Econ 330: Urban Economics

Lecture 18

John Morehouse
05 March, 2020

Lecture 18: Urban Sorting & The Environment

Schedule

Today

1) **Household Sorting, Land-use Restrictions, and Carbon Emissions**

- Walk through of Colas & Morehouse (2020)

Upcoming

- **Final**

Intro

Household emit carbon for many reasons.

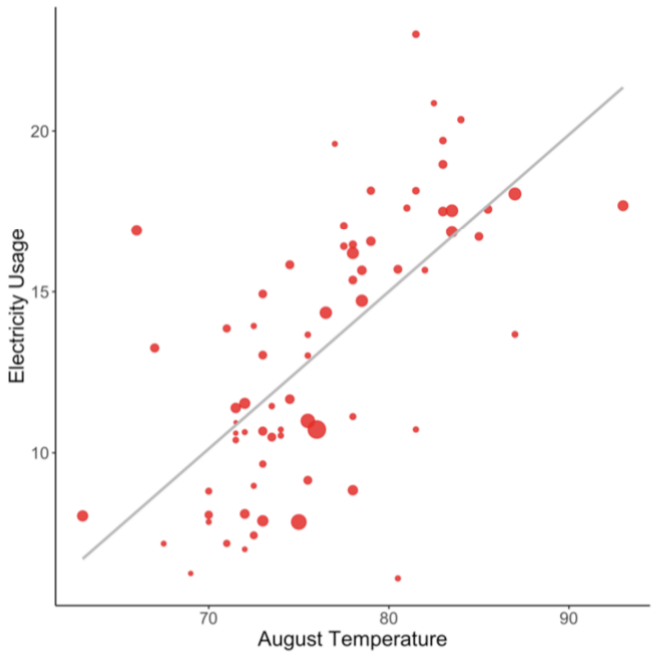
1) Use of appliances. Main Culprits:

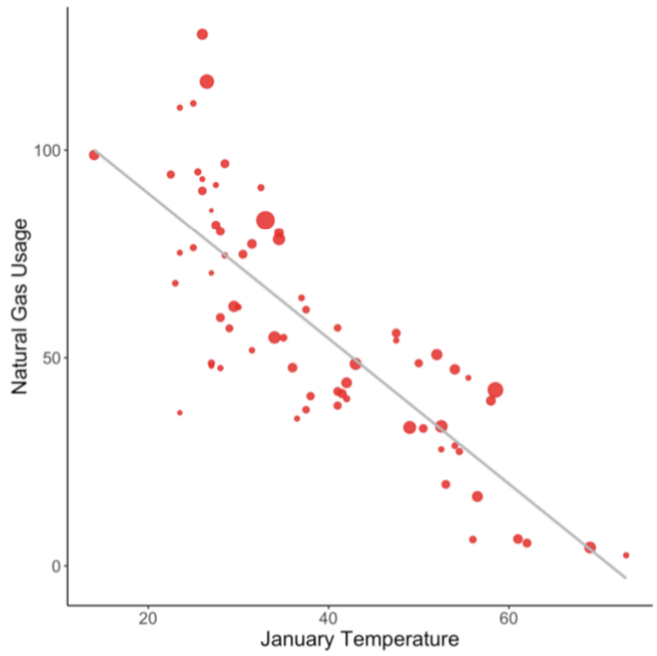
- Air conditioning (electricity)
- Heating (natural gas)

2) Driving

We will focus on 1). The amount of electricity and natural gas a household consumes varies considerably across cities

Energy Use and Climate





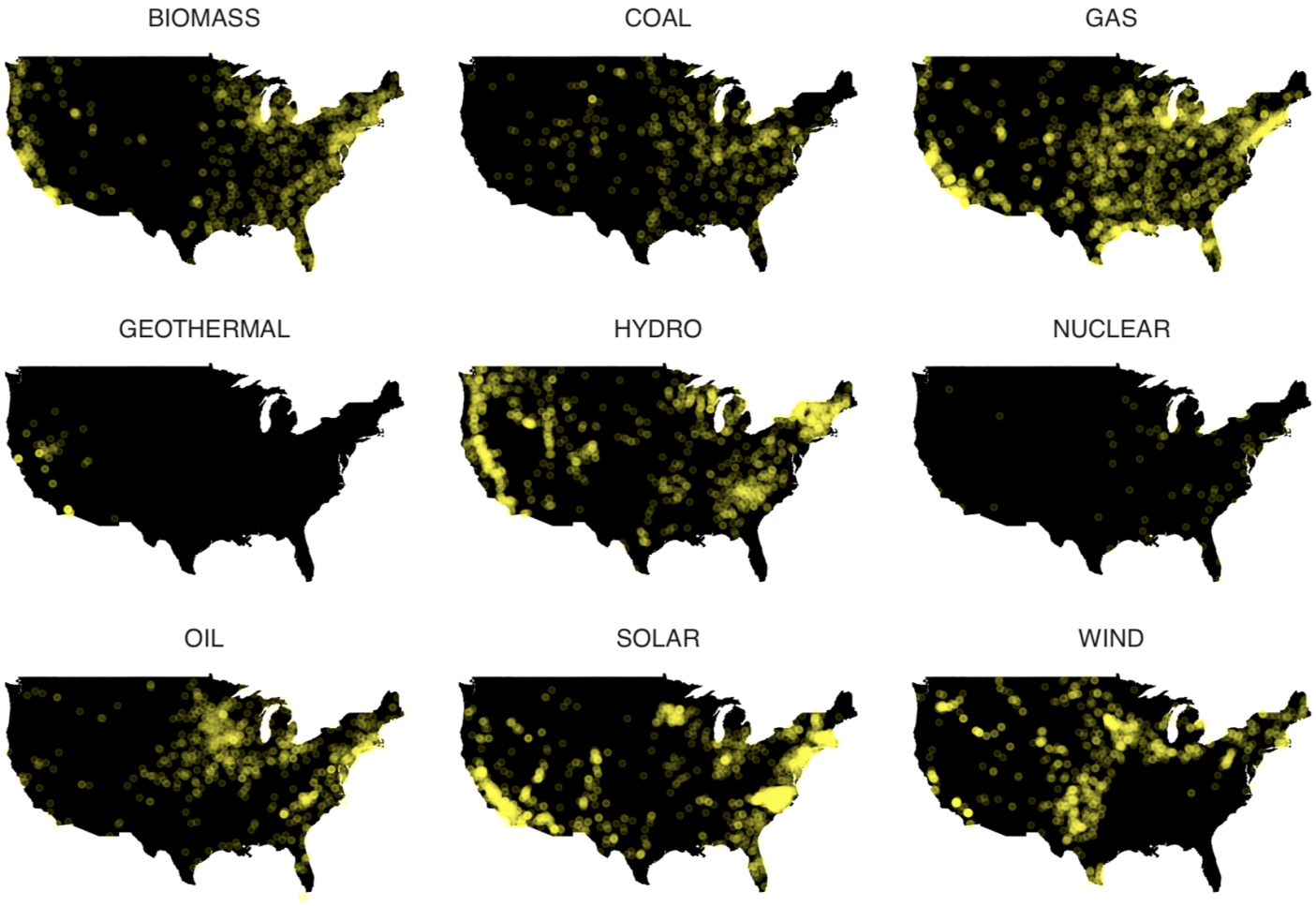
Carbon Emissions

Utilization of energy (natural gas, electricity) leads to carbon emissions

- Natural gas directly emits carbon (so the emissions factor is independent of location)
- Electricity needs to be produced at a power plant.
  - Power plants use different fuels
  - Different fuels $\implies$ different emissions factors for electricity use across locations

Example of clean energy? Dirty Energy?

Plant Types



So Far

Household carbon emissions vary by location due to

1. Temperature Differences

2. Variation in carbon intensity of local power plants

Question: A representative household in San Diego is responsible for 11.2 thousands pounds of carbon emissions per year from electricity and natural gas usage. How much is the same family in Memphis responsible for?

Data

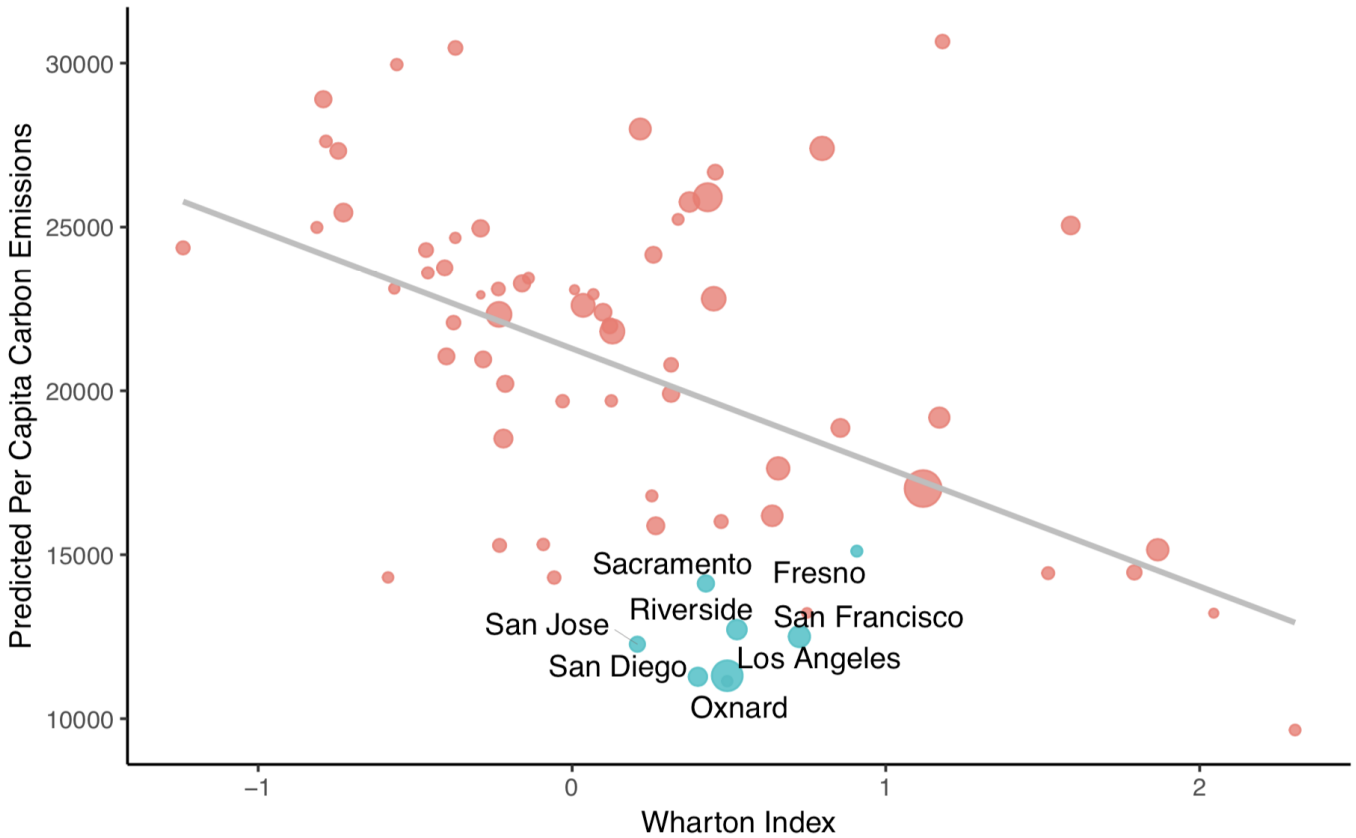
CBSA	Rank	Emissions (1000 lbs)	Nat. Gas Emissions (1000 lbs)	Fuel Oil Emissions (1000 lbs)	Electricity Emissions (1000 lbs)
Lowest emissions					
Honolulu, HI	1	9.65	0.30	0.07	9.29
Oxnard, CA	2	11.14	5.29	0.11	5.75
San Diego, CA	3	11.28	4.65	0.15	6.48
Los Angeles, CA	4	11.31	4.95	0.08	6.28
San Jose, CA	5	12.27	5.70	0.11	6.46
San Francisco, CA	6	12.50	5.94	0.13	6.43
Highest emissions					
Tulsa, OK	65	27.61	7.54	0.16	19.92
Detroit, MI	66	27.99	14.97	0.28	12.75
Kansas City, MO-KS	67	28.90	8.77	0.18	19.95
Omaha, NE	68	29.96	13.02	0.26	16.68
Oklahoma City, OK	69	30.46	7.21	0.19	23.06
Memphis, TN-MS-AR	70	30.66	6.70	0.15	23.81

Land-Use Restrictions

Cities also vary in the amount of land use restrictions they have. In some cities, land use restrictions are tight, meaning lots of costs and restrictions from building more housing.

- Measured by the Wharton Land Use Regulation Index

Policy and Emissions



Recap

So Far

- Cities vary drastically in terms of average Household carbon emissions
    - This variation stems from:
    - Differing carbon intensities of local power plants
    - Spatial variation in the *marginal benefit* of energy consumption
- Cities with lower per capita carbon emissions have stricter land-use regs (on average)

Up Next

- Develop a quantative model to estimate the impact of land-use restrictions on national carbon emissions. Specifically, relax land-use regulations in CA to a "reasonable" level

Model: Overview

1) **Locations** vary by

- Wages, rents, energy prices, and amenities
- Carbon Intensity of regional power plants
- Marginal benefit of energy use for different energy types

2) **Households**

- Demand a composite consumption good, housing, and energy
- Decide where to live (and thus work)
- Vary by demographic, birth locations, and an unobservable component (to the researchers) to location preferences

3) **Emissions**

- Use of energy leads to carbon emissions
- Emissions factors for electricity use vary by location

Simplified Model

Suppose we have two locations. Utility in location j is given by:

$$U(w_j, R_j, P_j^{elec}) = w_j + \frac{1}{2} * R_j + \frac{1}{10} P_j^{elec}$$

- Rents in each city are given by $R_j = (1 + k_j) * L_j$ where:
  - k_j is the level of land-use restrictions in location j
  - L_j is the population of location j
- Carbon emissions in location 1: 200 per 1 unit of electricity
- Carbon emissions in location 2: 100 per 1 unit of electricity
  - Denote carbon emissions per unit in city j as δ_j

Example

Suppose $k_1 = 2$, $k_2 = 4$. Also suppose $P_1^{elec} = 10$ and $P_2^{elec} = 10$.

- Assume $w_1 = 200, w_2 = 205$ and total population is fixed at 1000.

Q1: Compute equilibrium population levels in each city

Example

Example

Furthermore, let e_j^* be the households optimal consumption of electicity in location j. This is given by:

$$e_j^* = \frac{\frac{1}{10} * w_j}{P_j^{elec}}$$

Q2: Compute emissions in each city and total emissions. Hint: Emissions in each city is given by:

$$Emis_j = \delta_j * e_j^* * L_j^*$$

Example

Recompute total emissions when $k_2 = 2$.

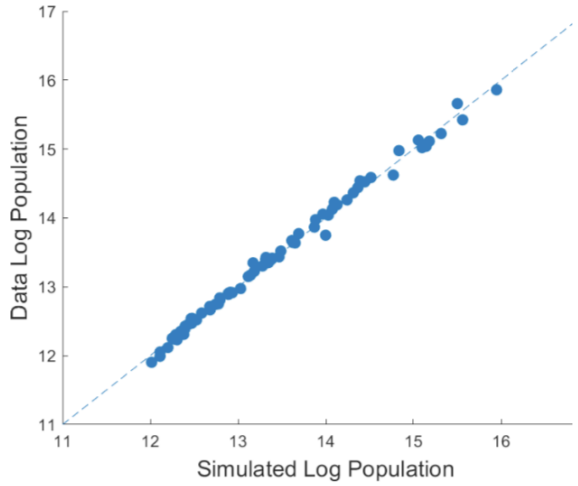
Example

Example

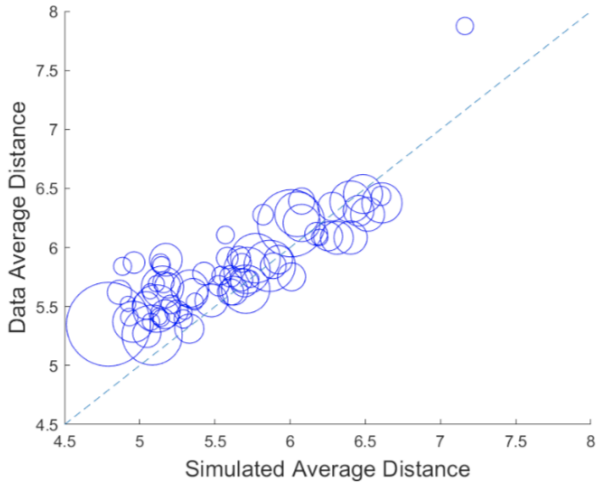
Model Fit

- Mark and I estimate the model on publicly available data
    - This part is the hard part, so I won't go into detail
- Can check how well model fits the data by solving the equilibrium in the model and compare the models outputs to the data.

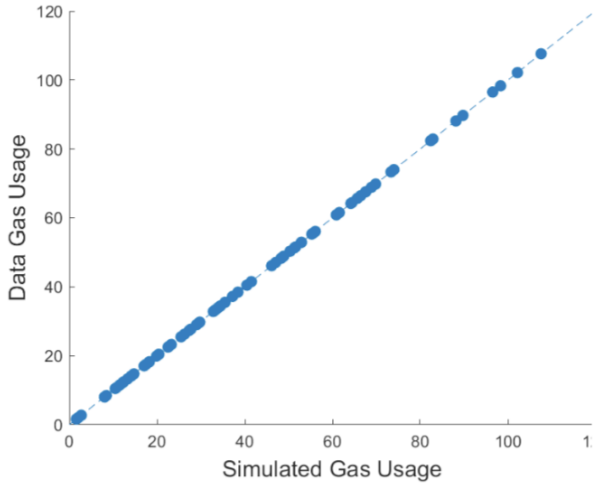
Model Fit



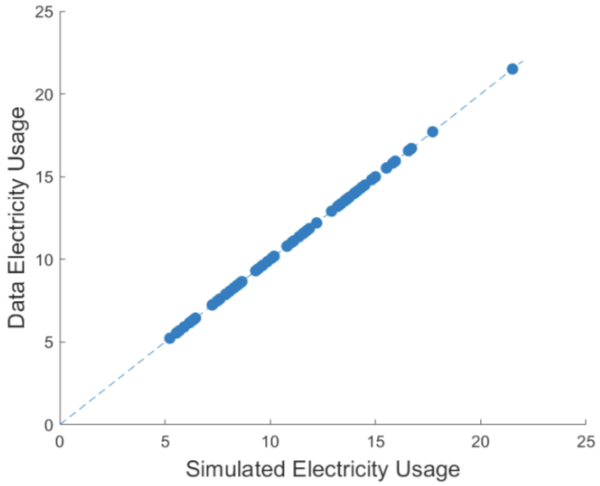
(a) Population by City



(b) Average Distance



(c) Natural Gas



(d) Electricity

Counterfactual

- We estimate the model on publicly available data. Then:

Main Counterfactual: Relax land-use regulation in CA to match the national median

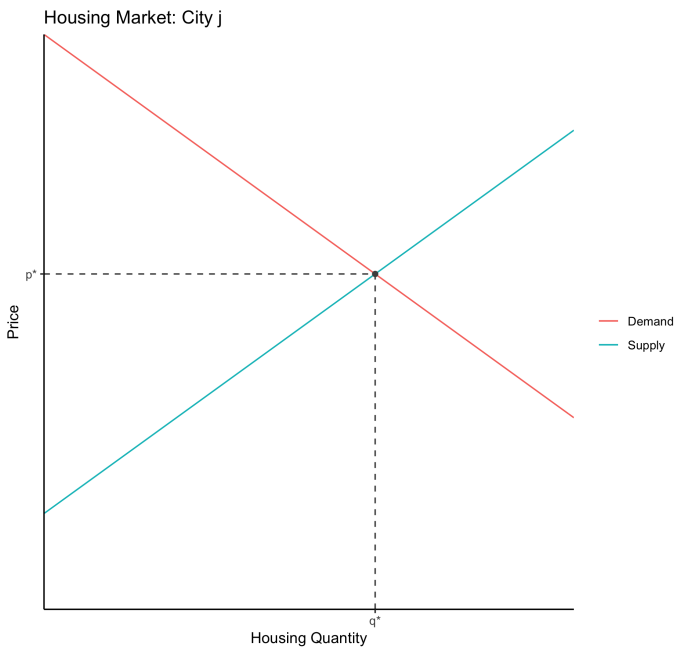
Mechanism:

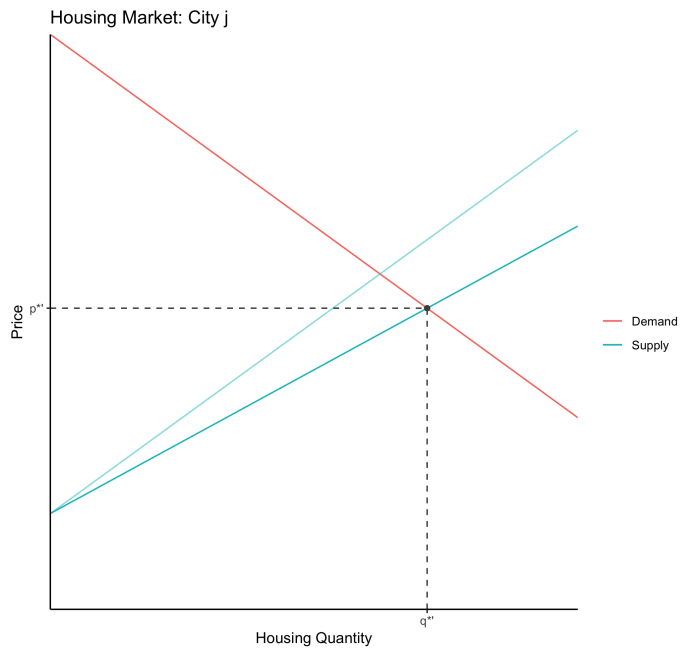
- Mechanically, relaxing land-use regs decrease rents in CA
- Households move to CA due to cheaper rents
- Economy reaches a new equilibrium in rents, wages, and location choices

Carbon Emissions:

- **CA**: low marginal benefit of energy use (temperate climate)
- Carbon efficient power plants
- Thus, should expect equilibrium emissions to fall as a result

Graph


Housing Market: City j
Price
p*
q*
Housing Quantity
Demand
Supply


Housing Market: City j
Price
p*'
q*'
Housing Quantity
Demand
Supply

SB501


Support the
More HOMES Act
to solve the California housing crisis


STOP SB50
SAY NO TO MORE DISPLACEMENT

Results

	Baseline	Relax CA	% Change
I. **Usage**			
N.Gas (1000 cu.ft)	53.18	52.58	-1.13
Electricity (MwH)	13.27	13.04	-1.73
Fuel Oil (gallons)	28.47	26.84	-5.73
II. **Emissions** (**lbs of CO_2**)			
N.Gas	6228	6157	-1.13
Electricity	12804	12465	-2.65
Fuel Oil	765	721	-5.73
Total	19796	19343	-2.29

Conclusion

Takeaways

- Land-use policies that change where workers live have important implications for national carbon emissions
- Estimated the impact of relaxed land-use regulations in CA
    - Predicted national household carbon emissions fall by 2.29%