Zoning and the Density of Urban Development

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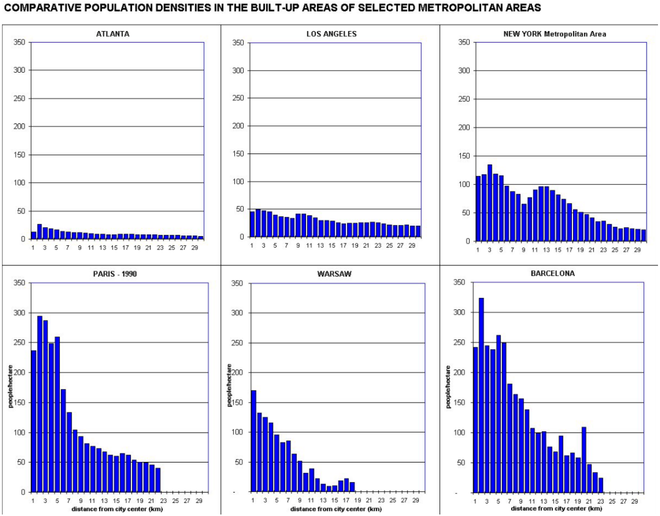
U.S. Cities aren't very dense



Source: Alain Bertaud, 2013, [link]

Why?

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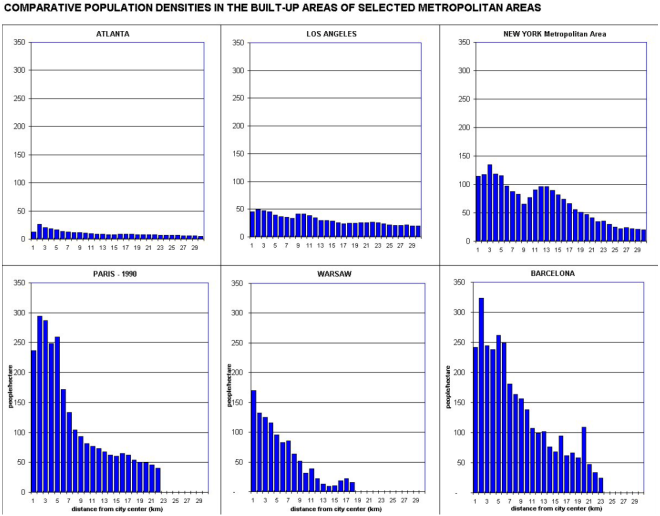

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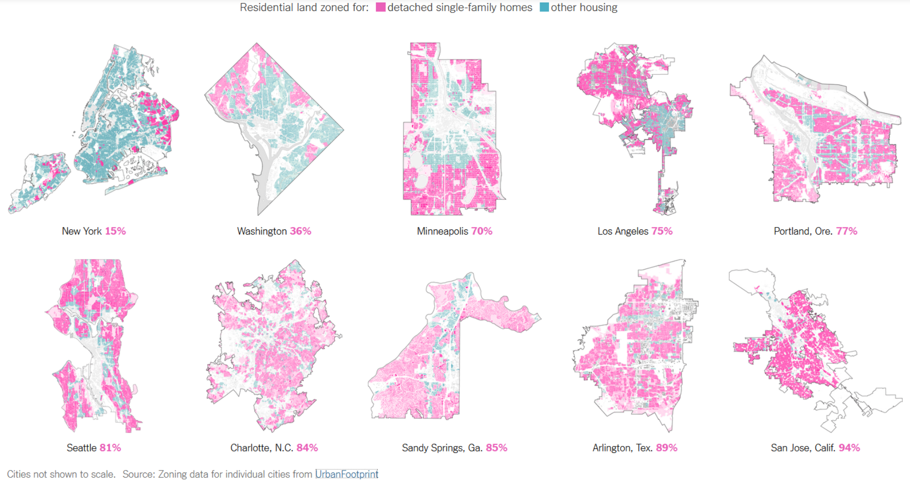
Why?

- *(Hint: It's the zoning!)*

Hard to build denser when it's illegal...

Single-family detached zoning (in pink) is major *(but not only)* culprit...



Source: New York Times, 06/18/2019, [link]

Motivation

Density restriction leads to

- high housing costs
- sprawl
- inefficient allocation of labor at macro level
- *(Hsieh & Moretti 2019, Parkhomenko 2020, inter alia)*

Yet, relaxing restrictions is *politically fraught*.

Research questions:

- **Where** inside the city would relaxing restriction be most effective?
- *(Eventually)* **How much** restriction, given relevant externalities?

What We Do

- Quantitative general equilibrium model of Los Angeles metro
  - detailed geography: nearly 4,000 locations
  - *firms* choose where to offer jobs
  - *workers* choose where to live and work, considering commuting costs
  - *developers* supply commercial and residential real estate, subject to **zoning** and **density limits**
- Calibrate the model to Los Angeles in 2012–2016
- Run some counterfactual experiments

Model

City and Commuting

- Model similar to *Ahlfeldt, Redding, Sturm & Wolf (2015)* and *Heblich, Redding & Sturm (2020)*
- Closed city
- Many discrete locations, $i \in \{1, ..., I\}$
- Locations are separated by commuting times t_{ij}
- The city is populated by workers, firms, and floorspace developers

Workers: Indirect utility

- Individual n, living in i, working in j, optimal consumption choices:

$$U^*_{ijn} = z_{ijn} V_{ij}$$

  - v_{ijn}: idiosyncratic pref., drawn from $F(z) = e^{-z^{-\epsilon}}$

- Common value V_{ij}:

$$V_{ij} \equiv \frac{X_i E_j b_{ij}}{e^{\kappa t_{ij}}} \frac{w_j}{q_{Ri}^{\gamma}}$$

  - t_{ij}: commute time from i to j
  - $\kappa > 0$: elasticity of commute disutility to time
  - X_i, E_j: residential, employment amenities
  - b_{ij}: pair-specific shifter
  - w_j: wage paid in j
  - q_{Ri}: residential floorspace price in i

Workers: Optimal Choices

- The probability of choosing to live in i and work in j is

$$\pi_{ij} = \frac{V_{ij}^{\epsilon}}{\sum_{r \in \mathcal{I}} \sum_{s \in \mathcal{I}} V_{rs}^{\epsilon}},$$

- Equilibrium residential population is: $N_{Ri} = \sum_{j \in \mathcal{I}} \pi_{ij}$
- Equilibrium employment is: $N_{Wj} = \sum_{i \in \mathcal{I}} \pi_{ij}$

Firms and Wages

- Firms in location j produce using labor and floorspace:

$$Y_j = A_j \left(N_j\right)^{\alpha} \left(H_j\right)^{1-\alpha}$$

- Equilibrium wages:

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

Floorspace Developers

- Production of floorspace:

$$H_{mi} = K_{mi}^{1-\eta} \left(\phi_{mi} L_{mi}\right)^{\eta}$$

- $m \in \{R, W\}$: either residential or commercial
- K_{mi}: consumption goods
- $L_{mi} = \Lambda_{mi}$: amount of land zoned for commercial/residential
- ϕ_{mi}: reflects density limits

Agglomeration and Spillovers

- Productivity:

$$A_j = a_j \left[\sum_{s \in \mathcal{I}} e^{-\delta t_{sj}} \frac{N_{Ws}}{L_s} \right]^{\lambda}$$

$\lambda \geq 0$: agglomeration externalities; $\delta \geq 0$: spatial spillovers

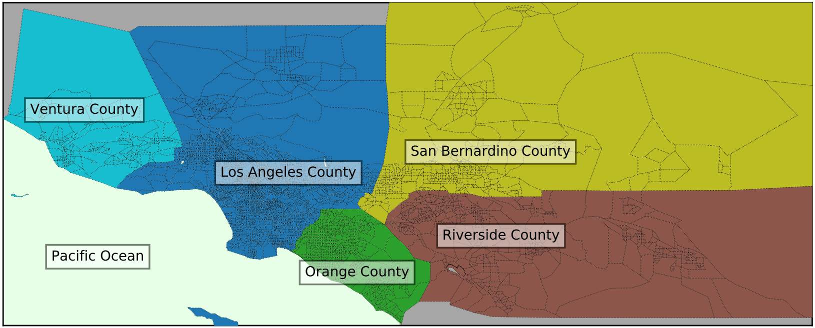
- Residential amenities:

$$X_i = x_i \left[\sum_{r \in \mathcal{I}} e^{-\rho t_{ri}} \frac{N_{Rr}}{L_r} \right]^{\chi}$$

$\chi \geq 0$: agglomeration externalities; $\rho \geq 0$: spatial spillovers

Data and Calibration

Los Angeles-Long Beach Combined Statisical Area



- 2012-2016 population: 18.7 million
- 3,917 Census Tracts

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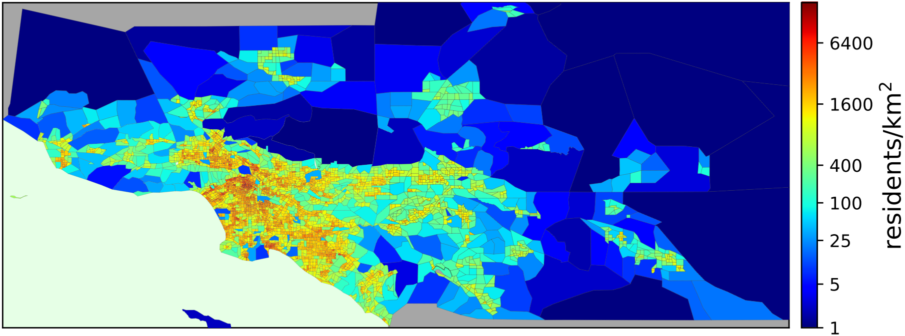

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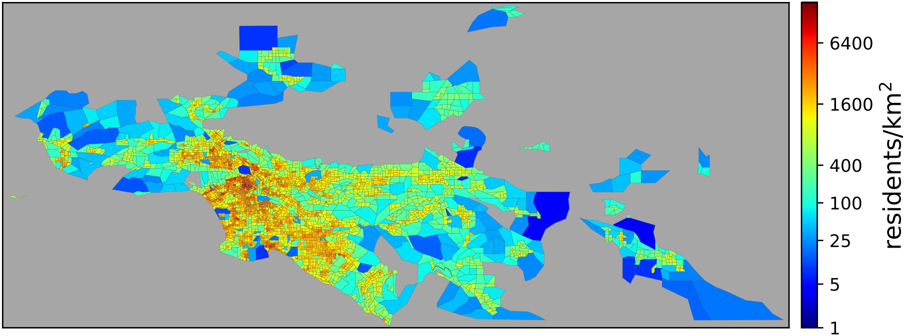


- 2012-2016 population: 18.7 million
- 3,917 Census Tracts
- drop tracts in bottom 2.5% of residence and job density
- 3,847 tracts, 99.2% of population remain

Data

- *LODES*: employment at residence and workplace and commuting flows at tract level
- *CTPP*: wages and commuting times between tracts
- *ACS*: wages and other socioeconomic characteristics
- *DataQuick/CoreLogic*: transaction-level price data for residential and commercial properties
- Focus on 2012–2016

Calibration: City-Wide Parameters

Parameter	Value	Source/Target
Housing expenditure share	$\gamma = 0.24$	Davis & Ortalo-Magne (2011)
Labor & non-structure capital	$\alpha = 0.8$	Valentinyi & Herrendorf (2008)
Land share	$\eta = 0.25$	Combes, Duranton & Gobillon (2018)
Disutility of commuting	$\kappa = 0.011$	Ahlfeldt, et al (2015); Tsivanidis (2019)
Amenity agglomeration	$\chi = 0.1553$	Ahlfeldt, et al (2015)
Productivity agglomeration	$\lambda = 0.0710$	Ahlfeldt, et al (2015)
Amenity spillover decay	$\rho = 0.7595$	Ahlfeldt, et al (2015)
Productivity spillover decay	$\delta = 0.3617$	Ahlfeldt, et al (2015)

Estimation: Frèchet elasticity

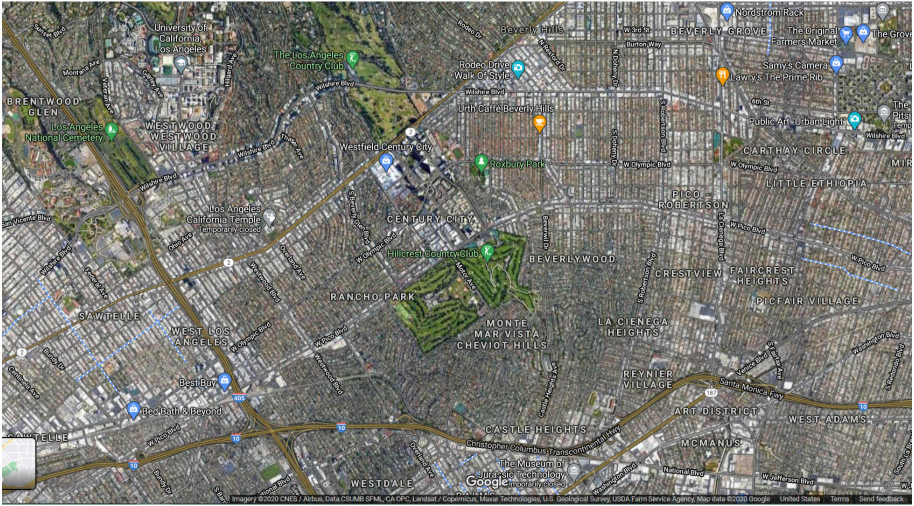
- Gravity equation for commuting:

$$\tilde{\pi}_{ij} = \exp\{-\boldsymbol{\epsilon}\kappa t_{ij}\}\varphi_i^R \varphi_j^W b_{ij}$$

- estimate with Max Likelihood, following *Dingel & Tintelnot, 2020*
- With $\kappa = 0.011$ from *Ahlfeldt, et al (2015)*/*Tsivanidis (2019)*, we find $\epsilon = 7.96$
- We project π_{ij} for pairs with observed $\pi_{ij} = 0$

Counterfactual Experiments

Ultimate density limit: Rancho Park Golf Course + Hillcrest Country Club



How Efficiently Is Land Used in L.A.?

Ultimate density limit: Rancho Park Golf Course + Hillcrest Country Club

- Rancho Park: **200 acres** + Hillcrest: **140 acres**
  - Together, *1/2 the size of Central Park!*
- Hillcrest: private club
- Rancho Park owned by the city (!!)
- Architect D. Dunham: 15k homes for 50k people on Rancho Park alone (*Bloomberg, 2020* [link])
- Project could *(for example)* house most of L.A.'s homeless population

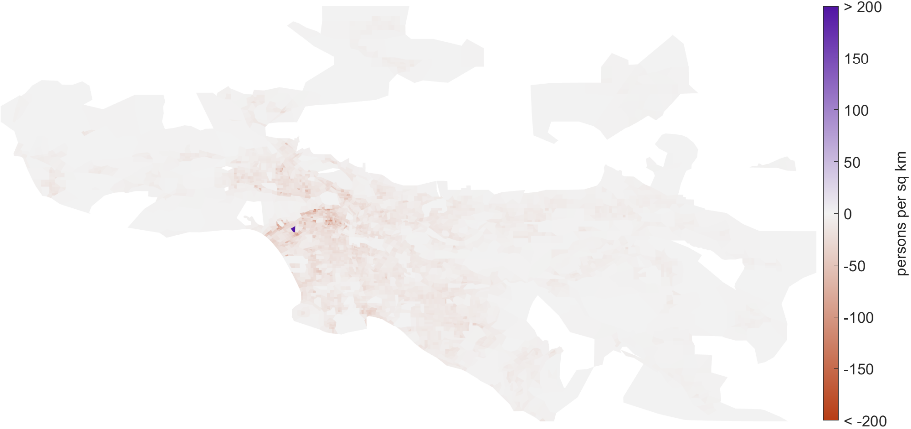
How Efficiently Is Land Used in L.A.?

Counterfactual Experiment

- Give planned Rancho Park development the green light
- Set ϕ^R for Rancho Park so that at least 50,000 people move in
- Proceed in three stages:
  1. no agglomeration externalities or spillovers
  2. agglomeration externalities
  3. agglomeration externalities and spillovers
- Use "exact-hat algebra" (*Dekle, Eaton & Kortum, 2007*)

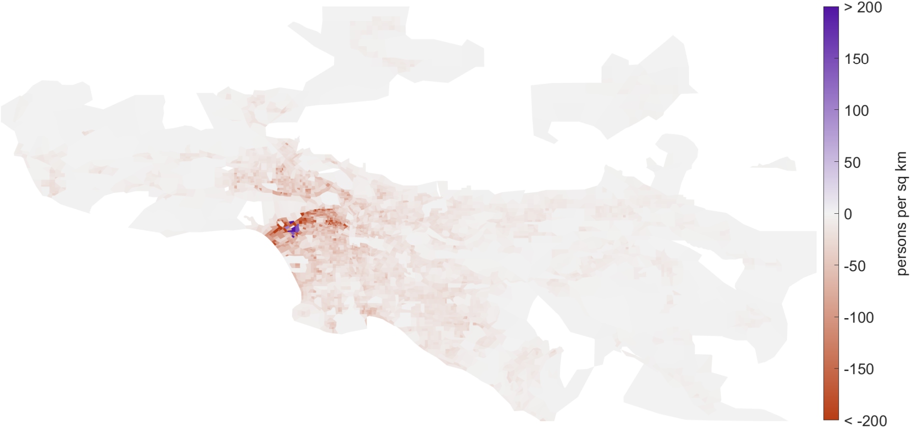
Change in density of residents

Fixed amenities, productivity



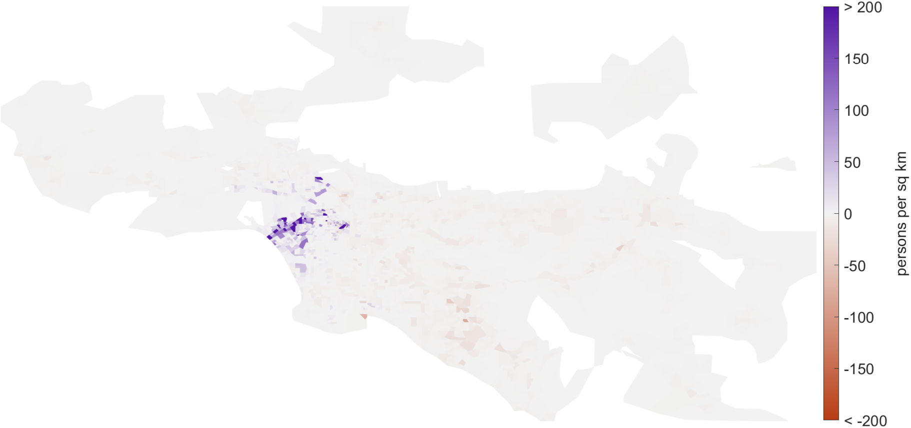
Change in density of residents

Endogenous amenities, productivity



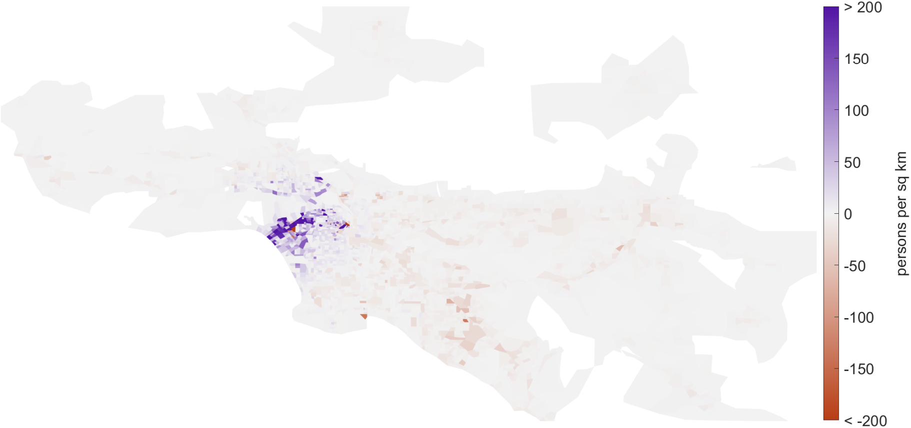
Change in job density

Fixed amenities, productivity



Change in job density

Endogenous amenities, productivity



Results

Endogenous amenities	–	✓
Endogenous productivities	–	✓
Aggregate Effects		
Wages, % chg	0.005	0.015
Residential prices, % chg	-0.232	0.201
Commercial prices, % chg	0.032	0.089
Time spent commuting, % chg	-0.060	-0.107
Distance traveled, % chg	-0.103	-0.187
Welfare, % chg	0.053	0.013

- real estate prices $\uparrow$
- commute time $\downarrow$
- wages, welfare $\uparrow$
- Back-of-the-envelope: $\approx$ \$500 mln benefit yearly

Conclusion

Conclusions and Further Thoughts

- Density limits distort supply of work space, housing
- We built a quantitative model of L.A. to study effects
- We found that density limits reduce welfare, especially in central areas

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- Open city: in-migration might mitigate gains for current residents
- Traffic congestion may mitigate gains
- Heterogeneity in jobs, skills $\rightarrow$ distributional effects

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- Density limits distort supply of work space, housing
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Future work:

- expand scope to entire U.S.
- consider better transit + remote work as substitutes to rezoning

Thank you

Estimation: Freéchet elasticity, pair-specific shifters

- Follow the methodology in *Heblich, Redding & Sturm (2020)*
- Take log of the gravity equation:

$$\ln \pi_{ij} = -\epsilon\kappa t_{ij} + \varphi_i^R + \varphi_j^W + \varepsilon_{ij}$$

- Identification problem: reverse causality from π_{ij} to t_{ij}
  Solution: instrument t_{ij} with straight-line distances between i and j
- Estimate $\epsilon\kappa$ and solve for ϵ based on the calibrated value $\kappa = 0.011$ from *Ahlfeldt, et al (2015)* and *Tsivanidis (2019)*
- We estimate $\epsilon\kappa = 0.0349$, therefore $\epsilon = 3.1726$

Estimation: gravity equation

Dependent variable:	(1)	(2)
$\ln \pi_{ij}$	OLS	IV
Second stage		
t_{ij}	-0.0348	-0.0349
	(0.000020)	(0.000021)
Residence f.e.	yes	yes
Workplace f.e.	yes	yes
Observations	5,533,047	5,533,047
R^2	0.530	–
First stage		
δ_{ij}		0.5665
		(0.000059)
Residence f.e.		yes
Workplace f.e.		yes
Observations		5,533,047
R^2		0.973

Estimation: pair-specific shifters

- Log of the gravity equation:

$$\ln \pi_{ij} = -\epsilon\kappa t_{ij} + \varphi_i^R + \varphi_j^W + \varepsilon_{ij}$$

- Residual ε_{ij} corresponds to the pair-specific shifter $\ln b_{ij}$

- Standard problem with estimating gravity models: what is b_{ij} for pairs with zero commuters?

- Standard solution: set $b_{ij} = 0$ whenever $\pi_{ij} = 0$. This is problematic (*Dingel & Tintelnot, 2020*)

Estimation: pair-specific shifters

Our approach:

- First, estimate the relationship between b_{ij} and distance δ_{ij}:

$$\ln b_{ij} = \beta_0 + \beta_1 \ln \delta_{ij}$$

- Then:
  - For (i, j) with $\pi_{ij} > 0$, assign $b_{ij} = e^{\varepsilon_{ij}}$
  - For (i, j) with $\pi_{ij} = 0$, assign $b_{ij} = e^{\beta_0 + \beta_1 \ln \delta_{ij}}$

- The model reproduces data exactly when the observed $\pi_{ij} > 0$ and creates small non-zero flows when the observed $\pi_{ij} = 0$

Return