Learning by working in big cities

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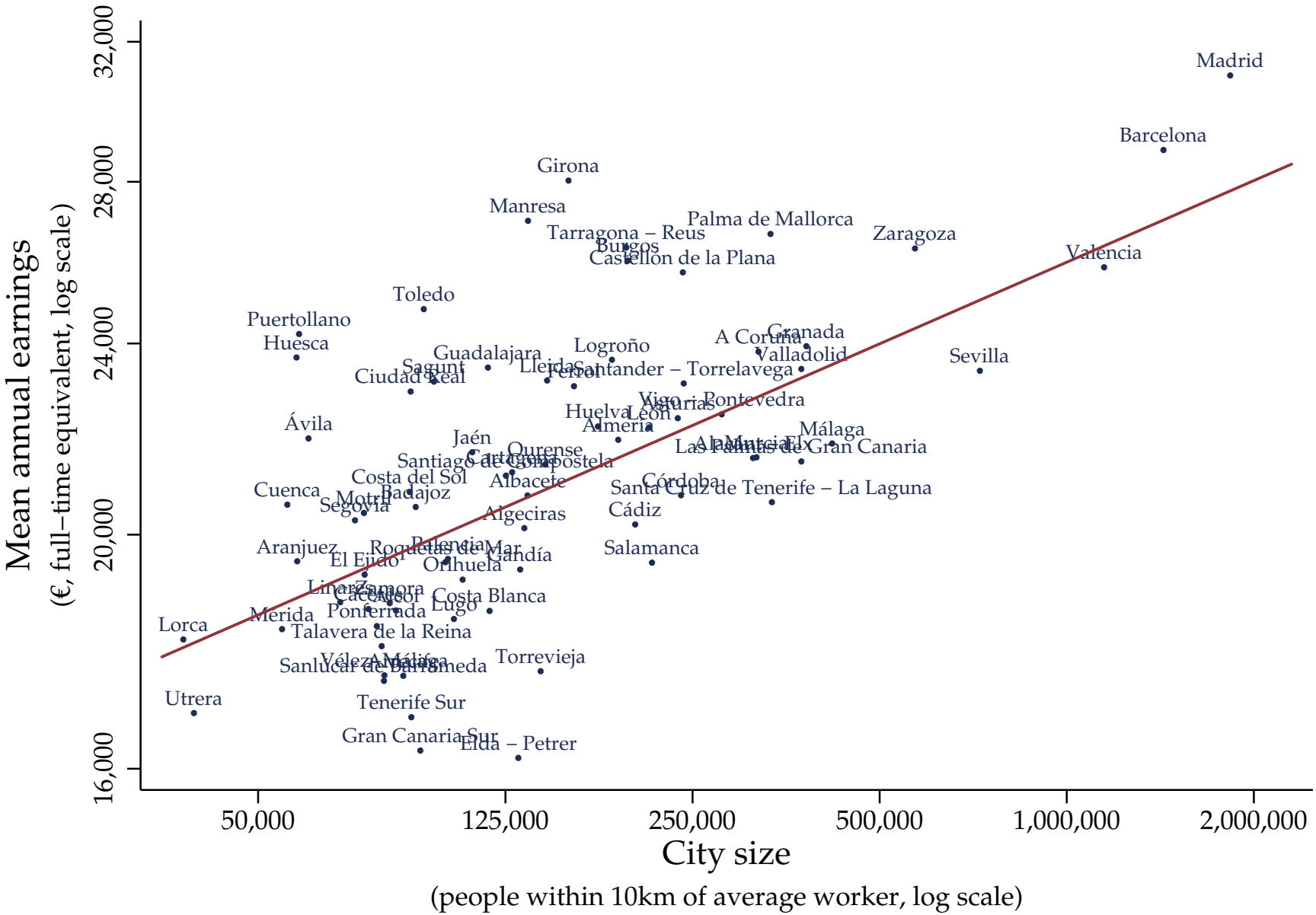
The earnings premium of bigger cities

- Workers in bigger cities earn significantly more (Glaeser and Maré, 2001, Wheaton and Lewis, 2002, Gould, 2007, Combes, Duranton, and Gobillon, 2008, Combes, Duranton, Gobillon, and Roux, 2010, Glaeser and Resseger, 2010, Baum-Snow and Pavan, 2012).
- Differences remain large even when we compare workers with the same education and years of experience and in the same industry.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(€, full−time equivalent, log scale)
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125,000
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(people within 10km of average worker, log scale)
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Spatial equilibrium

- From the point of view of workers, higher nominal earnings in bigger cities tend to be offset by differences in the cost of living (housing).
- However, in tradable sectors, if firms are willing to pay higher wages in bigger cities to workers with similar characteristics it is because of higher productivity.
- These productive advantages firms experience are confirmed by productivity estimations.

The earnings premium of bigger cities

- Three potential reasons why employers are willing to pay more in bigger cities to similar workers :
  - **Static advantages**, enjoyed while located in bigger cities and lost upon moving away.
  - **Sorting** into bigger cities by workers with higher initial ability.
  - **Learning advantages**, whereby bigger cities allow workers to accumulate more valuable experience. These advantages are dynamic and, if embedded into human capital, they may remain beneficial even when a worker moves away.
- We use rich administrative (matched social security, tax and census) panel data for Spain to evaluate all three.

Related literature

- Estimation of productivity advantages for firms from locating in bigger cities with more firms nearby (Henderson, 2003, Combes, Duranton, Gobillon, Puga, and Roux, 2011).
- Estimation of city size earnings premium (Combes, Duranton, and Gobillon, 2008, Mion and Naticchioni, 2009, Glaeser and Resseger, 2010).
- Learning advantages of big cities (Glaeser, 1999, Duranton and Puga, 2001, Glaeser and Maré, 2001, Gould, 2007).
- Structural work by Baum-Snow and Pavan (2012). Similar questions, different methodology, partly they must work with much smaller US NLSY sample (1,758 men observed annually, vs. 150,375 men observed monthly in our case).

Data : Cities

- City definitions :
  - We use 2008 urban area/city definitions by Spain's Department of Housing.
  - 85 cities comprising 744 municipalities and 30 million people (9.5 % of Spain's surface and 67.5% of its population).
  - Median (Jaen) 141,028 ; range : 5,966,067 (Madrid) – 35,396 (Teruel).


Ferrol
A Coruña
Asturias
Santander - Torrelavega
Bilbao
Donostia/San Sebastián
Lugo
Santiago de Compostela
Vitoria/Gasteiz
Pamplona
Ponferrada
León
Ourense
Burgos
Logroño
Vigo - Pontevedra
Huesca
Palencia
Soria
Girona
Sant Feliú de Guixols
Zaragoza
Manresa
Blanes - Lloret de Mar
Valladolid
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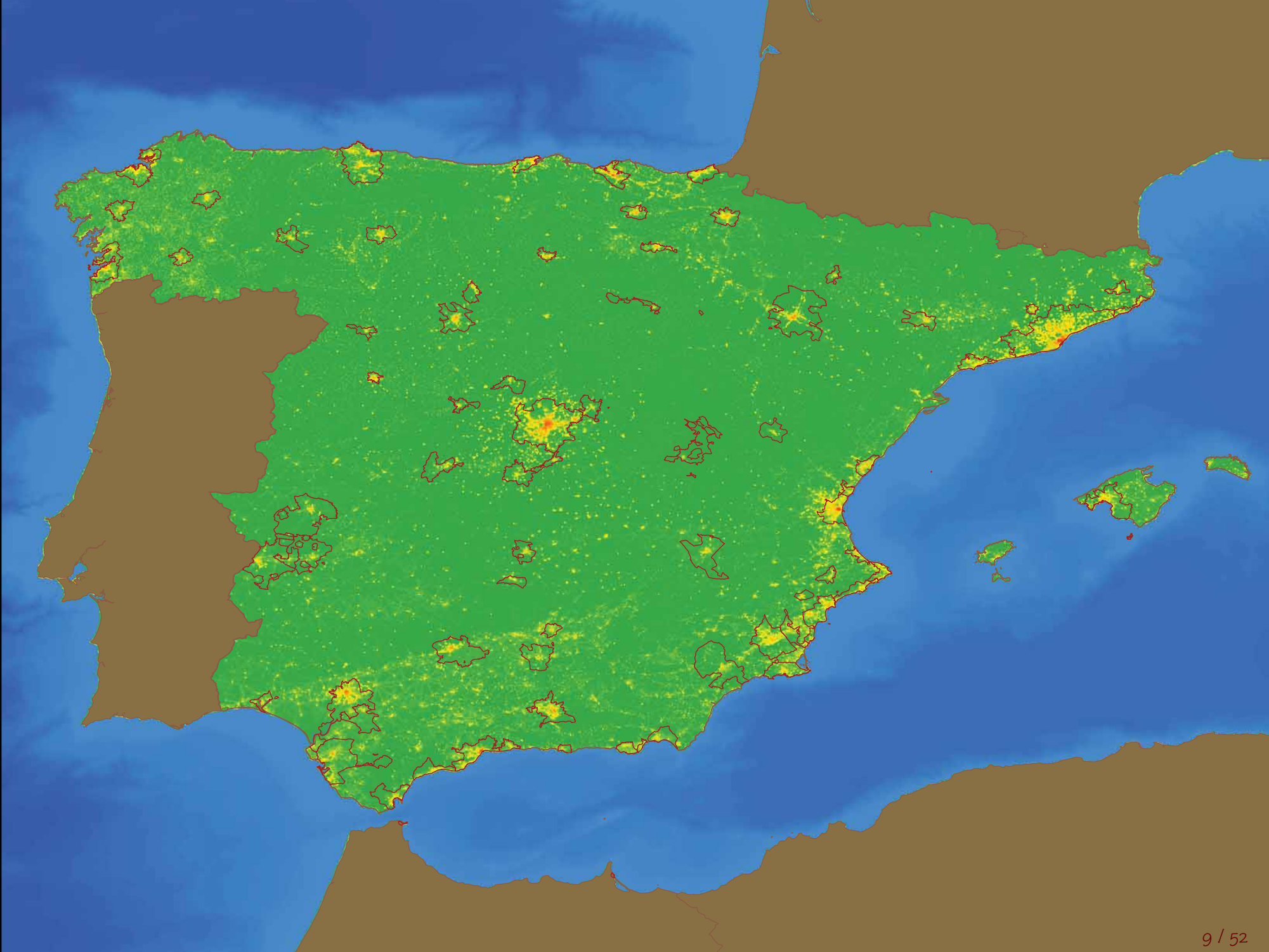

Data : City size

- When measuring the scale of each city we wish to capture the potential for interactions between workers.
- We calculate the number of people within 10 kilometres of the average person.
- Our measure of city size is highly correlated with a simple population count (0.94), but deals more naturally with unusual cities, in particular those that are polycentric.
- This measure is also less prone to border problems than simple density measures that divide population by area.


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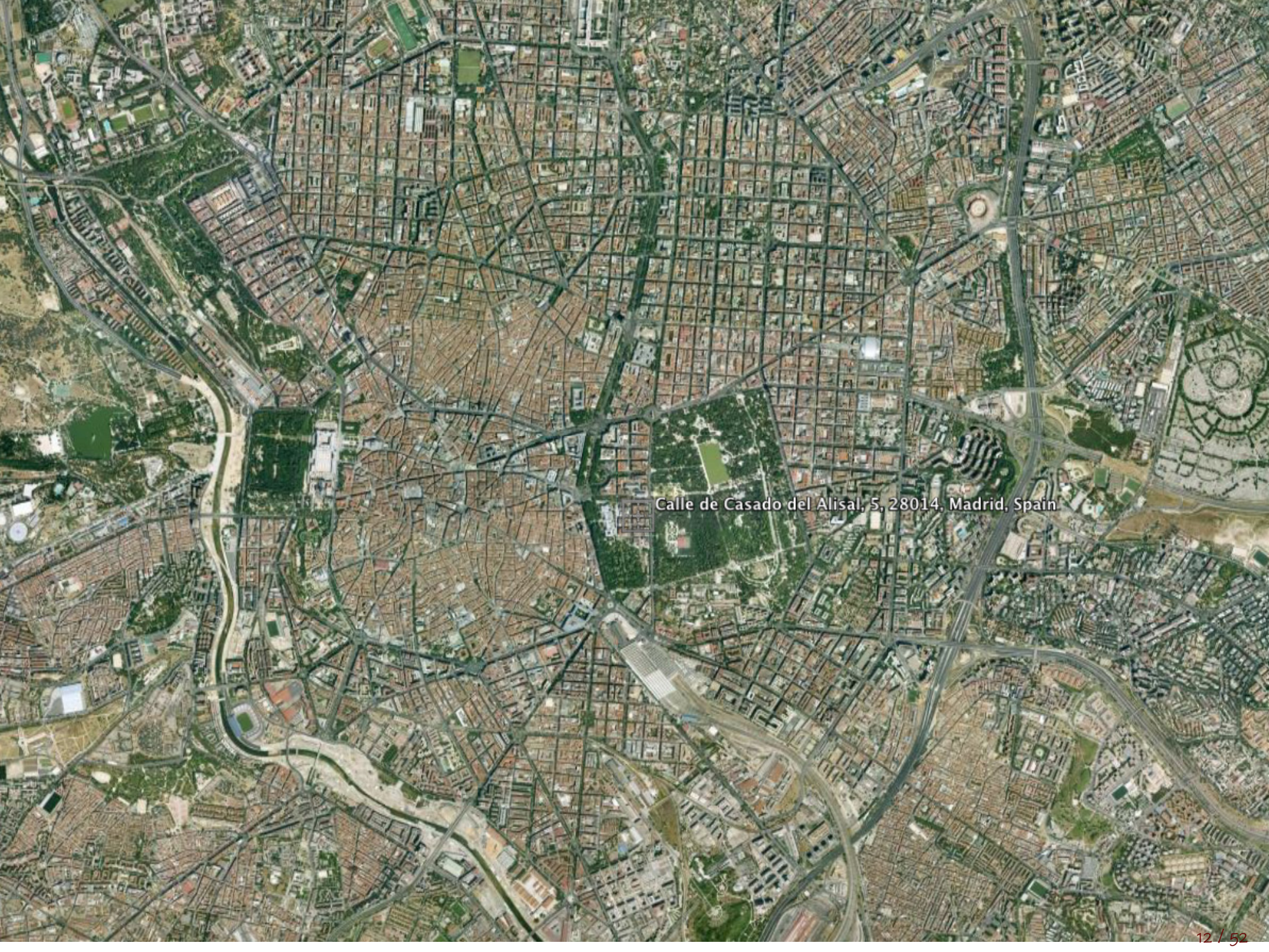
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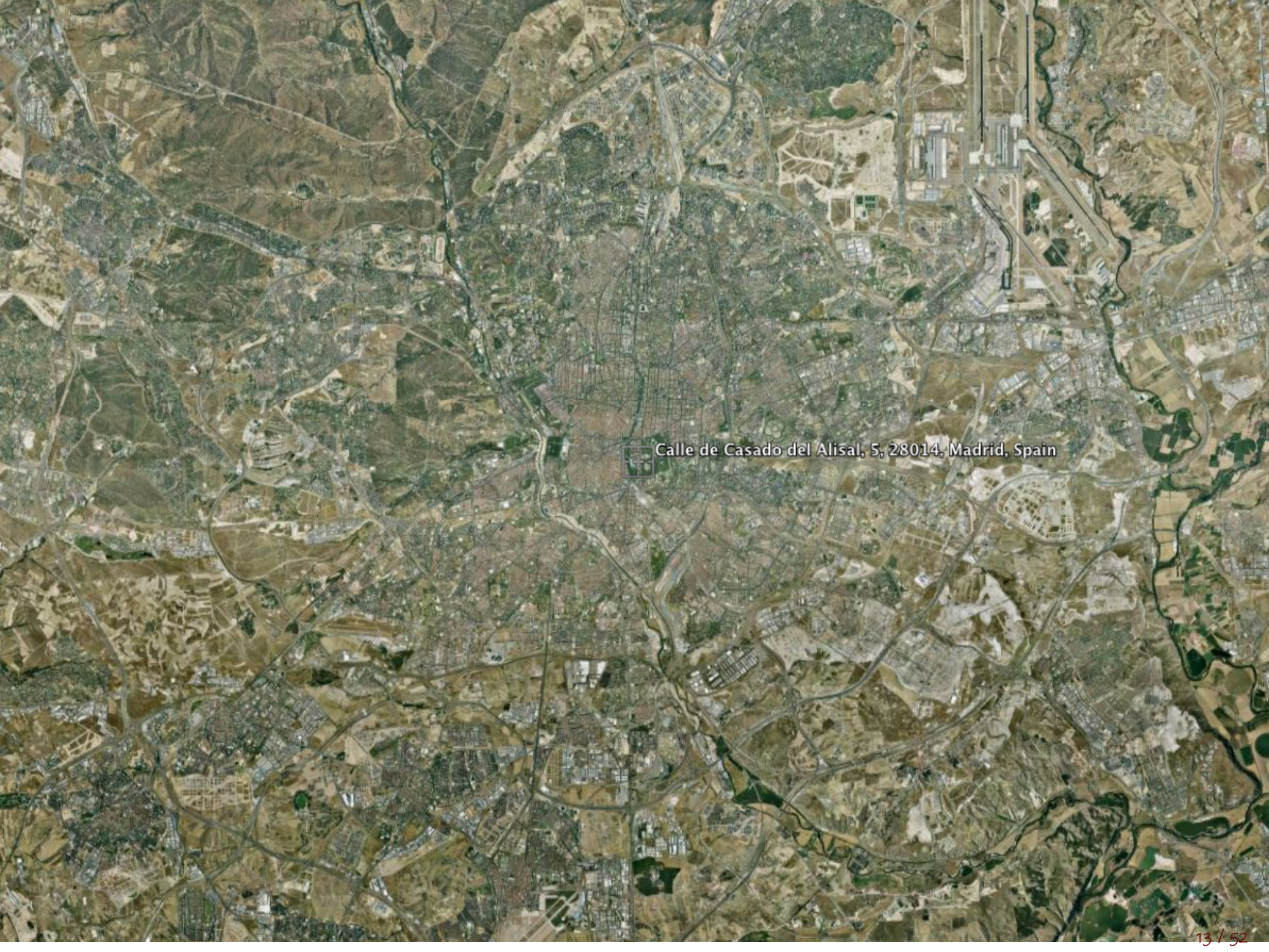
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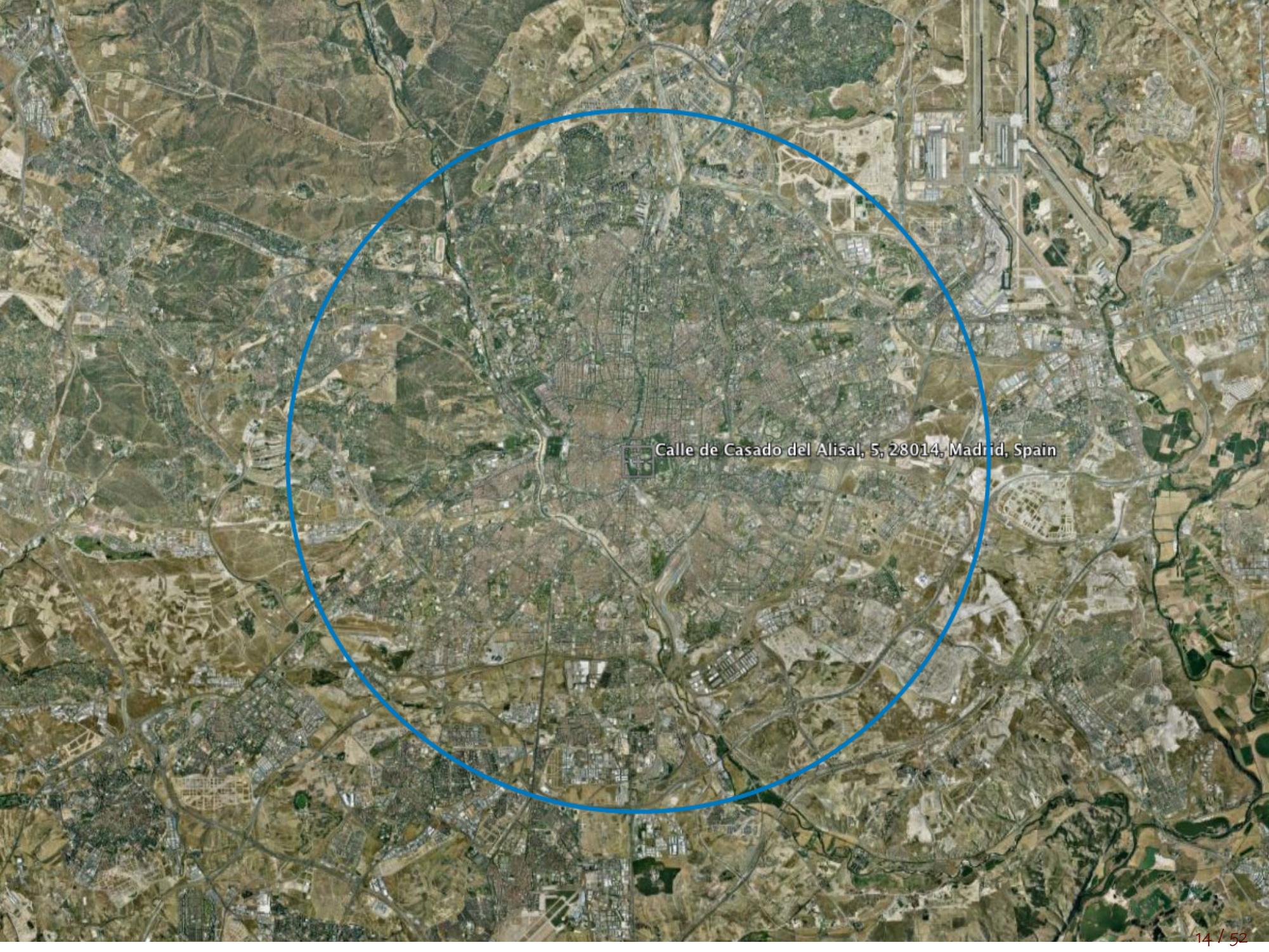
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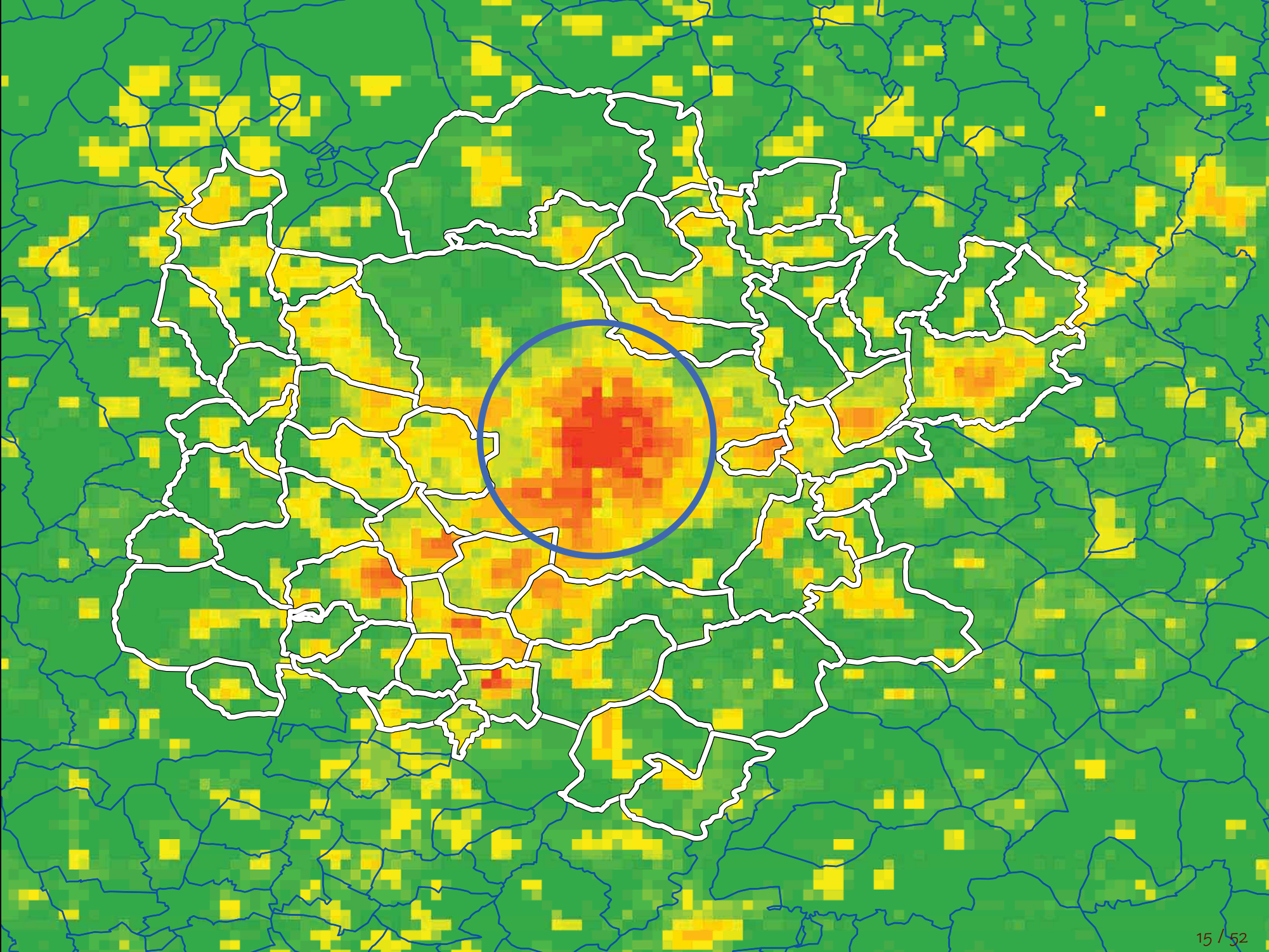
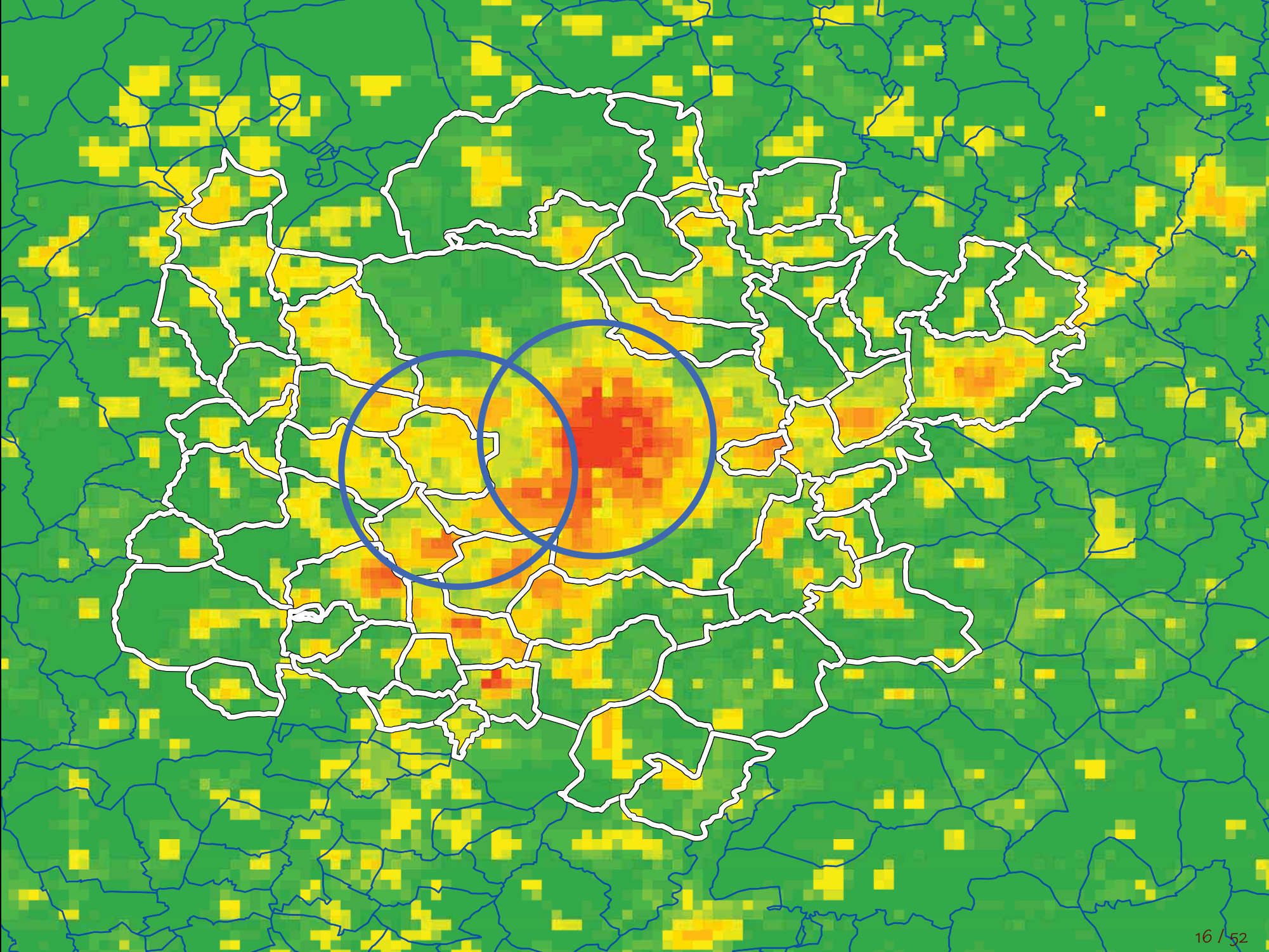
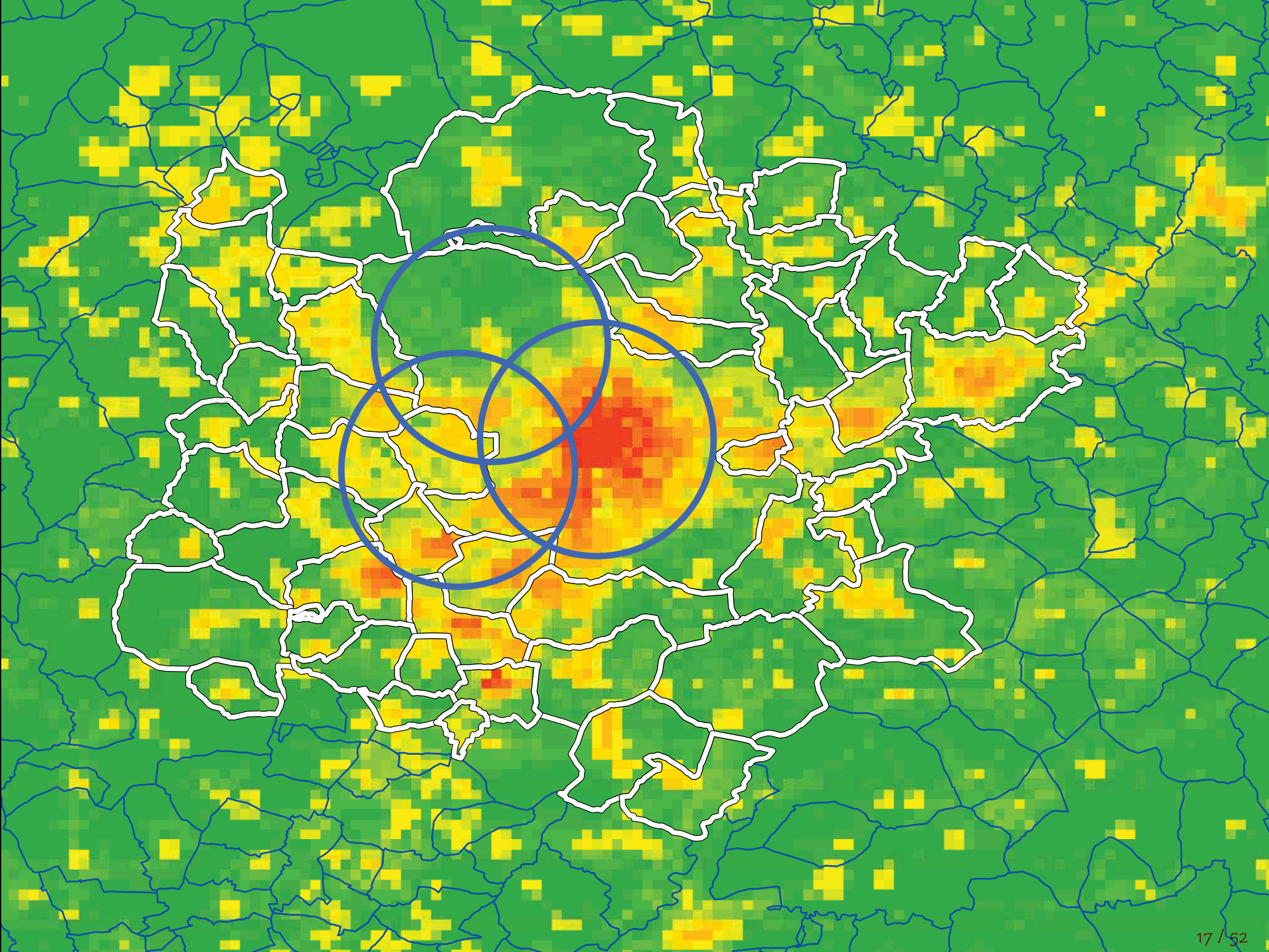
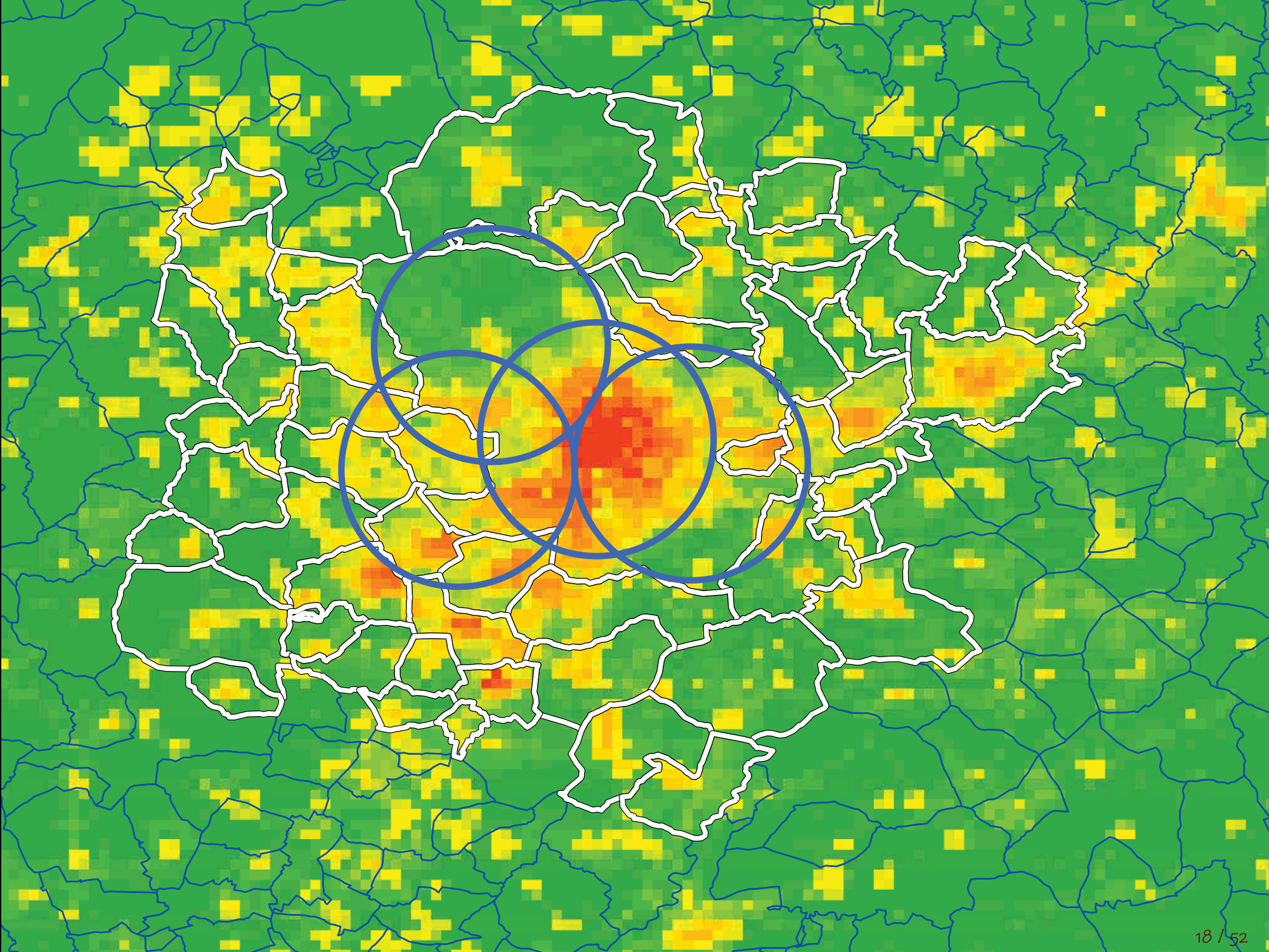
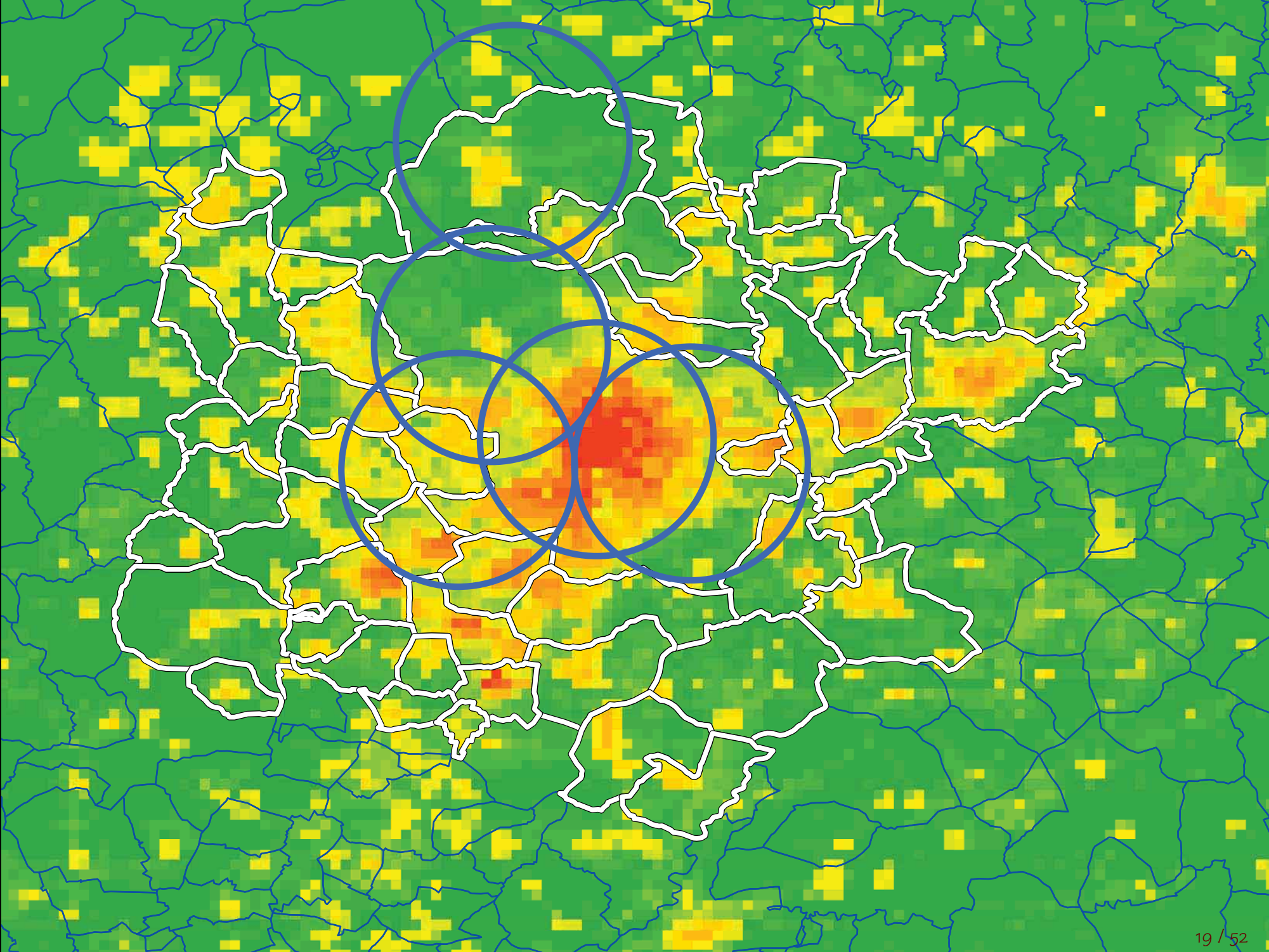










Data : MCVLThe worker sample

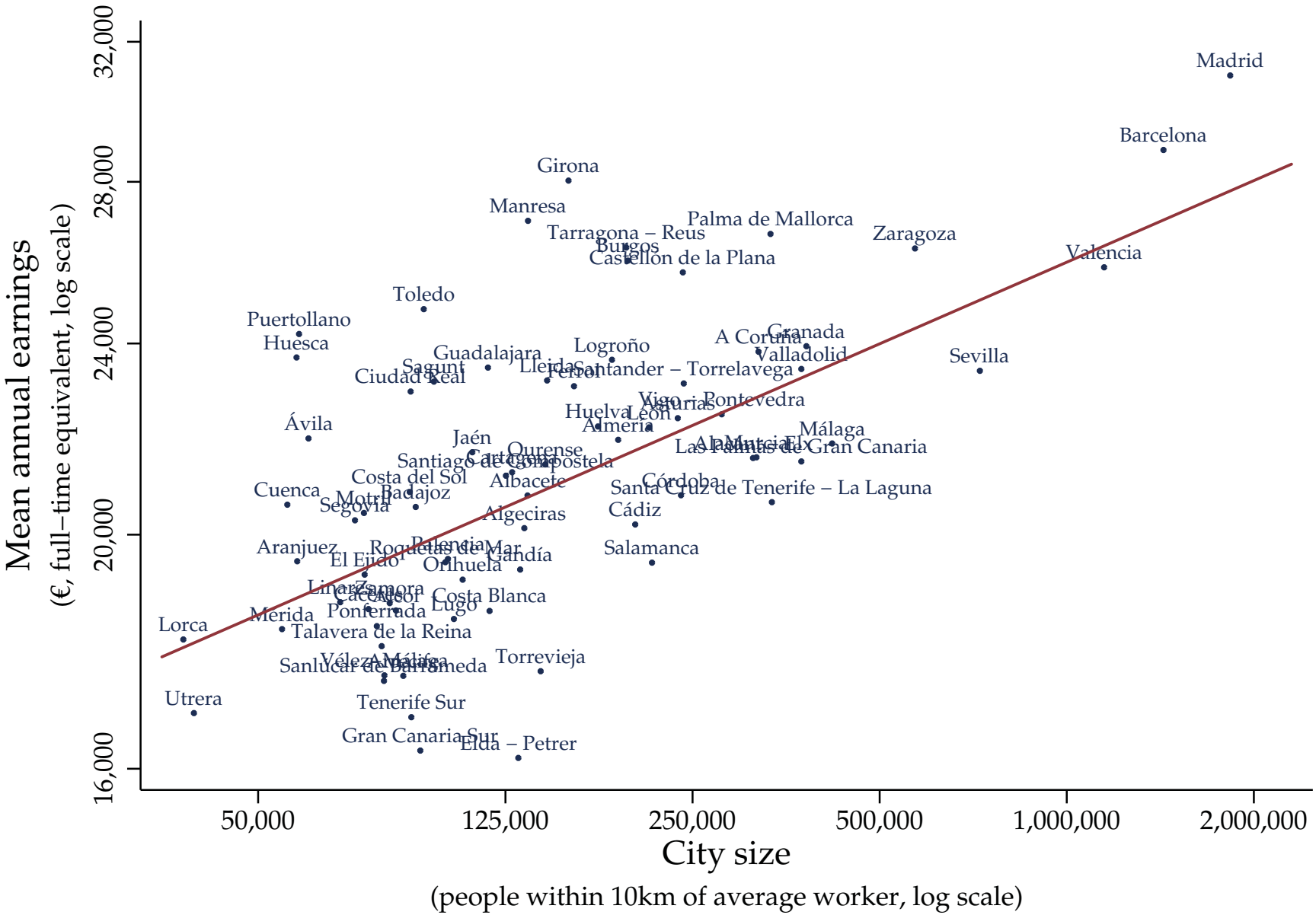
- Our main data set is Spain's Continuous Sample of Employment Histories (*Muestra Continua de Vidas Laborales* or MCVL).
- Administrative data with longitudinal information obtained by matching social security, income tax, and census records.
- Tracks a 4% non-stratified random sample of the population who on a given year have any relationship with Spain's Social Security (individuals who are working, receiving unemployment benefits, or receiving a pension).
- The unit of observation is any change in the individual's labour market status or any variation in job characteristics (including changes in occupation or contractual conditions within the same firm).
- The data record all changes since the date of first employment, or since 1981 for earlier entrants.
- Also personal characteristics from matched Census data.
- Earnings by source from matched income tax returns for 2004–2009.

The worker sample

- Data covering 73 out of 83 cities :
  - tax (earnings) data is missing for the 4 cities in Basque Country and Navarre,
  - location data is not available for workers in municipalities with a population below 40,000 in 2001, hence, another 6 cities lost.
- Our starting sample are Spanish male employees aged 18–46 working in any of these cities : 183,477 workers and 7,154,764 monthly obs.
- We eliminate workers
  - in the public sector and in education and health services because their salaries are heavily regulated,
  - in agrarian, mining/extractive, fishing and household activites
  - who, among all jobs, have performed less than 30 days of full-time equivalent work in the calendar year.
- We end up with 150,375 individuals and 5,821,846 monthly obs.

Some summary statistics

- The average worker
  - is 32.4 years old,
  - has 10.10 years of overall work experience,
  - has accumulated experience in a single city during 7.24 years,
  - has had 5.9 distinct jobs in his life.
- 14.4% of workers move across cities at least once during 2004-2009 (useful for worker fixed-effects estimation).
- 10.1% of workers always work in high-skilled occupations.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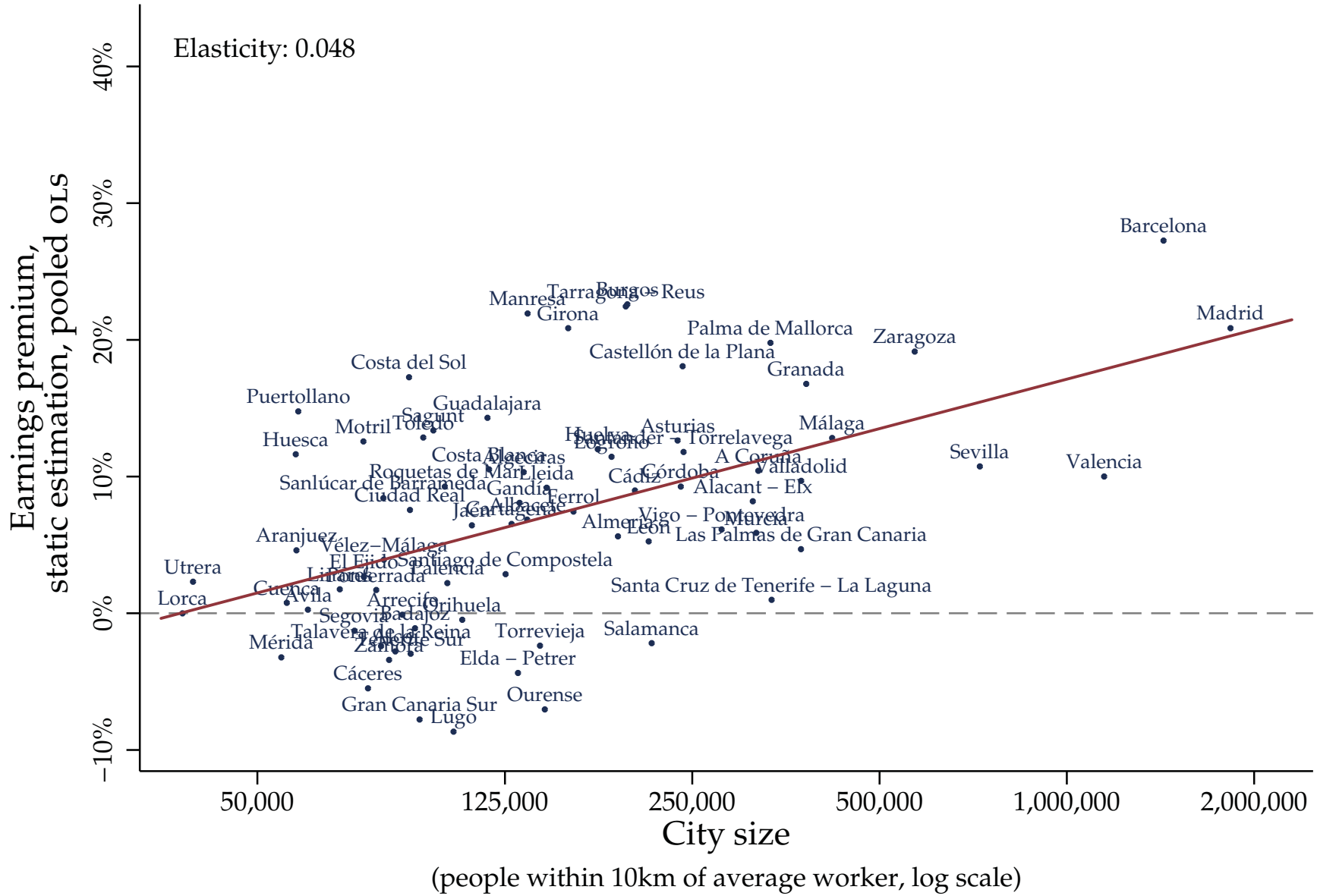
Estimating the static city-size earnings premium

- We follow a two-stage process.
  - In the first stage, we regress log daily earnings on a complete set of city indicators, while controlling for individual and job characteristics.
  - In the second stage, we regress the coefficients of the city indicators on our measure of log size to estimate the elasticity of earnings with respect to city size.

	(1)	(2)	(3)	(4)
Dependent variable :	Log earnings	City indicator coefficients column (1)	Log earnings	City indicator coefficients column (3)
Log city size		0.048 (0.008)***		
City indicators	Yes			
Worker fixed-effects	No			
Experience	0.033 (0.001)***			
Experience^2	-0.001 (0.000)***			
Firm tenure	0.014 (0.001)***			
Firm tenure^2	-0.001 (0.000)***			
Secondary education	0.101 (0.002)***			
University education	0.186 (0.004)***			
Very-high-skilled occupation	0.791 (0.006)***			
High-skilled occupation	0.520 (0.005)***			
Medium-high-skilled occupation	0.375 (0.006)***			
Medium-skilled occupation	0.230 (0.004)***			
Medium-low-skilled occupation	0.121 (0.005)***			
Low-skilled occupation	0.065 (0.002)***			
Observations	5,821,846	73		
R^2	0.514	0.253		


Elasticity: 0.048
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Using working fixed-effects to address sorting

- If we study workers at one isolated point in time, we cannot distinguish the advantages of a location from unobserved characteristics of workers (being creative, hard-working, etc.) that could results in a higher wage.
- A possible solution is to introduce worker fixed-effects, comparing wages for the same worker across different cities as he moves over time.

	(1)	(2)	(3)	(4)
Dependent variable :	Log earnings	City indicator coefficients column (1)	Log earnings	City indicator coefficients column (3)
Log city size		0.048 (0.008)***		
City indicators	Yes			
Worker fixed-effects	No			
Experience	0.033 (0.001)***			
Experience^2	-0.001 (0.000)***			
Firm tenure	0.014 (0.001)***			
Firm tenure^2	-0.001 (0.000)***			
Secondary education	0.101 (0.002)***			
University education	0.186 (0.004)***			
Very-high-skilled occupation	0.791 (0.006)***			
High-skilled occupation	0.520 (0.005)***			
Medium-high-skilled occupation	0.375 (0.006)***			
Medium-skilled occupation	0.230 (0.004)***			
Medium-low-skilled occupation	0.121 (0.005)***			
Low-skilled occupation	0.065 (0.002)***			
Observations	5,821,846	73		
R^2	0.514	0.253		

	(1)	(2)	(3)	(4)
Dependent variable :	Log earnings	City indicator coefficients column (1)	Log earnings	City indicator coefficients column (3)
Log city size		0.048 (0.008)***		0.026 (0.006)***
City indicators	Yes		Yes	
Worker fixed-effects	No		Yes	
Experience	0.033 (0.001)***		0.103 (0.002)***	
Experience^2	-0.001 (0.000)***		-0.001 (0.000)***	
Firm tenure	0.014 (0.001)***		0.001 (0.000)***	
Firm tenure^2	-0.001 (0.000)***		-0.000 (0.000)***	
Secondary education	0.101 (0.002)***			
University education	0.186 (0.004)***			
Very-high-skilled occupation	0.791 (0.006)***		0.251 (0.006)***	
High-skilled occupation	0.520 (0.005)***		0.189 (0.004)***	
Medium-high-skilled occupation	0.375 (0.006)***		0.123 (0.005)***	
Medium-skilled occupation	0.230 (0.004)***		0.092 (0.003)***	
Medium-low-skilled occupation	0.121 (0.005)***		0.057 (0.005)***	
Low-skilled occupation	0.065 (0.002)***		0.019 (0.002)***	
Observations	5,821,846	73	5,821,846	73
R^2	0.514	0.253	0.163	0.165

Comparison with other countries

- Our static pooled OLS estimate of the elasticity of the earnings premium with respect to city size (0.048) is in line with previous estimates :
  - Combes, Duranton, Gobillon, and Roux (2010) find an elasticity of 0.051 for France.
  - Glaeser and Resseger (2010) obtain an elasticity of 0.041 for the US
- When worker fixed-effects are introduced, the elasticity falls to 0.26, similar to previous estimates :
  - Combes, Duranton, Gobillon, and Roux (2010) see the elasticity drop to 0.033 (our same 0.026 when instrumenting).
  - Mion and Naticchioni (2009) find a larger drop for Italy.
- Usual interpretation of the drop : evidence of strong sorting of the more able workers into the biggest cities.
- However, the drop can also be due in part to the fact that the bias from not considering dynamic effects is greatly mitigated when moving from the pooled OLS to the fixed-effects estimation.

Are the benefits of agglomeration only static or also dynamic?

- The usual view : the city size premium is associated with a current city,
  - the premium is attained immediately upon arrival in a big city,
  - and lost immediately upon departure.
- Some authors suggest that the key advantages of big cities are dynamic, they facilitate learning, experimentation, and the acquisition of skills (Glaeser, 1999, Glaeser and Maré, 2001, Duranton and Puga, 2001).
- To examine this, we need to relate the city size premium to the entire history of workplace location.
- We estimate :

$$w_{ict} = \underbrace{\sigma_c}_{\substack{\text{Instantaneous premium of} \\ \text{working in city } c}} + \mu_i + \gamma e_{it} + \nu e_{it}^2 + \underbrace{\sum_{j=1}^{C} (\delta_{jc} e_{ijt} + \lambda_{jc} e_{ijt}^2)}_{\substack{\text{Extra value of experience} \\ \text{depending on where} \\ \text{acquired and used}}} + \mathbf{x}_{it}'\beta + \varepsilon_{ict}$$

- Note σ_c is still estimated only on the basis of migrants, but δ_{jc} and λ_{jc} use the entire sample.

Initial city size premium

- By regressing the instantaneous premium

$$\underbrace{\sigma_c}_{\substack{\text{Instantaneous} \\ \text{premium of} \\ \text{working in city } c}}$$

on log size, we can calculate the elasticity with respect to city size of the initial earnings premium a worker gets right upon moving into a city.

- We can think of this as capturing the instantaneous benefits of working in big cities.

Medium-term city size premium

- Let $\bar{e}$ be an amount of time defined as the medium-term (i.e., the average value of experience accumulated in one city, 7.24 years).
- By regressing the medium-term premium

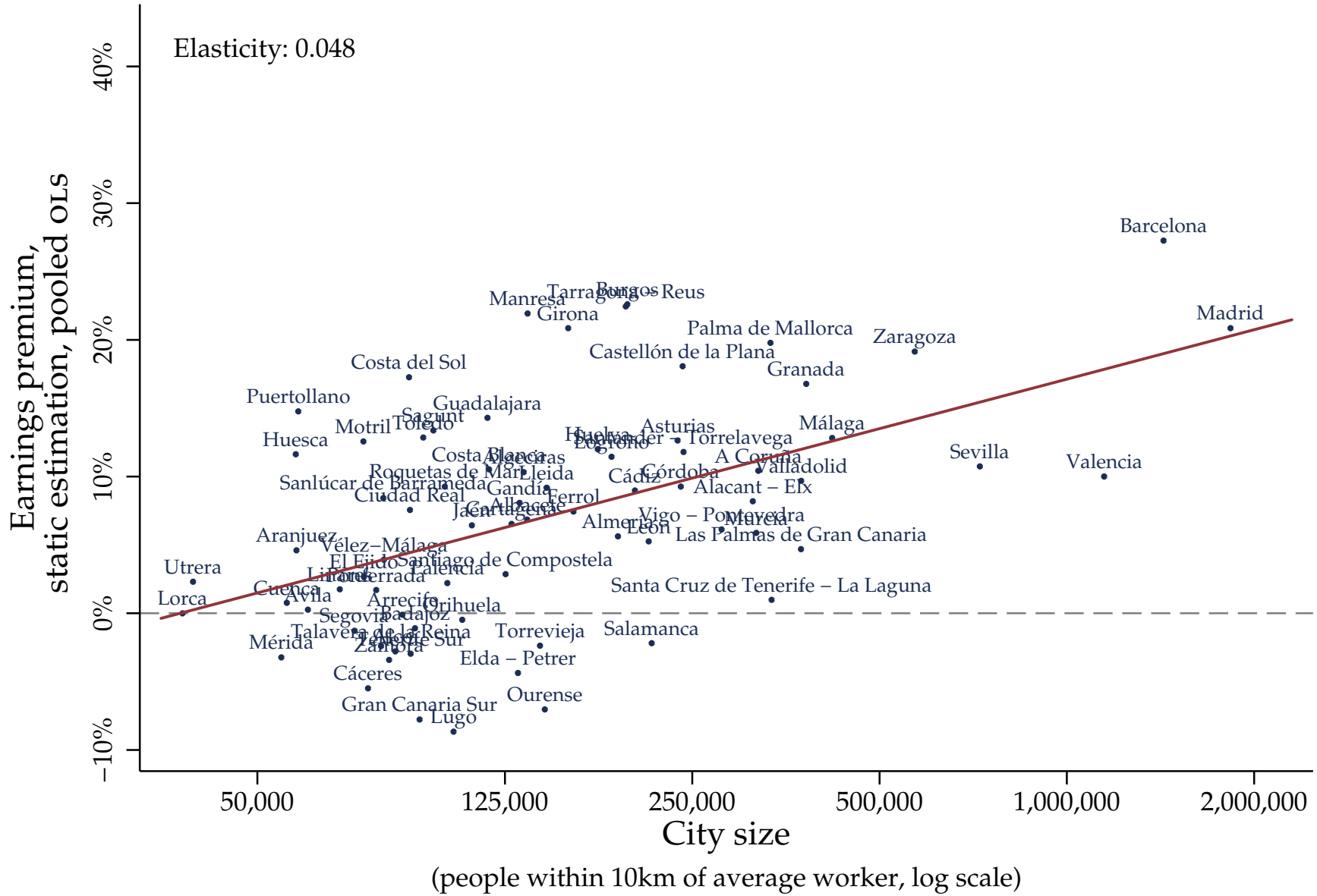
$$\underbrace{\sigma_c}_{\substack{\text{Instantaneous} \\ \text{premium of} \\ \text{working in city } c}} + \underbrace{\delta_c \bar{e} + \lambda_c \bar{e}^2}_{\substack{\text{Extra value} \\ \text{of experience} \\ \text{acquired in city } c}}$$

  on log size, we can calculate the elasticity with respect to city size of the medium-term earnings premium a worker gets after $\bar{e}$ years working in a city.
- We can think of this as capturing the medium-term benefits of learning by working in big cities.

	(1)	(2)	(3)
Dependent variable :	Log earnings	Initial premium (city indicator coefficients column (1))	Medium-term premium (initial + 7 years local experience
Log city size		0.026 (0.006)***	0.048 (0.011)***
City indicators	Yes		
Worker fixed-effects	Yes		
Experience 1st-2nd biggest cities	0.027 (0.001)***		
(Experience 1st-2nd biggest cities)^2	-0.001 (0.000)***		
Experience 1st-2nd biggest cities × now in smaller	0.002 (0.001)*		
Experience 3rd-5th biggest cities	0.011 (0.001)***		
(Experience 3rd-5th biggest cities)^2	-0.000 (0.000)***		
Experience 3rd-5th biggest cities × now in bigger	0.000 (0.003)		
Experience 3rd-5th biggest cities × now in smaller	-0.002 (0.002)		
Experience	0.090 (0.002)***		
Experience^2	-0.001 (0.000)***		
Firm tenure	0.001 (0.000)		
Firm tenure^2	-0.000 (0.000)***		
Occupation indicators	Yes		
Observations	5,821,846	73	73
R^2	0.166	0.165	0.362

Comparison of static and dynamic estimates

- The elasticity of the initial (instantaneous) earnings premium with respect to size in the dynamic fixed-effects estimation (0.026) is identical to that of the static fixed-effects estimation.
- The elasticity of the medium-term earnings premium with respect to size in the dynamic fixed-effects estimation (0.048) takes us back to the static pooled OLS estimation
- The medium-term calculation recovers learning effects while still leaving out sorting on unobservables. Thus, the drop from static pooled OLS to static fixed-effects can be fully accounted for by learning.
- In addition to reviewing the importance of sorting (more on this later), we also separate the static from the dynamic component.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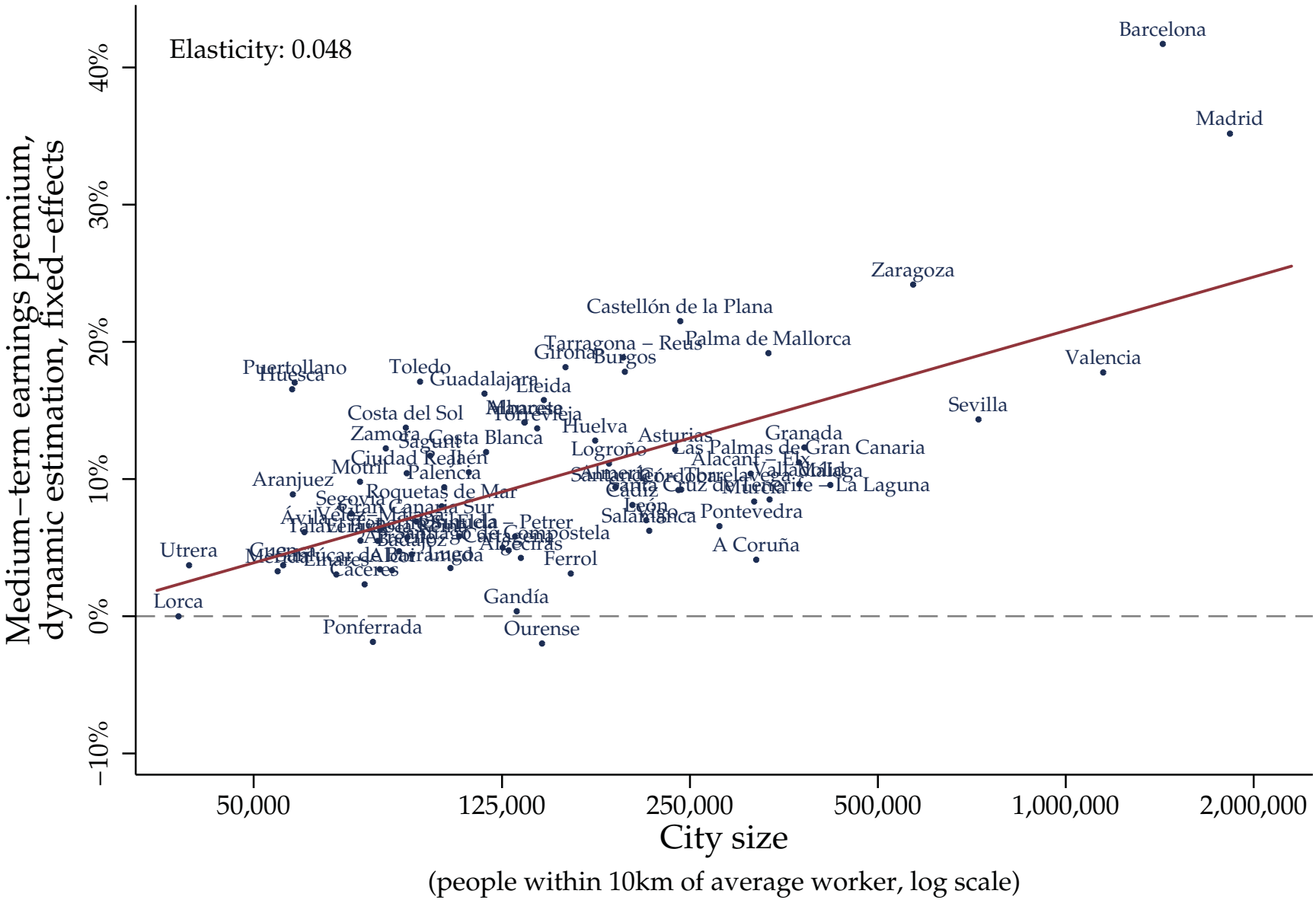
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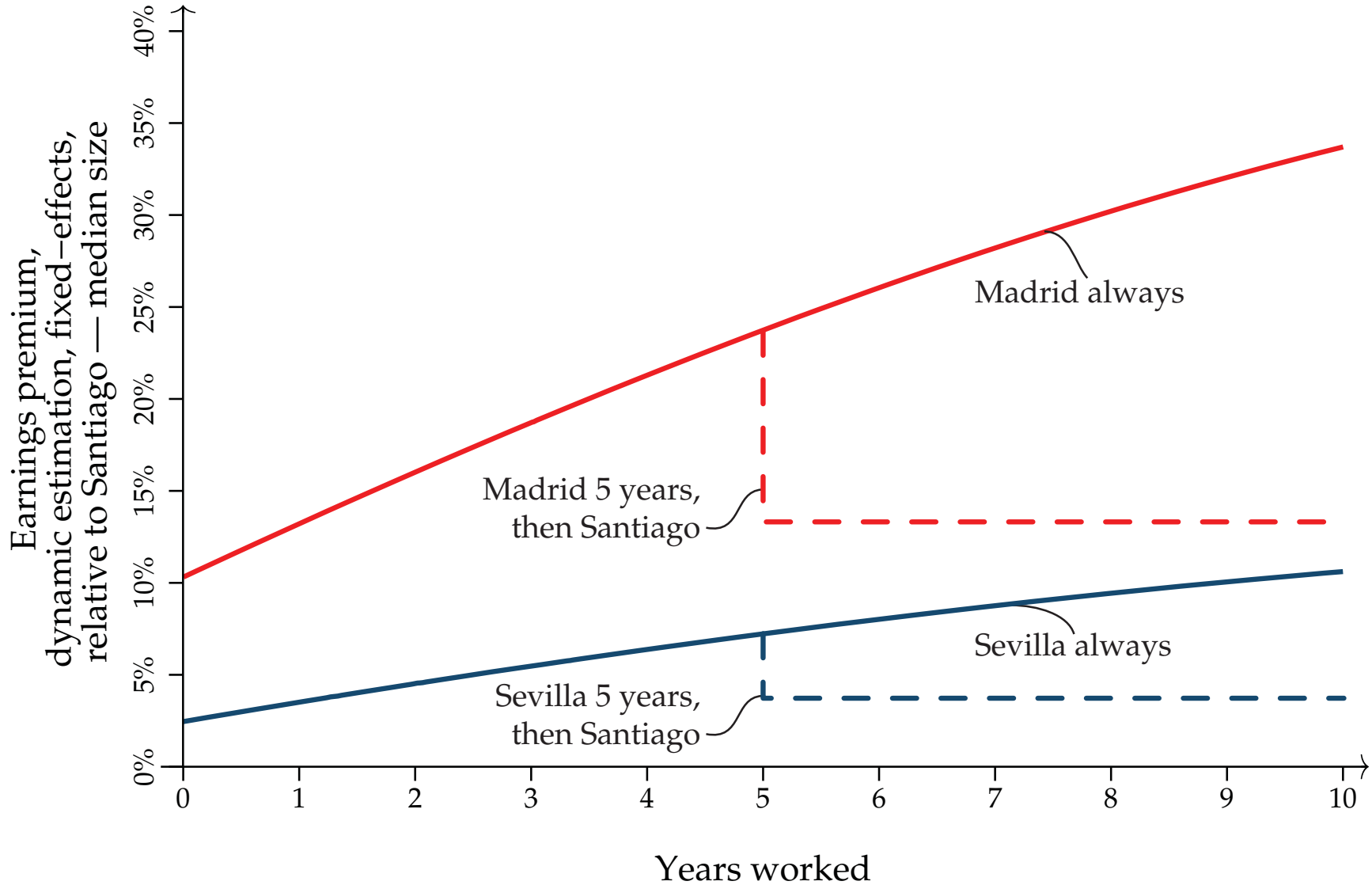
500,000
1,000,000
2,000,000
City size
(people within 10km of average worker, log scale)
Barcelona
Madrid
Zaragoza
Castellón de la Plana
Palma de Mallorca
Tarragona – Reus
Girona
Burgos
Valencia
Sevilla
Puertollano
Huesca
Toledo
Guadalajara
Lleida
Costa del Sol
Torrevieja
Huelva
Zamora
Sagunt
Costa Blanca
Asturias
Granada
Logroño
Las Palmas de Gran Canaria
Alacant
Ciudad Real
Motril
Palencia
Aranjuez
Roquetas de Mar
Segovia
Cádiz
La Laguna
León
Pontevedra
Salamanca
Utrera
A Coruña
Ferrol
Lorca
Gandía
Ponferrada
Ourense

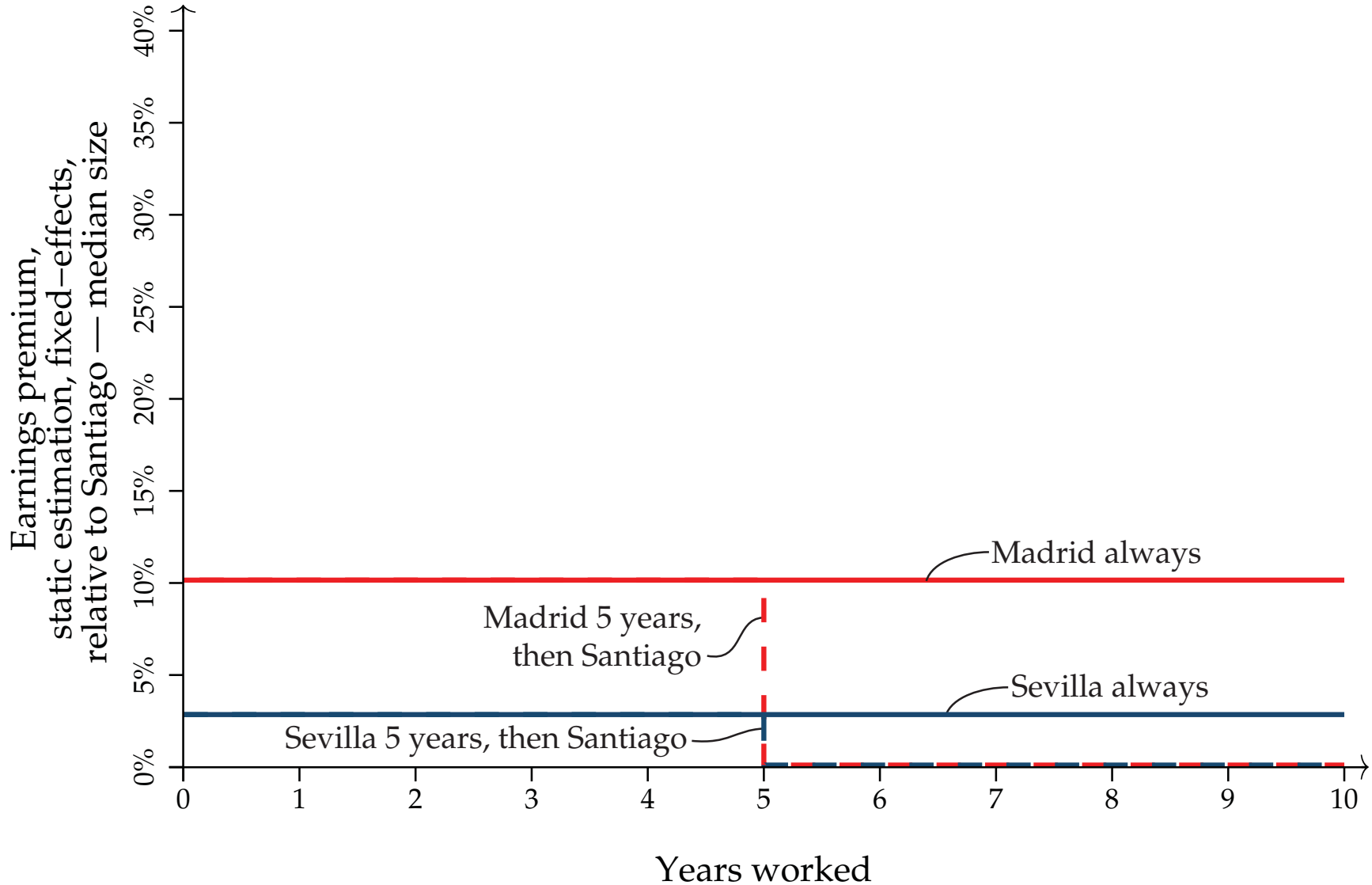
Gradual accumulation of the city size premium

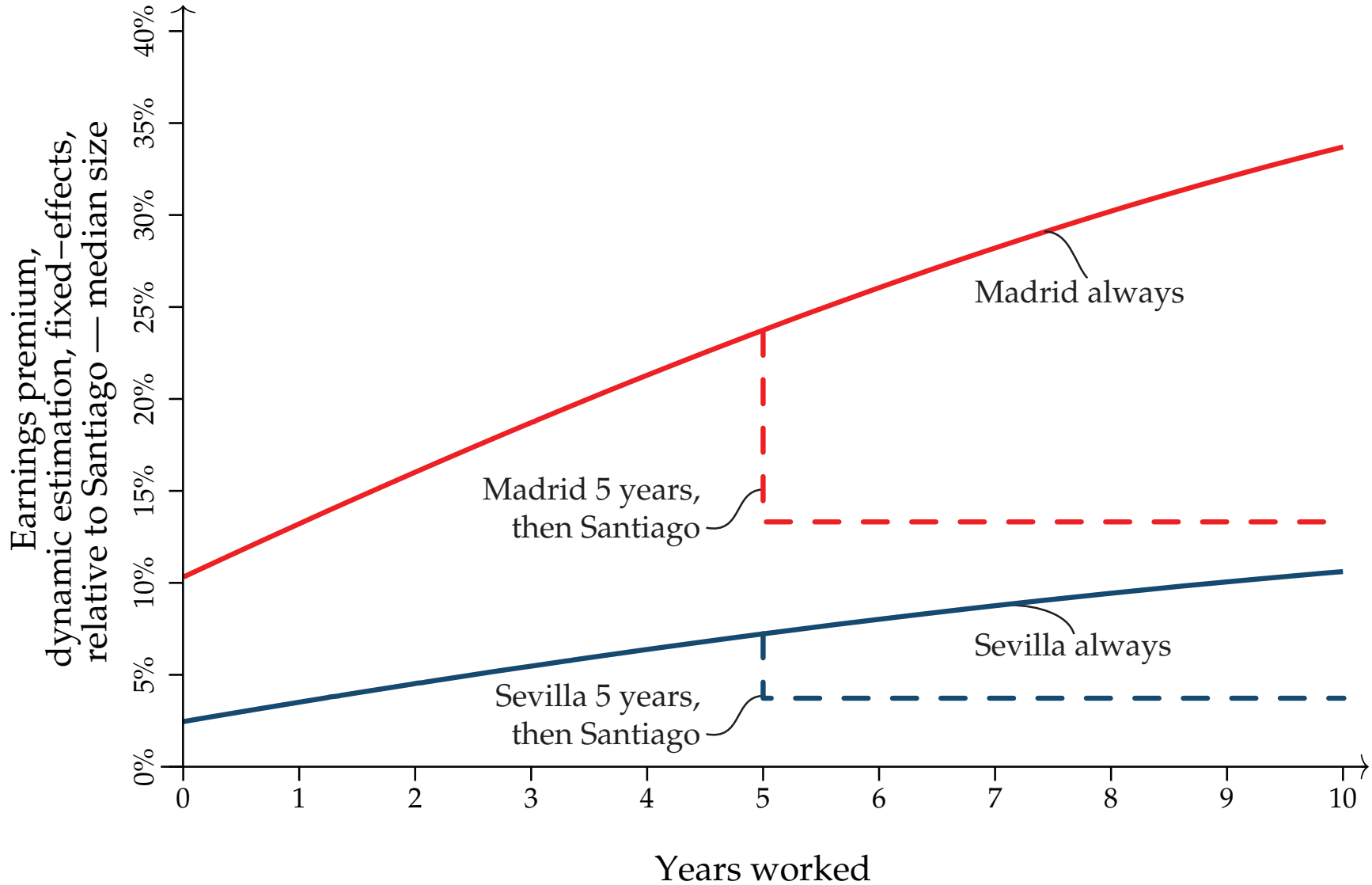
- These estimations show that
  - a premium is attained immediately upon arrival in a big city,
  - but much of the gains accumulate gradually over time,
  - and workers who leave take most of the accumulated premium upon departure.
- To visualize the last two points more clearly, based on the above estimation, we can calculate how differences between the earnings of workers with particular location histories evolve over time.


Earnings premium,
dynamic estimation, fixed−effects,
relative to Santiago — median size
0%
5%
10%
15%
20%
25%
30%
35%
40%
0
1
2
3
4
5
6
7
8
9
10
Years worked
Madrid always
Madrid 5 years,
then Santiago
Sevilla always
Sevilla 5 years,
then Santiago

Comparison with static estimation

- Note how this differs from the usual static estimation. The dynamic estimation shows that
  - the earnings premium associated with working in a big city is not a one-off instantaneous gain, instead there is an initial jump but then the premium grows over time;
  - the accumulated premium is not lost upon departure.


Earnings premium,
static estimation, fixed−effects,
relative to Santiago — median size
0%
5%
10%
15%
20%
25%
30%
35%
40%
0
1
2
3
4
5
6
7
8
9
10
Years worked
Madrid always
Madrid 5 years,
then Santiago
Sevilla always
Sevilla 5 years, then Santiago

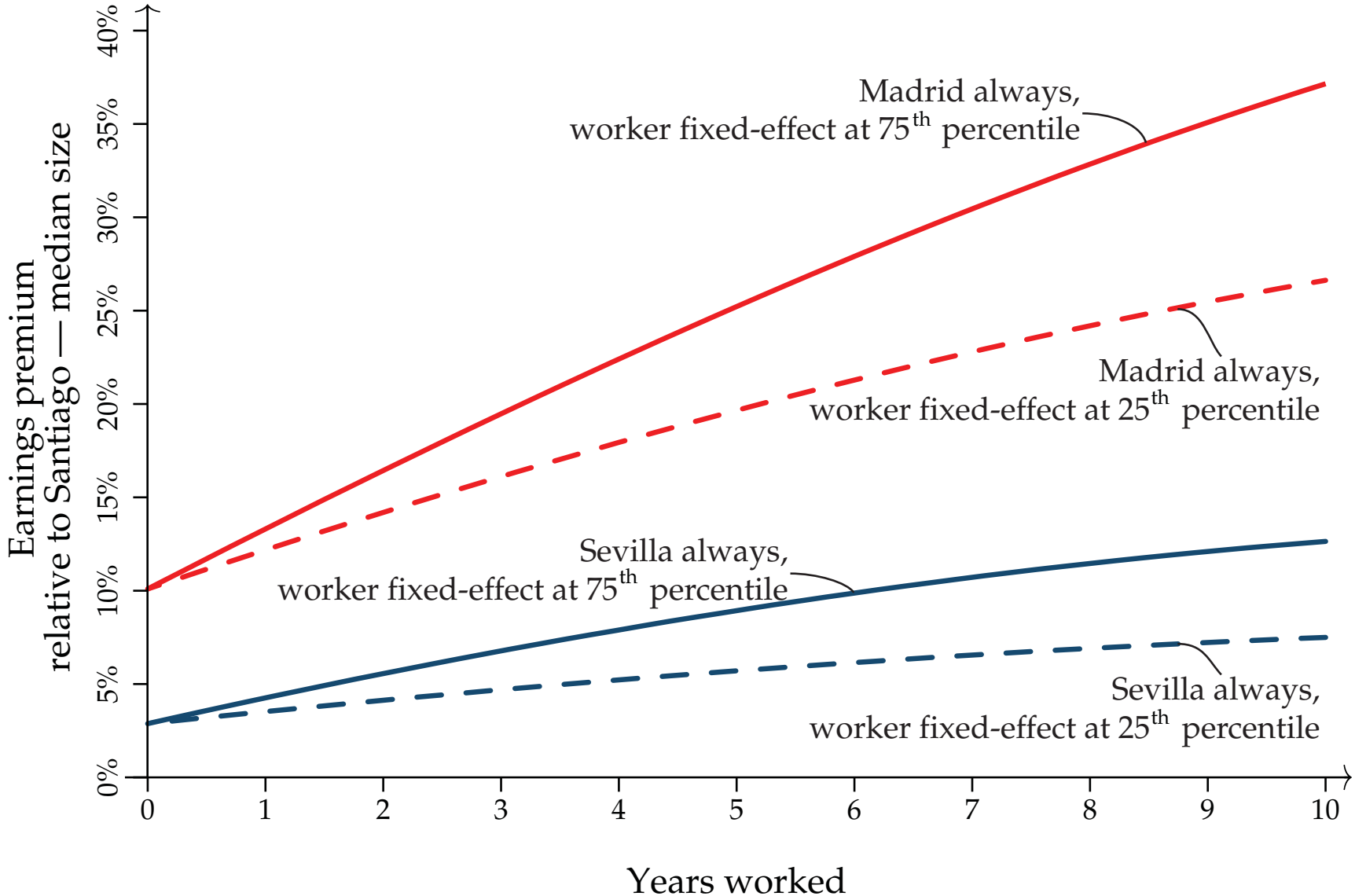

Earnings premium,
dynamic estimation, fixed−effects,
relative to Santiago — median size
0%
5%
10%
15%
20%
25%
30%
35%
40%
0
1
2
3
4
5
6
7
8
9
10
Years worked
Madrid always
Madrid 5 years,
then Santiago
Sevilla always
Sevilla 5 years,
then Santiago

Dependent variable :	(1) Log size	(2) Initial premium	(3) Medium-term premium
Instrumented log city size		0.024 (0.008)***	0.048 (0.014)***
Log city size 1900	0.702 (0.074)***		
% high-quality land within 25km of city centre	0.016 (0.006)**		
% water within 25km of city centre	0.006 (0.002)**		
% steep terrain within 25km of city centre	-0.014 (0.006)**		
Log mean elevation within 25km of city centre	0.292 (0.086)***		
Observations	73	73	73
R^2	0.687	0.165	0.362
P-value J test (H_0 : instruments uncorr. with error term)		0.207	0.124
P-value LM test (H_0 : model underidentified)		0.008	0.008
F-test weak ident. (H_0 : instruments jointly insignificant)		35.698	35.698

Heterogeneous dynamic advantages of bigger cities

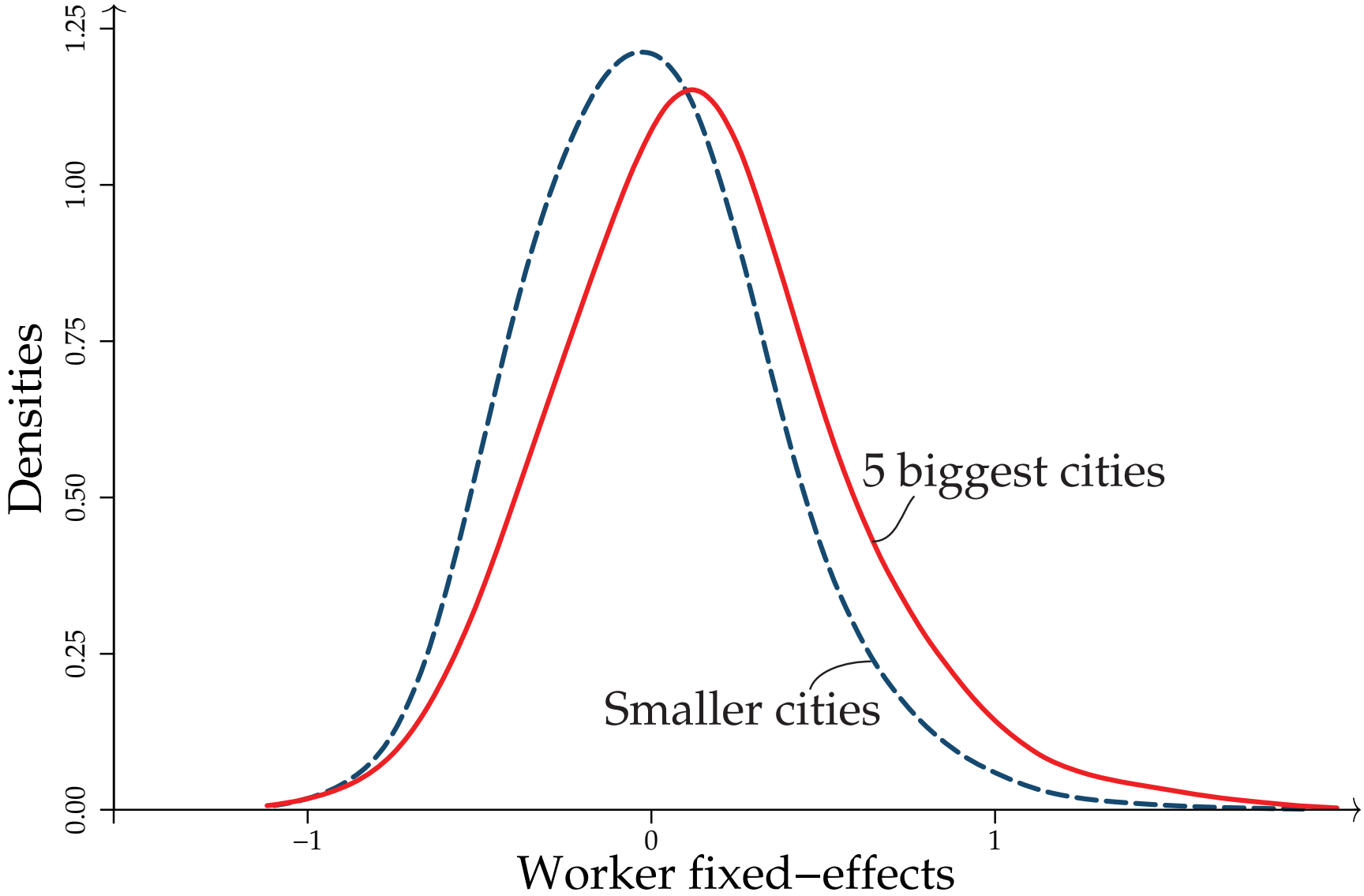
- We have seen that an important part of the advantages associated with bigger cities is that they provide steeper earnings profiles.
- Following Baker (1997), a large literature emphasizes heterogeneity in earnings profiles across workers.
- This suggests, not just allowing for heterogeneous profiles across workers, but also exploring whether there are complementarities between bigger cities and greater individual skills in terms of the value of experience.
- Is the additional value of experience in bigger cities even greater for more able workers?

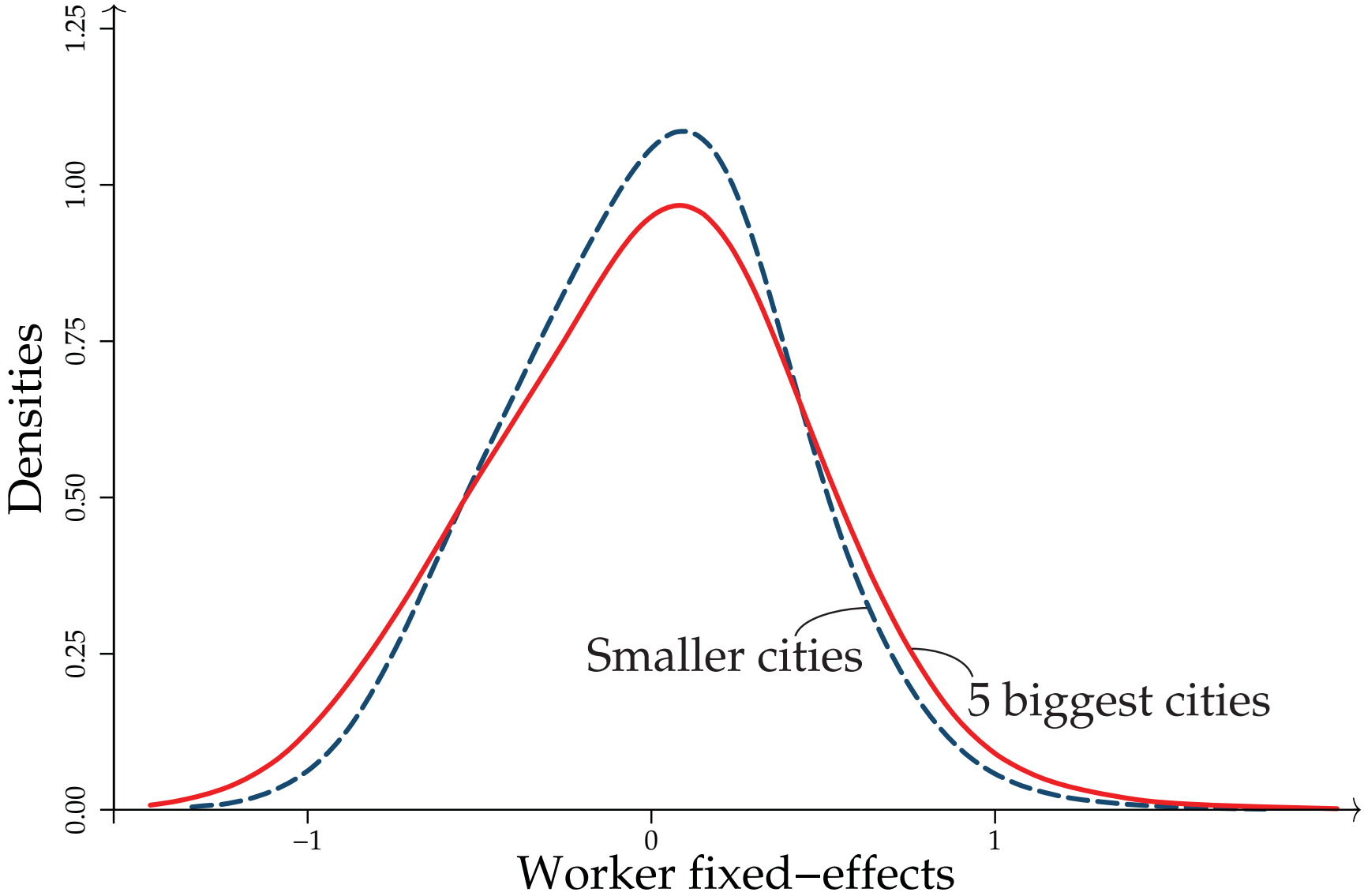
Dependent variable :	(1) Log earnings	(2) Initial premium (city indicator coefficients column (1))	(3) Medium-term premium (initial + 7 years local experience
Log city size		0.025 (0.006)***	0.046 (0.010)***
City indicators	Yes		
Experience 1^{st}-2^{nd} biggest cities	0.024 (0.000)***		
(Experience 1^{st}-2^{nd} biggest cities)^2	-0.001 (0.000)***		
Exp. 1^{st}-2^{nd} biggest × worker fixed-effect	0.020 (0.000)***		
(Exp. 1^{st}-2^{nd} biggest)^2× worker fixed-effect	-0.000 (0.000)***		
Experience 3^{rd}-5^{th} biggest cities	0.010 (0.000)***		
(Experience 3^{rd}-5^{th} biggest cities)^2	-0.000 (0.000)***		
Exp. 3^{rd}-5^{th} biggest × worker fixed-effect	0.014 (0.000)***		
(Exp. 3^{rd}-5^{th} biggest)^2× worker fixed-effect	-0.001 (0.000)***		
Experience	0.100 (0.000)***		
Experience^2	-0.001 (0.000)***		
Experience × worker fixed-effect	0.059 (0.000)***		
(Experience)^2× worker fixed-effect	-0.002 (0.000)***		
Firm tenure and its square	Yes		
Occupation indicators	Yes		
Observations	5,821,846	73	73
R^2	0.817	0.156	0.334

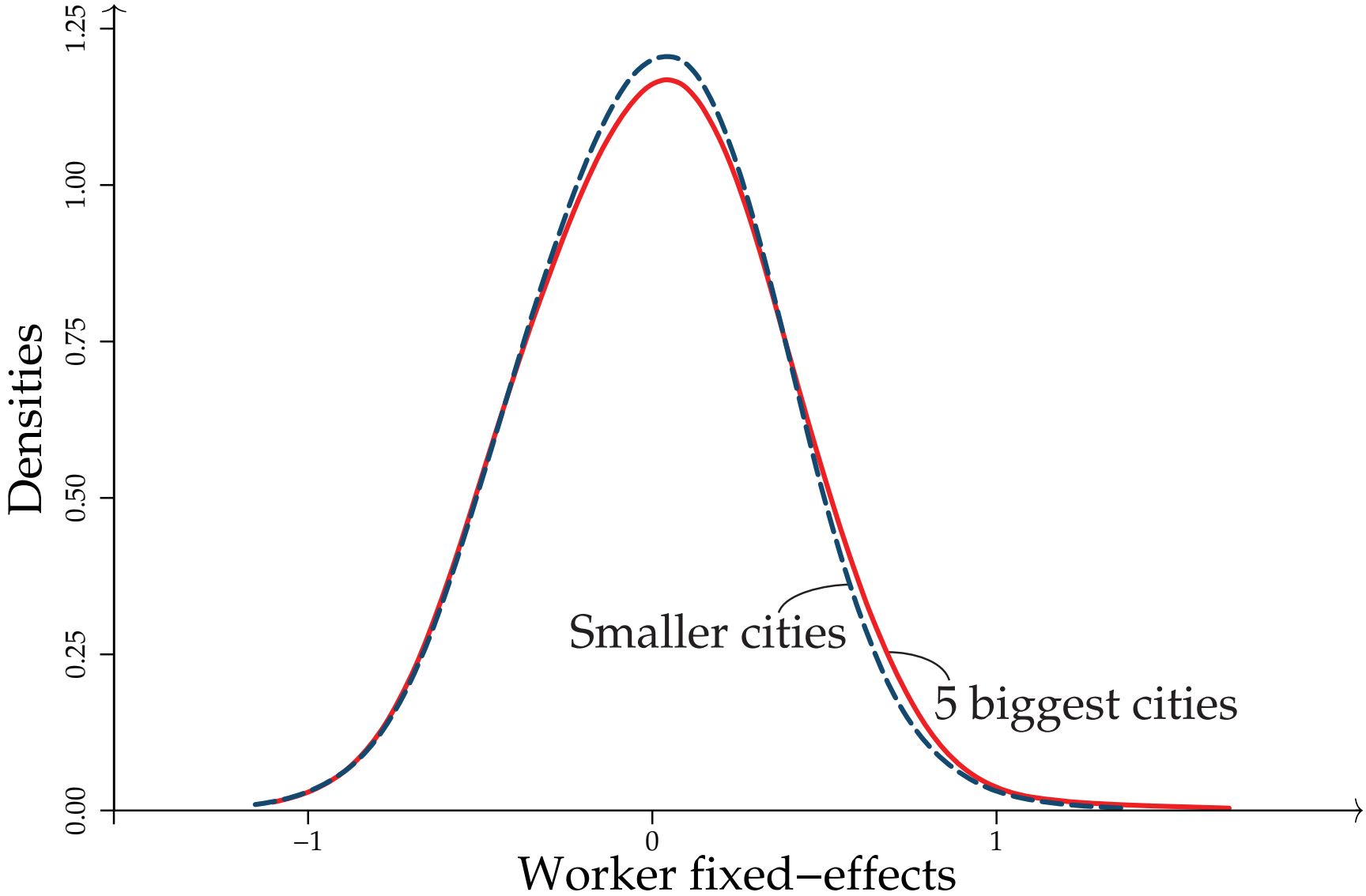

Earnings premium
relative to Santiago — median size
0%
5%
10%
15%
20%
25%
30%
35%
40%
0
1
2
3
4
5
6
7
8
9
10
Years worked
Madrid always,
worker fixed-effect at 75th percentile
Madrid always,
worker fixed-effect at 25th percentile
Sevilla always,
worker fixed-effect at 75th percentile
Sevilla always,
worker fixed-effect at 25th percentile

Not considering learning biases worker fixed-effects

- If the heterogeneous dynamic fixed-effects estimation is correct, then estimated worker fixed-effects capture initial unobserved ability.
- Then, the standard static fixed effects specification mixes initial unobserved ability with the extra value of experience acquired in bigger cities.
- The interpretation is very different :
  - Do bigger cities attract workers who are more able or productive to start with ?
  - Or are they initially similar to workers in other cities, but become more productivity thanks to the experience they accumulate in bigger cities ?


Densities
0.00
0.25
0.50
0.75
1.00
1.25
−1
0
1
Worker fixed−effects
5 biggest cities
Smaller cities


Densities
0.00
0.25
0.50
0.75
1.00
1.25
−1
0
1
Worker fixed−effects
Smaller cities
5 biggest cities


Densities
0.00
0.25
0.50
0.75
1.00
1.25
−1
0
1
Worker fixed−effects
Smaller cities
5 biggest cities

Worker fixed-effects estimation	Shift ($\hat{A}$)	Dilation ($\hat{D}$)	$M(0,1)$	R^2	Obs.
Static premium only, controlling for age, sector	0.152 (0.005) ***	1.163 (0.006) ***	5.3e-02	0.992	84,662
Homogenous dynamic and static premium, full controls	-0.001 (0.006)	1.156 (0.008) ***	7.3e-03	0.993	84,662
Heterogeneous dynamic and static premium, full controls	0.011 (0.003) ***	1.040 (0.005) ***	6.6e-04	0.919	84,662

Notes: The table applies the methodology of Combes, Duranton, Gobillon, Puga, and Roux (2011) to approximate the distribution of worker fixed-effects in the five biggest cities, $F_B(\mu_i)$, by taking the distribution of worker fixed-effects in smaller cities, $F_S(\mu_i)$, shifting it by an amount A, and dilating it by a factor D. $\hat{A}$ and $\hat{D}$ are estimated to minimize the mean quantile difference between the actual big-city distribution $F_B(\mu_i)$ and the shifted and dilated small-city distribution $F_S((\mu_i - A)/D)$. $M(0,1)$ is the total mean quantile difference between $F_B(\mu_i)$ and $F_S(\mu_i)$. $R^2 = 1 - M(\hat{A},\hat{D})/M(0,1)$ is the fraction of this difference that can by explained by shifting and dilating $F_S(\mu_i)$. Coefficients are reported with bootstrapped standard errors in parenthesis (re-estimating worker fixed-effects in each of the 100 bootstrap iterations). ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Conclusions

- By tracking not just workers' current job location but also their entire workplace location histories, we show that
  - an earnings premium is attained immediately upon arrival in a big city,
  - but much of the gains accumulate gradually over a lengthy period as workers accumulate more valuable experience,
  - and workers who leave take most of the accumulated premium upon departure.
- Furthermore, differences in worker skills across cities
  - appear not to be the result of sorting (workers in big and small cities appear initially very similar),
  - but the result of workers accumulating more valuable experience in bigger cities (which increases mean skills),
  - and this making more of a difference for more able workers (which increases the variance)
- We interpret this as evidence that an important part of the benefits of dense cities are related to learning and these benefits are highly portable.