A Dynamic Model of Residential Sorting Using Aggregate Data : Welfare Implications of Urban Fracking

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Background

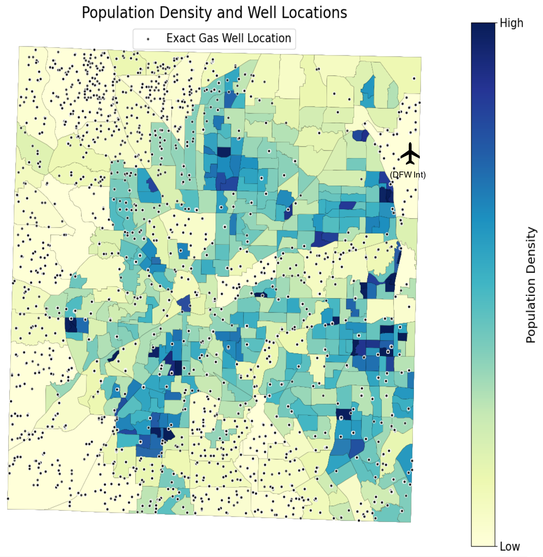
Tarrant County, TX (DFW Metro Area)

An urban county, also a birthplace of the Shale Revolution

Population: 2.1 Million
Largest City: Fort Worth
Pop Density: 2620/sqm
# of Gas Wells: 4828

# of Residents Living Within a **1-Mile** Radius of the Nearest **Gas Well:**

1 Million



Research Question

How did urban fracking **reshape neighborhoods** and what are the impacts?

- What is the overall **welfare effect** of urban fracking on nearby residents?
- How do responses to fracking **differ across racial and ethnic groups**?
- What **distributional** changes arise through **endogenous neighborhood sorting**?

Aimed to contribute to policy discussions in regulating pollution industries in urban setting, and reducing environmental inequalities

Channels To Consider

Fracking activity causes noise, environmental risks, increased commercial traffic, etc.

- **Environmental Disamenities** lower utility for nearby residents.
- **Housing Demand** falls in well-exposed areas.
- **Housing Costs** adjust downward in equilibrium.
- **Socioeconomic Groups** may respond differently to the amenity-rent trade-off.
- **Households Re-Sort** across areas over time, changing demographic composition of neighborhoods.

Empirical Strategy

- Data: Tract-level aggregate ACS, and RRC of TX shale gas well data
- Estimate a **dynamic residential sorting model** using ACS tract-level data, incorporating nearby urban fracking sites.
- Use the estimated model to simulate **general equilibrium counterfactuals** for rents, resident welfare, and racial re-sorting.

Model, and Estimation

Household's Dynamic Location Choice

$$u_{ijgt} = f(p_{jt}, X_{jt}, \xi_{jt}; \theta_g) - sc_{gt} I(d_{it} \neq j) + \epsilon_{ijt}$$

- Household i in group g, currently at d_{it}, chooses area j
- Flow utility u_{ijgt} depends on rent p_{jt}, observed neighborhood characteristics X_{jt}, unobserved amenities ξ_{jt}, and moving cost sc_{gt}

Forward-Looking Residents, and Choice-Specific Values

$$CV_{jgt} = f_j(\Omega_t) + \beta \mathbf{E}[EV(j, \Omega_{t+1}) | \Omega_t]$$

- Households are infinitely lived, and forward-looking.
- They care not only about current utility, but also about future continuation value, given their beliefs about the future states.

Aggregate Housing Demand, Supply, and Equilibrium

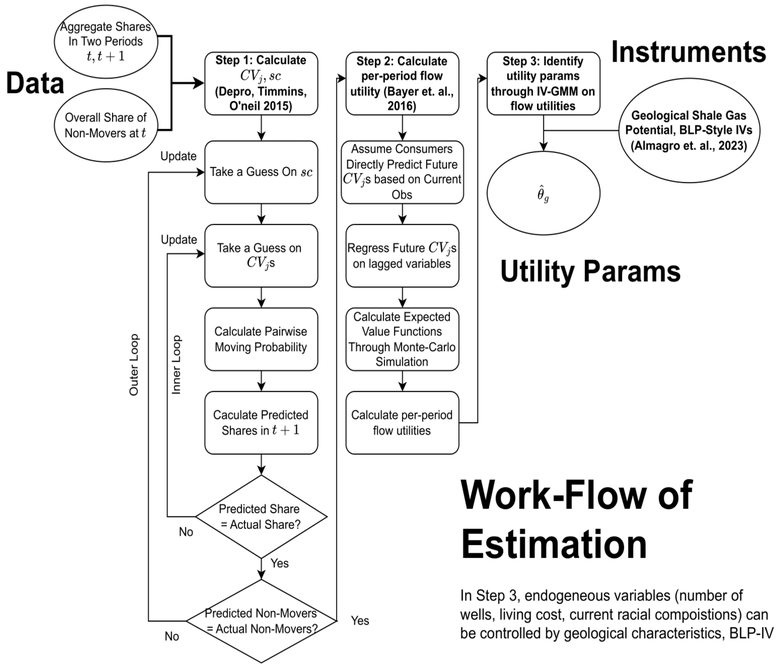
- Let P_{jkg} denote the model-implied probability of moving from j to k

Demand (Population): $N_{jt} = \sum_g \sum_k N_{kg,t-1} P_{jkg,t-1}$

Housing Supply (Baum-Snow and Han, 2024): $S_{jt}(p_{jt}) = \lambda_{jt} p^{\psi}{}_{jt}$

- Market clearing in equilibrium implies $N_{it} = S_{it}$ for all j and t.

Estimation



Work-Flow of Estimation

In Step 3, endogeneous variables (number of wells, living cost, current racial compoistions) can be controlled by geological characteristics, BLP-IV

Contribution in Methods

- **Combines** Depro, Timmins, and O'Neil (2015) with Bayer et al. (2016) to estimate a dynamic sorting model (under high dimensionality in state space) without requiring individual-level data that tracks mobility flows.
- Backs out **mobility flows** and incorporating **dynamics,** using only **basic tract-level aggregate census data** that are public, and commonly available.

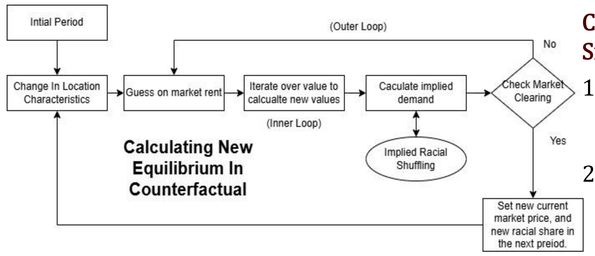
Willingness To Avoid Gas Wells

$$\mathbf{WTP}(\text{Avoid}) = \frac{\beta_{\text{Wells}}}{\beta_{\text{Rent}}}$$

Group	WTP, △ Wells
White	\$19.86/Month (13.38)
Hispanic	\$6.17/Month (3.17)
Black	\$10.59/Month (4.63)

- WTP, as implied by the utility parameter estimates, represents residents' willingness to trade off the dis-utility from adding **one** additional gas well for a dollar/month discount in rent.
- Conditional on having a gas well, a census tract typically has **10+** wells within its boundary.
- As in Cain, et al. (2021), WTPs for disamenities differ by race/ethnicity as White > Black > Hispanic.

Counterfactual Equilibrium Analysis

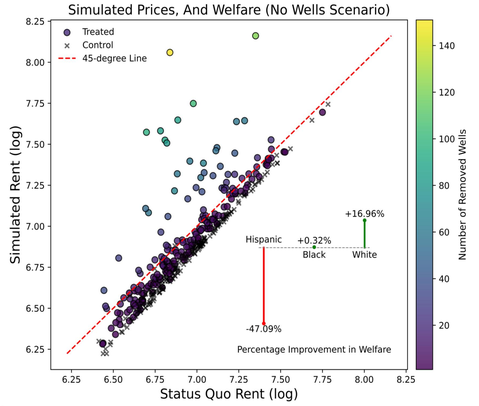


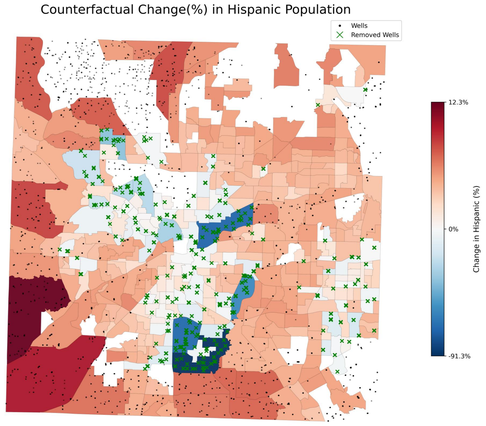
Counterfactual Simulations

1. Remove all wells from the entire area
2. Remove wells only from majority-Hispanic areas

Removing All Wells From The Entire Area

- Results in rent adjustments in all locations (spillovers).
- Change in rent is correlated with change in # of wells.
- Improved environmental amenities, adjustments in rents, and demographic re-sorting result in **benefits** for White households, while **harming** Hispanic households





Removing Wells Only From Majority Hispanic Areas

- Simulation for a policy aimed at improving pollution exposure in minority areas.
- Despite improvements in environmental amenities, due to upward adjustments in rent and re-sorting of residents, Hispanic households in the treated areas are replaced by White and Black households.
- This leads to **gentrification** of minority neighborhoods.