Topic 6
The economics of density: Evidence from the Berlin Wall

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Quantitative Spatial Economics

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Acknowledgements

- This slide deck uses material from the following lectures
  - Urban Economics lecture in 2022-23 LSE course EC532—International Economics for Research Students, by Daniel M. Sturm
  - Quantitative Urban Models lecture from the UEA lecture series, by Stephen J. Redding

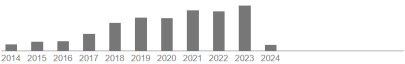
Introduction

Motivation

- Frisch Medal
  - 2018
- More than 1000
  - As of March 10, 2024
- Many recent JMPs build on the model, including
  - Prottoy Akbar (Aalto) Sara Bagagli (LSE) Lea Bou Sleiman (NUS) Fabian Eckert (UCSD) Matthias Hoelzlein (Notre Dame) Gabriel Kreindler (Harvard) Andrii Parkhomenko (USC) Giorgio Pietrabissa (LSE) Chris Severen (Philly Fed) Nick Tsivanidis (Berkeley) Pablo Warnes (Aalto) Laura Weiwu (.) Román D. Zárate (World Bank)

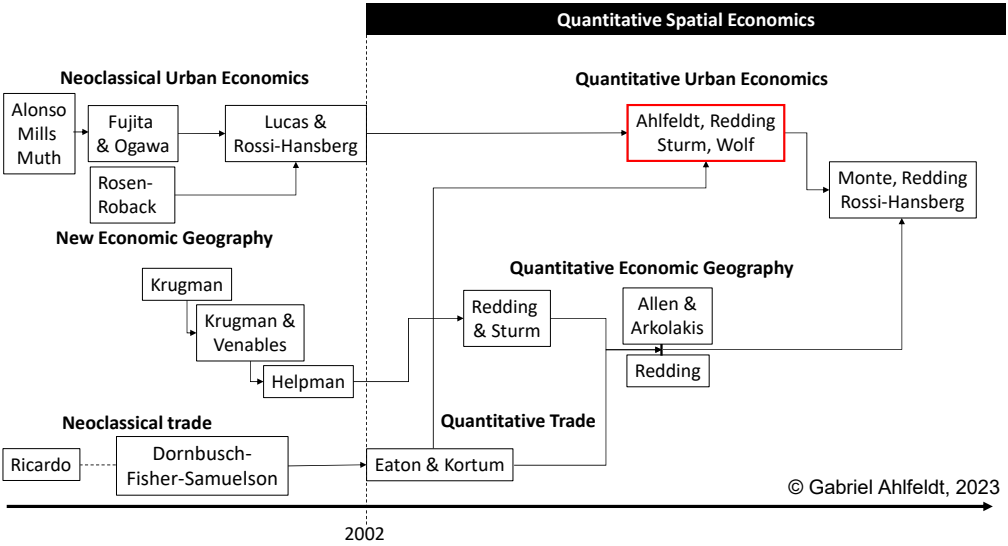
The economics of density: Evidence from the Berlin Wall

Authors	Gabriel M Ahlfeldt, Stephen J Redding, Daniel M Sturm, Nikolaus Wolf
Publication date	2015/11
Journal	Econometrica
Volume	83
Issue	6
Pages	2127-2189
Publisher	Blackwell Publishing Ltd
Description	This paper develops a quantitative model of internal city structure that features agglomeration and dispersion forces and an arbitrary number of heterogeneous city blocks. The model remains tractable and amenable to empirical analysis because of stochastic shocks to commuting decisions, which yield a gravity equation for commuting flows. To structurally estimate agglomeration and dispersion forces, we use data on thousands of city blocks in Berlin for 1936, 1986, and 2006 and exogenous variation from the city's division and reunification. We estimate substantial and highly localized production and residential externalities. We show that the model with the estimated agglomeration parameters can account both qualitatively and quantitatively for the observed changes in city structure. We show how our quantitative framework can be used to undertake counterfactuals for changes in the organization of economic …
Total citations	Cited by 1031



Scholar articles
The economics of density: Evidence from the Berlin Wall
GM Ahlfeldt, SJ Redding, DM Sturm, N Wolf - Econometrica, 2015
Cited by 1031 Related articles All 40 versions

History of thought



Where we stand

- Key ingredients that we have **covered**
  - **Spatial equilibrium** & capitalization in wages and rents
    - Agglomeration and dispersion forces
  - **Location factors**
    - Commuting cost as well as fundamental productivity and amenity
  - Interplay of **primitives and endogenous objects**
    - Model quantification
    - Referencing an equilibrium and solving numerically
  - Taste **heterogeneity** generates upward-sloping local labour supply
- **Toolkit** waiting for you to explore it ARSW2015-toolkit
  - Now, you only need a bit of **endurance**

Roadmap

- **Topic 6** (today)
  - Building blocks of the model
  - Reduced-form evidence
- **Topic 7**
  - Estimation
  - Inversion
- **Topic 8**
  - Counterfactuals with exogenous fundamentals
  - Counterfactuals with agglomeration forces

Agglomeration economies

Q: Why is it challenging to identify the strength of agglomeration economies?

The model

Problems of the monocentric city model

- **Monocentric city model** has obvious **shortcomings**:
  - Real-world cities are not on a **line**
    - It is therefore difficult to tightly connect the model to data from cities.
  - **Labour markets** do not clear
    - Already accounted for space consumption in Ahlfeldt & Barr (2022)
  - **Firms do not choose their location** optimally
    - No sub-centres or edge cities
  - **Commuting flows are more complex** than simple flows from and to the CBD
    - Almost all locations attract some commuters
  - No (local) **agglomeration effects**
    - Production (such as spillovers)
    - Consumption (such as nice restaurants).

Overview of the ARSW model

- ARSW build on the urban model of Lucas and Rossi-Hansberg (2002):
  - City is a continuous two-dimensional space
  - Firms and residents compete over space
  - However, the city is restricted to be a symmetric circular city
- ARSW develop an **empirically-tractable** version of this model:
  - They model a city as a large number of **discrete locations**
    - Model **rationalizes data** observed for those locations
  - **Locations differ** in
    - productivity (fundamental and endogenous)
    - residential amenities (fundamental and endogenous)
    - supply of floor space
    - transport connections and commuting cost across locations

Tractability of the model

- Such a model would normally be highly **non-tractable**
  - Imagine workers living at the same distance from two firms
  - They would all work for the firm that offers marginally higher wages
- Model remains **tractable due to heterogeneity** in workers' commuting decisions
  - Modeled following Eaton and Kortum (2002)
- These shocks imply:
  - **Labor supply** to each location is a **upward-sloping** function of local wage
  - A **gravity structure for commuting flows** that fits the available data very well

Stylized models get around non-tractability by assuming one workplace location

Model setup

- ARSW consider an **open city** embedded within a larger economy
  - Provides an exogenous reservation level of utility ($\bar{U}$)
- The city consists of a set of **discrete locations** indexed by i
  - Blocks are endowed with K_i units of **land**
- Construction firms combine land and capital to build floor space L_i
  - Density of development is $\varphi_i = \frac{L_i}{K_i^{1-\mu}}$, here μ is share of land in housing
- **Floor space** within each location is optimally allocated
  - Between residential and commercial use.
- **A single final good** is costlessly traded
  - Chosen as the numeraire
- All markets are **perfectly competitive**

Model setup continued

- **Workers maximize utility**
  - choose commuting origin and destination, and consumption of the final good
    - commuting cost is a function of travel time
  - Workplace-residence choice is influenced by an idiosyncratic utility shock
    - revealed once workers decide to enter the city
- **Firms maximize profits**
  - Choose inputs of labor and floor space
  - Make zero profits in equilibrium.
- Productivity A_i
  - depends on fundamentals a_i and spillovers Y_i.
- Amenities B_i
  - depend on fundamentals b_i and spillovers Ω_i.

Indirect utility function

- Workers have the following simple **indirect utility** function:

$$U_{ij\omega} = \frac{w_j B_i z_{ij\omega}}{d_{ij} P_i^{1-\beta} Q_i^{1-\beta}}$$

- Hence living in i and working in j is more attractive for worker ω if:
  - The workplace pays well (w_j high).
  - The residence location is pleasant (B_i high), offers cheap housing (Q_i low)
    - and cheap consumption, though here $P_i = 1$
  - The commute is not too painful (d_{ij} low)
    - $d_{ij} = \exp^{\kappa \tau_{ij}}$ where τ_{ij} is bilateral travel time
  - Worker have drawn a more positive shock $z_{ij\omega}$ for this commute
    - Includes features at residence, workplace, and along the route
    - For example, a nice cycle lane offering scenic views...

Distribution of the idiosyncratic shocks

- **Idiosyncratic shock** to worker location choices drawn from a Fréchet distribution:

$$F(z_{ij\omega}) = e^{-T_i E_j z_{ij\omega}^{-\epsilon}}, \quad T_i, E_j > 0, \epsilon > 1$$

- The shape parameter ϵ
  - Inversely related to the variance of the utility shocks (key parameter of the model)
- The scale parameters T_i and E_j
  - shift the mean level of these shock by place of residence and place of work
    - Can think of E_j as workplace amenity
    - T_i conceptually hard to distinguish from B_i

Notice the difference to Topic 5: It is a **bilateral** utility shock!

Commuting flows

- **Probability worker chooses to live in location i and work in location j:**

$$\pi_{ij} = \frac{T_i E_j \left(\frac{B_i w_j}{d_{ij} Q_i^{1-\beta}} \right)^{\epsilon}}{\sum_{r=1}^{S} \sum_{s=1}^{S} T_r E_s \left(d_{rs} Q_r^{1-\beta} \right)^{-\epsilon} (B_r w_s)^{\epsilon}} = \frac{\Phi_{ij}}{\Phi}$$

  - where w_j is wage at workplace and Q_i is rent at residence
  - Taking logs produces a **commuting gravity equation**
- Conditional on living in location i, the commuting probability is:

$$\pi_{ij|i} = \frac{E_j \left(\frac{w_j}{d_{ij}} \right)^{\epsilon}}{\sum_{s=1}^{S} E_s \left(\frac{w_s}{d_{is}} \right)^{\epsilon}}$$

Consumer decision to move to the city

- **Spatial equilibrium**
  - Workers are ex-ante indifferent between living in the city and the outside utility of $\bar{U}$:

$$\mathbb{E}[U] = \gamma \left[\sum_{r=1}^{S} \sum_{s=1}^{S} T_r E_s (d_{rs} Q_r^{1-\beta})^{-\epsilon} (B_r w_s)^{\epsilon} \right]^{1/\epsilon} = \bar{U}$$

  - where $\gamma = \Gamma\left(\frac{\epsilon-1}{\epsilon}\right)$ and $\Gamma(\cdot)$ is the Gamma function.
- Can generate an upward-sloping labor supply function to the city
  - Need idiosyncratic taste for being in the city (can also be Fréchet-distributed)

Production

- A **single final good** (numeraire) is produced under conditions of perfect competition, constant returns to scale and zero trade costs with a larger economy:

$$y_j = A_j \left(H_{Mj}\right)^{\alpha} \left(\theta_j L_j\right)^{1-\alpha}, \quad 0 < \alpha < 1$$

  - H_{Mj} is workplace employment
  - L_j is total floor space
  - θ_j is the fraction of floor space allocated to commercial use
- Profit-maximization and zero profits give commercial bid rent:

$$q_{ij} = (1-\alpha)\left(\frac{\alpha}{w_j}\right)^{\frac{\alpha}{1-\alpha}} \frac{1}{A_j^{1-\alpha}}$$

Returns to density in production

- Productivity (A_j) is depends on **fundamentals** (a_j) and **spillovers** (Υ_j):

$$A_j = a_j \times \Upsilon_j^{\lambda}, \quad \Upsilon_j = \left[\sum_{s=1}^{S} e^{-\delta \tau_{is}} \left(\frac{H_{Ms}}{K_s} \right) \right]$$

- Spillovers are a function of the **surrounding density of employment** (H_{Ms}/K_s)
  - δ is the rate of decay of spillovers.
  - λ is the density elasticity of productivity
- Large literature suggesting $\lambda \approx 4\%$ (Ahlfeldt & Pietrostefani, 2019)
  - $\lambda \approx 2\%$ conditional on heterogeneity in worker productivity
- Much less evidence on δ

Returns to density in amenities

- Amenities (B_i) are a function of **fundamentals** (b_i) and **spillovers** (Ω_i):

$$B_i = b_i \times \Omega_i^{\eta}, \quad \Omega_i = \left[\sum_{s=1}^{S} e^{-\rho \tau_{is}} \left(\frac{H_{Rs}}{K_s} \right) \right]$$

- Spillovers are a function of the **surrounding density of population** (H_{Rs}/K_s)
  - ρ is the rate of decay of spillovers.
  - η is the density elasticity of amenities
- No empirical consensus on the size (or direction) of residential spillover effect

Commuter market clearing

- Workplace employment in location j must equal the sum across all inflows of commuters to this location (including the own flow):

$$H_{Mj} = \sum_{i=1}^{S} \frac{E_j \left(\frac{w_j}{d_{ij}}\right)^{\epsilon}}{\sum_{s=1}^{S} E_s \left(\frac{w_s}{d_{is}}\right)^{\epsilon}} H_{Ri}, \quad d_{ij} = e^{\kappa \tau_{ij}}$$

  - Notice that we are using the **conditional commuting probabilities** here
- Notice that we can solve for ("adjusted") wages if we
  - observe workplace employment (H_{Mj}), residence employment (H_{Ri}) and bilateral travel times τ_{ij} (and hence d_{ij}).
  - assume (or have estimated) values for ϵ and κ.

Land market clearing

- **Supply** of residential floor space (left) must equate Marshallian **demand** (right)
  $(1-\theta_i)L_i = (1-\beta)\left[\sum_{s=1}^{S} \frac{E_s(w_s/d_{is})^{\epsilon}}{\sum_{r=1}^{S} E_r(w_r/d_{ir})^{\epsilon}} w_s\right] \frac{H_{Ri}}{Q_i}$
  - used the conditional commuting probability $\pi_{ij|i}$ to compute expected income
- **Supply** of commercial floor space must equate **demand**:
  - $\theta_i L_i = \left(\frac{(1-\alpha)A_i}{q_i}\right)^{\frac{1}{\alpha}} H_{Mi}$
    - Have used marginal rate of substitution and commercial bid rent
- Floor space L **supplied by a competitive construction sector**
  - $L_i = \varphi_i K_i^{1-\mu}, \quad \varphi_i = M_i^{\mu} = \frac{L_i}{K_i^{1-\mu}}$
    - Geographic land K and capital M are inputs:

Berlin Wall

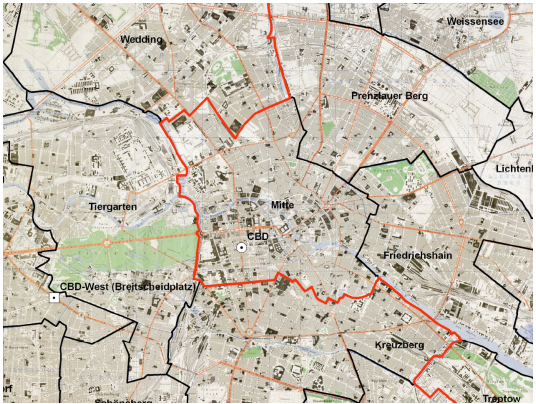
The empirical setting

- Division and unification provide **exogenous variation in effective density**
  - Can use that variation to **estimate structural parameters**
  - **Conduct counterfactuals**
    - Do endogenous forces account for changes in outcomes observed in data?
  - Requires a heroic effort **collect data** from before during and after the Wall period
- Before we jump into the quantification
  - Let's think about the **qualitative predictions**
  - Enjoy some **descriptives and reduced-form evidence**
    - Even the quantitative spatial economist deserves a break every now and then...

Let's develop the intuition first

Brief history

- The Allies planned to jointly occupy Berlin and organized the city for this purpose into an American, British, French and Soviet sector
- With the intensification of the Cold War the East German authorities constructed the Berlin Wall in 1961 to stop outmigration
- The Berlin Wall ran through the middle of the city and **separated West Berlin from the pre-war Central Business District (CBD)**

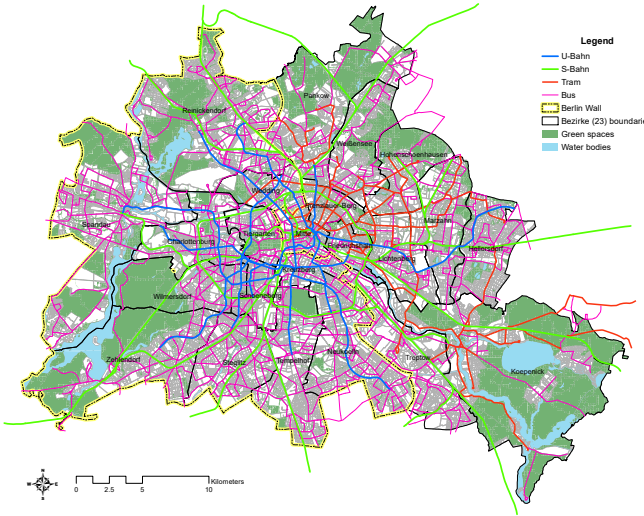


Data

- Main data
  - land prices, workplace employment, residence employment, and bilateral travel times
  - for Greater Berlin in 1936 and 2006 and for West Berlin in 1986
  - at the level of statistical blocks, around 16,000 in Berlin (9,000 in West Berlin)
- Other data
  - land area, land use, 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
- Building the database
  - Data often collected from historic registers and maps, processed within GIS
  - Adjusted to fit with the 2006 definition of statistical blocks

Transport in 2006

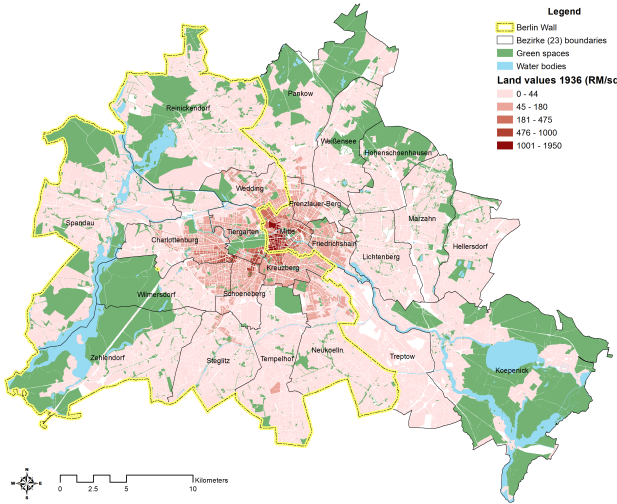
- Least-cost travel times between all blocks
  - Accounting for the full network of S-Bahn, U-Bahn, Tram, Bus
  - Modelling stations where you can enter and leave the network
  - Exchange between lines and modes, including penalties
- For 1936 and 1986
  - Removed parts of network that were built later



Land values in 1936

Q: What spatial impacts of division should we expect on **West Berlin**?

- Land rents
- Workplace employment
- Residence employment



Qualitative predictions for division I

- **Firms** in West Berlin cease to benefit from production externalities
  - **Cut off from employment centers** in East Berlin
  - **Reduces productivity**, leading to
    - lower land prices
    - less employment
- **Firms** in West Berlin lose access to flows of commuters
  - **Cut off from residential concentrations** in East Berlin
  - **Reduces labour**, requiring higher wage, leading to
    - lower land prices
    - less employment

Qualitative predictions for division II

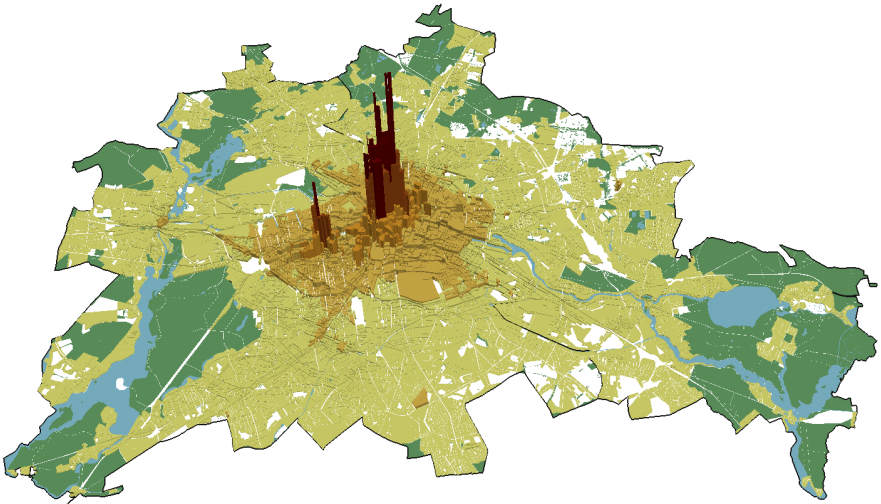
- **Residents** in West Berlin lose access to employment opportunities
  - **Cut off from employment centers** in East Berlin
  - Reduces expected worker income, leading to
    - land prices
    - fewer residents
- **Residents** in West Berlin lose access to consumption externalities
  - **Cut off from residential concentrations** in East Berlin
  - Reduces amenities, leading to
    - lower land prices
    - fewer residents

Qualitative predictions for division III

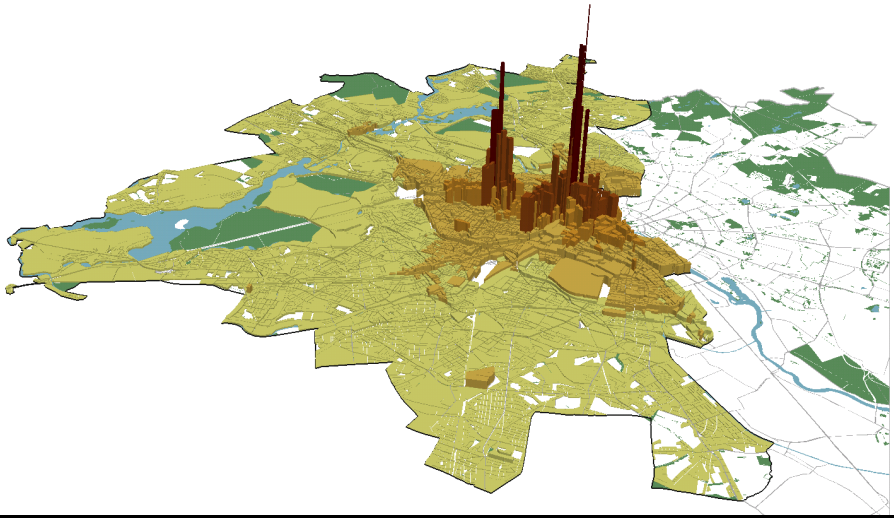
- The **impact is greater** for parts of West Berlin **closer to**
  - employment concentrations in East Berlin
  - residential concentrations in East Berlin
  - **East Berlin central business district (Mitte)**
- Employment and residents **reallocate**
  - **within West Berlin** and the larger economy
- **Wages and land prices adjust** such that:
  - Firms make zero profits in each location with positive production
  - Workers are indifferent across all locations with positive residents
  - No-arbitrage between commercial and residential land use

West Berlin areas close to CBD should lose out on all dimensions

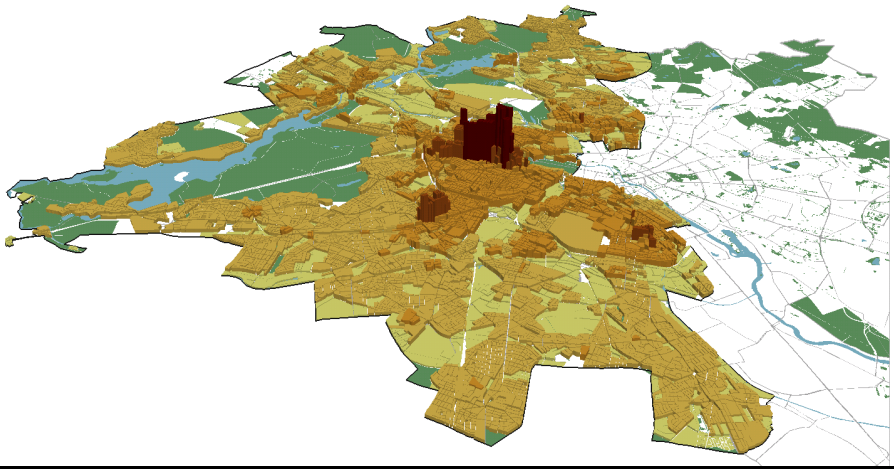
Land values in Berlin 1936



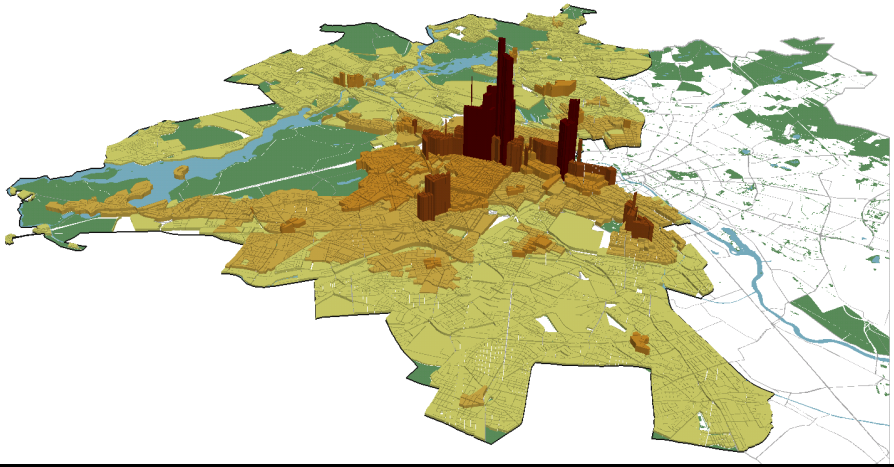
Land values in West-Berlin 1936



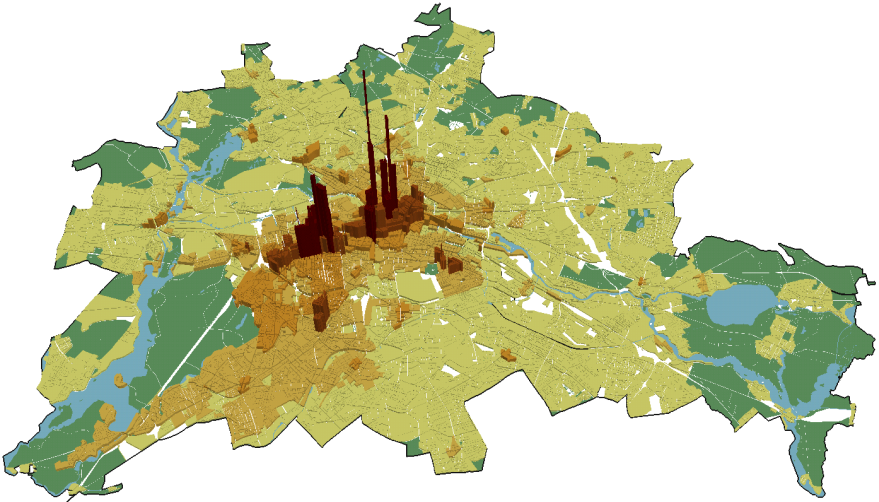
Land values in West-Berlin 1986



Land values in West-Berlin 2006



Land values in Berlin 2006



Change in log land values

- Each point represents one of 15,937 statistical blocks
- Each line calculated with *lowess regressions*
- West Berlin areas closer to the historical center lost from division and gained from unification
- In 2006, still some legacy from division
- Flat pre-trends before division and unification!

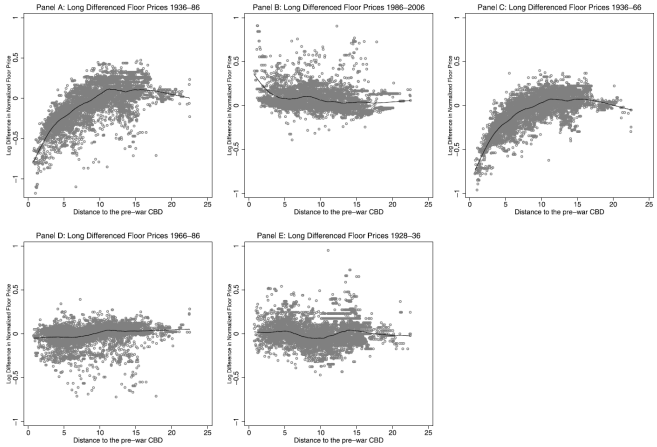
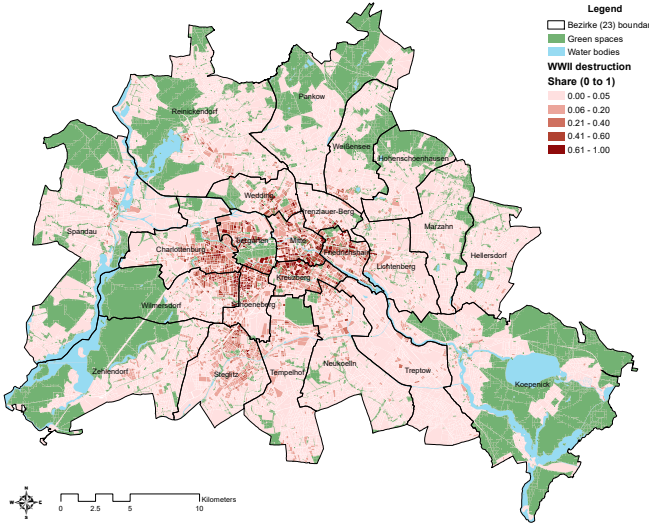


FIGURE 3.—Division and reunification treatments and placebos. Note: Log floor prices are normalized to have a mean of zero in each year before taking the long difference. Solid lines are fitted values from locally-weighted linear least squares regressions.

Confounders

- We naturally wonder about **potential confounders**
- Really about CBD proximity or **proximity to Wall**?
- More **bombing** near CBD
- What about emerging **secondary centre** (Kudamm)?
- ...
- Collect more data...



Change 1936-1986

- Regression results show *conditional effects* considering other location attributes
- West Berlin areas **closer to the historical CBD lost** in terms of land value, employment, and population (log effects)
- Survises controlling for proximity to Wall, WWII damage, etc.

	(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%.

Change 1986-2006

- Regression results show *conditional effects* considering other location attributes
- West Berlin areas **closer to the historical CBD gained** in terms of land value, employment, and population (log effects).

	(1) $\Delta \ln Q$	(2) $\Delta \ln Q$	(3) $\Delta \ln Q$	(4) $\Delta \ln Q$	(5) $\Delta \ln Q$	(6) $\Delta \ln \text{EmpR}$	(7) $\Delta \ln \text{EmpR}$	(8) $\Delta \ln \text{EmpW}$	(9) $\Delta \ln \text{EmpW}$
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%.

Lessons from the reduced-form

- **Transparent evidence** in support of predicted spatial reallocation effect
  - **Division** led to a re-orientation of West Berlin's land price gradient
    - **away from the pre-war city center**
  - **Reunification** led to a re-emergence of West Berlin's land price gradient
    - **towards the pre-war city center**
- Effects travel quite far up to 15 km
  - Suggests **role for commuting and labour supply**
- Strong effects localized near the historic CBD
  - Suggests **role for agglomeration spillovers**

Readers appreciate transparent reduced-form evidence in structural work

Important papers building on the model

Authors	Year	Journal	Topic
Delventhal, Parkhomenko	2023	Revise &R. Restud	Telecommuting
Dingel, Tintelnot	2023	Revise &R. Ecta	Granular Settings
Heblich, Redding, Sturm	2020	QJE	Transport and suburbanization
Hoelzlein	2023	Revise & R. AER	Sorting and spatial inequality
Miyauchi, Nakajima, Redding	2022	Reject & R. QJE	Trip chaining
Tsivanidis	2023	AER	Transport and income sorting
Zárate	2022	Revise & R. AER	Transport and spatial misallocation

- These papers are all great and influential
- The list is incomplete
  - Many other papers in this rapidly emerging literature that are worth a look...

Conclusion

Summary

- ARSW develop a quantitative theoretical model to provide
  - Accounts for endogenous agglomeration and dispersion forces
    - Commuting costs, productivity spillovers, and residential spillovers lead to **agglomeration**
    - Inelastically supplied land generates a **dispersion** force via high rents
  - Rationalizes observed data via fundamentals
- Exploit **exogenous** variation provided by Berlin's division and reunification
  - **Reduced-form evidence** supports the model's prediction of spatial reallocation
    - Suggests a role for commuting and agglomeration spillovers

Next week: **Quantification (counterfactuals in Topic 8)**

Literature I

Core readings

- **Ahlfeldt, G., Redding, S., Sturm, D., Wolf, N. (2015): The economics of Density: Evidence from the Berlin Wall. Econometrica, 83(6), 2127–2189.**

Other readings

- Ahlfeldt, G., Pietrostefani, E. (2019): The economic effects of the density: A synthesis. Journal of Urban Economics, 111
- Delventhal, M. and Parkhomenko, A. (2023): Spatial Implications of Telecommuting. http://dx.doi.org/10.2139/ssrn.3746555
- Dingel, J. and Tintelnot, F. (2023): Spatial Economics for Granular Settings http://dx.doi.org/10.2139/ssrn.3610868
- Eaton, J. and Kortum, S. (2002): Technology, Geography, and Trade. Econometrica, 70(5), 1741-1779
- Heblich, S.,S. Redding, D. Sturm (2020): The Making of the Modern Metropolis: Evidence from London, The Quarterly Journal of Economics, 135(4), 2059–2133.
- Hoelzlein, M. (203): Two-sided sorting and spatial inequality in cities. Working paper.
- Lucas, R., Rossi-Hansberg, E. (2002): On the internal structure of cities. Econometrica, 60(4), 1445-1476.

Literature II

- Miyauchi, Y., Nakajima, K., Redding, S. (2022): The Economics of Spatial Mobility: Theory and Evidence Using Smartphone Data. NBER WP 28497.
- Tsivanidis, N. (2024): Evaluating the Impact of Urban Transit Infrastructure: Evidence from Bogotá's TransMilenio. American Economic Review, forthcoming.
- Zárate, R. D. (2023): Spatial Misallocation, Informality and Transit Improvements: Evidence from Mexico City. Working paper.