Urban Policy and Spatial Exposure to Environmental Hazards

Augusto Ospital
LMU Munich

NBER SI Urban Economics
July 26, 2024

Motivation

- Dangers of climate change depend on where people live
  - E.g.: drought, earthquake, flood, landslide, tornado, wildfire, cold weather
  - 1/2 of new US homes in 2000-17 were built in areas at risk of environmental hazards
- Regulations on housing supply may limit access to the safest areas
  - E.g.: minimum lot sizes, maximum density limits
  - Positive correlation between housing supply elasticity and risk in 105/141 U.S. cities
- **How do restrictive land use regulations affect exposure of people to risky areas?**

This paper: wildfire risk in the San Diego Metro

- **Questions**
  - Current welfare cost of wildfires? Including property damages + safety, health, and comfort
  - How do LUR affect that cost? How do distortions in property insurance markets?
  - How will climate change and population growth affect these?

- **Model**: QSE + **land use regulations (LUR)**, **wildfire risk**, and **property insurance**
  - Simulate changes in the distributions of LUR and wildfire risk
  - Obtain the distributions of population, house prices, and welfare

- **Data**: LUR, risk, and damages
  - Collect **zoning maps and municipal codes** of all 19 localities
  - Probabilistic measures of wildfire risk and **expected damages** to property at fine resolutions
  - Estimate the **amenity cost** associated to wildfire risk exposure

Contributions

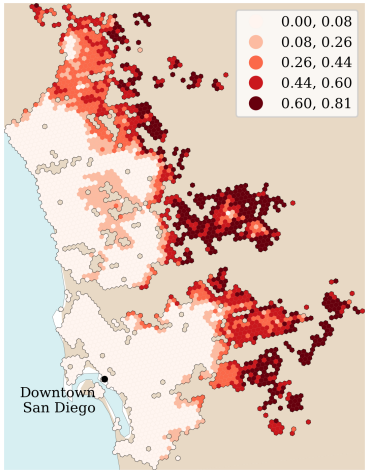
- **Environmental change and econ geography**: [Global warming: Costinot, Donaldson, and Smith (16), Nath (21), Cruz (21), Cruz and Rossi-Hansberg (21); Flooding: Hsiao (23), Desmet et al. (20), Balboni (19), Jia, Ma, and Xie (22); droughts: Albert, Bustos and Ponticelli (21)]
  - **Explicit about constraints to relocation (LUR) and about mitigation (insurance)**
  - **Within-city focus**

- **Consequences of land use restrictions**: [Glaeser, Gyourko and Saks (09), Glaeser and Ward (09), Gyourko and Molloy (15), Herkenhoff, Ohanian, and Prescott (18), Khan (19), Parkhomenko (20), Acosta (20), Parkhomenko, Delventhal, and Kwon (20), Anagol, Ferreira, and Rexter (21), Song (21), Martynov (21), Favilukis, Mabille, and Nieuwerburgh (22), ...]
  - **How they shape exposure to environmental hazards**

- **Economic impacts of wildfire**: [firefighting: Baylis and Boomhower (19), Wibbenmeyer, Anderson, and Plantinga (19), Plantinga, Walsh, and Wibbenmeyer (20); building codes Baylis and Boomhower (21); home prices Mueller, Loomis, and Gonz´alez-Cab´an (2009), McCoy and Walsh (18), Garnache (20), Issler et al. (20); behavior Burke et al. (21), Heft-Neal et al. (23)]
  - **Model equilibrium within a city $\rightarrow$ counterfactuals and welfare**

Wildfire risk data: urban periphery exposed to risk

Wildfire likelihood over 30 yrs



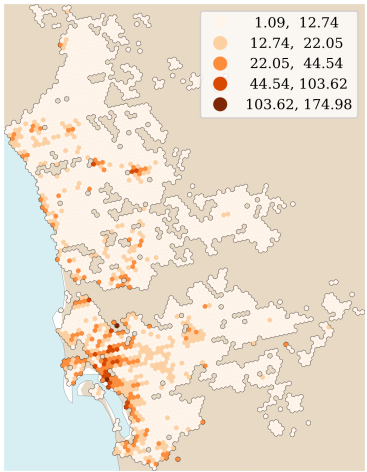
Areas with likelihood >20% account for...

- 7% of the population (200k people)
- 36% of all residential land

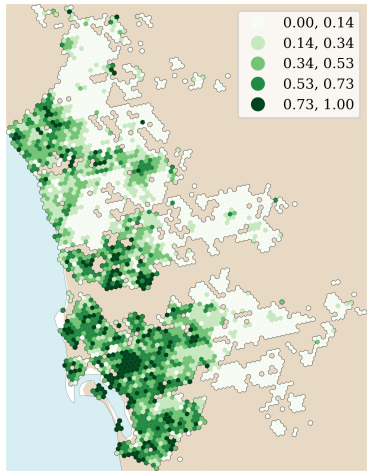
Note: Regular hexagons of side length 560 m. Only populated hexagons are shown.

LUR data: urban core has regulations that restrict housing supply

Homes allowed per acre



Homes built / homes allowed



Note: Regular hexagons of side length 560 m. Only populated hexagons are shown.

Quantitative spatial equilibrium model: setup

- Workers – location decisions: labor supply & housing demand
  - Commuting choice between 561 pairs of census tracts
  - Resdidential choice of 14,245 hexagons (215 m sides, area 29 acres)
- Landowners – housing supply & **insurance demand**
- **Wildfires** exogenously destroy homes (supply shock) and amenities (demand shock)
- **LUR** exogenously impose density limits
- **Insurance supply**: uniform pricing to reflect pricing frictions

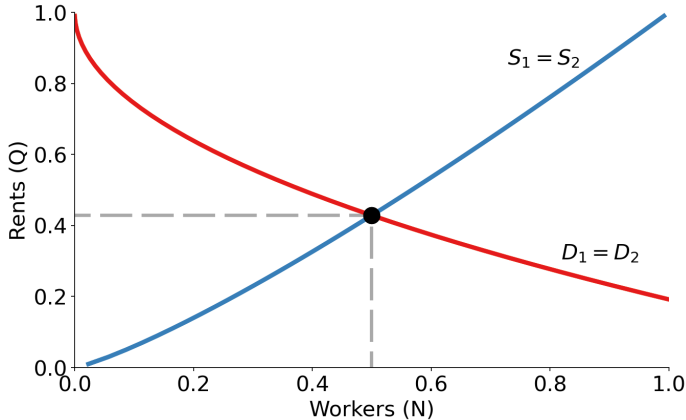
Quantitative spatial equilibrium model: mechanisms

- **Density limits bind** *if* demand for a location is high enough *and* LUR strict enough
  - $\Rightarrow$ Equilibrium rents increase
  - $\Rightarrow$ People reallocate out of places with binding regulations

- Degree that **workers reallocate to riskier areas** depends on...
  1. the spatial correlation between rents and wildfire risk
  2. workers' preferences on risk exposure and other residential amenities
  3. the labor market access of these locations

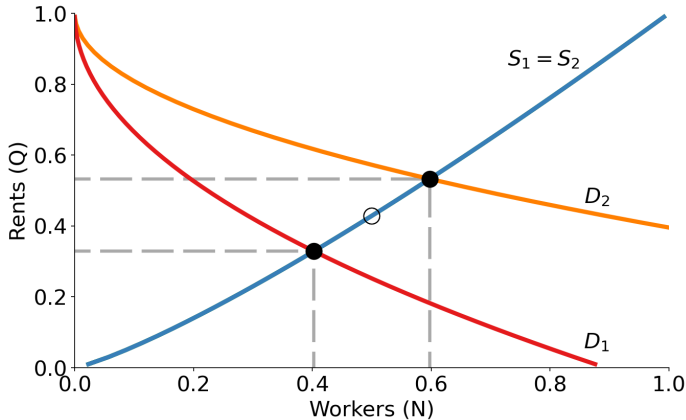
- **Insurance magnification**: cross-subsidization depresses housing supply in safer locations

Example: Spatial equilibrium with two homogeneous locations



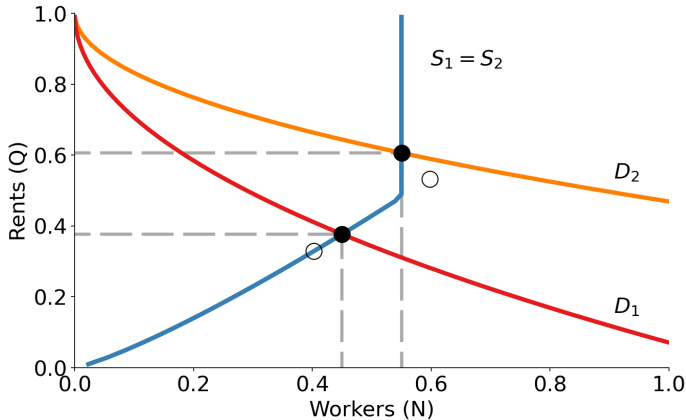
- Closed city, two homogeneous locations, mass 1 of workers
- $\Rightarrow$ uniform rents (Q) and population (N)

Example: Spatial equilibrium with one risky location



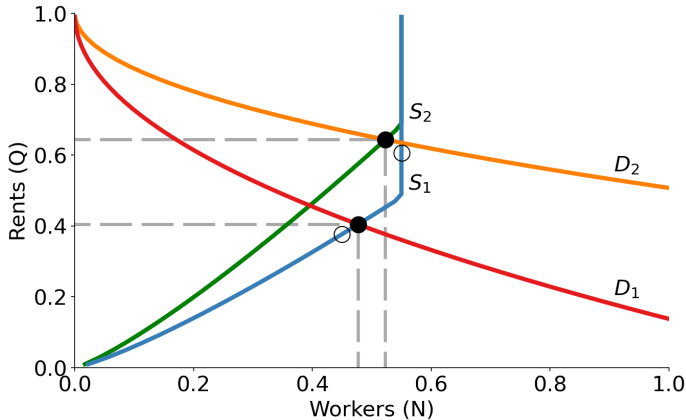
- Risk exposure is a negative demand shock to location 1
- Spatial equilibrium $\Rightarrow$ positive demand shock to location 2

Example: Introduce a binding density limit



- Population falls and rents rise in location 2
- Spatial equilibrium $\Rightarrow$ positive demand shock to location 1

Example: The safe location subsidizes insurance of the risky location



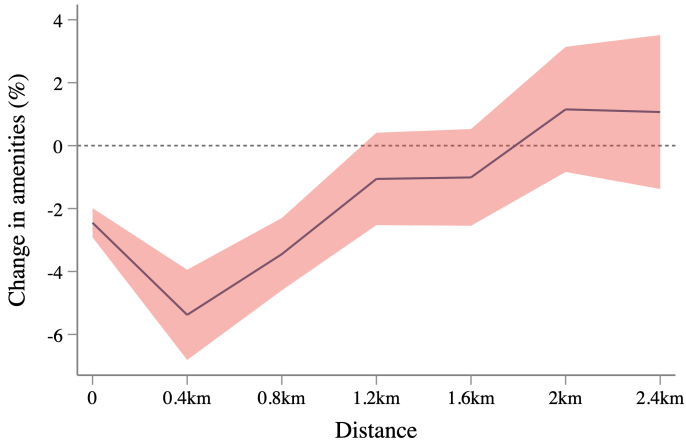
- Insurance costs are a negative supply shock in location 2
- Spatial equilibrium $\Rightarrow$ positive demand shock to location 1

Estimation: key new parameters

- New parameters that control the **amenity cost** of wildfire risk
  - Captures risks to safety, health, and comfort
  - Other parameters: calibrate and consider variations for robustness
- Recover model-implied amenity index by estimating location demand
  - Tract-tract workers: average 2017-19 flows from LODES
  - Hex-level home counts and values: Tax Assessors
- Estimate how burn probabilities affect the amenity index
  - Controls: tract FEs, distance to wildland, distance to ocean, topography, weather
  - Robustness: non-anthropogenic wildfire risk from Parisien et al. (12) as IV
  - Robustness: nearby burn history as 'saliency' IV

Estimates of amenity damages

Effect of a 1 S.D. increase in annual burn probability



$\Rightarrow$ WTP 4.8% of annual income to avoid a 20% likelihood of burning within 30 years

Simulations: summary of main results

- The fraction of people in at-risk areas would fall **16%** in the absence of LUR
- **$14.7 bn** present-discounted cost of wildfire risk falls by **10%** in absence of LUR
- **1/10** of that 10% is due to insurance magnification
- Increase in wildfire risk and national population to 2060 levels
  - $\Rightarrow$ If LUR stay fixed, as population grows exposure will grow more than proportionally
  - $\Rightarrow$ 12% more exposed people and 18.7% higher welfare cost of wildfire risk

More results and robustness

- Robustness to **density externalities on amenities**?
  - Estimate that amenities $\nearrow$ in density

  $\Rightarrow$ Baseline is lower bound of the actual costs of LUR

- Robustness to **density externalities on wildfire risk**?
  - Estimate decreasing relation between population density and burn probability

  $\Rightarrow$ Reducing population in the periphery increases risk, but overall effect is small

- How close can a **"realistic" policy** get us to the benefits of full deregulation?
  - Upzoning 8.5% of land with highest transit access replicates 85.6% of welfare gains

Conclusions

- In San Diego, LUR displace people to live in areas at risk of wildfires
  - Distortions in insurance market magnify this cost
  - If LUR do not change, as population grows exposure will grow more than proportionally
- Results matter for **other places** and **other risks**
  - 1/2 of new US homes in 2000-17 were built in areas at risk of environmental hazards
  - Positive correlation between housing supply elasticity and risk in 105/141 U.S. cities
- Takeaways
  - **Institutional constraints** have an important role in **adaptation** to natural hazard risks
  - Key roles for equilibrium forces and heterogeneity **within cities**