Agglomeration Economies

Urban Economics

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Agenda

Quantitative Spatial Models

- One of the most striking economic features of our world is the uneven distribution of economic activity across space.
- These rich patterns of the concentration of economic activity can be explained by a three-way interaction between natural advantages, agglomeration forces, and dispersion forces.
- The complexity of modeling these forces in spatial equilibrium has meant that the traditional theoretical literature on cities focused on stylized settings, such as a monocentric city or the Rosen Roback framework.
  - These models, however, **cannot** capture the rich internal variation in patterns of economic activity within and between real world locations

Quantitative Spatial (Urban) Models

- Although traditional models in urban economics explain certain features of the data, their simplifying assumptions olimit their usefulness for empirical work.
- These simplifying assumptions abstract from empirically relevant differences in natural advantage across locations, such as access to natural harbors or green parks.
- To address these limitations, recent quantitative spatial (urban) models allow for empirically relevant differences in natural advantage while also incorporating agglomeration forces.
- These models are designed to connect directly to observed data on cities.

Introduction to a basic quantitative spatial model

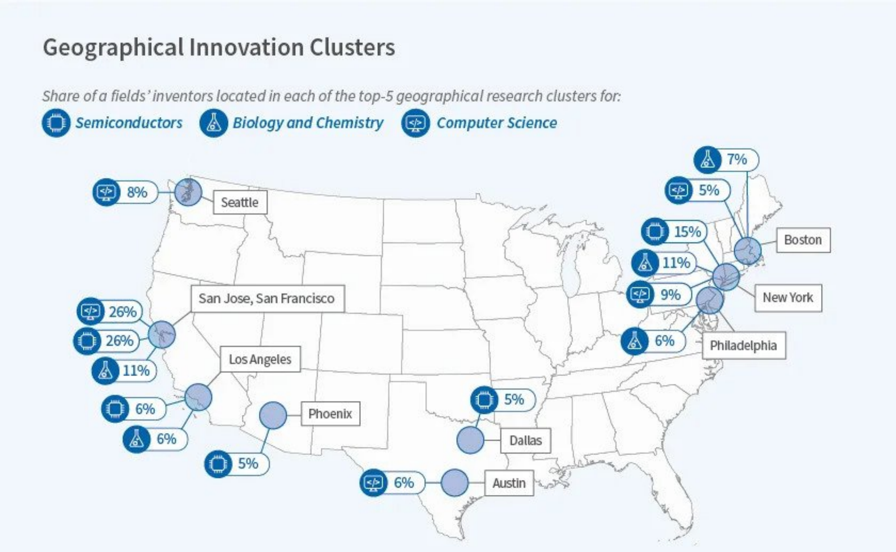
- Consider a city (or coutry), embedded in a wider economy.
- The city/country consists of a set of discrete locations (blocks/cities).
- These locations are populated by workers, who are mobile between locations and the larger economy.
- Workers have idiosyncratic preferences for living and working in different locations within the city/country).
- They consider all the personal, work-related, or amenity-related reasons and pick the locations that yields the highest utility.

Introduction to a basic quantitative spatial model

- We begin with a twist to Rosen-Roback; between cities
- Rosen–Roback key insight is that any local shock to the demand or supply of labor in a city is, in equilibrium, fully capitalized in the price of land.
- As a consequence, shocks to a local economy do not affect worker welfare.
- This rule's outs some interesting questions

Agglomeration and Empirics

Moretti (2021)



Agglomeration and Empirics

Moretti (2021)

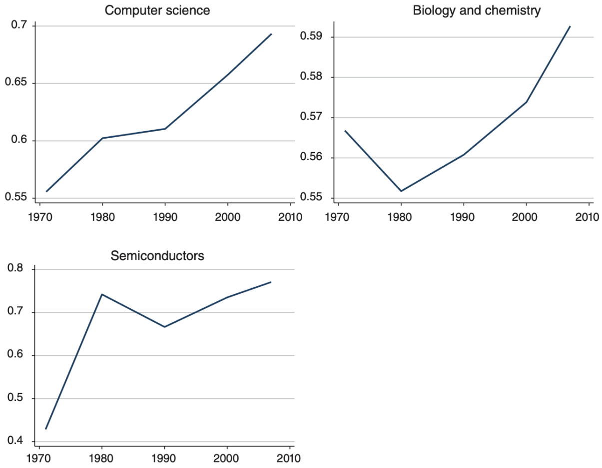


Figure 1. Share of Top Ten Cities over Time

Agglomeration and Empirics

Moretti (2021)

TABLE 2—DIFFERENCE-IN-DIFFERENCE ESTIMATES: 1996–2007 PRODUCTIVITY CHANGE OF NON-KODAK INVENTORS IN ROCHESTER COMPARED TO OTHER CITIES

					Weighted
	(1)	(2)	(3)	(4)	(5)
Panel A					
Rochester × 2007	−0.0641	−0.0673	−0.0805	−0.0916	−0.0947
	(0.00757)	(0.00674)	(0.00631)	(0.00665)	(0.00860)
Rochester	−0.0148	−0.0364	−0.0317		
	(0.0105)	(0.0101)	(0.00987)		
2007	−0.190	−0.189			
	(0.00757)	(0.00713)			
Observations	194,120	194,120	194,120	194,120	193,331
Field		Yes	Yes	Yes	Yes
Field × year			Yes	Yes	Yes
Field × city				Yes	Yes

Agglomeration and Empirics

Moretti (2021)

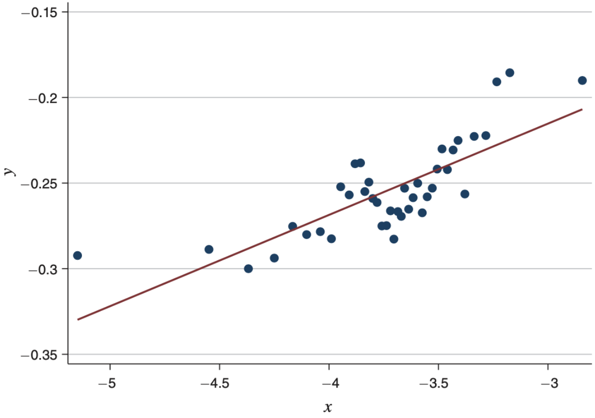


FIGURE 4. AVERAGE LOG NUMBER OF PATENTS PER INVENTOR PER YEAR AND LOG CLUSTER SIZE: ALL YEARS AND FIELDS

Agglomeration and Empirics
Moretti (2021)

Table 3—Effect of Cluster Size on Inventor Productivity: Baseline Models

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log size	0.0518							
	(0.00815)							
Observations	932,059							
Year	Yes							
City	Yes							
Field	Yes							
Class	Yes							
City × field								
City × class								
Field × year								
Class × year								
Inventor								
City × year								
Firm								

Notes: Each column is a separate regression. The level of observation in the regressions is inventor-year. The dependent variable is log of number of patents filed in a year. The model estimated is equation (1). Standard errors are clustered by city × research field.

Agglomeration and Empirics

Moretti (2021)

TABLE 3—EFFECT OF CLUSTER SIZE ON INVENTOR PRODUCTIVITY: BASELINE MODELS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log size	0.0518	0.0762	0.0881	0.0907				
	(0.00815)	(0.0167)	(0.0187)	(0.00926)				
Observations	932,059	932,059	932,059	932,059				
Year	Yes	Yes	Yes	Yes				
City	Yes	Yes	Yes	Yes				
Field	Yes	Yes	Yes	Yes				
Class	Yes	Yes	Yes	Yes				
City × field		Yes	Yes	Yes				
City × class			Yes	Yes				
Field × year				Yes				
Class × year								
Inventor								
City × year								
Firm								

Notes: Each column is a separate regression. The level of observation in the regressions is inventor-year. The dependent variable is log of number of patents filed in a year. The model estimated is equation (1). Standard errors are clustered by city × research field.

Agglomeration and Empirics

Moretti (2021)

Table 3—Effect of Cluster Size on Inventor Productivity: Baseline Models

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log size	0.0518	0.0762	0.0881	0.0907	0.0677			
	(0.00815)	(0.0167)	(0.0187)	(0.00926)	(0.00862)			
Observations	932,059	932,059	932,059	932,059	932,059			
Year	Yes	Yes	Yes	Yes	Yes			
City	Yes	Yes	Yes	Yes	Yes			
Field	Yes	Yes	Yes	Yes	Yes			
Class	Yes	Yes	Yes	Yes	Yes			
City × field		Yes	Yes	Yes	Yes			
City × class			Yes	Yes	Yes			
Field × year				Yes	Yes			
Class × year					Yes			
Inventor								
City × year								
Firm								

Notes: Each column is a separate regression. The level of observation in the regressions is inventor-year. The dependent variable is log of number of patents filed in a year. The model estimated is equation (1). Standard errors are clustered by city × research field.

Agglomeration and Empirics

Moretti (2021)

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	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log size	0.0518	0.0762	0.0881	0.0907	0.0677	0.0923		
	(0.00815)	(0.0167)	(0.0187)	(0.00926)	(0.00862)	(0.00990)		
Observations	932,059	932,059	932,059	932,059	932,059	932,059		
Year	Yes	Yes	Yes	Yes	Yes	Yes		
City	Yes	Yes	Yes	Yes	Yes	Yes		
Field	Yes	Yes	Yes	Yes	Yes	Yes		
Class	Yes	Yes	Yes	Yes	Yes	Yes		
City × field		Yes	Yes	Yes	Yes	Yes		
City × class			Yes	Yes	Yes	Yes		
Field × year				Yes	Yes	Yes		
Class × year					Yes	Yes		
Inventor						Yes		
City × year								
Firm								

Notes: Each column is a separate regression. The level of observation in the regressions is inventor-year. The dependent variable is log of number of patents filed in a year. The model estimated is equation (1). Standard errors are clustered by city × research field.

Agglomeration and Empirics

Moretti (2021)

TABLE 3—EFFECT OF CLUSTER SIZE ON INVENTOR PRODUCTIVITY: BASELINE MODELS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log size	0.0518	0.0762	0.0881	0.0907	0.0677	0.0923	0.0545	
	(0.00815)	(0.0167)	(0.0187)	(0.00926)	(0.00862)	(0.00990)	(0.0116)	
Observations	932,059	932,059	932,059	932,059	932,059	932,059	932,059	
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
City	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Field	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Class	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
City × field		Yes	Yes	Yes	Yes	Yes	Yes	
City × class			Yes	Yes	Yes	Yes	Yes	
Field × year				Yes	Yes	Yes	Yes	
Class × year					Yes	Yes	Yes	
Inventor						Yes	Yes	
City × year							Yes	
Firm								

Notes: Each column is a separate regression. The level of observation in the regressions is inventor-year. The dependent variable is log of number of patents filed in a year. The model estimated is equation (1). Standard errors are clustered by city × research field.

Agglomeration and Empirics

Moretti (2021)

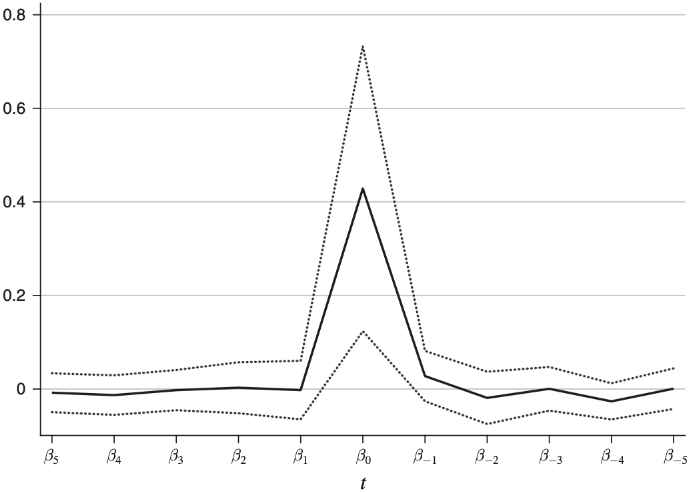
TABLE 3—EFFECT OF CLUSTER SIZE ON INVENTOR PRODUCTIVITY: BASELINE MODELS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log size	0.0518	0.0762	0.0881	0.0907	0.0677	0.0923	0.0545	0.0676
	(0.00815)	(0.0167)	(0.0187)	(0.00926)	(0.00862)	(0.00990)	(0.0116)	(0.0139)
Observations	932,059	932,059	932,059	932,059	932,059	932,059	932,059	823,375
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Field	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Class	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City × field		Yes	Yes	Yes	Yes	Yes	Yes	Yes
City × class			Yes	Yes	Yes	Yes	Yes	Yes
Field × year				Yes	Yes	Yes	Yes	Yes
Class × year					Yes	Yes	Yes	Yes
Inventor						Yes	Yes	Yes
City × year							Yes	Yes
Firm								Yes

Notes: Each column is a separate regression. The level of observation in the regressions is inventor-year. The dependent variable is log of number of patents filed in a year. The model estimated is equation (1). Standard errors are clustered by city × research field.

Agglomeration and Empirics

Moretti (2021)



Agglomeration and Empirics

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Table 5—Models in Differences: Effect of Changes in Cluster Size on Changes in Inventor Productivity: OLS and IV Estimates

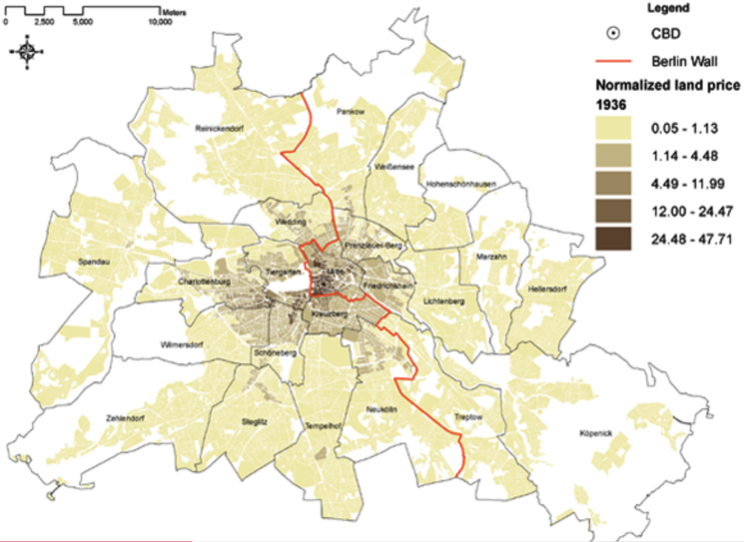
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. OLS						
Δlog size	0.0141	0.0145	0.0153	0.0164	0.0162	0.0159
	(0.00394)	(0.00392)	(0.00376)	(0.00397)	(0.00392)	(0.00385)
Panel B. 2SLS						
Δlog size	0.0422	0.0630	0.0502	0.0496	0.0502	0.0491
	(0.0186)	(0.0211)	(0.0189)	(0.0131)	(0.0137)	(0.0144)
First stage	1.109	1.076	1.096	1.431	1.475	1.488
	(0.151)	(0.170)	(0.167)	(0.214)	(0.189)	(0.185)
F-statistic	53.8	40.2	43.0	44.5	60.8	64.2
Observations	419,596	419,596	419,565	405,111	405,111	403,955
Year	Yes	Yes	Yes	Yes	Yes	Yes
Field		Yes	Yes	Yes	Yes	Yes
Class			Yes	Yes	Yes	Yes
Firm				Yes	Yes	Yes
Field × year					Yes	Yes
Class × year						Yes

The economics of density: evidence from the Berlin wall

- Ahlfeldt et al. (2015) tackle the question of how strong are agglomeration and dispersion forces in a city.
- We already know that this is a difficult question, and they point out two reasons why this is the case.
  1. Endogeneity: it is hard to disentangle the strength of agglomeration forces from simple differences in location fundamentals. For this you would need exogenous variation in agglomeration.
  2. It is hard to bring the traditional urban models to data on cities.
- Ahlfeldt et al. (2015) leverage a great source of exogenous variation to identify the effects of agglomeration: the Berlin Wall.

The economics of density: evidence from the Berlin wall

Historical Background



The economics of density: evidence from the Berlin wall

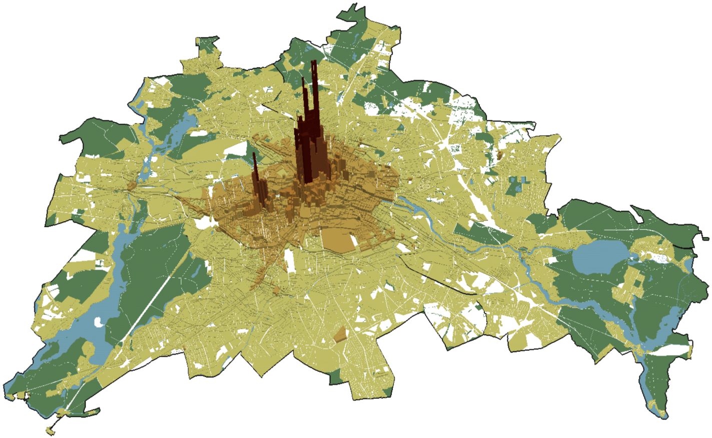
Data

- Data on land prices, workplace employment, residence employment and bilateral travel times
  - Data for Greater Berlin in 1936 and 2006
  - Data for West Berlin in 1986
  - Land prices: official assessed land value of a representative undeveloped property or the fair market value of a developed property if it were not developed
  - Geographical Information Systems (GIS) data on:
    - landarea, landuse, building density, proximity to U-Bahn(underground) and S-Bahn (suburban) stations, schools, parks, lakes, canals and rivers, Second World War destruction, location of government buildings and urban regeneration programs

The economics of density: evidence from the Berlin wall

Reduced form evidence

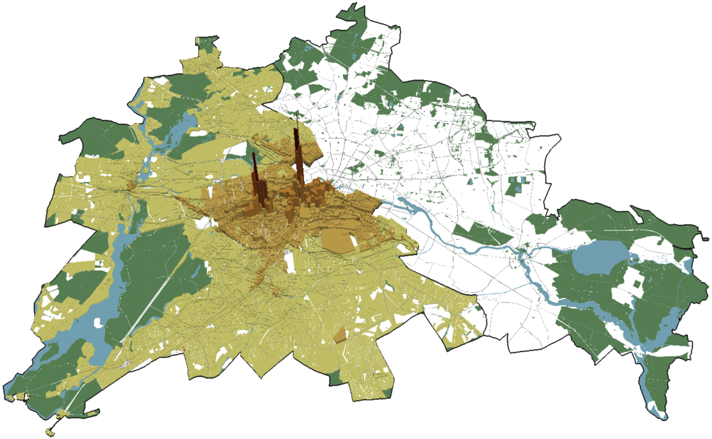
Berlin 1936



The economics of density: evidence from the Berlin wall

Reduced form evidence

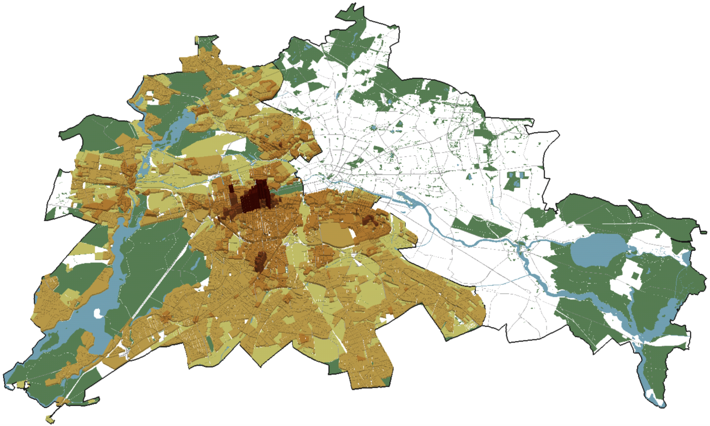
West Berlin 1936



The economics of density: evidence from the Berlin wall

Reduced form evidence

West Berlin 1986



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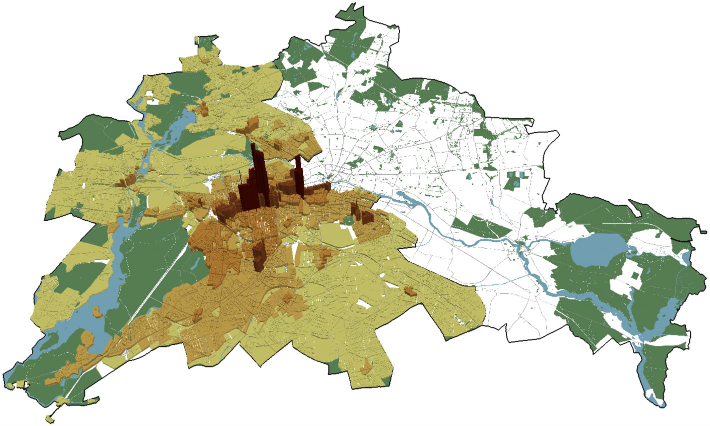
Reduced form evidence

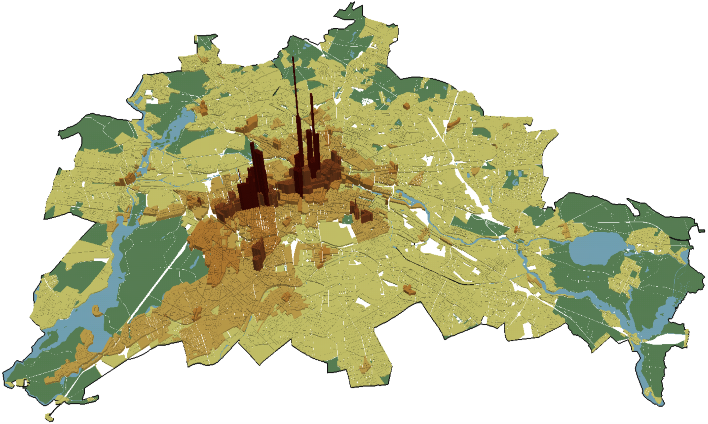
West Berlin 2006



The economics of density: evidence from the Berlin wall

Reduced form evidence

Berlin 2006



The economics of density: evidence from the Berlin wall

Reduced form evidence

TABLE I

BASELINE DIVISION DIFFERENCE-IN-DIFFERENCE RESULTS (1936–1986)[a]

	(1) $\Delta \ln Q$	(2) $\Delta \ln Q$	(3) $\Delta \ln Q$	(4) $\Delta \ln Q$	(5) $\Delta \ln Q$	(6) $\Delta \ln$ EmpR	(7) $\Delta \ln$ EmpR	(8) $\Delta \ln$ EmpW	(9) $\Delta \ln$ EmpW
CBD 1	−0.800***	−0.567***	−0.524***	−0.503***	−0.565***	−1.332***	−0.975***	−0.691*	−0.639*
	(0.071)	(0.071)	(0.071)	(0.071)	(0.077)	(0.383)	(0.311)	(0.408)	(0.338)
CBD 2	−0.655***	−0.422***	−0.392***	−0.360***	−0.400***	−0.715**	−0.361	−1.253***	−1.367***
	(0.042)	(0.047)	(0.046)	(0.043)	(0.050)	(0.299)	(0.280)	(0.293)	(0.243)
CBD 3	−0.543***	−0.306***	−0.294***	−0.258***	−0.247***	−0.911***	−0.460**	−0.341	−0.471**
	(0.034)	(0.039)	(0.037)	(0.032)	(0.034)	(0.239)	(0.206)	(0.241)	(0.190)
CBD 4	−0.436***	−0.207***	−0.193***	−0.166***	−0.176***	−0.356**	−0.259	−0.512***	−0.521***
	(0.022)	(0.033)	(0.033)	(0.030)	(0.026)	(0.145)	(0.159)	(0.199)	(0.169)
CBD 5	−0.353***	−0.139***	−0.123***	−0.098***	−0.100***	−0.301***	−0.143	−0.436***	−0.340***
	(0.016)	(0.024)	(0.024)	(0.023)	(0.020)	(0.110)	(0.113)	(0.151)	(0.124)
CBD 6	−0.291***	−0.125***	−0.094***	−0.077***	−0.090***	−0.360***	−0.135	−0.280**	−0.142
	(0.018)	(0.019)	(0.017)	(0.016)	(0.016)	(0.100)	(0.089)	(0.130)	(0.116)
Inner Boundary 1–6			Yes	Yes	Yes		Yes		Yes
Outer Boundary 1–6			Yes	Yes	Yes		Yes		Yes
Kudamm 1–6				Yes	Yes		Yes		Yes
Block Characteristics					Yes		Yes		Yes
District Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,260	6,260	6,260	6,260	6,260	5,978	5,978	2,844	2,844
R^2	0.26	0.51	0.63	0.65	0.71	0.19	0.43	0.12	0.33

[a] Q denotes the price of floor space. EmpR denotes employment by residence. EmpW denotes employment by workplace. CBD1–CBD6 are six 500 m distance grid cells for distance from the pre-war CBD. Inner Boundary 1–6 are six 500 m grid cells for distance to the Inner Boundary between East and West Berlin. Outer Boundary 1–6 are six 500 m grid cells for distance to the outer boundary between West Berlin and East Germany. Kudamm 1–6 are six 500 m grid cells for distance to Breitscheid Platz on the Kurfürstendamm. The coefficients on the other distance grid cells are reported in Table A.2 of the Technical Data Appendix. Block characteristics include the log distance to schools, parks and water, the land area of the block, the share of the block's built-up area destroyed during the Second World War, indicators for residential, commercial and industrial land use, and indicators for whether a block includes a government building and urban regeneration policies post-reunification. Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley (1999)). * significant at 10%; ** significant at 5%; *** significant at 1%.

The economics of density: evidence from the Berlin wall

Reduced form evidence

TABLE II

BASELINE REUNIFICATION DIFFERENCE-IN-DIFFERENCE RESULTS (1986–2006)[a]

	(1) $\Delta \ln Q$	(2) $\Delta \ln Q$	(3) $\Delta \ln Q$	(4) $\Delta \ln Q$	(5) $\Delta \ln Q$	(6) $\Delta \ln$ EmpR	(7) $\Delta \ln$ EmpR	(8) $\Delta \ln$ EmpW	(9) $\Delta \ln$ EmpW
CBD 1	0.398***	0.408***	0.368***	0.369***	0.281***	1.079***	1.025***	1.574***	1.249**
	(0.105)	(0.090)	(0.083)	(0.081)	(0.088)	(0.307)	(0.297)	(0.479)	(0.517)
CBD 2	0.290***	0.289***	0.257***	0.258***	0.191**	0.589*	0.538*	0.684**	0.457
	(0.111)	(0.096)	(0.090)	(0.088)	(0.087)	(0.315)	(0.299)	(0.326)	(0.334)
CBD 3	0.122***	0.120***	0.110***	0.115***	0.063**	0.340*	0.305*	0.326	0.158
	(0.037)	(0.033)	(0.032)	(0.032)	(0.028)	(0.180)	(0.158)	(0.216)	(0.239)
CBD 4	0.033***	0.031	0.030	0.034	0.017	0.110	0.034	0.336**	0.261
	(0.013)	(0.023)	(0.022)	(0.021)	(0.020)	(0.068)	(0.066)	(0.161)	(0.185)
CBD 5	0.025***	0.018	0.020	0.020	0.015	−0.012	−0.056	0.114	0.066
	(0.010)	(0.015)	(0.014)	(0.014)	(0.013)	(0.056)	(0.057)	(0.118)	(0.131)
CBD 6	0.019**	−0.000	−0.000	−0.003	0.005	0.060	0.053	0.049	0.110
	(0.009)	(0.012)	(0.012)	(0.012)	(0.011)	(0.039)	(0.041)	(0.095)	(0.098)
Inner Boundary 1–6			Yes	Yes	Yes		Yes		Yes
Outer Boundary 1–6			Yes	Yes	Yes		Yes		Yes
Kudamm 1–6				Yes	Yes		Yes		Yes
Block Characteristics					Yes		Yes		Yes
District Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,050	7,050	7,050	7,050	7,050	6,718	6,718	5,602	5,602
R^2	0.08	0.32	0.34	0.35	0.43	0.04	0.07	0.03	0.06

[a] Q denotes the price of floor space. EmpR denotes employment by residence. EmpW denotes employment by workplace. CBD1–CBD6 are six 500 m distance grid cells for distance from the pre-war CBD. Inner Boundary 1–6 are six 500 m grid cells for distance to the Inner Boundary between East and West Berlin. Outer Boundary 1–6 are six 500 m grid cells for distance to the outer boundary between West Berlin and East Germany. Kudamm 1–6 are six 500 m grid cells for distance to Breitscheid Platz on the Kurfürstendamm. The coefficients on the other distance grid cells are reported in Table A.4 of the Technical Data Appendix. Block characteristics include the log distance to schools, parks and water, the land area of the block, the share of the block's built-up area destroyed during the Second World War, indicators for residential, commercial and industrial land use, and indicators for whether a block includes a government building and urban regeneration policies post-reunification. Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley (1999)). * significant at 10%; ** significant at 5%; *** significant at 1%.

Assumptions:

- Open city.
- In the agricultural area utility is $\bar{U}$.
- The city is in discrete space, and there are S blocks indexed by $i = 1, \ldots, S$
- There is L_i floor space in every block, and these blocks can be assigned to residential or commercial usage.
- θ_i is the endogenous fraction of every block that is dedicated to commercial use.
- The city produces a single numeraire good that is costlessly traded.
- The blocks are connected, and there are H (endogenous) workers that can freely move within the city.

The economics of density: evidence from the Berlin wall

Model: Workers

$$U_{ijo} = \frac{B_i}{d_{ij}} \left(\frac{c_{ijo}}{\beta} \right)^{\beta} \left(\frac{l_{ijo}}{1-\beta} \right)^{(1-\beta)} z_{ijo} \tag{1}$$

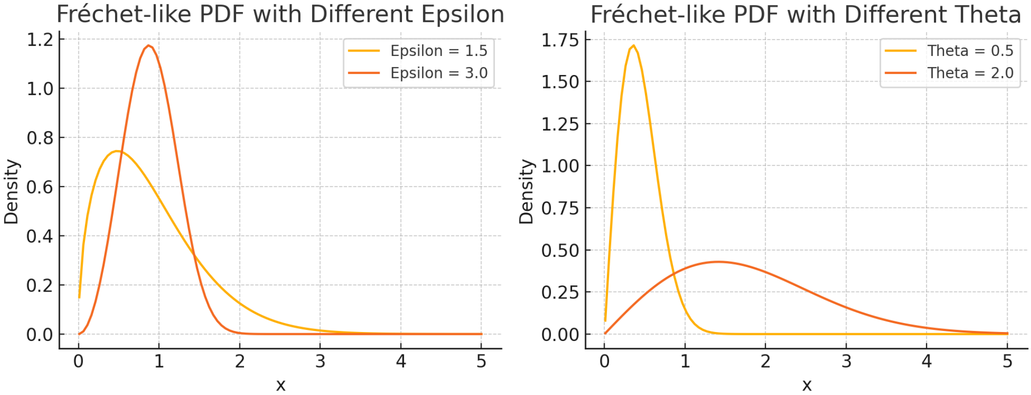
$$z_{ijo} \sim Frechet \tag{2}$$

$$F(z_{ijo}) = exp(-T_i E_j z_{ijo}^{-\epsilon}) \tag{3}$$

with

- scale parameters:
  - $T_i > 0$ determines the average utility derived from living in block i
  - $E_j > 0$ determines the average utility derived from working in block j
- the shape parameter $\epsilon > 1$ controls the dispersion of idiosyncratic utility.

Frechet Magic



The economics of density: evidence from the Berlin wall

Model: Workers choice

- After observing her realizations for idiosyncratic utility for each pair of residence and employment blocks,
- each worker chooses where to live and work to maximize her utility, taking as given residential amenities, goods prices, factor prices, and the location decisions of other workers and firms.
- The indirect utility