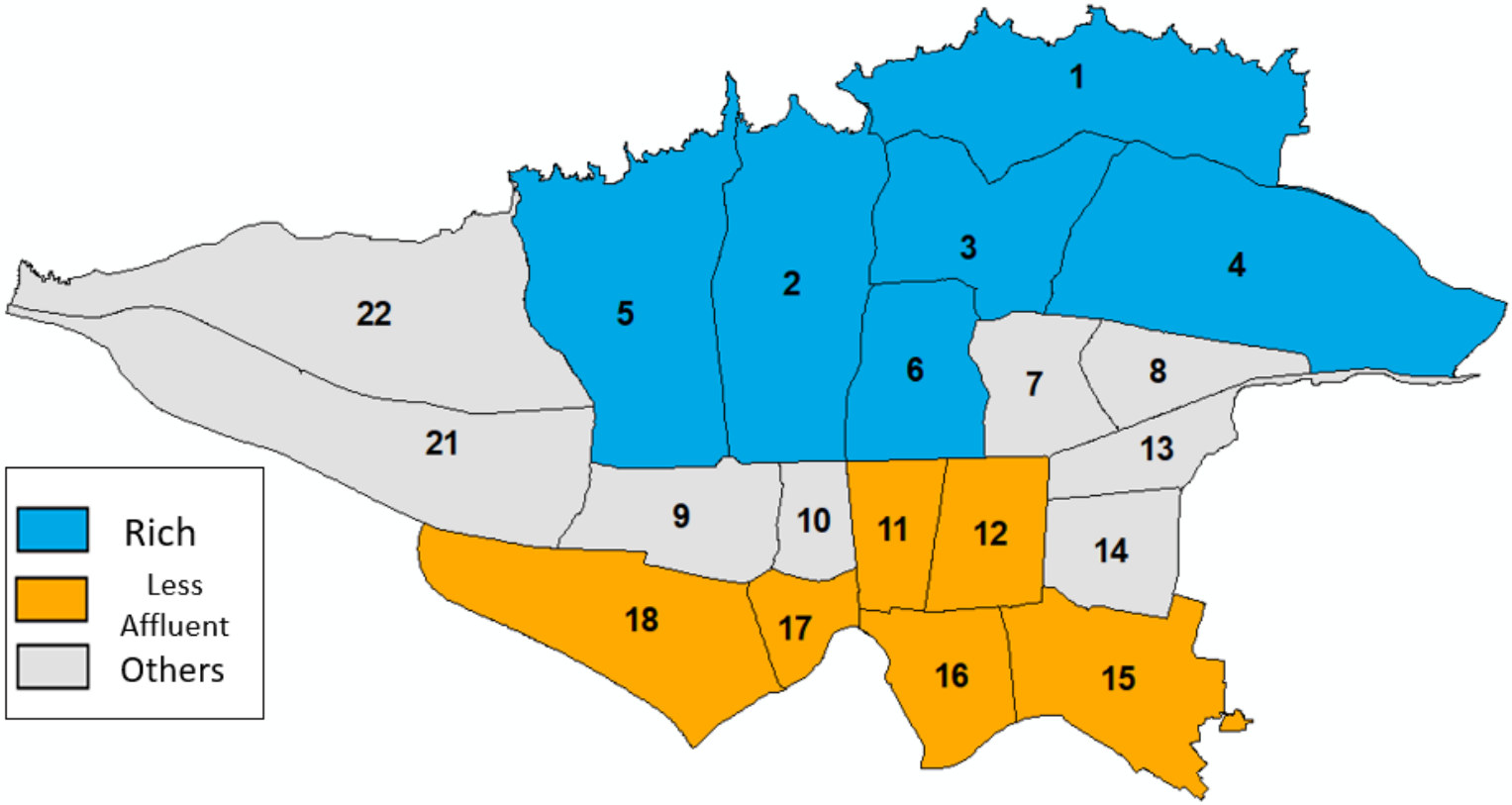
	Dep. Var.: LnPrice			
	2010-18	2010-11	2012-16	2017-18
DisPark	-0.000238	-0.004080***	0.000650*	0.000636
DisMetro	-0.0127***	-0.0108**	-0.0097***	-0.0177***
MetroGroup=2	-1.70***	-0.82	-0.79	-3.22***
DisMetro.MetroGroup=2	0.0119***	0.0102**	0.0087***	0.0170***
Time FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Time*Region FE	Yes	Yes	Yes	Yes
FrameType FE	Yes	Yes	Yes	Yes
N	1099488	237074	610462	251952
R^2	0.773	0.463	0.630	0.792

p-values: * p<0.05, ** p<0.01, *** p<0.001

- All coefficients multiplied by 100.

Geographic Distribution of Housing Prices

- We divide Tehran into 2 distinct groups based on house prices.
  - Rich regions
  - Less Affluent regions



Distance to the Nearest Park- Rich and Less Affluent Regions

	Rich Regions		Less Affluent Regions	
	2010-11	2017-2018	2010-2011	2017-2018
DisPark	-0.0150***	-0.0118***	0.0137***	0.0181***
DisMetro	-0.0114	-0.0270***	-0.0207**	-0.0099**
MetroGroup=2	3.00	-1.10	-3.33	-1.44
DisMetro.MetroGroup=2	0.0113	0.0268***	0.0152*	0.0080*
N	116327	124541	40811	39936
R^2	0.347	0.727	0.238	0.589

p-values: * p<0.10, ** p<0.05, *** p<0.01

- Rich regions are 6 districts with the highest average housing prices and less affluent regions are 6 districts at the bottom.
- All coefficients multiplied by 100.

Distance to each Type of Park- Rich Regions

	Rich Regions			
	2010-11	2017-2018	2010-2011	2017-2018
Very small	-0.000235	-0.00277***	0.000399	0.000741
Small	-0.00150***	-0.00293**	-0.000541	-0.00235**
Midize	-0.00330***	-0.00325***	-0.00385***	-0.00225***
Big	-0.00606***	-0.00652***	-0.00585***	-0.00616***
Very big	-0.00237***	-0.00259***	-0.00231***	-0.00243***
N	519826	116327	278958	124541
R^2	0.751	0.357	0.506	0.736

p-values: * p<0.05, ** p<0.01, *** p<0.001

- All coefficients multiplied by 100.

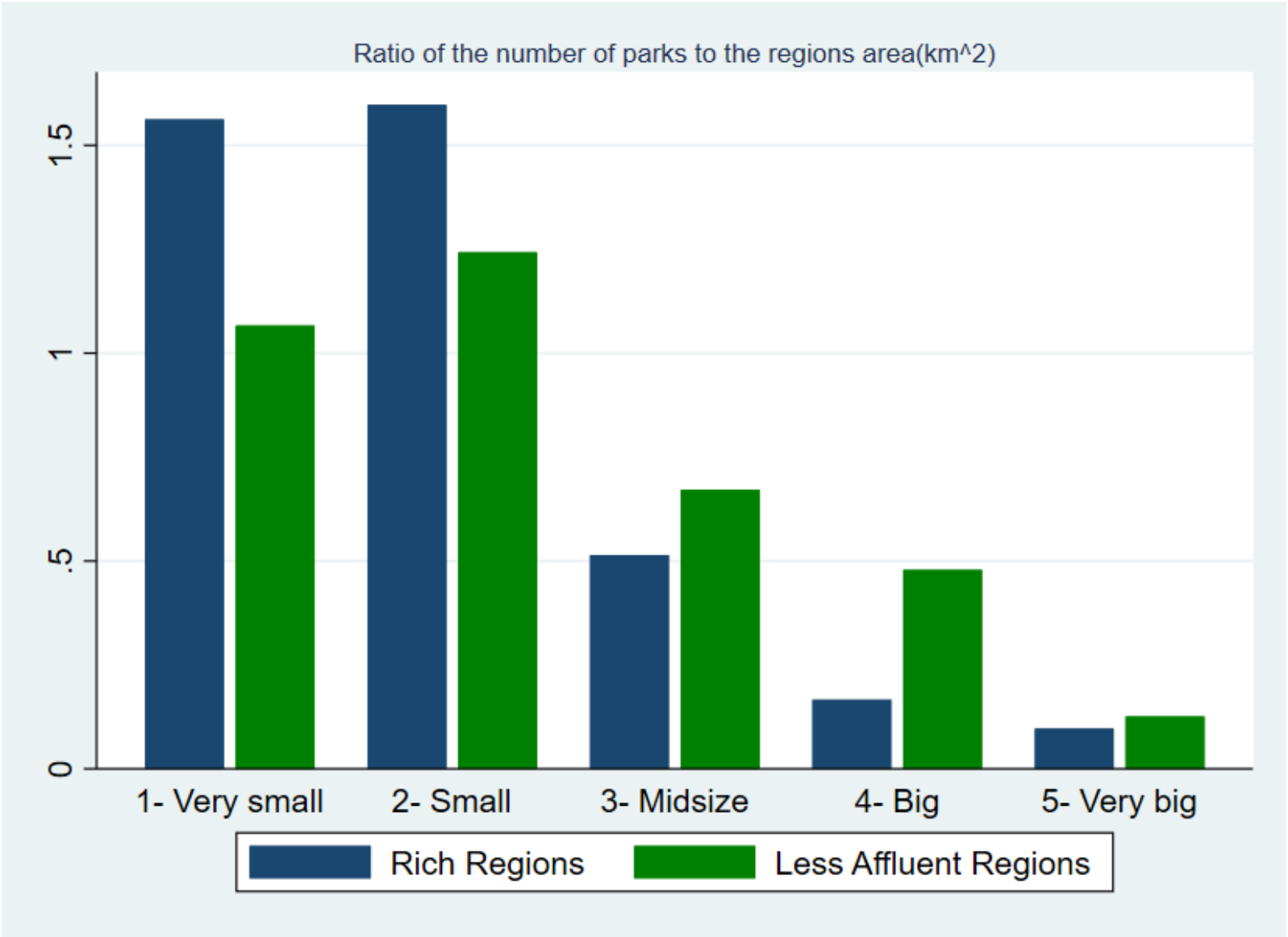
Distance to each Type of Park- Less Affluent Regions

	Less Affluent Regions			
	2010-18	2010-11	2012-2016	2017-18
Very small	0.0000961	-0.00202*	0.000498	0.00217*
Small	-0.00197***	-0.00260**	-0.00290***	0.00401***
Midsize	0.00879***	0.0106***	0.0106***	0.00139
Big	0.00782***	0.00209***	0.00864***	0.0101***
Very big	0.00122***	-0.000276	0.000304	0.00800***
N	204837	40811	124090	39936
R^2	0.648	0.250	0.376	0.625

p-values: * p<0.05, ** p<0.01, *** p<0.001

- All coefficients multiplied by 100.

Park's Distribution in Rich and Less Affluent Regions



Difference in Differences

- We only consider Midsize parks:
  - Small parks has a little economical significance
  - Big parks construction violates "no anticipation" assumption
- Treatment and post variables are defined:

$$Treatment = \begin{cases} 1 & \textit{in 400 m radius} \\ 0 & \textit{between 400 m and 1500 m} \end{cases}$$

$$Post = \begin{cases} 1 & \textit{3 years after parks' construction} \\ 0 & \textit{3 years before parks' construction} \end{cases}$$

- If a park has been constructed in 2014, we use traded houses in 2012-14 as the pre_treatment, and 2014-16 as the post_treatment.

Summary Stats- Midsize parks

- The table shows the number of constructed midsize park in Tehran from 2011 to 2018:

Year	Tehran*	Rich	Less Affluent
2011	6	6	0
2012	10	5	3
2013	11	5	0
2014	8	5	3
2015	5	2	3
2016	2	1	1
2017	5	2	2
2018	1	1	0
Total	48	27	12

- More than 50% of midsize parks constructed in rich regions (Spatial variation)

* Districts 19, and 20 have been excluded

Staggered Difference in Differences

- Model specification:

$$\ln P_{it} = \beta_0 + \beta_X X_{it} + \beta_p post_{it} + \beta_{tr} treat_{it} + \beta_{ptr} post.treat_{it} + \epsilon_{it}$$

- $\ln P_{it}$: Natural logarithm of the price P of property i in in year $t \in \{2010, ..., 2018\}$
.
- X_{it}: Control variables
- $treat_{it}$: Dummy variable equal 1 if house i has been treated in year t.
- $post_{it}$: (series of) Dummy variable(s) indicating the time period after the park opening.
- $post.treat_{it}$: The interaction term of $treat_{it}$ and $post_{it}$.

DiD- Results

	Rich Regions		Less Affluent Regions	
	400 m	500 m	400 m	500 m
1.post	0.0521***	0.0568***	-0.0568***	0.0528***
	(0.000)	(0.000)	(0.000)	(0.000)
1.Treat	-0.0529***	-0.0419***	-0.0142***	-0.0138***
	(0.000)	(0.000)	(0.009)	(0.002)
1.post#1.Treat	0.0289***	0.0190***	-0.0357***	-0.0279***
	(0.000)	(0.001)	(0.000)	(0.000)
N	110376	110258	62959	62959
R^2	0.663	0.663	0.618	0.618
p-values in parentheses $*p < 0.05, **p < 0.01, ***p < 0.001$				

- Midsize parks have positive impacts in rich regions, while its impacts are reversed in less affluent regions.

Parallel Trend: Pre-Treatment Effect

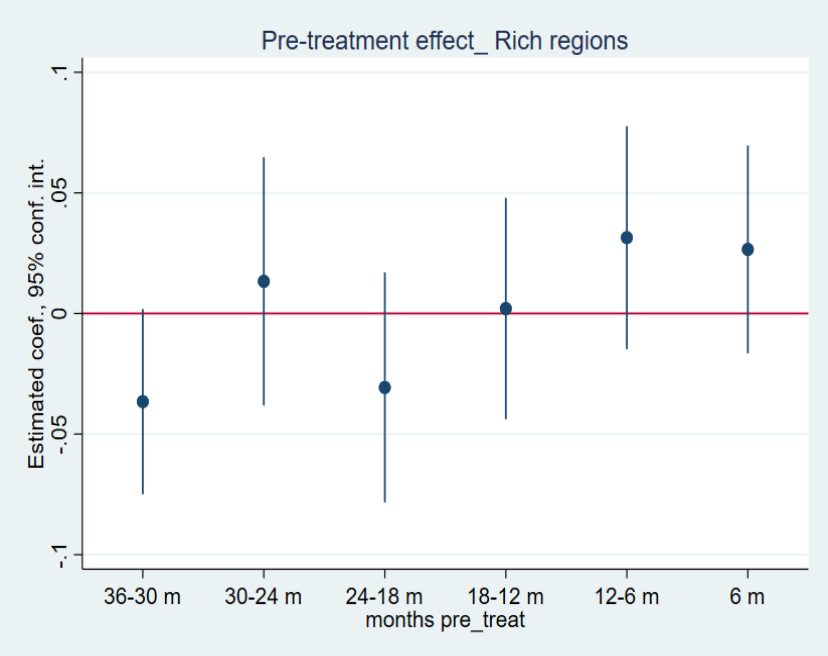


Figure: Rich Regions

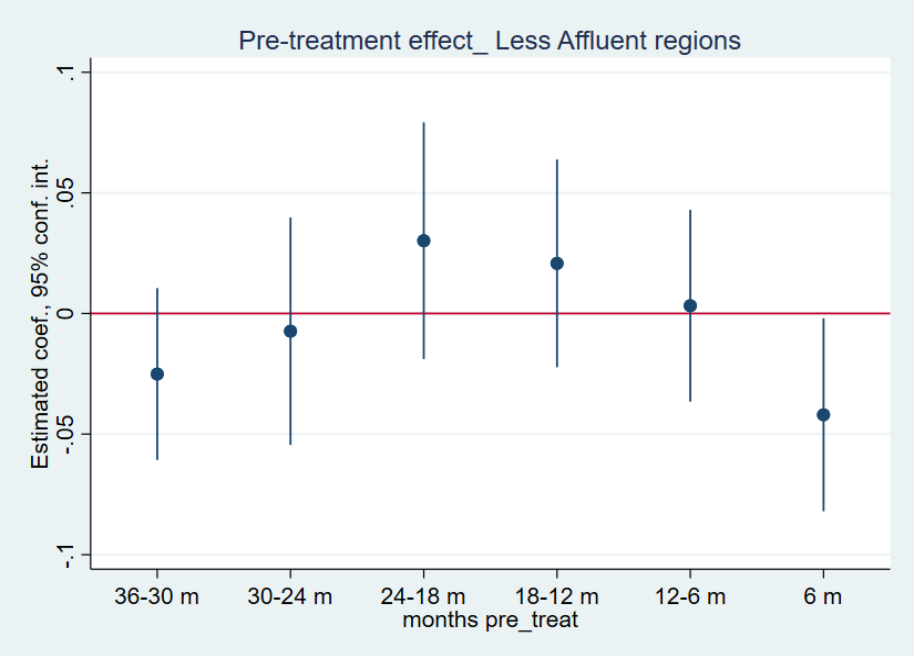


Figure: Less Affluent Regions

- The coefficients of treatment group before the construction of the parks are insignificant

Robustness check

- Like the previous method, the treatment is defined based on proximity to the parks' boundaries.
- For the post variable, we use following methods:

the value of post variable	2 years	all years
0	2 years before treat	all years before treat
1	2 years after treat	all years after treat

Robustness Check

	Rich Regions				Less Affluent Regions			
	2 years		all years		2 years		all years	
	400 m	500 m	400 m	500 m	400 m	500 m	400 m	500 m
1.post	0.0325***	0.0344***	0.0323***	0.0314***	-0.0109*	-0.00857	-0.164***	-0.161***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.085)	(0.169)	(0.000)	(0.000)
1.Treat	-0.0394***	-0.0270***	-0.0764***	-0.0592***	-0.0259***	-0.0189***	0.0102**	-0.00681*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.024)	(0.070)
1.post#1.Treat	0.0190***	0.00661	0.0373***	0.0153***	-0.0224***	-0.0144***	-0.0598***	-0.0391***
	(0.014)	(0.318)	(0.000)	(0.002)	(0.008)	(0.037)	(0.000)	(0.000)
N	85411	85409	181219	180765	48340	48340	94008	94005
R^2	0.678	0.678	0.741	0.741	0.630	0.630	0.642	0.642

p-values in parentheses $*p < 0.05, **p < 0.01, ***p < 0.001$

Dynamic Effects

- To measure dynamic impacts of the parks' construction, we conduct another method for post variable definition.

$$n = \textit{time of trade} - \textit{time of treat}$$

$$post = \begin{cases} 0 & n < 0 \\ n + 1 & n \geq 0 \end{cases}$$

- For instance, if a house has been traded 2 years after the park's construction, the post variable equals to 3.

Dynamic Effects

	Rich Regions		Less Affluent Regions	
	400 m	500 m	400 m	500 m
1.Treat	-0.0737***	-0.0543***	0.00962**	-0.00653*
	(0.000)	(0.000)	(0.032)	(0.081)
1.post#1.Treat	0.0206**	0.0176**	-0.0774***	-0.0466***
	(0.021)	(0.023)	(0.000)	(0.000)
2.post#1.Treat	0.0596***	0.0366***	-0.0790***	-0.0571***
	(0.000)	(0.000)	(0.000)	(0.000)
3.post#1.Treat	0.0260***	0.00566	-0.0477***	-0.0498***
	(0.003)	(0.484)	(0.000)	(0.000)
4.post#1.Treat	0.0319***	0.00884	-0.0762***	-0.0522***
	(0.000)	(0.208)	(0.000)	(0.000)
5.post#1.Treat	0.0373***	0.00147	-0.0747***	-0.0503***
	(0.000)	(0.844)	(0.000)	(0.000)
6.post#1.Treat	0.0610***	0.0194***	-0.113***	-0.110***
	(0.000)	(0.006)	(0.000)	(0.000)
7.post#1.Treat	0.0722***	0.0438***	-0.125***	-0.105***
	(0.000)	(0.000)	(0.000)	(0.000)
N	172924	172859	94008	94005
R^2	0.726	0.727	0.651	0.651

p-values in parentheses $*p < 0.05, **p < 0.01, ***p < 0.001$

Dynamic Effects- coefficients

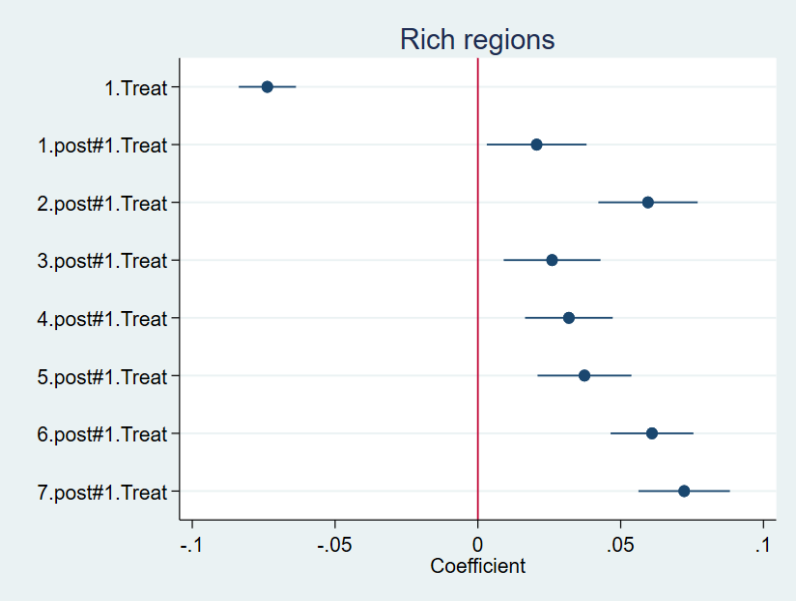


Figure: Rich Regions

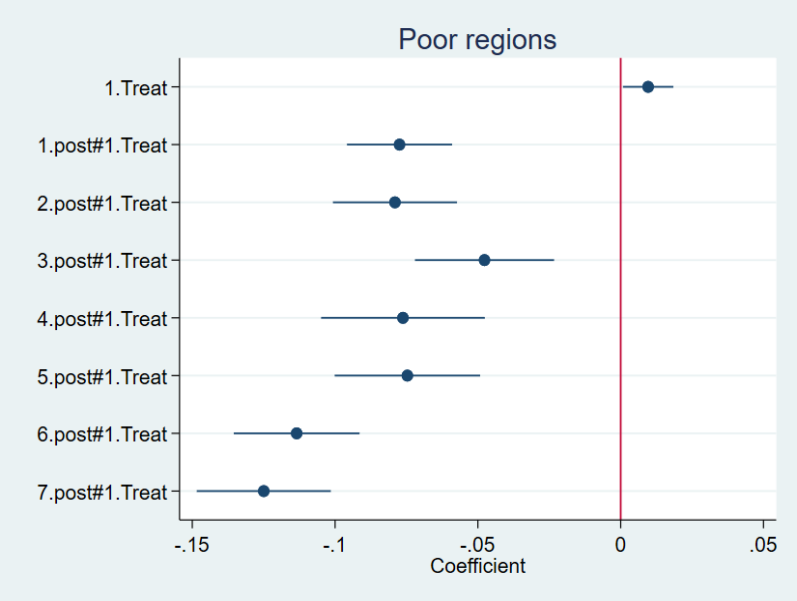


Figure: Less Affluent Regions

- The magnitude of treatment go through an increasing trend in positive and negative amount, respectively in rich and Less Affluent regions.

Conclusions

- Green spaces have different effects on houses regarding their area and location.
- People who live in rich regions, spend more money for being close to the park.
- Housing market inflation reduce peoples' willingness to pay for environmental amenities.
- Opening of midsize parks in rich regions, on average, increased 2% - 4% price of its neighboring houses.
- In less affluent regions, construction of a park can lower house prices by 2.5% - 6%.

Thanks

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