THE URBAN ECONOMY IN GENERAL EQUILIBRIUM

Urban Economics

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I COURSE COMPONENTS

the idea

- Block I
  - Introduction to Urban and Regional Economics and Course Overview
  - Topic I: Regional and urban concentration forces
  - Topic II: The empirics of agglomeration
  - Topic III: Costs and benefits of agglomeration
- Block 2
  - Topic IV: Monocentric city I (household location choice)
  - Topic V: Monocentric city II (household location choice)
  - Topic VI: Firm location choice
  - **Topic VII: The urban economy in general equilibrium**
- Block 3
  - Topic VIII: The vertical dimension of cities
  - Topic IX: Suburbanization and gentrification
  - Topic X: Hedonic analysis

I INTRODUCTION

roadmap

- **Last time: *Firm location choice***
  - **1) Firms in the monocentric city model**
    - **Firm bid-rent**
    - **Land-use segregation**
  - **2) Agglomeration and decentralization**
    - **Endogenous agglomeration**
    - **Multiple equilibria**
  - **3) Emergence of new clusters**
    - **Sub-centres**
    - **Edge cities**
    - **Historic anchoring**

I INTRODUCTION

roadmap

- **This time: *The urban economy in general equilibrium***
  - **1) Recap**
    - **Compensating differentials, location choice, supply side**
  - **2) The Ahlfeldt-Redding-Sturm-Wolf model**
    - **Model setup**
  - **3) Separating spillovers from location fundamentals**
    - **Reduced-form evidence**
    - **Difference-in-difference analysis**
  - **4) Structural estimation and simulation**
    - **Identifying structural parameters**
    - **Simulating the effect of a new metro line**

II RECAP

what do we know

Q: Why is it important to understand the *causal effect* of productivity spillovers (and labour supply)?

I RECAP

roadmap

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I HOUSEHOLD LOCATION COICE

recall

- **Households maximize utility subject to budget constrain**
  - Dislike longer commutes
  - Like higher wages
  - Like residential amenities
- **Spatial equilibrium:**
  - Households must be indifferent across locations
  - Rents offset for differences in utility across location
    - Reflect acces to firms and amenities

Household location choice conditional on firm location

I FIRM LOCATION COICE

recall

- **Firms maximize profits**
  - Like agglomeration / clustering
  - Like produciton amenities
  - Like access to workers and lower wages (ignored so far)
- **Spatial equilibrium:**
  - Firm profits must be equalized across locations
  - Rents (and wages) offset for differences in productivity across location
    - Reflect production amenities and agglomeration

Firm location choice should also depend on household location (wages)

I DEVELOPERS

recall

- **Profit-maximizing developers provide floor space**
  - Convex production cost (building denser more expensive)
  - Use more capital when floor space rents are higher
- **Spatial equilibrium:**
  - Developer profits must be equalized across locations
  - Building density higher when floor space prices are higher
  - Greater construction costs compensate for greater revenues
    - Land rents higher where floor space rents are higher

Supply side links floor space rent to land rent

I OPEN CITY MODEL AND ROSEN-ROBACK

recall

- **Residents are mobile across cities**
  - Attractive features attract residents from other cities
  - Densification increases cost of living in a city
- **In equilibrium:**
  - Reservation utility level constant across locations
- **Rosen-Roback framework**
  - Residential amenities increase rents and decrease wages
  - Produciton amenities increase wages and rents

There is a world outside the city

II RECAP

roadmap

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II UNIFYING THE FRAMEWORKS

the ARSW model

- **Can we have a model with the following features?**
  - Endogenous household location choice
  - Endogenous firm location choice
  - Dispersed commuting
  - Profit-maximizing developers
  - Fundamental production and residential amenities
  - Agglomeration effects on production and consumption side
  - A region with which the city interacts

Yes, we can!

II THE ARSW MODEL

the ARSW model

- **Ahlfeldt, Redding, Sturm, Wolf (2015)**
  - Combines features of various urban models
  - No “awkward” geography
    - City consists of a series of “blocks”
    - Can take any form observed in real world
  - Empirically **tractable GE model**
  - First urban economics paper to win “Frisch medal”
    - Best paper of last five years in 2018 (Econometric Society)

II THE ARSW MODEL

the ARSW model

- **Ressources**
  - User-friendly VOXEU column
    - https://voxeu.org/article/economics-density-evidence-berlin-wall
  - Macroeconomic insights
    - http://microeconomicinsights.org/economics-density-evidence-berlin-wall/
  - Video: Gabriel explaining the impact of the model
    - https://www.youtube.com/watch?v=feZPzB29oU8
  - Video: Gabriel explaining what winning the Frisch Medal means for urban economics
    - https://www.youtube.com/watch?v=tDHw07csbIo


Gabriel Ahlfeldt


Steve Redding


Daniel Sturm


Nikolaus Wolf

II THE GENERAL SETUP

the ARSW model

ARSW (2015)

- City embedded in larger economy – *reservation utility* $\overline{U}$
- A single final good which is freely traded
- All markets are perfectly competitive
- Households and firms make optimal choices
- Discrete city blocks *i*
- Effective land is optimally allocated between residential and commercial use
- Construction sector producing floor space using land and capital

Within-city characteristics

- Fundamental production and consumption amenities
- Consumption spillovers **lead to concentration of residents**
- Production spillovers **lead to concentration of fims**
- Commuting costs **lead to co-location of firms and residents**

II RESIDENTS I

the ARSW model

Utility for worker o residing in block i and working in block j:

$$U_{ijo} = \frac{B_i z_{ijo}}{d_{ij}} \left(\frac{c_{ij}}{\beta} \right)^{\beta} \left(\frac{\ell_{ij}}{1-\beta} \right)^{1-\beta}, \qquad 0 < \beta < 1,$$

Standard Cobb-Douglas utility function with consumption of housing and other goods

- Consumption of the final good (c_{ij}), chosen as numeraire ($p_i = 1$)
- Residential floor space (ℓ_{ij})
- Residential amenity B_i
- Commuting costs $d_{ij} = e^{\kappa \tau_{ij}}$
- Idiosyncratic shock z_{ijo} that captures idiosyncratic reasons for a worker living in block i and working in block j

Making use of first-order conditions and budget constrain

Indirect utility →

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

Decreases in rent Q
Decreases in commuting cost d
Increases in residential amenities B
Depends on "idiosyncratic" tastes z

The idiosyncratic shock to worker productivity is drawn from a Fréchet distribution:

$$F(z_{ijo}) = e^{-T_i E_j z_{ijo}^{-\epsilon}}, \qquad T_i, E_j > 0, \ \epsilon > 1,$$

II RESIDENTS II

the ARSW model

Probability worker chooses to live in block i and work in block j is:

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

Residential and workplace choice probabilities

$$\pi_{Ri} = \sum_{j=1}^{S} \pi_{ij} = \frac{\sum_{j=1}^{S} \Phi_{ij}}{\Phi}, \qquad \pi_{Mj} = \sum_{i=1}^{S} \pi_{ij} = \frac{\sum_{i=1}^{S} \Phi_{ij}}{\Phi}.$$

Commuting market clearing →

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

More labour supplied to locations *j* where/if: *wages w are higher and/or there are more workers with within a short commuting range*

Workers working at j

Workers living at i

II SPATIAL EQUILIBRIUM IN OPEN CITY

the ARSW model

Expected utility of moving to the city

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

Spatial equilibrium in an open city framework implies that expected utility at all locations within the city is fixed to a reservation utility level

Solve for adjusted residential amenities ($\tilde{B}_i$):

$$\ln\left(\frac{\tilde{B}_i}{\overline{\tilde{B}}}\right) = \frac{1}{\epsilon} \ln\left(\frac{H_{Ri}}{\overline{H}_R}\right) + (1-\beta) \ln\left(\frac{\mathbb{Q}_i}{\overline{\mathbb{Q}}}\right) - \ln\left(\frac{W_i}{\overline{W}}\right),$$

Postive residential amenities *B* compensated for by higher rents *Q* and/or lower wages (net of commuting) *W*

Rosen-Roback equivalent within cities!

II FIRMS

the ARSW model

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

$$X_j = A_j H_{Mj}^{\alpha} L_{Mj}^{1-\alpha}, \qquad 0 < \alpha < 1,$$

Very similar to Ahlfeldt & Wendland (2013), except firms use floor space not land

Profit maximization and zero profits:

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

Solve for adjusted productivity ($\tilde{A}_i$):

$$\ln\left(\frac{\tilde{A}_{it}}{\overline{\tilde{A}}_t}\right) = (1-\alpha)\ln\left(\frac{Q_{it}}{\overline{Q}_t}\right) + \alpha \ln\left(\frac{\tilde{w}_{it}}{\overline{\tilde{w}}_t}\right)$$

Positive production amenities *A* compensated for by higher rents *Q* and/or higher wages *w*

Rosen-Roback equivalent within cities!

II FUNDAMENTALS AND SPILLOVERS

the ARSW model

- Productivity depends on
  - Exogenous production fundamentals
  - Endogenous pruduciton externalities (spillovers)

$$A_j = a_j \Upsilon_j^{\lambda}, \qquad \Upsilon_j \equiv \sum_{s=1}^{S} e^{-\delta \tau_{js}} \left(\frac{H_{Ms}}{K_s} \right)$$

Production *a* and residential *b* fundamentals are exogenously given, e.g. view on river or lake, location on top of a hill, etc.

Production spillovers depend on the surrounding workers at *workplace*, weighted by distance, e.g. due to knowledge spillovers

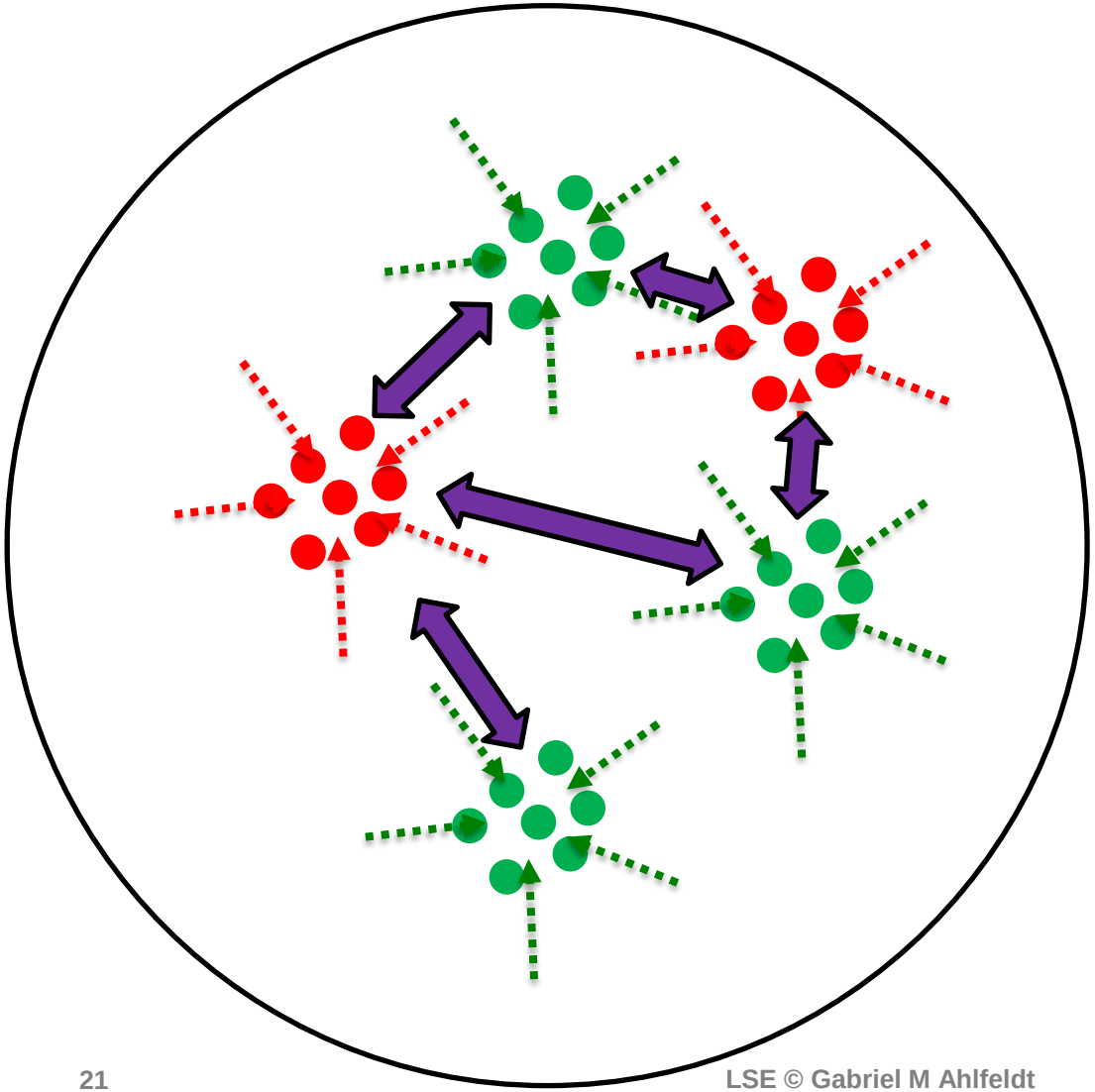
- Residential amenities depend on
  - Exogenous residential fundamentals
  - Endogenous residential externalities (spillovers)

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

Residential spillovers depend on the surrounding workers at *residence*, weighted by distance, e.g. attract endogenous amenities such as restaurants

II CONCENTRATION FORCES

the ARSW model



1) Production spillovers lead to concentration of firms

2) Residential spillovers lead to concentration of residents

3) Commuting cost lead to co-location of firms and residents

Q) Why does the city not collapse into a single "hyper-concentrated" point?

II PRODUCTION OF FLOOR SPACE

the ARSW model

- **Land is limited and inelastically supplied**
- **Floor space is produced by a construction sector with a concave production function, using land and capital**
- ***In perfect analogy to topic IV***
  - **More space can only be provided at higher floor space rents**
  - **Higher floor space price translates to higher land rents**

Cost of building dense and tall creates a dispersion force that prevents hyper-concentration

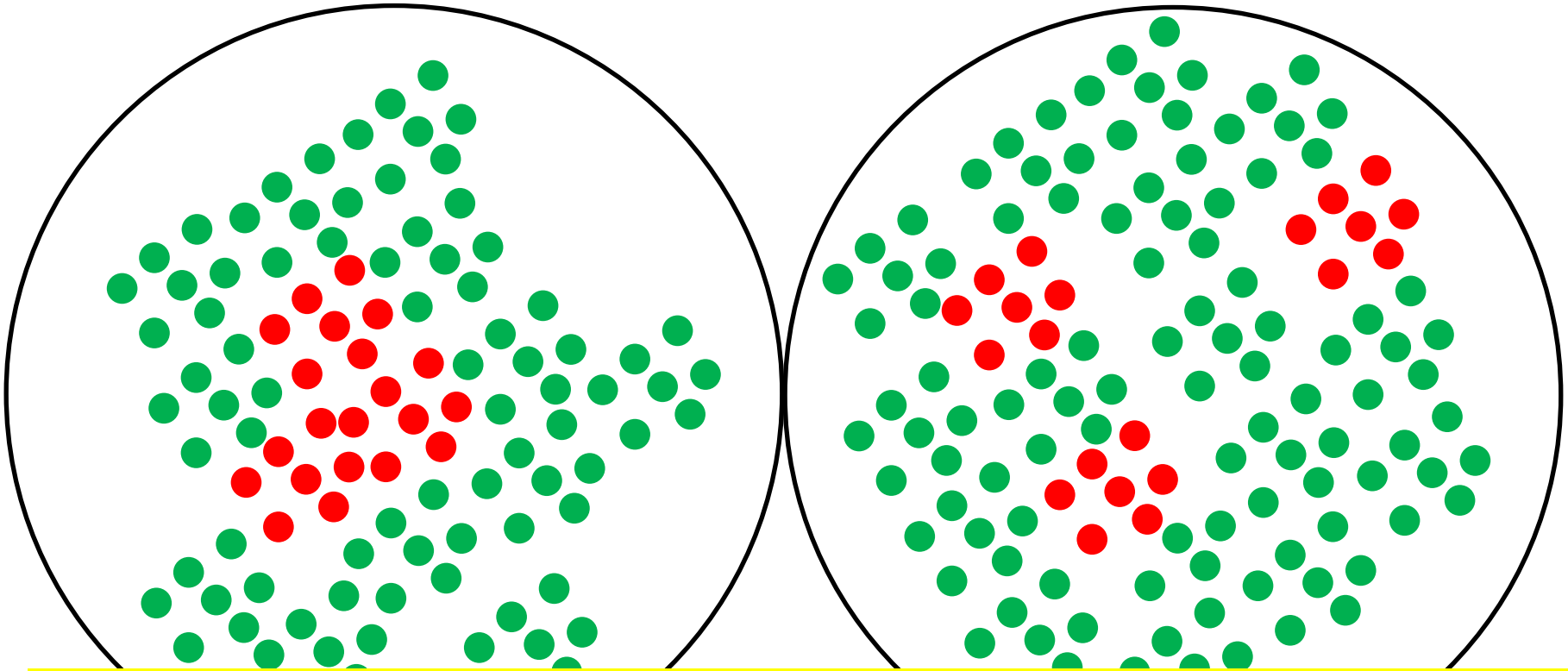
End up with clusters of commercial activity, residential areas and mixed-use zones. City can have different configurations (multiple equilibria, see topic VI)

II CONCENTRATION FORCES

the ARSW model

Monocentric city

Polycentric city



Recall Topic VI: Can transform cities IFF external returns to scale matter!

Recall Topic II: Estimating agglomeration effects is challenging due to endogeneity

III SEPARATING SPILLOVERS FROM FUNDAMENTALS

roadmap

- **This time:** ***The urban economy in general equilibrium***
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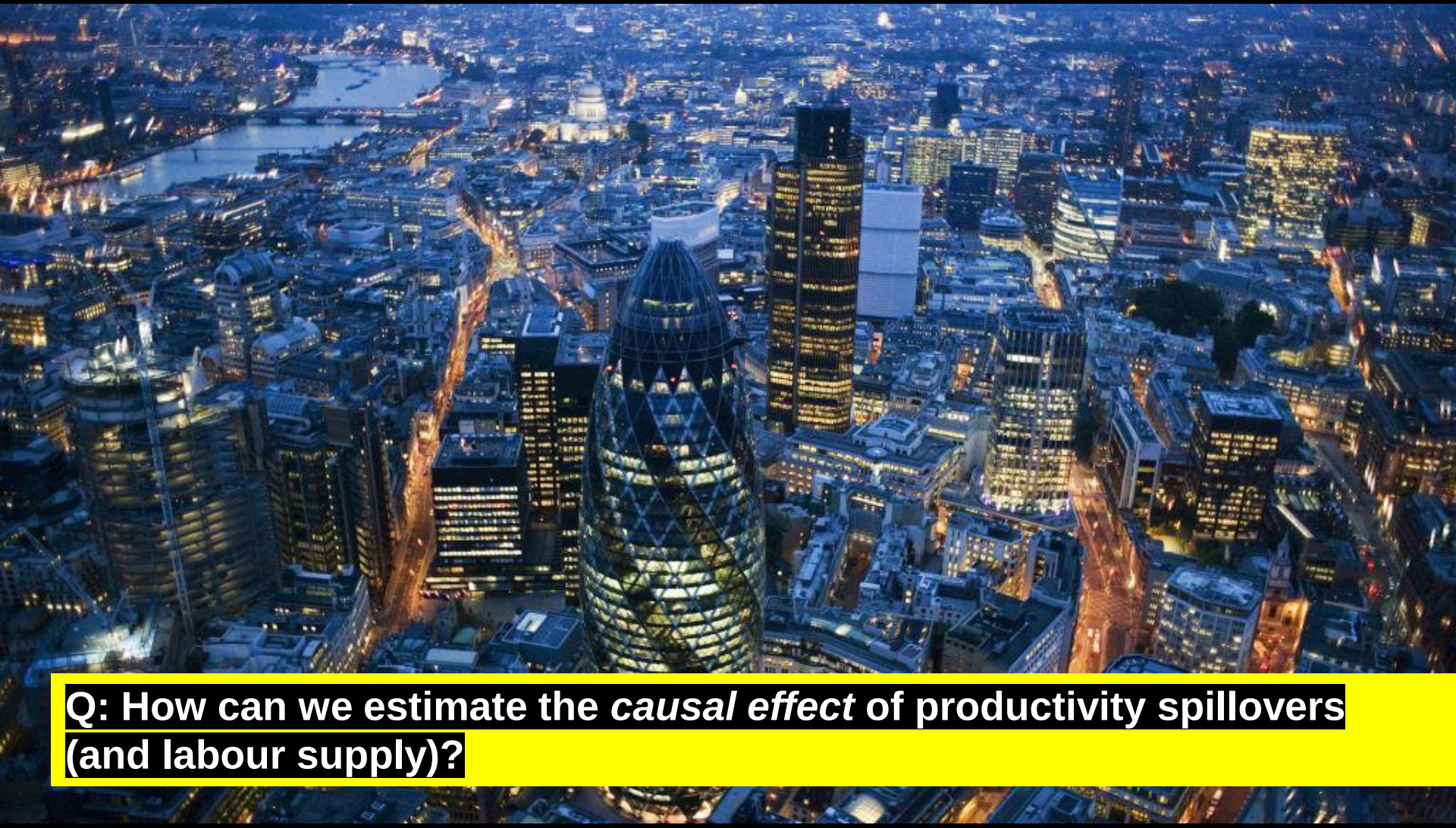


Q: How can we estimate the *causal effect* of productivity spillovers (and labour supply)?

III TESTING FOR SPILLOVERS

separating spillovers from location fundamentals

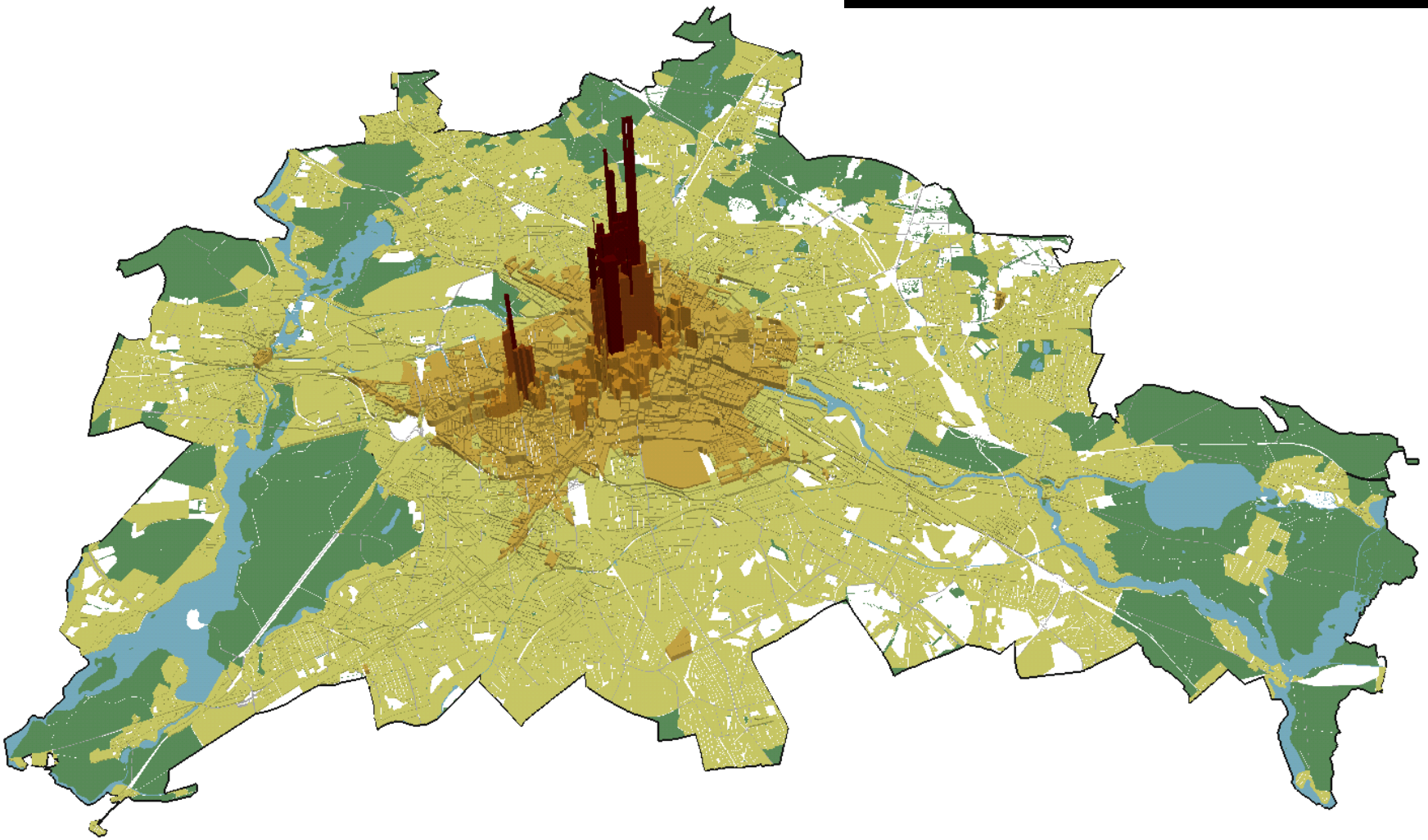
- To separate spillovers from location fundamentals, we need
  - plausibly exogenous variation in exposure to spillovers
  - over time
- Variation over time allows for a before-after comparison
  - Can rule out local fundamentals which are time-invariant
- Need a shock that increases or decreases some location's exposure to spillovers from other locations and affects
  - Shared inputs
  - Labour market pooling
  - Knowledge spillovers

Q: Why type of events induce changes in exposure to spillovers?

III LAND PRICES IN BERLIN 1936

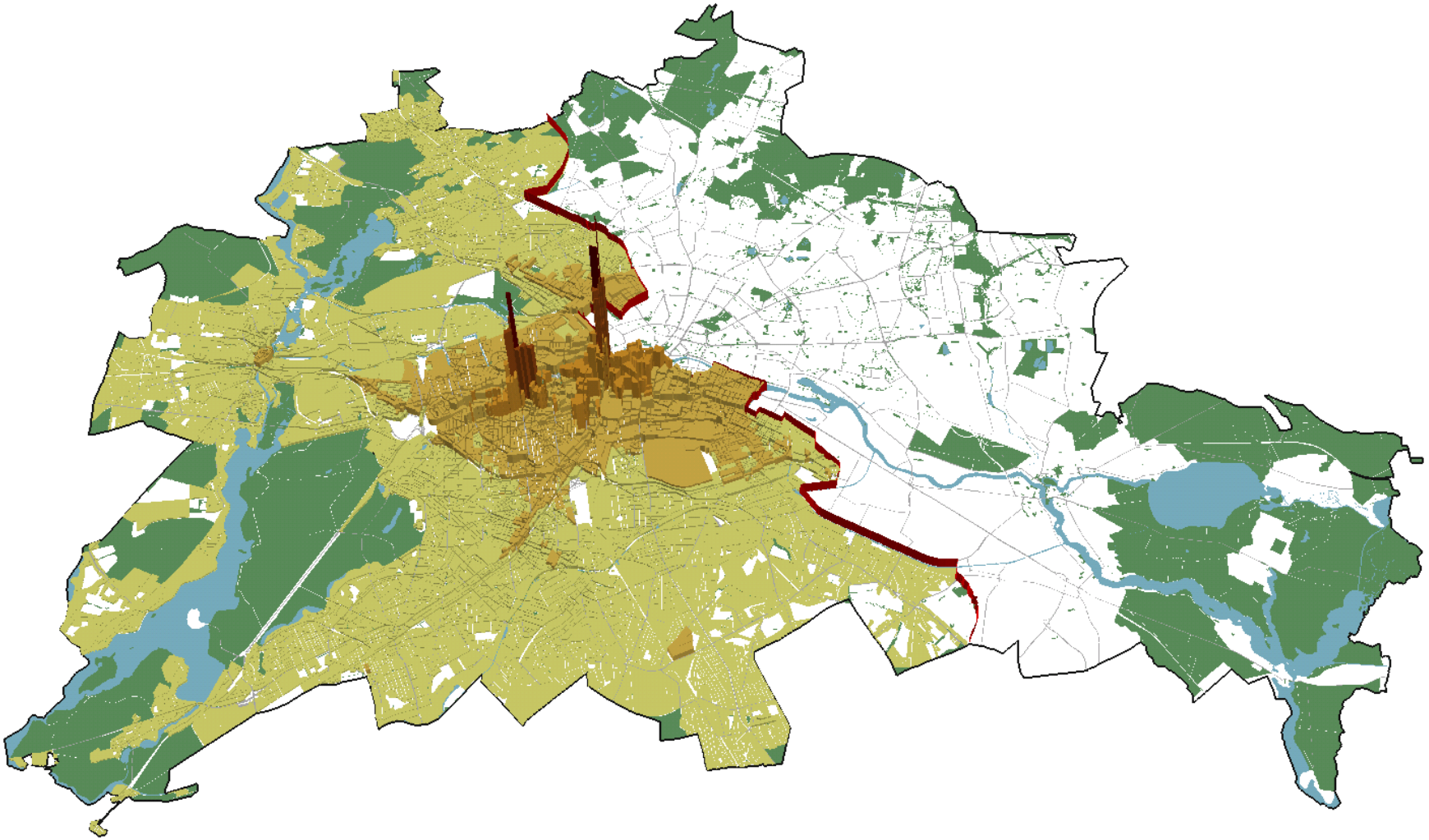
separating spillovers from location fundamentals

A descriptive version of ARSW, 2015



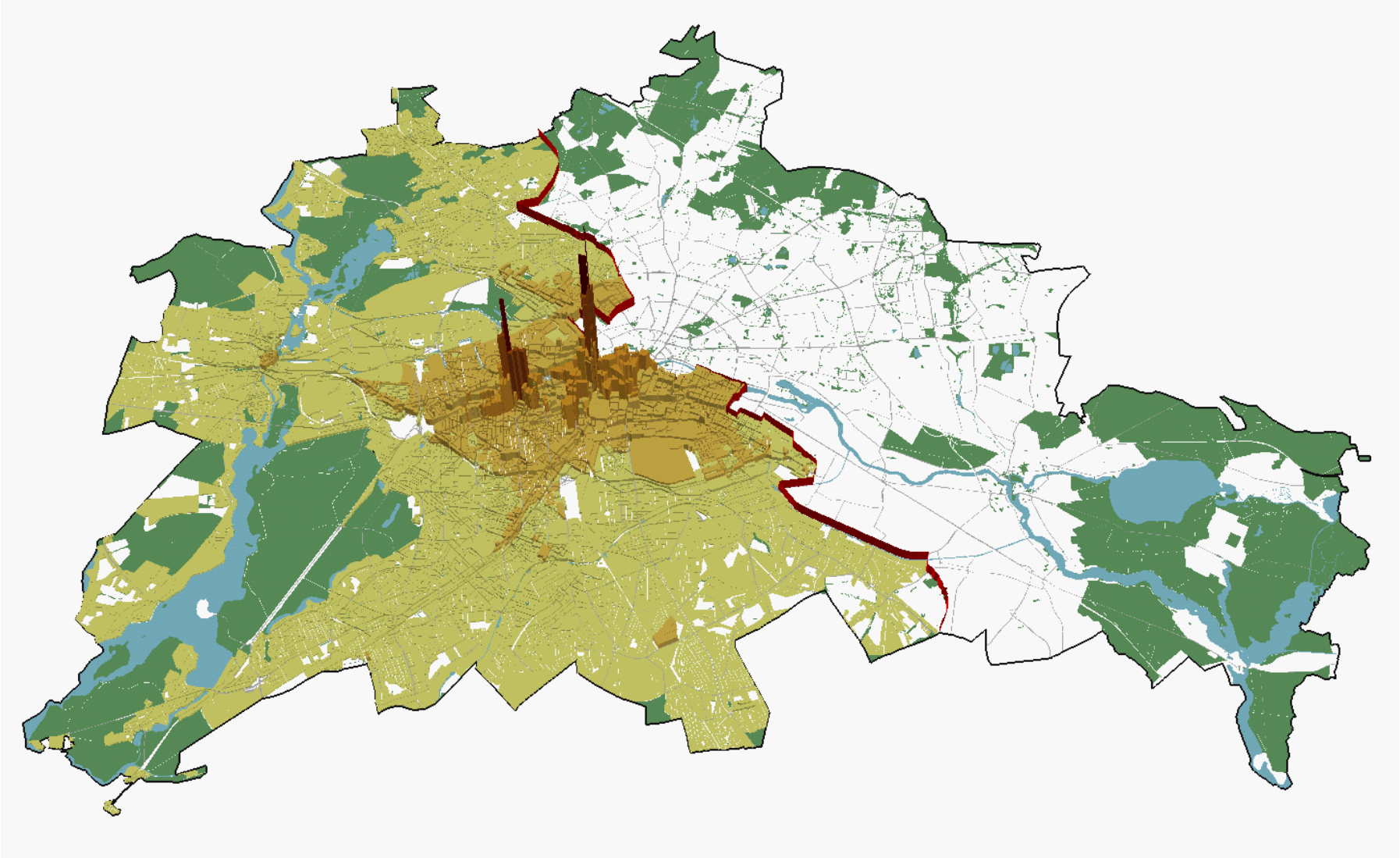
III LAND PRICES IN WEST BERLIN 1936

separating spillovers from location fundamentals



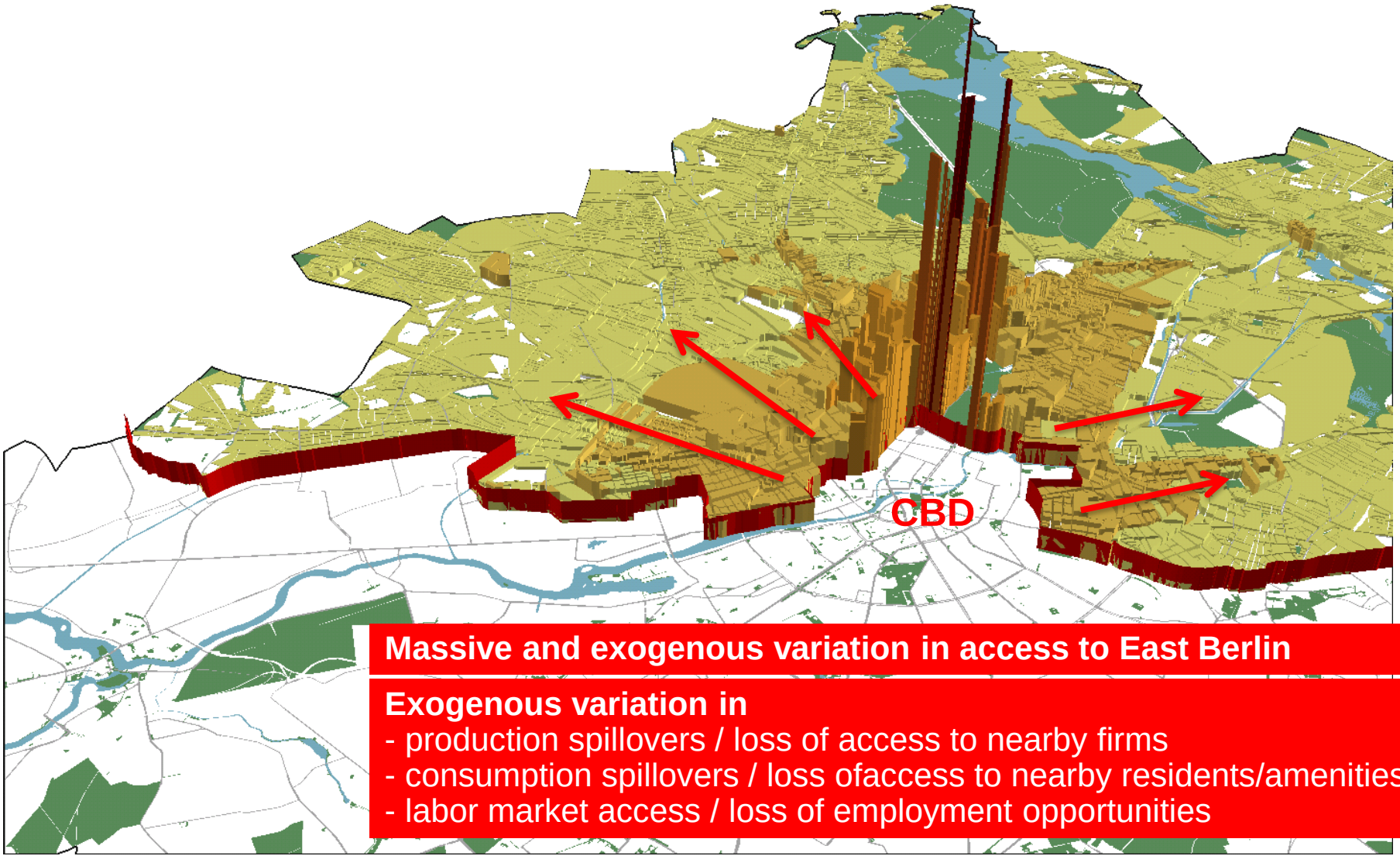
III LAND PRICES IN WEST BERLIN 1936

separating spillovers from location fundamentals



III LAND PRICES IN WEST BERLIN 1936

separating spillovers from location fundamentals

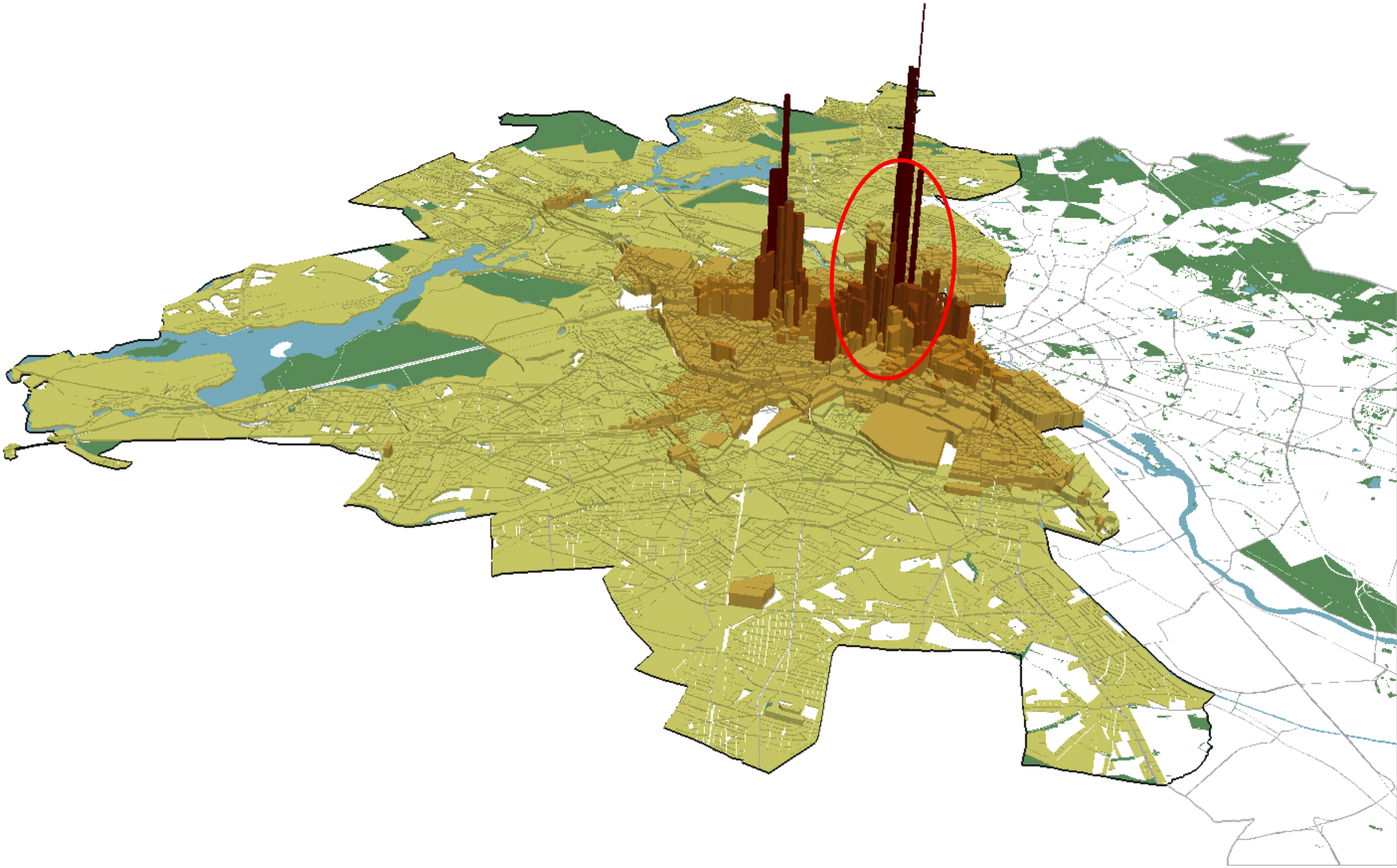


Massive and exogenous variation in access to East Berlin

Exogenous variation in
- production spillovers / loss of access to nearby firms
- consumption spillovers / loss ofaccess to nearby residents/amenities
- labor market access / loss of employment opportunities

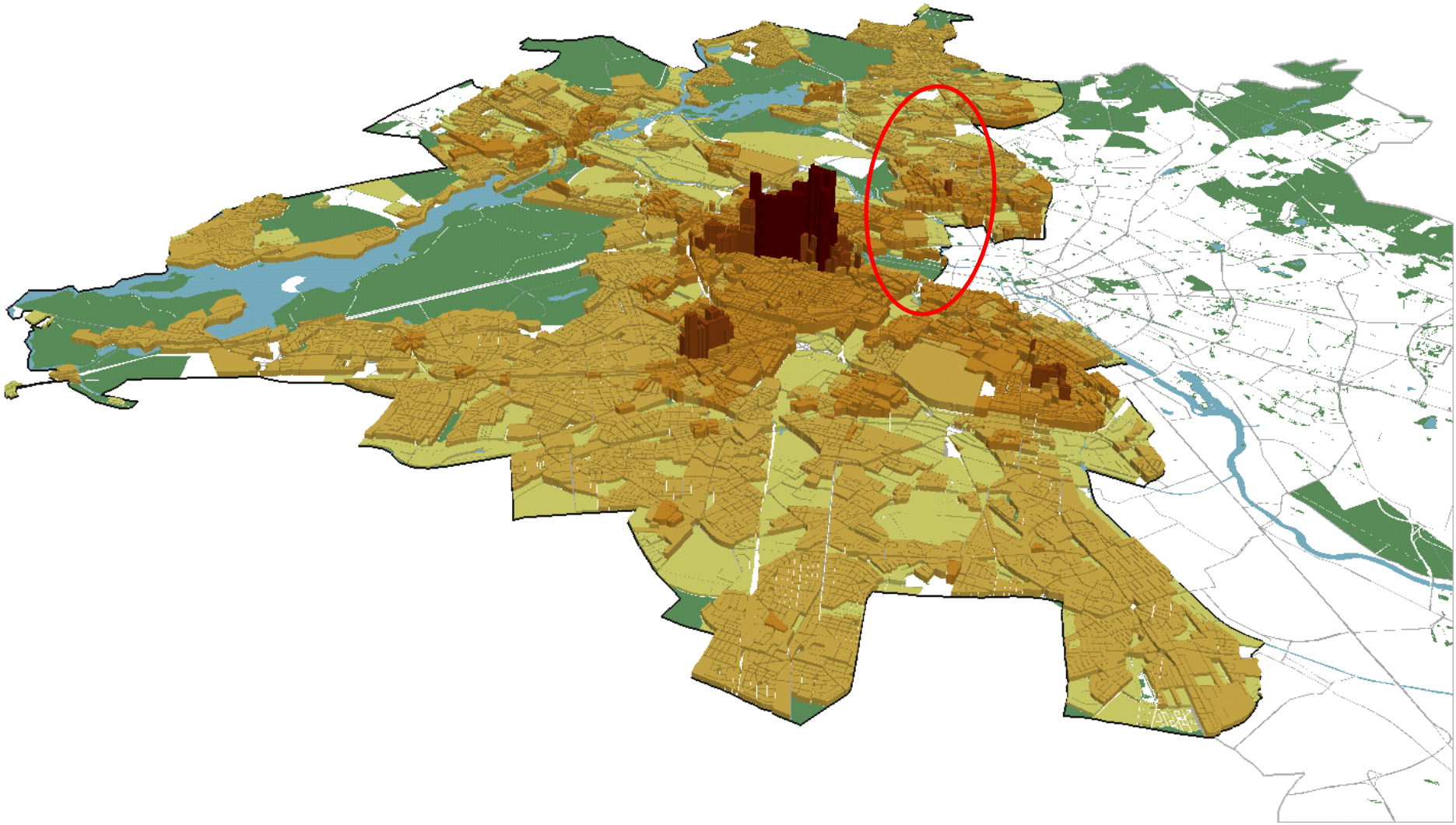
III LAND PRICES IN 1936 (PRE-DIVISION)

separating spillovers from location fundamentals



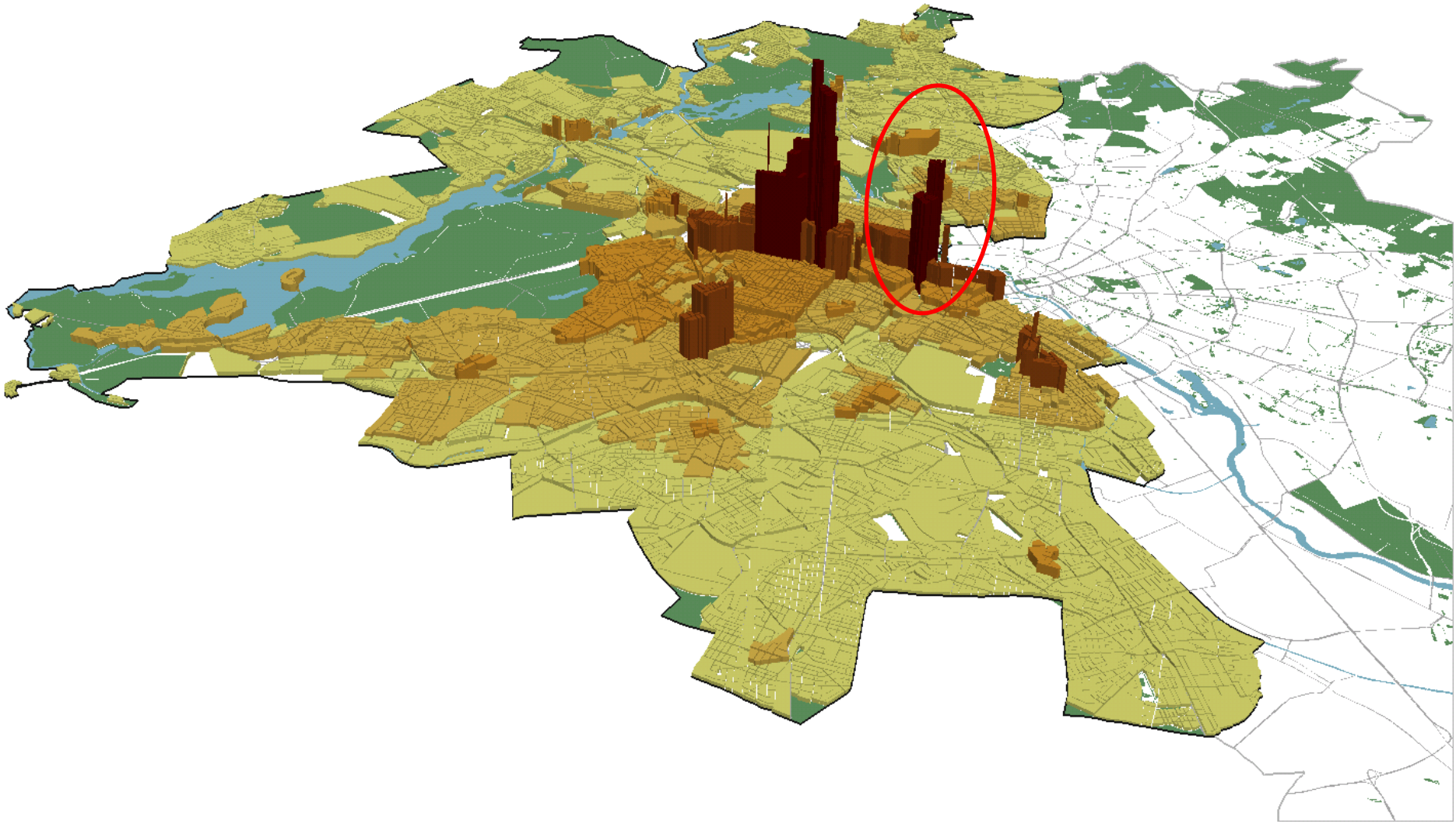
III LAND PRICES IN 1986 (DIVISION)

separating spillovers from location fundamentals



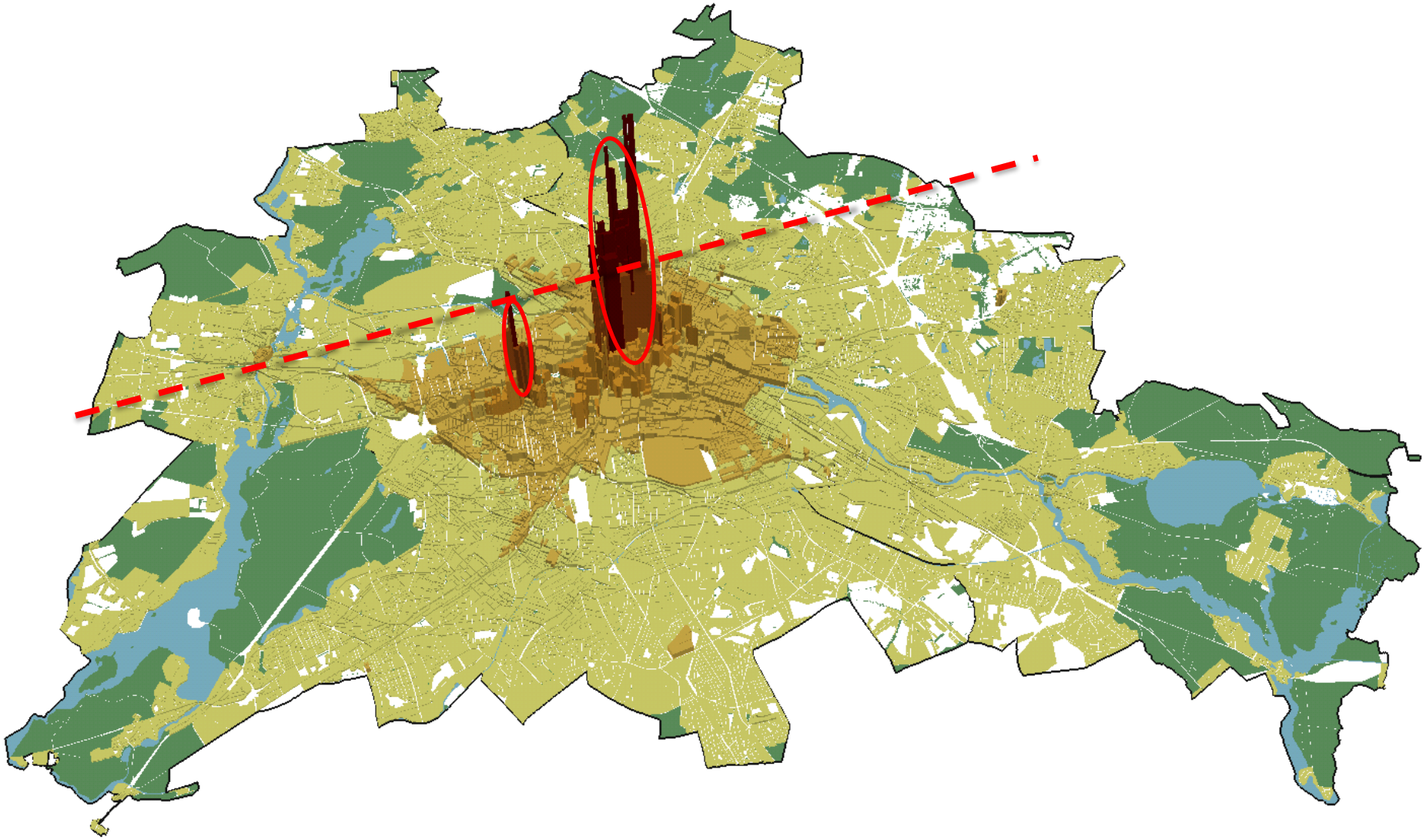
III LAND PRICES IN 2006 (POST-UNIFICATION)

separating spillovers from location fundamentals



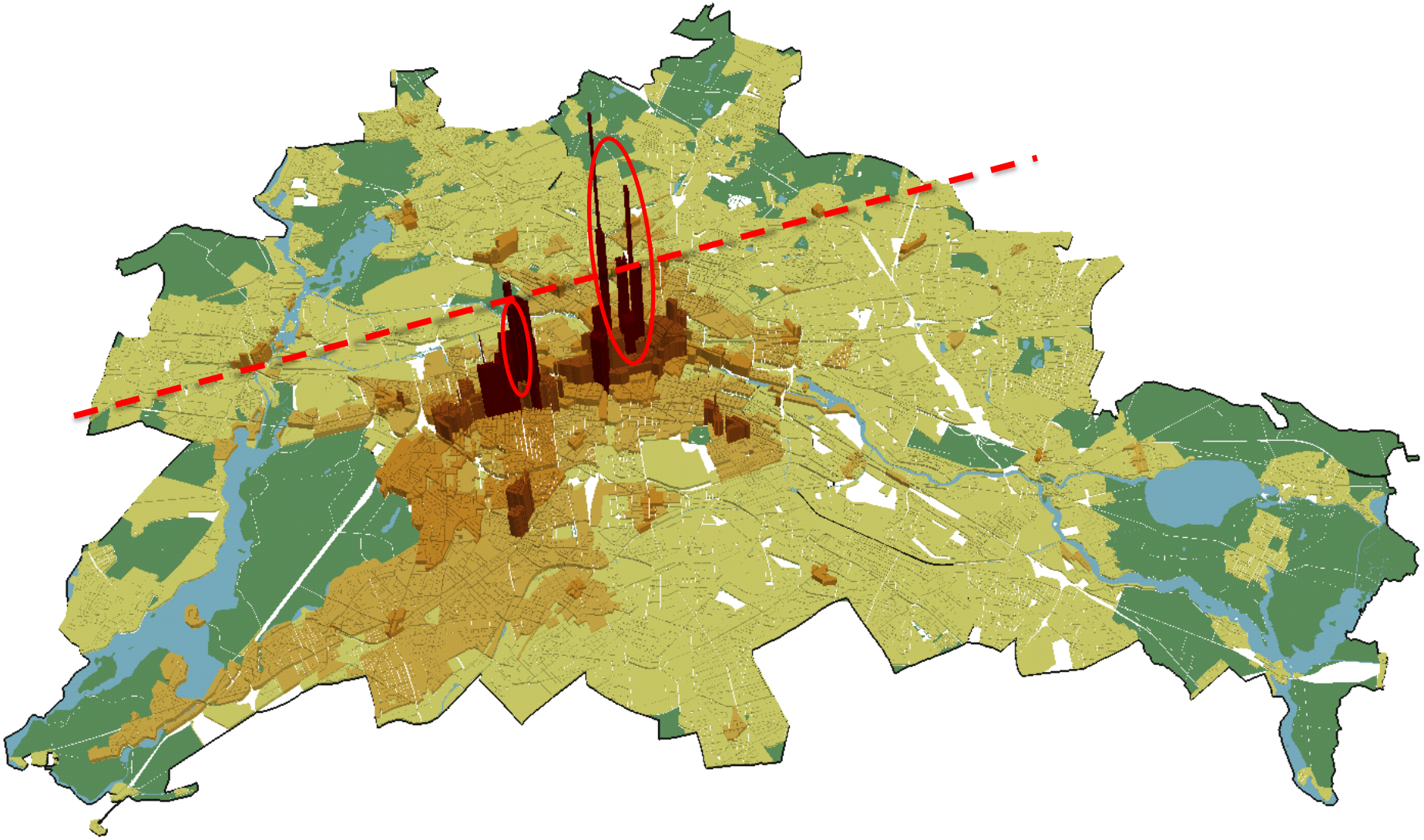
III LAND PRICES IN 1936 (PRE-DIVISION)

separating spillovers from location fundamentals



III LAND PRICES IN 2006 (POST-DIVISION)

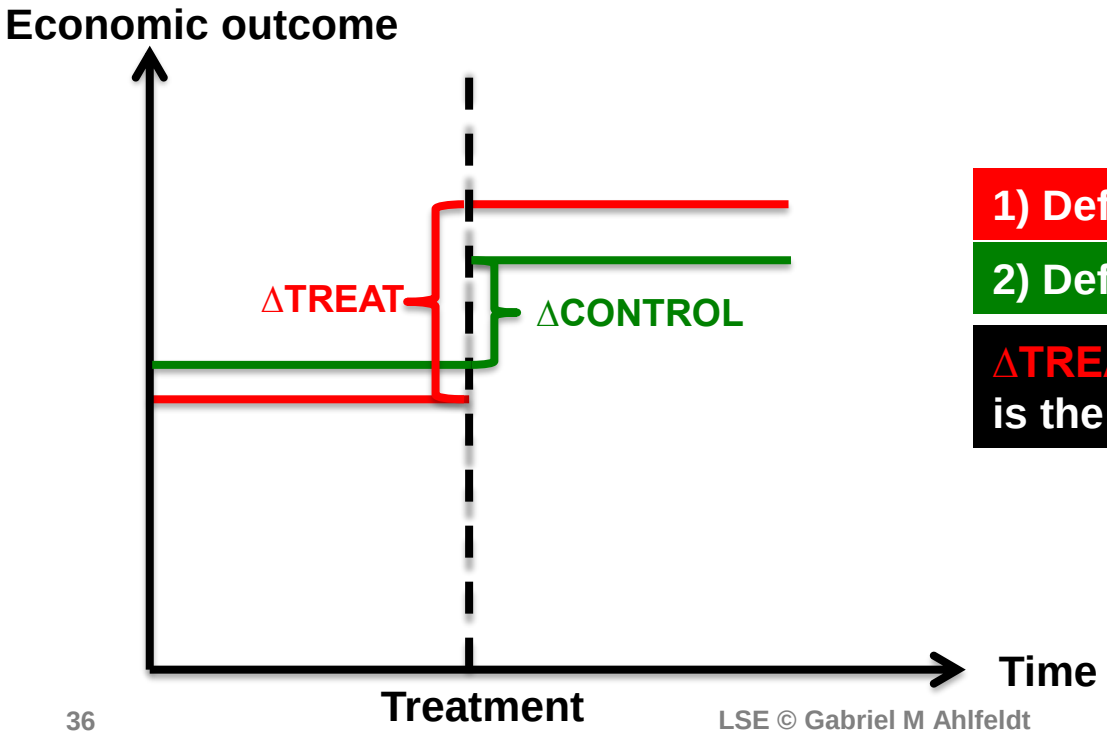
separating spillovers from location fundamentals



III HOW TO QUANTIFY THE EFFECT STATISTICALLY?

separating spillovers from location fundamentals

- **Difference-in-differences**
  - **Standard and simple framework for before-after comparisons**
  - **More detail during econometrics classes (GY458)**



1) Define group of treated

2) Define control group

ΔTREAT-ΔCONTROL
is the difference-in-difference!

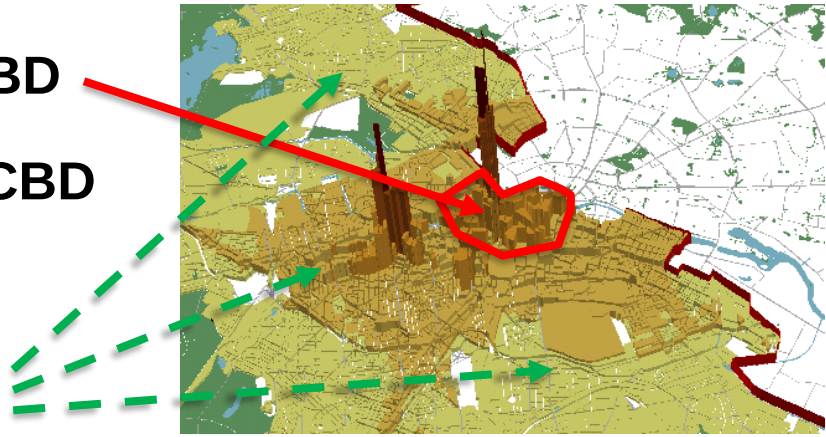
III HOW TO IMPLEMENT HERE?

separating spillovers from location fundamentals

- Event
  - Division of the city: Berlin Wall in 1961
  - Re-unification in 1989
- Treatment group
  - West Berlin areas close to the CBD
    - Lost/gained spillovers from CBD
- Control group
  - West Berlin areas further away
    - Less exposed to changes in spillovers

One DD analysis for division effects

One DD analysis for re-unification effects



III DIFFERENCE-IN-DIFFERENCES SPECIFICATION

separating spillovers from location fundamentals

- **Standard specification:** $Y_{ist} = \alpha + \beta T_s + \gamma P_t + \delta T_s P_t + \varepsilon_{ist}$
  - **i: spatial units**
  - **t: time periods**
    - **0 indexes before, 1 indexes after**
  - **s: group**
    - **0 indexes control, 1 indexes treatment**

1 if treated
0 if not

1 if after event
0 if before

- **Treatment effect:**

$$\delta = \left(\bar{Y}_{s=1,t=1} - \bar{Y}_{s=1,t=0}\right) - \left(\bar{Y}_{s=0,t=1} - \bar{Y}_{s=0,t=0}\right)$$

III DIFFERENCE-IN-DIFFERENCES SPECIFICATION

separating spillovers from location fundamentals

- **Standard specification:** $Y_{ist} = \alpha + \beta T_s + \gamma P_t + \delta T_s P_t + \varepsilon_{ist}$
  - **Can be estimated using standard OLS regressions**
- **Alternative way of putting it:** $Y_{it} = \alpha + \delta T_i P_t + \mu_i + \varphi_t + \varepsilon_{it}$
  - **Where μ_i and φ_t are individual fixed effects and time fixed effects that replace group (T_s) and period (P_t) indicators**
- **In a two-period setting, we can take time differences to get**

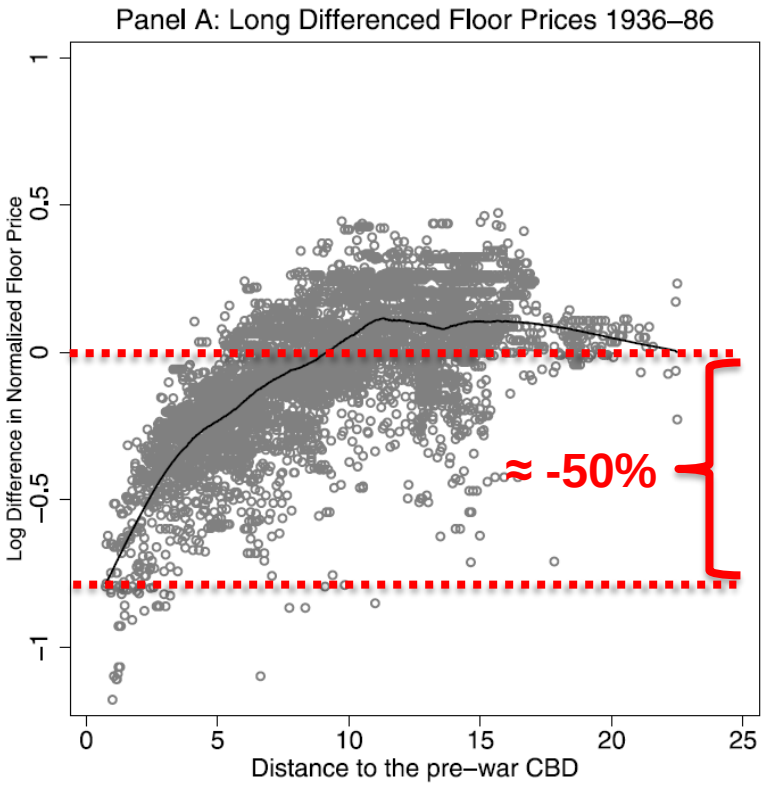
$$\Delta Y_{is} = \varphi + \delta T_s + \varepsilon_{is}$$ ← **ARSW specification**

  - **Δ denotes before-after difference $(Y_{i,s=1} - Y_{i,s=0})$**
  - **α and μ_i are differenced out since time-invariant**
  - **φ_t become a regression constant**

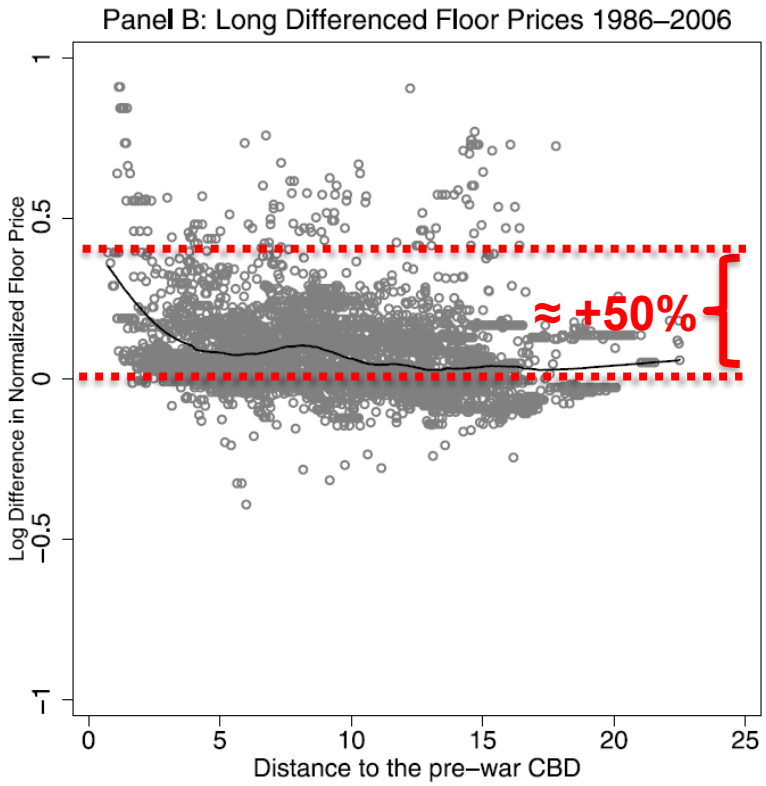
III TREATMENT EFFECTS ON LAND PRICES

separating spillovers from location fundamentals

Division



Unification



"% effect" = exp("log-point effect"-1)

Spillover effects create huge investment opportunities!

III DD RESULTS: DIVISON

separating spillovers from location fundamentals

TABLE I

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

	(1) Δ ln Q	(2) Δ ln Q	(3) Δ ln Q	(4) Δ ln Q	(5) Δ ln Q	(6) Δ ln EmpR	(7) Δ ln EmpR	(8) Δ ln EmpW	(9) Δ 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%.

Significant and robust treatment effects on land prices, population, and employment!

III III DD RESULTS: REUNIFICATION

separating spillovers from location fundamentals

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

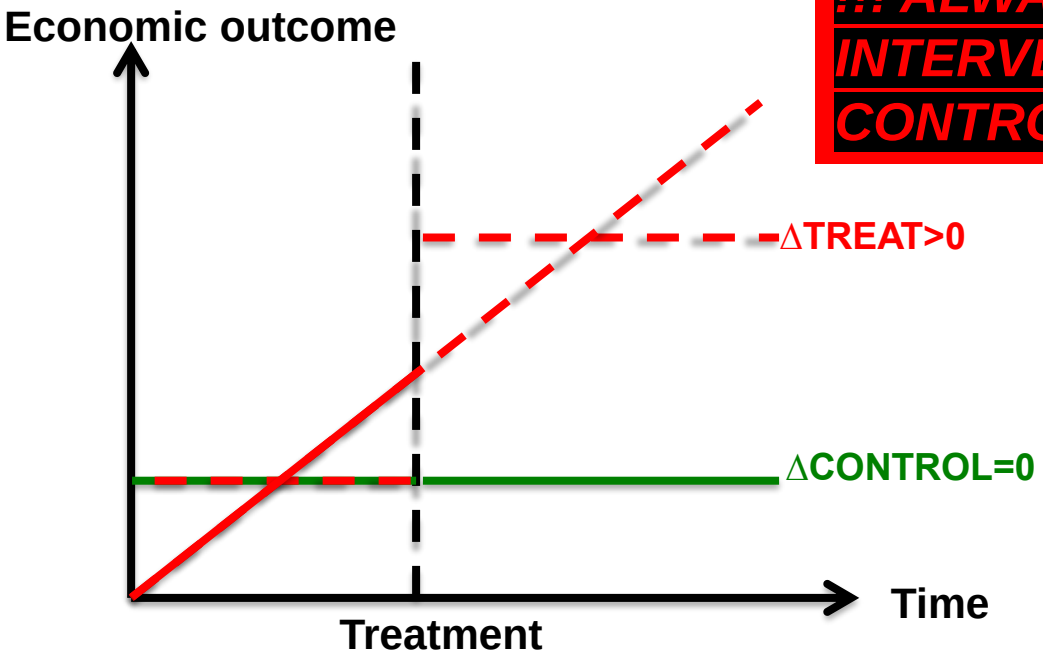
[a] Q denotes the price of floor space. EmpR denotes employment by residence. EmpW denotes employment by workplace. CBD1–CBD6 are six 500 m distance grid cells for distance from the pre-war CBD. Inner Boundary 1–6 are six 500 m grid cells for distance to the Inner Boundary between East and West Berlin. 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%.

Significant and robust treatment effects on land prices, population, and employment!

III NON-PARALLEL TRENDS

separating spillovers from location fundamentals

- **Key DD assumption: In absence of treatment, treatment and control group would follow parallel trend**
- **Counterfactual trends cannot be observed, but "pre-trends" can**



!!! ALWAYS CHECK TRENDS BEFORE INTERVENTION IN TREATMENT AND CONTROL GROUP!!!

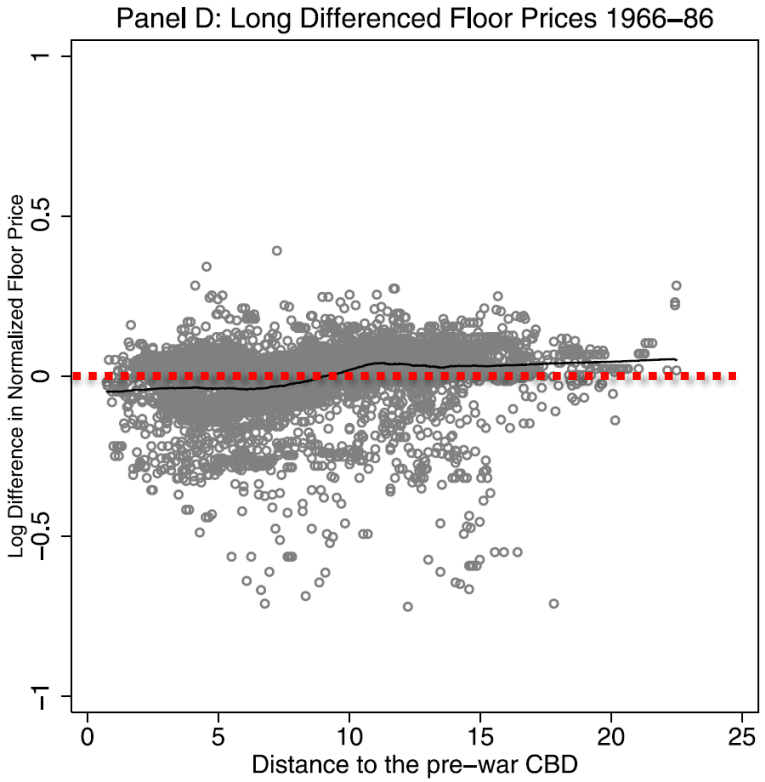
ΔTREAT-ΔCONTROL >0

Comparison not credible if pre-trends explain treatment effect!

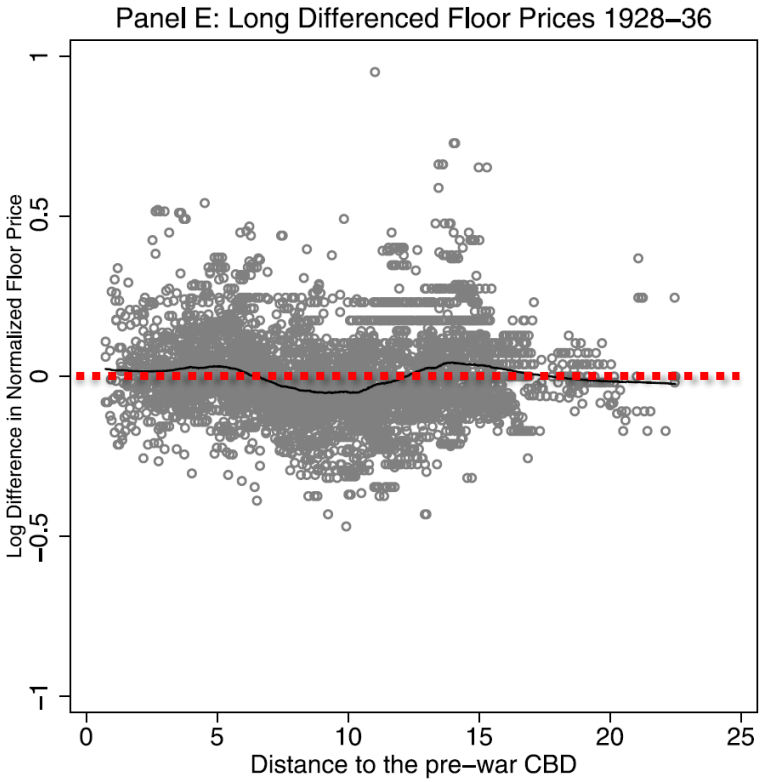
III PRE-TREND EVAULUATION

separating spillovers from location fundamentals

Before unification



Before division



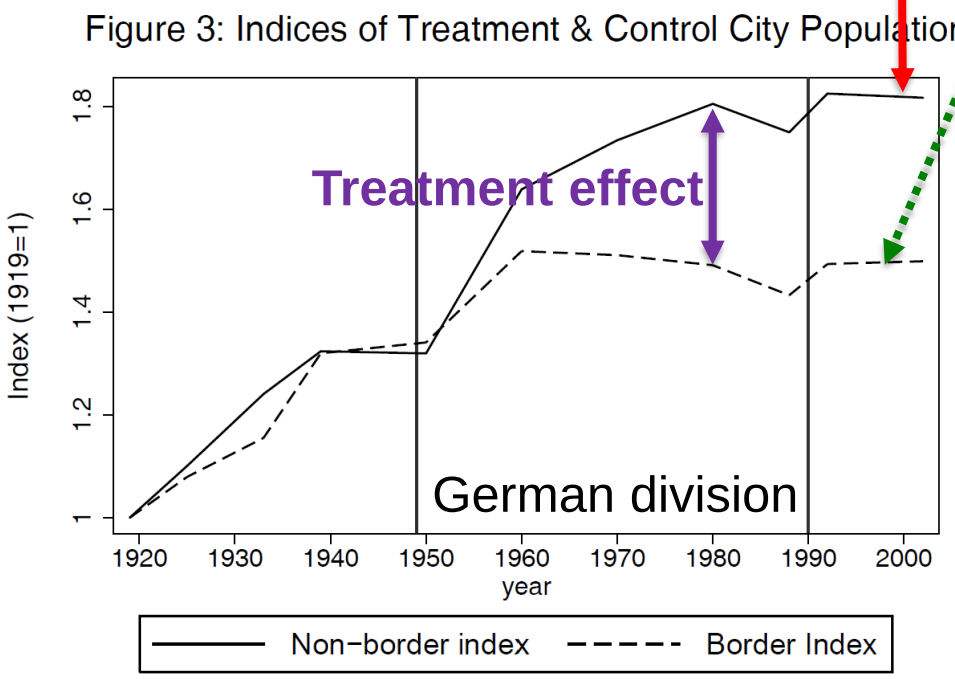
Placebo tests: No effect of treatment effect where no treatment
=> parallel-trends assumption credible

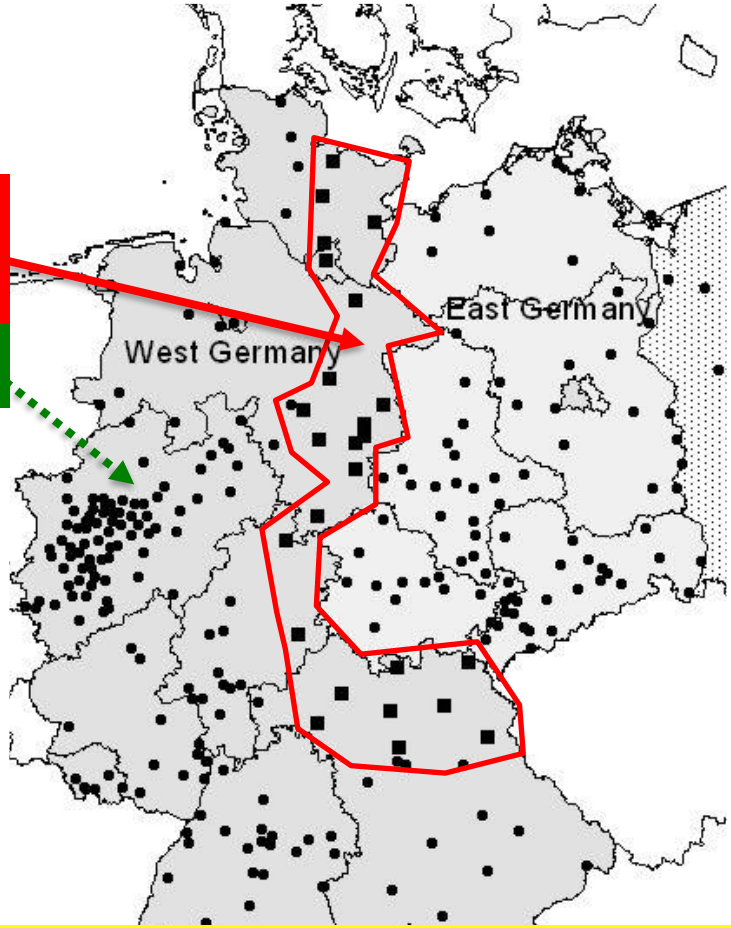
III REDDING & STURM (2008)

separating spillovers from location fundamentals

Treatment group: West German cities close to inner-German boarder

Control group: Other West German cities





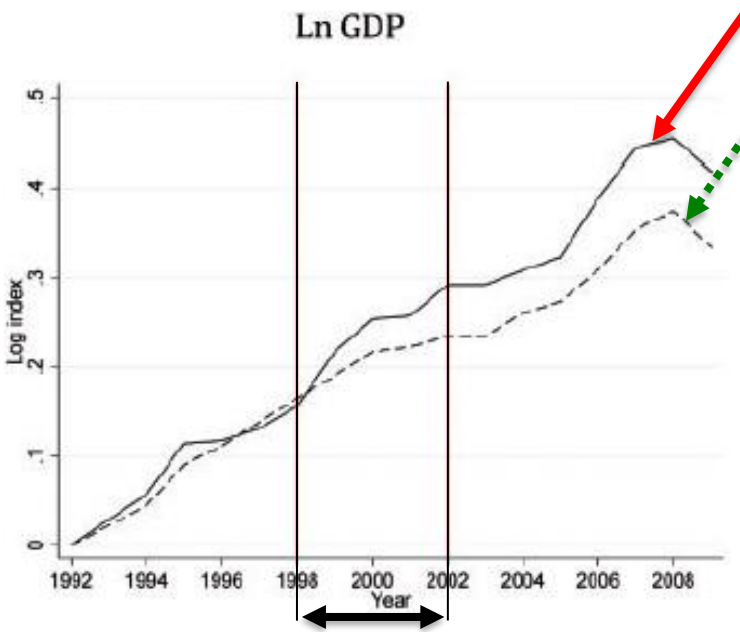
Negative impact of loss of agglomeration due to division on population growth

III AHLFELDT & FEDDERSEN (2018)

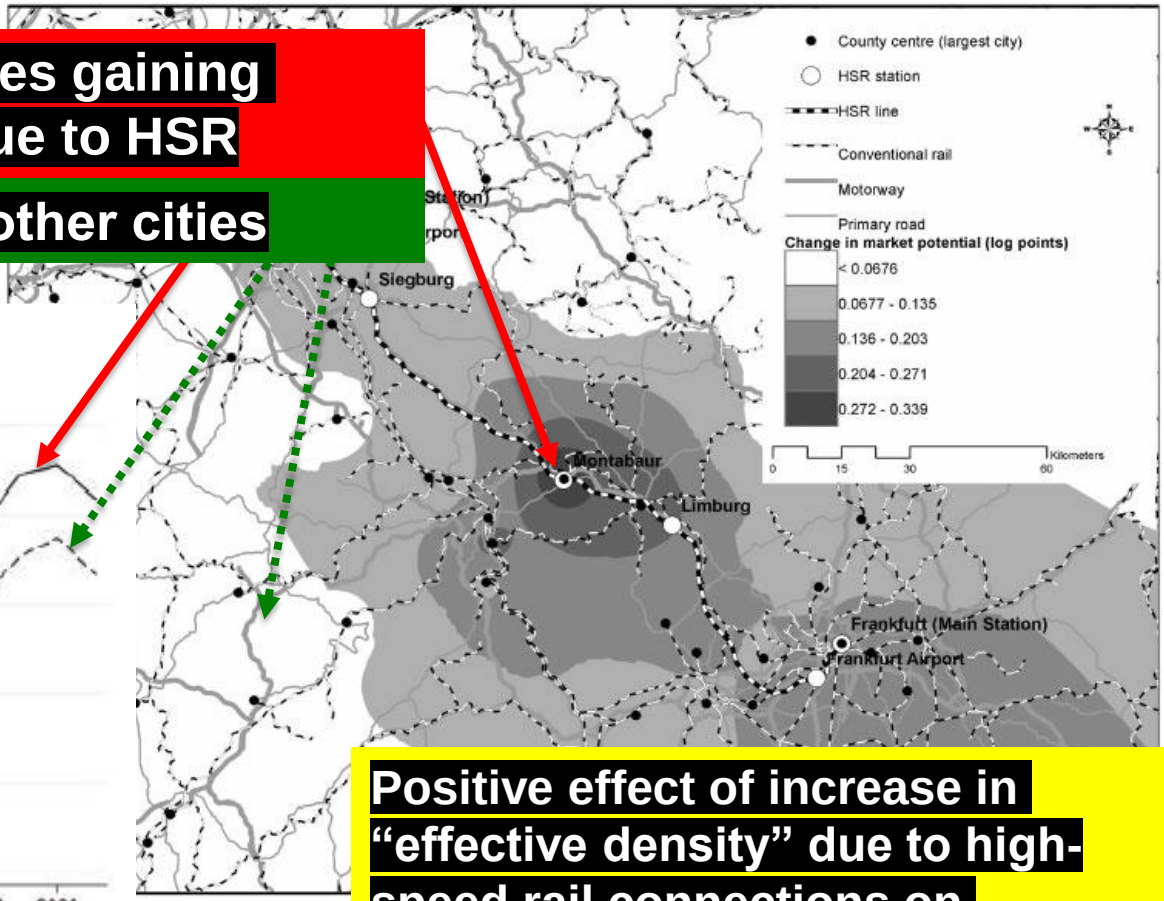
separating spillovers from location fundamentals

Treatment group: Small cities gaining access to agglomeration due to HSR

Control group: "Matched" other cities



HSR construction



Positive effect of increase in "effective density" due to high-speed rail connections on productivity and GDP

III CHECK LIST FOR A GOOD DD STUDY

separating spillovers from location fundamentals

- 1) Show descriptive stats for treatment and control group
  - Mean, s.d., etc. for outcome variable and other observables
- 2) Show trends in outcome for treatment and control group
  - Plot the trends in the outcome over time
  - Are the trends parallel before the treatment?
  - Conduct an event study (Autor, 2003)
- 3) "Narrow" the control group to improve comparability
  - Propensity score matching
    - Rosenbaum and Rubin, 1983
  - Synthetic control method
    - Abadie and Gardeazabal, 2003
  - Inverse probability weighting
    - E.g. Hernan et al., 2001
  - Entropy balancing
    - Hainmueller, 2012
- 4) Address non-parallel trends
  - Parametric control for trends
    - E.g. Ahlfeldt, Moeller, Waights, Wendland, (2017)
  - Time differencing
    - Lee, 2016
- 5) Coupled with discontinuity designs
  - Ahlfeldt, Koutroumpis, Valletti, 2017
  - Duranton, Gobillon, Overman, 2011

Always do!

Always do!

Makes an impression…

Do if 1) does not look right!
(always makes an impression)

Do if 2) does not look right!

Do if possible

III SEPARATING SPILLOVERS FROM FUNDAMENTALS

roadmap

- **This time: *The urban economy in general equilibrium***
  - **1) Recap**
    - **Compensating differentials, location choice, supply side**
  - **2) The Ahlfeldt-Redding-Sturm-Wolf model**
    - **Model setup**
  - **3) Separating spillovers from location fundamentals**
    - **Reduced-form evidence**
    - **Difference-in-difference analysis**
  - **4) Structural estimation and simulation**
    - **Identifying structural parameters**
    - **Simulating the effect of a new metro line**

IV BACK TO ARSW

structural estimation and simulation

- **ARSW model is a structural general equilibrium model**
  - Once structural parameters are identified (or plausibly assumed), we can use the model to **simulate effects of shocks**
- **GMM estimation strategy**
  - Use the structure of the model and the shock from the Berlin Wall to **identify structural parameters**
  - **Find parameters** that ensure changes in fundamentals over time are uncorrelated with distance from the CBD
    - **A: Fundamentals don't change systematically over time**
- **Simulation strategy**
  - **Shock the system, e.g. by building a new metro line**
  - **Let model converge to a new equilibrium**

IV STRUCTURAL ESTIMATION RESULTS I

structural estimation and simulation

TABLE V

GENERALIZED METHOD OF MOMENTS (GMM) ESTIMATION RESULTS[a]

	(1) Division Efficient GMM	(2) Reunification Efficient GMM	(3) Division and Reunification Efficient GMM
Commuting Travel Time Elasticity ($\kappa\varepsilon$)	0.0951***	0.1011***	0.0987***
	(0.0016)	(0.0016)	(0.0016)
Commuting Heterogeneity (ε)	6.6190***	6.7620***	6.6941***
	(0.0939)	(0.1005)	(0.0934)
Productivity Elasticity (λ)	0.0793***	0.0496***	0.0710***
	(0.0064)	(0.0079)	(0.0054)
Productivity Decay (δ)	0.3585***	0.9246***	0.3617***
	(0.1030)	(0.3525)	(0.0782)
Residential Elasticity (η)	0.1548***	0.0757**	0.1553***
	(0.0092)	(0.0313)	(0.0083)
Residential Decay (ρ)	0.9094***	0.5531	0.7595***
	(0.2968)	(0.3979)	(0.1741)

[a]Generalized Method of Moments (GMM) estimates. Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley (1999)). * significant at 10%; ** significant at 5%; *** significant at 1%.

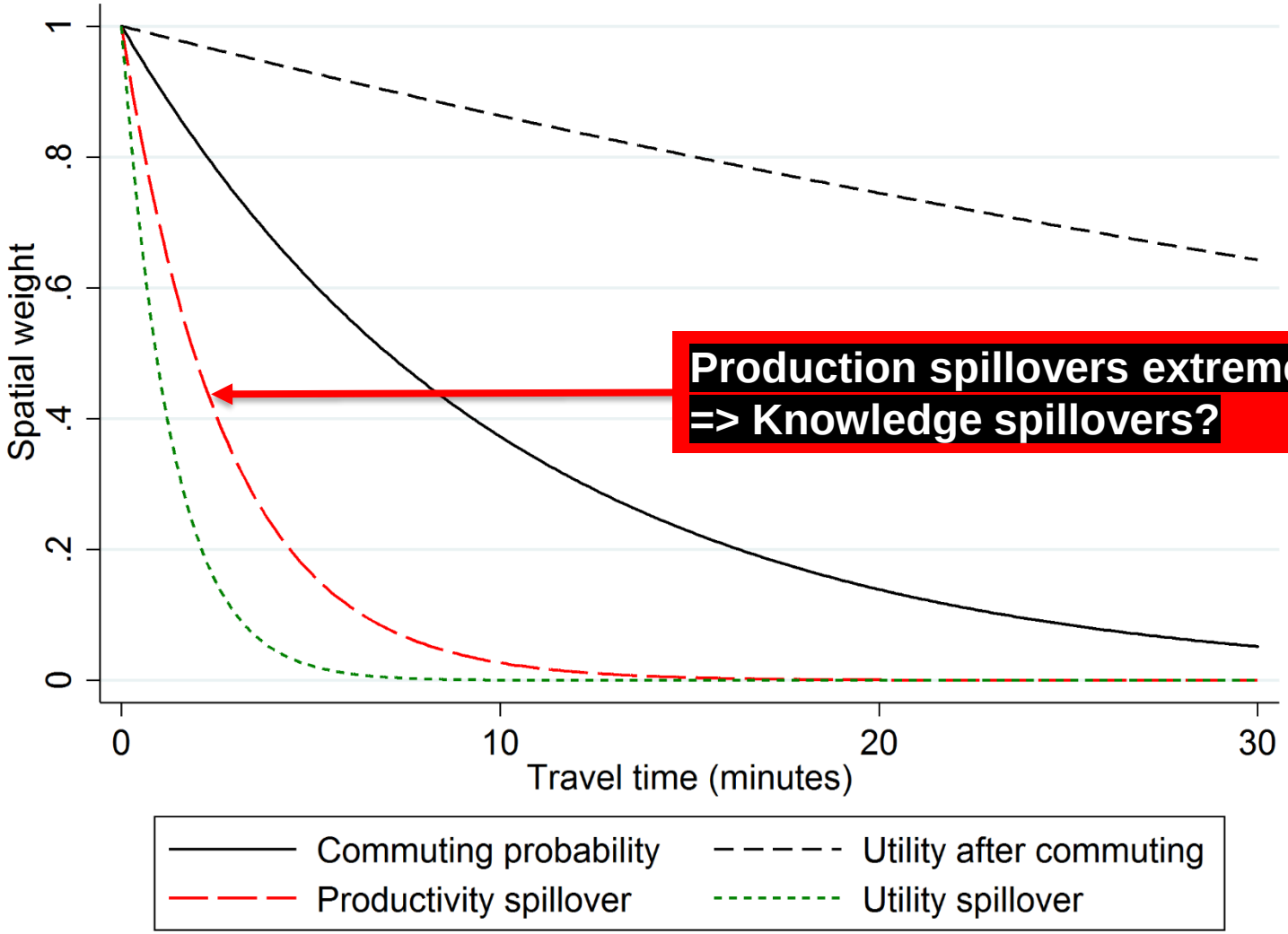
Workers provide more labour at a location if wage is higher!

Production spillovers matter

Residential spillovers matter, too

IV STRUCTURAL ESTIMATION RESULTS II

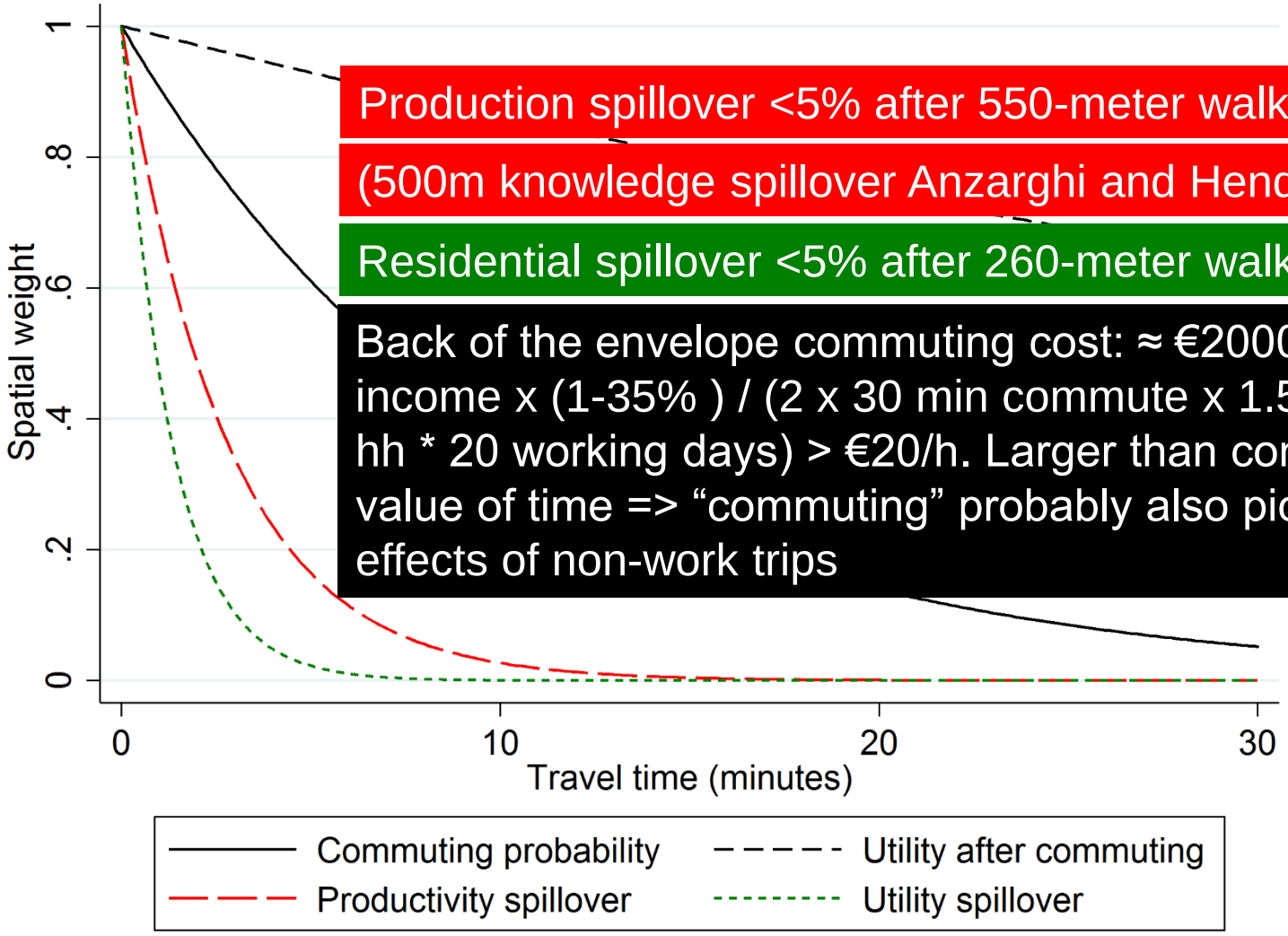
structural estimation and simulation



Production spillovers extremely localized
=> Knowledge spillovers?

IV STRUCTURAL ESTIMATION RESULTS II

structural estimation and simulation



Production spillover <5% after 550-meter walk (4 km/h)

(500m knowledge spillover Anzarghi and Henderson 2008)

Residential spillover <5% after 260-meter walk (4 km/h)

Back of the envelope commuting cost: ≈ €2000 disp. hh. income x (1-35%) / (2 x 30 min commute x 1.5 workers per hh * 20 working days) > €20/h. Larger than conventional value of time => “commuting” probably also picks up effects of non-work trips

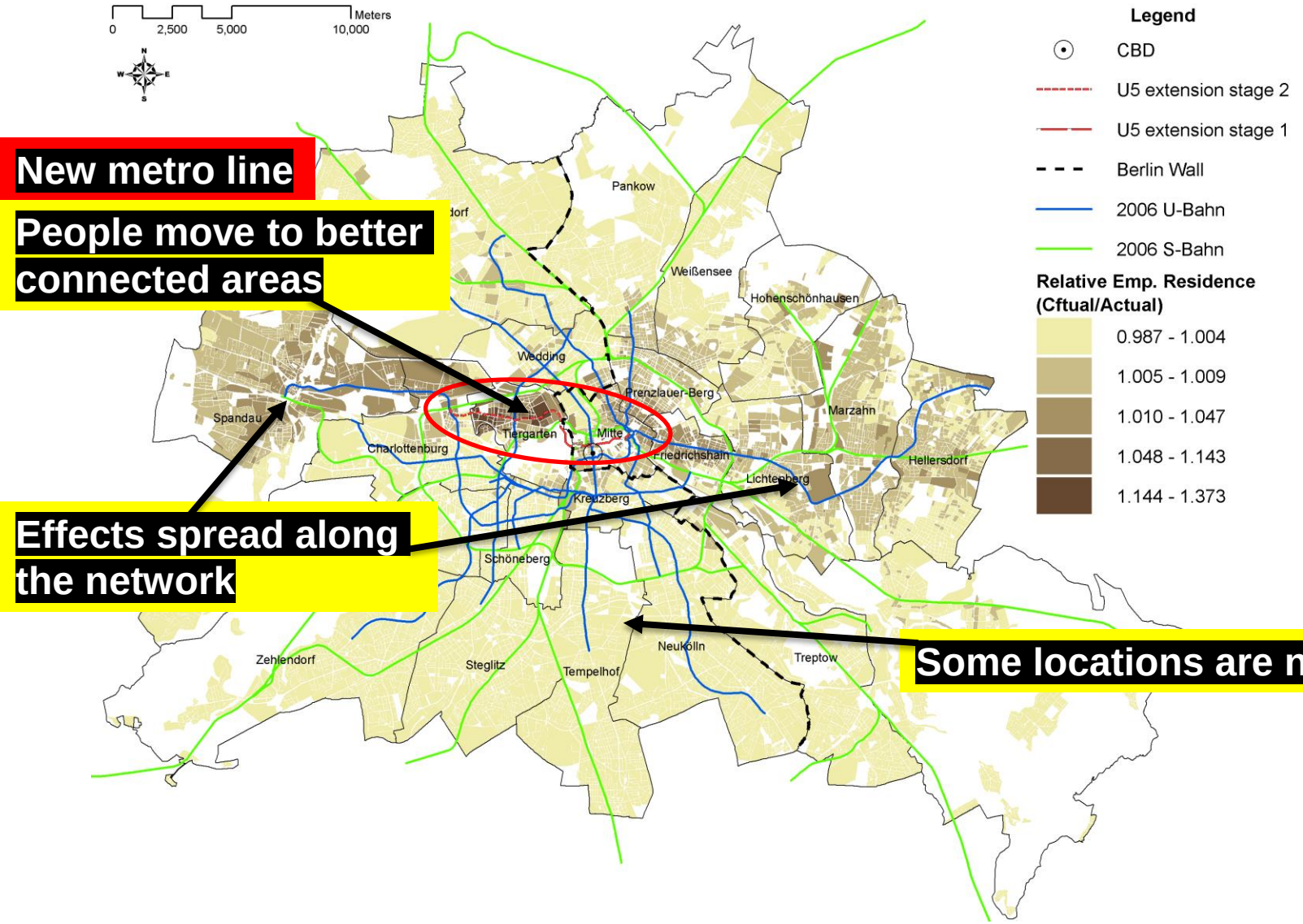
IV SIMULATION

structural estimation and simulation

- **Can use the model to predict the effects of exogenous shocks on various outcomes**
  - Distributions of rent, wages, population, employment, in/outmigration
- **General equilibrium implies that we can model relocations**
  - If some locations win, others can lose
- **Ahlfeldt, Redding, Sturm (2016)**
  - Focus on the effect of a **new metro line** to be opend in 2020. But could also predict effects of other things
    - A new edge city
    - Change in height regulation
    - Increase in agglomeration economies
  - **…**

IV SIMULATED IMPACT OF “U5” ON POPOULATION

structural estimation and simulation



New metro line

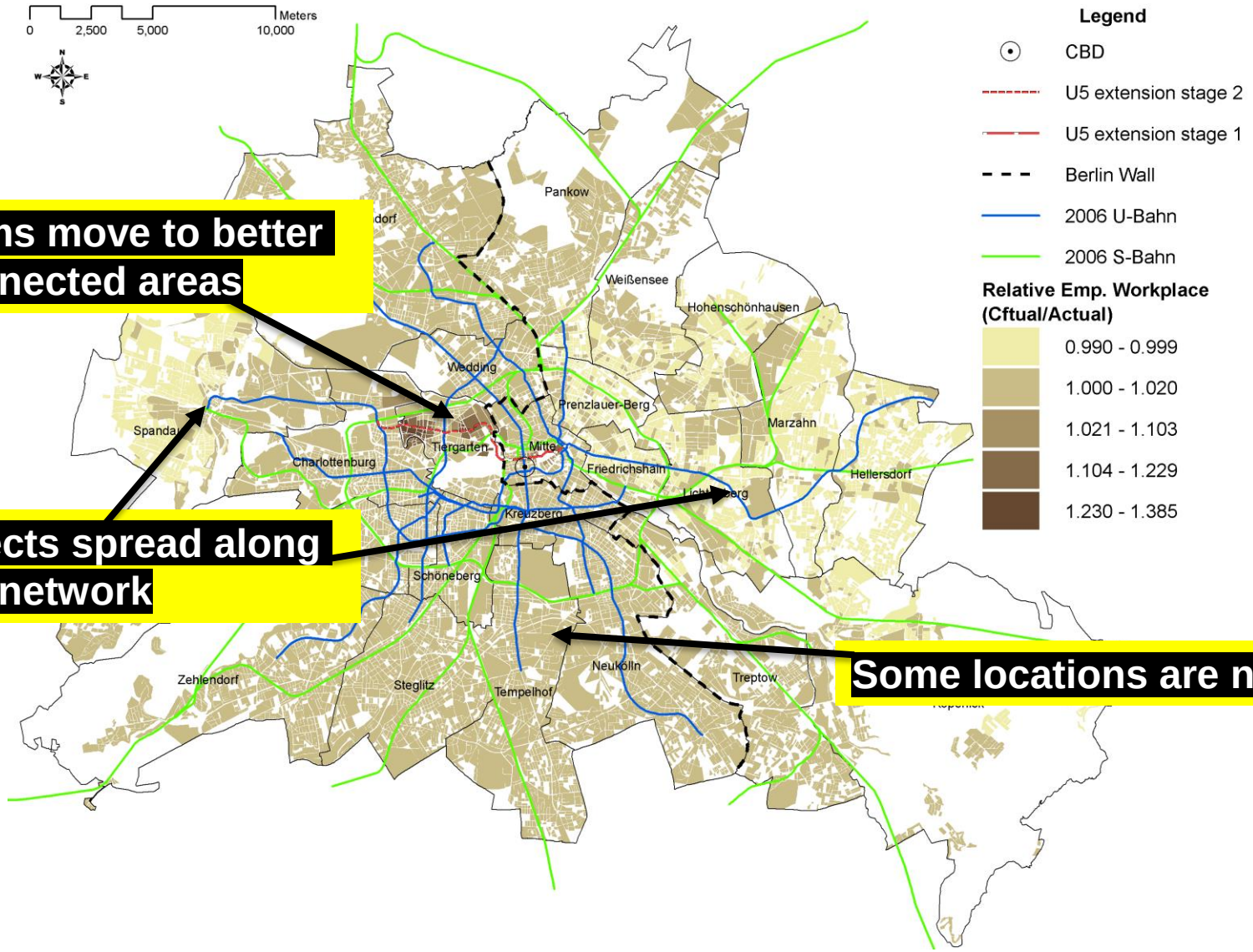
People move to better connected areas

Effects spread along the network

Some locations are net-losers!

IV SIMULATED IMPACT OF "U5" ON EMPLOYMENT

structural estimation and simulation



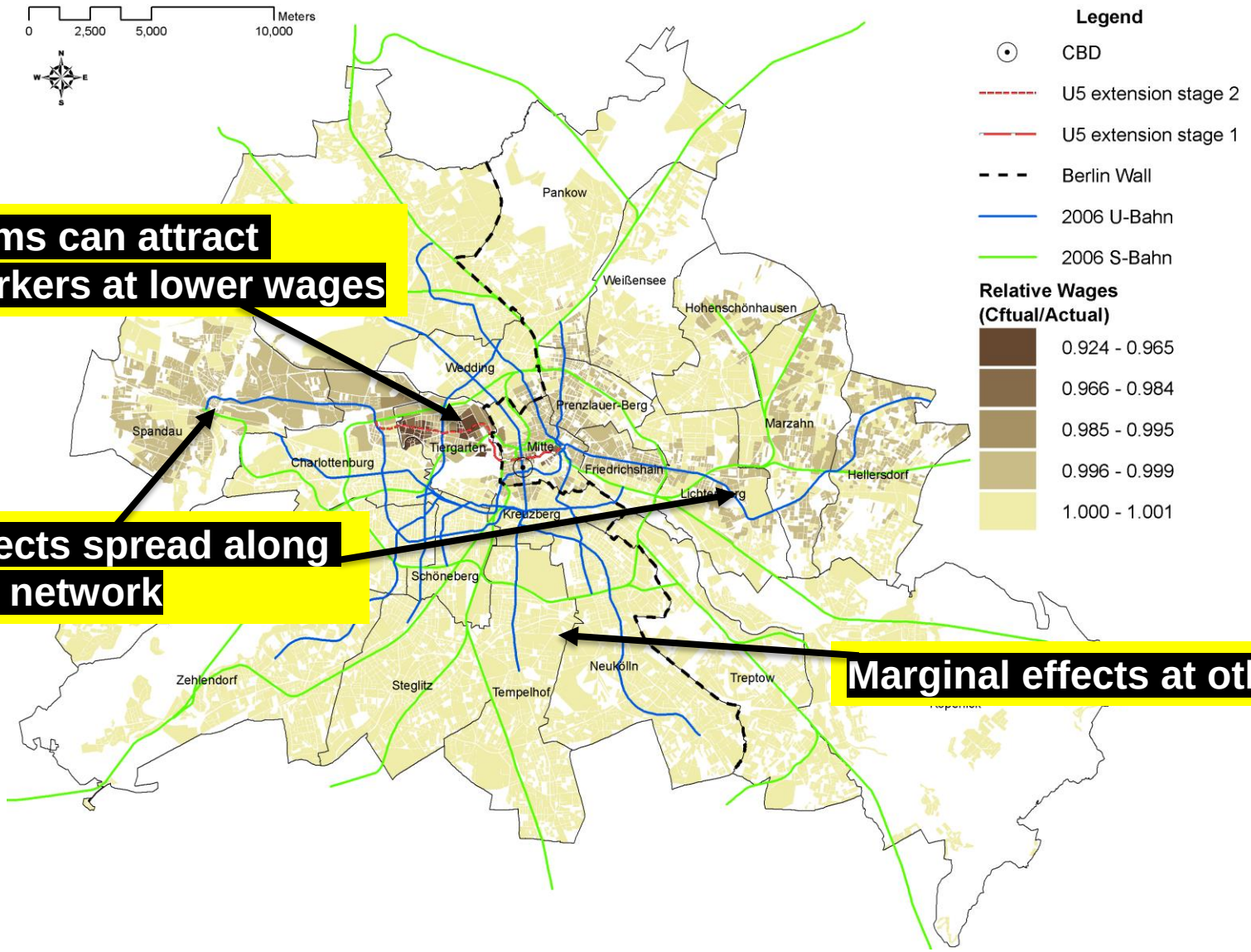
Firms move to better connected areas

Effects spread along the network

Some locations are net-losers!

IV SIMULATED IMPACT OF “U5” ON WAGES

structural estimation and simulation



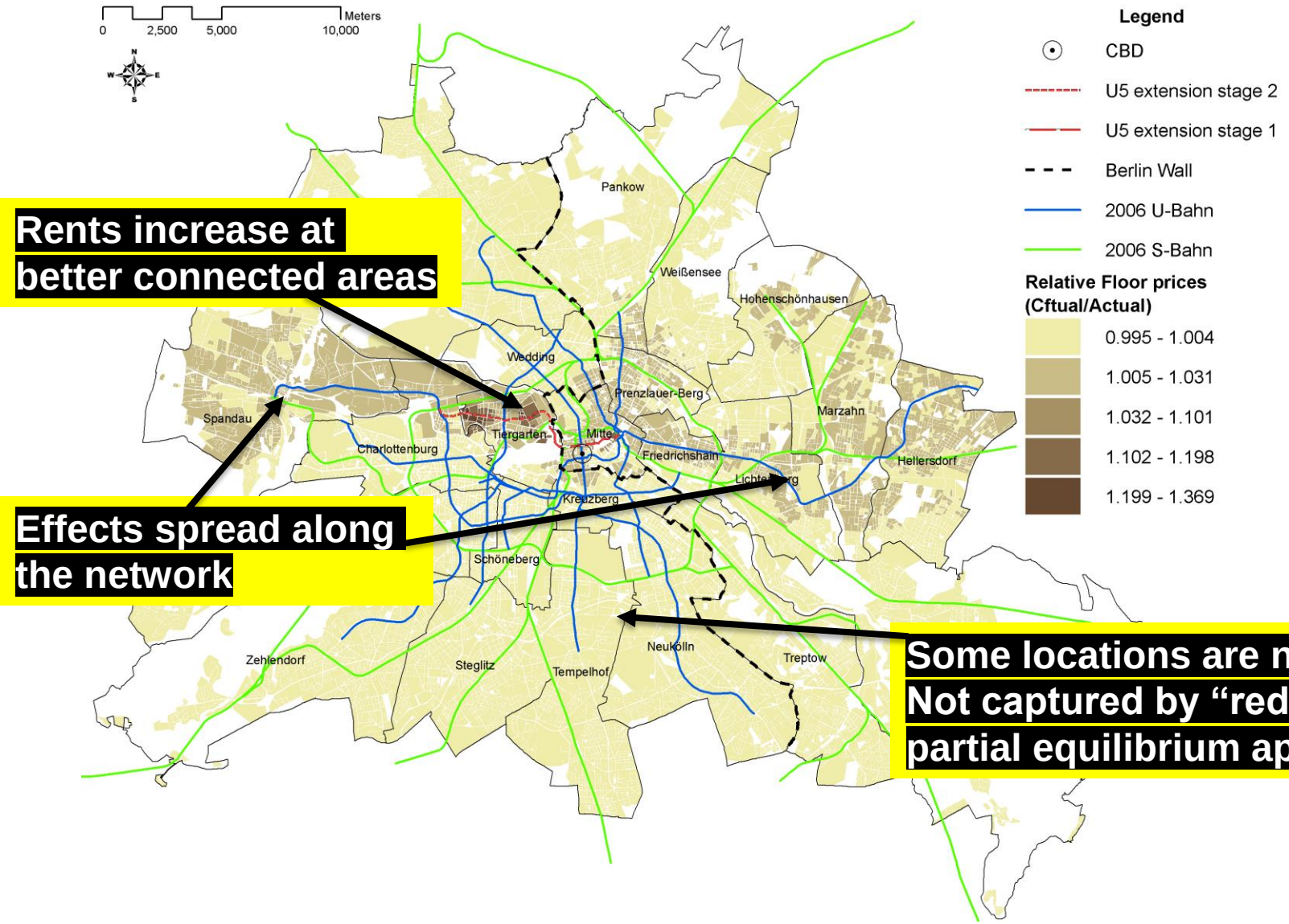
Firms can attract workers at lower wages

Effects spread along the network

Marginal effects at other locations

IV SIMULATED IMPACT OF “U5” ON RENTS

structural estimation and simulation



Rents increase at better connected areas

Effects spread along the network

Some locations are net-losers! Not captured by “reduced-form” partial equilibrium approaches!

IV TESTING THE MODEL'S PREDICTIONS

structural estimation and simulation

- **How to evaluate the „out-of-sample" predictive power?**
  - Want to test the model using data that model hasn't used
    - Model simulation based on 2006 data
    - Test the model predictions using 2000-2015 data
      - Credible announcemnet: 2009
- Approach similar to Ahlfeldt (2013), but in general equilibrium

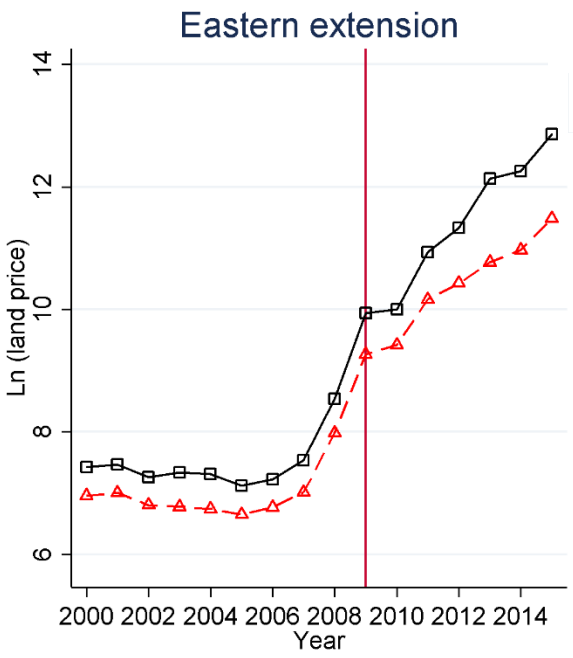
Q: Do adjustment in the real word match the ex-ante model predictions?

Q: Should we make investment decisions based on model predictions?

IV TREATED VS CONTROL

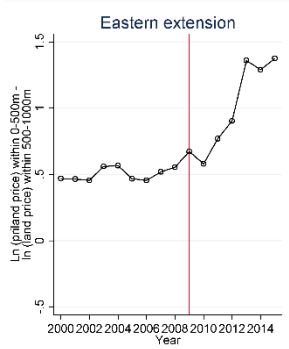
structural estimation and simulation

Price trends at varying distances from U5 stations



Notes: Markers denote mean prices within year bins.
Horizontal line denotes the completion of the U55 segment.

Relative price trends within 500m vs. 500-1000m of U5 stations

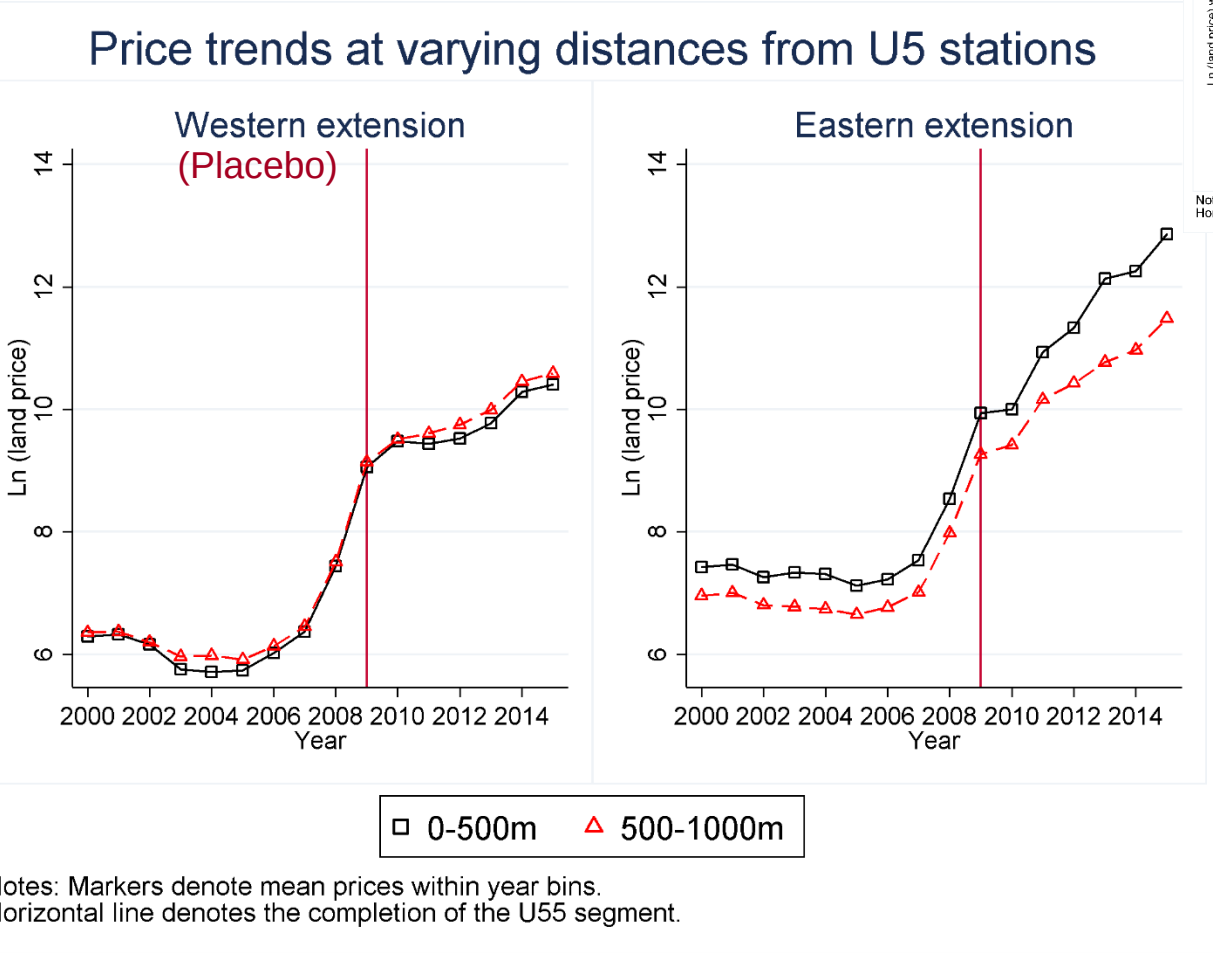


Notes: Markers denote differences in mean prices within year bins.
Horizontal line denotes the completion of the U55 segment.

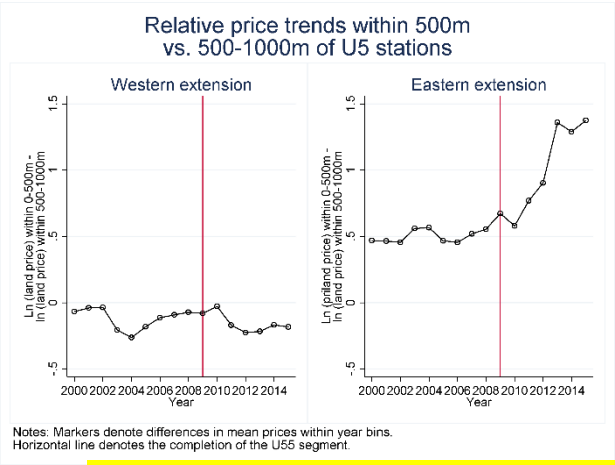
Measurable capitalization effects after partial completion of line

IV "PLACEBO" TEST

structural estimation and simulation



Notes: Markers denote mean prices within year bins.
Horizontal line denotes the completion of the U55 segment.

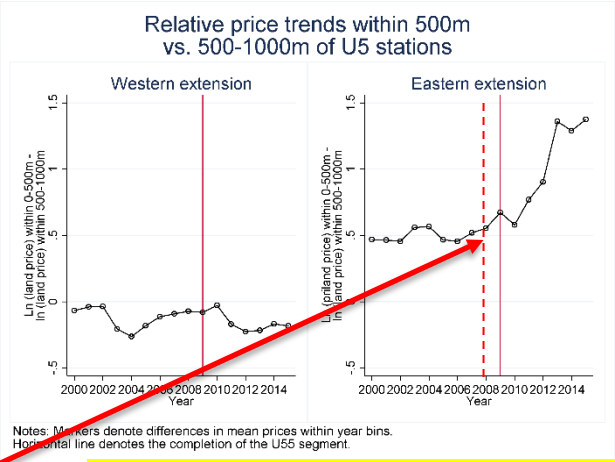


Notes: Markers denote differences in mean prices within year bins.
Horizontal line denotes the completion of the U55 segment.

Measurable capitalization effects after partial completion of line

IV DID SEE IT COMING…

structural estimation and simulation



08.06.2008 00:00 Uhr

Measurable capitalization effects after partial completion of line

Immobilien

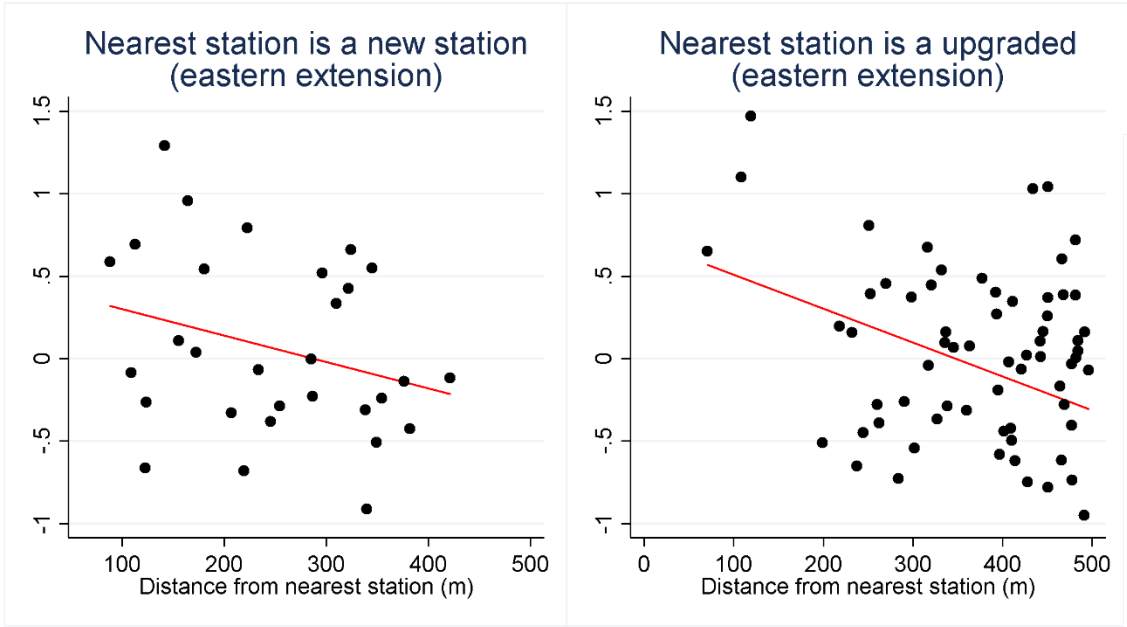
U5 treibt Mieten in die Höhe

Die Grundstücke an der Linienführung der U5 gewinnen deutlich an Wert. Ein Wissenschaftler schlägt deshalb vor, die Anrainer an den Kosten zu beteiligen. Der Senat hält davon nichts. KLAUS KURPJUWEIT

Von einem besseren Anschluss des Hauptbahnhofs an das Netz von U- und S-Bahn würden nicht nur Fahrgäste, sondern auch Immobilieneigentümer profitieren. Mieter dagegen müssten damit rechnen, dass sie mehr für ihre Läden oder Wohnungen zahlen müssen. Der Gesamtwert der Grundstücke im Einzugsgebiet des Hauptbahnhofs könnte sich nach einer wissenschaftlichen Untersuchung um bis zu 133 Millionen Euro erhöhen. Einzelne Grundstücke könnten maximal elf Prozent wertvoller werden. Ökonomisch sinnvoll wäre es deshalb, die Eigentümer der Grundstücke, die im Wert steigen, an den Kosten des S- und U-Bahn-Ausbaus zu beteiligen, schlägt der Volkswirt Gabriel Ahlfeldt von der Universität Hamburg vor. Die Stadtentwicklungsverwaltung lehnt dies ab. Nach Ahlfeldts Berechnungen würde allein der Bau der U 5 vom Brandenburger Tor bis zum Alexanderplatz den Wert der Grundstücke um bis zu 93 Millionen Euro steigen lassen. Die Effekte seien hier besonders stark, weil wegen der hohen Immobilienpreise im Bereich Unter den Linden selbst relativ kleine prozentuale Veränderungen zu hohen Summen führen, sagte Ahlfeld.

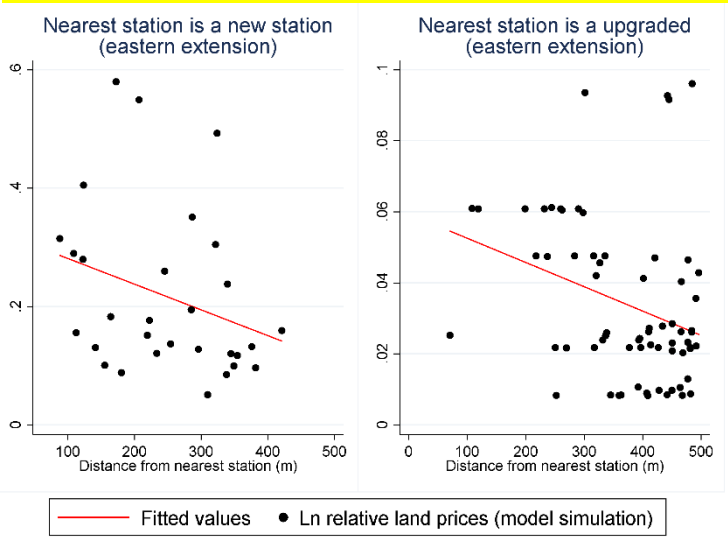
IV STATION EFFECTS

structural estimation and simulation



Notes: Residuals are from regressions of log differences in land prices on lagged ln land prices in levels (2000) and trends (2005-2000), Cartesian coordinates, number of listed buildings within block, noise pressure within block, school quality (IDW of nearby blocks), distance from nearest water space, park, U-/S-Bahn station (in 2006), the share of block area affected by WWII destruction, and a full set of 500 m distance from CBD effects.

Capitalization effects large and highly localized as predicted by the model



IV AGGREGATE EFFECTS I

structural estimation and simulation

MOBILE POPULATION			IMMOBILE POP.	
	Counterfactual / Actual		Counterfactual / Actual	
Percentage Increase	Exogenous	Endogenous	Exogenous	Endogenous
Utility	0%	0%	0.22%	0.33%
Net City Employment	0.55%	1.06%	0%	0%
Value Total City Income	0.46%	1.01%	0.02%	0.11%
Value Total City Land Rents	0.46%	1.01%	0.02%	0.11%
Total Factor Productivity	0.03%	0.18%	0.03%	0.13%
Sum of Absolute Changes as Percent of Aggregate	Exogenous	Endogenous	Exogenous	Endogenous
Workplace Employment	0.58%	1.06%	0.70%	0.92%
Residence Employment	0.55%	1.06%	0.36%	0.44%
Output	0.49%	1.01%	0.58%	0.78%

IV AGGREGATE EFFECTS II (MOBILE POPULATION) II

structural estimation and simulation

Variable	Exogenous	Endogenous
Berlin GDP (2012 1,000s Euro)	105,148,850	
Increase GDP (2012 1,000s Euro)	479,421	1,056,767
Increase Land Rents (2012 1,000s Euro)	39,952	88,064
NPV Increase GDP (60 year, 3%)	13,747,679	30,303,380
NPV Increase GDP (60 year, 5%)	9,554,528	21,060,609
NPV Increase GDP (60 year, 10%)	5,257,890	11,589,726
NPV Increase Land Rents (60 year, 3%)	1,145,640	2,525,282
NPV Increase Land Rents (60 year, 5%)	796,211	1,755,051
NPV Increase Land Rents (60 year, 10%)	438,157	965,811

Cost of construction	
U55 HBF-Brandenburger Tor (completed)	320,000,000
Incl. U5 Brandenburger Tor Alexanderplatz (estimated)	845,000,000
Incl. U5 HBF-Jungfernheide (own estimate, 2012 prices)	**1,975,000,000**

Official CBA: Benefit (mainly direct user benefts) / cost (construction) ratio ≈ 2 (at 3%)

SUMMARY

conclusion

- **Ahlfeldt-Redding-Sturm-Wolfg model**
  - Household and firm location choice model
  - Features agglomeration and dispearsion forces
- **Separating location fundamentials from spillovers**
  - Correlation between density and productivity can stem from fundamentals
  - Agglomeration effects can be identified using exogenous varion over time
- **Model can be used for out-of-sample simulation in general equilibirum**
  - Model predictions take into account relocation and displacement effects
  - Model seems to predict changes in property prices well
- **Next: The vertical dimension of cities**
  - Vertical rent gradients
  - Determinants of the urban height profile


THANKS

READING

- Core readings:
  - Ahlfeldt. G. M., Redding, S. J., Sturm, D. M., Wolf, N. (2015): The Economics of Density: Evidence From the Berlin Wall. Econometrica, Vol. 83, No. 6 (November, 2015), 2127–2189
- Complementary readings and references:
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III ROLE OF SPILLOVERS

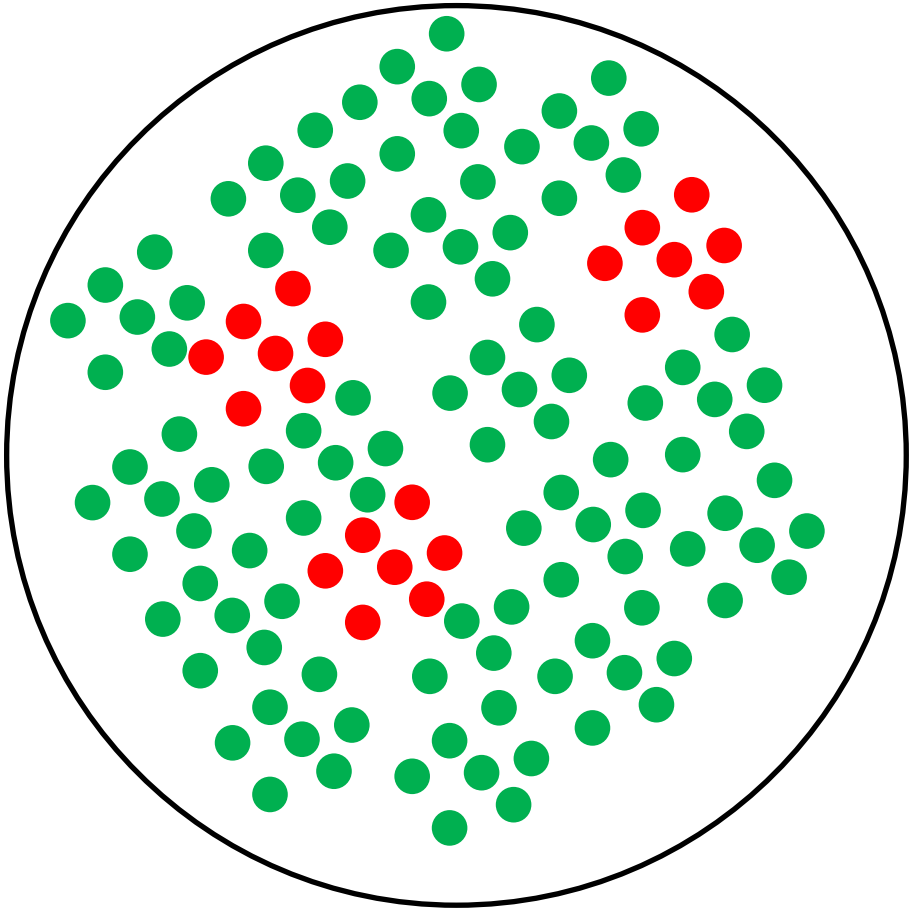
separating spillovers from location fundamentals

- ARSW model stresses the role of spillovers effects
  - Lead to concentration and higher rents!
- In a tradition of an empirical literature on agglomeration (topic II)
  - Fundamental identification problem
    - If rents increase in agglomeration:
      - Is there a causal effects of agglomeration on rents?
      - Is there a third fundamental factor leading to higher rents and agglomeration (correlation)?

Q: Why does it matter for policy and practice whether it is correlation or causation?

III ROLE OF SPILLOVERS

separating spillovers from location fundamentals



Can we realistically create a new sub-centre?

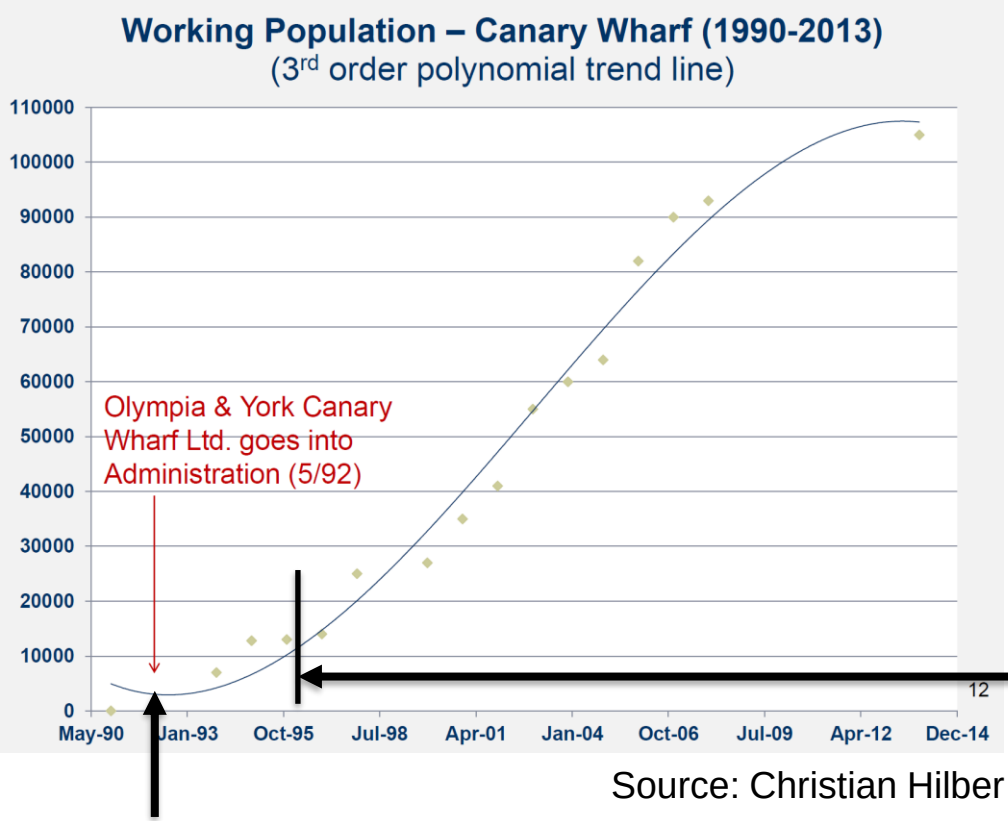
Yes, if spillover effect is causal
No, if it is all about fundamentals

Matters to investors:
Can by cheap land, invest into development and attraction of anchor tenants and benefit from increasing rents due to spillovers

Matters to planners:
Can try to create new centres to mitigate overcongestion in CBDs

III EXAMPLE CANARY WHARF

separating spillovers from location fundamentals



Source: Christian Hilber

No key firms were there initially
CW-developer went into administration in 1992 (recession did not help)

Developer bought back in 1993 and tried again. Citybank announces to come in 1996, in 1998 HSBC follows, etc.
Spillovers kick in, self-reinforcing process begins
(Jubelee line extension helps)

III NEW CAPITAL DISTRICT CAIRO

separating spillovers from location fundamentals

New administrative district planned about 45km out of Cairo
$3 billion investment, financed by Chinese loans

Q: Will it work? Critically depends on spillover effects (proximity to government might help)

Project features 20 towers, including the (at 345 meters) tallest building in Africa