The Unequal Effects of Upzoning: Evidence from Cook County

Rebecca Diamond[1 4] Zong Huang[2] Timothy McQuade[3 4]

[1]Harvard University [2]Stanford University

[3]UC Berkeley

[4]NBER

December 3, 2025

Housing affordability crisis has reached new heights

Affordable housing policy now on the national stage

- **Harris**: "Cut Red Tape and Needless Bureaucracy"
- **Trump**: "Use federal land for large-scale housing construction, areas will be ultra-low tax, ultra-low regulation"

Housing affordability crisis has reached new heights

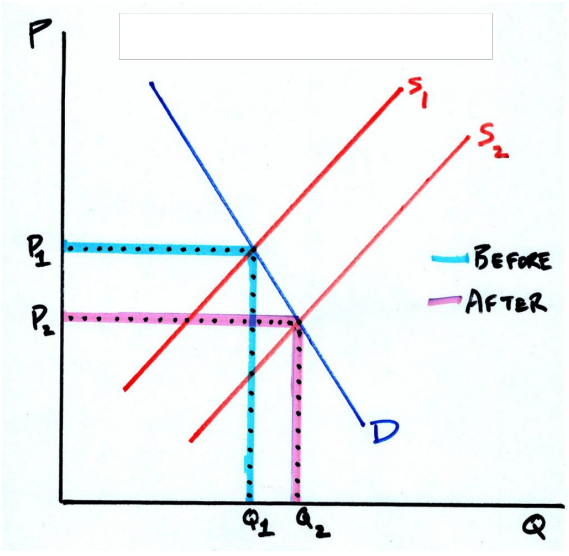
Affordable housing policy now on the national stage

- **Harris**: "Cut Red Tape and Needless Bureaucracy"
- **Trump**: "Use federal land for large-scale housing construction, areas will be ultra-low tax, ultra-low regulation"

States actively experimenting with reform:

- Ban single family zoning: CA, OR, WA, Cambridge, MA, Minneapolis, MN
- Allow residential in commercially zoned lots (California)
- Minimal zoning rules override local rules when cities do not satisfy state-set housing targets (California, Massachusetts)

Econ 101: Increase supply $\rightarrow$ lower prices



Not all zoning reforms are created equal

California "banned single family zoning" (2021) Allowed up to 2 units per lot and enables lot splits on current single family lots

- Calmatters, 2021: "Duplexes and small apartment buildings would spring up from single-family lots."
- Reality in 2025: Less than 100 total units built.

Why did it fail?

- Fine print made it essentially impossible to use: lot splits must be no more unequal than 60%/40%, application must be from owner occupant
  - Owner-occupied houses tend to be higher end, not worth demolishing (plus where would the owner live?)
  - Existing houses tend to be built in the center of the lot. No way to add housing/lot splits
  - Most homeowners not in business of redevelopment

Need framework to map zoning reform details to supply response

Building on the shoulders of giants

Importance of Supply Constraints in Affordability

Glaeser, Gyourko and Saks (2005); Glaeser, Gyourko, and Saiz (2008); Saiz (2010); Gyourko and Mallory (2015); Glaeser and Gyourko (2018); Hseih and Moretti (2019); Gyourko, Hartley, and Krimmel (2021); Baum-Snow and Han (2024)

Reduced form effects of zoning reform

Brueckner and Sridhar (2012); Ding (2013); Ganong and Shoag (2017); Song (2024)

Structural Models of zoning and developer behavior

Epple, Gordon, and Sieg (2010); Turner, Haughwout, and Van Der Klaauw (2014); Murphy (2018); Anagol, Ferreira, and Rexer (2021), Combes, Duranton, and Gobillon (2021); Soltas (2024)

This paper: Micro-model of housing developer decisions

1. **New data:** Linked parcel-level transactions, zoning, redevelopment, and historical parcel characteristics from Cook County

2. **Structural model:** Revealed preference estimation of developer behavior:
   - Flexible hedonic model for housing value
   - Developer profit model to buy existing structures and redevelop

3. **Counterfactuals:** Quantify impacts of proposed zoning reform, e.g. lower fixed costs vs. ban single-family zoning
   - Housing quantity vs. quality effects
   - Surplus from rezoning: Who benefits? Developers vs. property owners
   - Heterogeneity by neighborhood and property type

4. **Housing supply elasticities**: New parcel-level measure, heterogeneous supply response to multi-dimensional price shocks (e.g. single family demand shock in low-income neighborhoods vs. multi-family demand shock in city center) [No time for today]

Preview of Results

- Parcel characteristics play key role in prob. of redevelopment:
  - Only 41% of variance in Pr(redevelopment) explained by block-group FEs
  - Developers target low-end properties in high-end neighborhoods
- Avg lot built only to 52% zoned sqft capacity (96% in units), current prices/zoning support little development
  - Most lots with spare capacity located in lower-income areas, redevelopment not profitable
  - Lots that do redevelop mostly add quality (either new housing or sqft expansion)
- Redevelopment surplus split: 30% property owners, 70% developer profits

Counterfactuals:

- 3-flat zoning reform: Avg lot could more than double units built
  - 3-10% Supply increase, depending on density bonus
  - Generates largest windfall returns in low-income neighborhoods
- 25% reduction in fixed construction costs:
  - No increase in housing supply, 1% increase in avg unit price
  - Generates largest windfall returns in high-income neighborhoods

Administrative data from Cook County Assessor's Office

Property transactions:

- Property deed records: 1999-2023
- Use arm's length residential transactions

Residential property characteristics:

- Property tax rolls: 1999-2023
- Building square feet, year built, number of bedrooms, etc.

Property boundaries:

- Parcel maps: 1999-2023

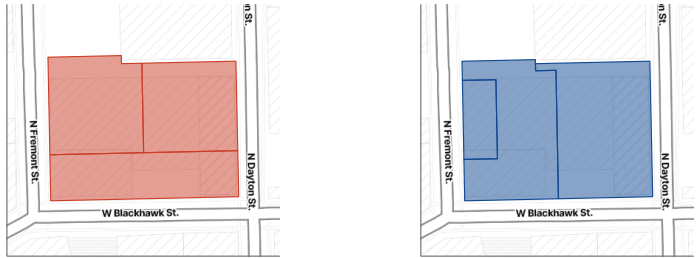
Ignore 40+ unit developments

- Never by-right, requires city discretion
- Not the focus of up-zoning reform

Identifying residential redevelopments

- Link together parcels over time, accounting for changes in parcels
  - Spatial overlay of historical parcel maps in GIS: ID prior properties on parcels

Boundaries in 2000 $\Longrightarrow$ Boundaries in 2020



- Classify a parcel as having undergone redevelopment if:
  1. Observe new residential building with year built between 2000 and 2023 (new construction)
  2. Residential building square footage increases by more than 10% (renovation)

Land use restrictions

Spatially merge in 2023 municipal zoning maps from Zoneomics:

Variable	Mean	Std. dev.	Min.	Max.
Permitted use				
Missing	2.1%			
Single-family	37.2%			
Duplex	15.2%			
Multi-family	26.4%			
Min. lot size (sq. ft.)	8,458	39,403	1,650	1,742,000
Min. lot size per unit (sq. ft.)	4,870	9,076	100	217,800
Max. floor area ratio (FAR)	1.51	2.20	0.01	16.00

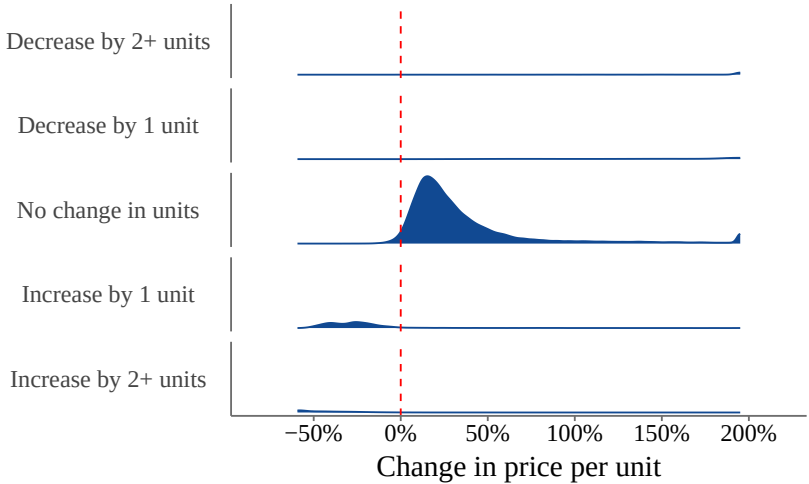
Very few zoning changes in sample over our time period.

Developers redevelop low-quality housing in richer neighborhoods

LPM: Binary Indicator of Parcel Redevelopment within 5 years

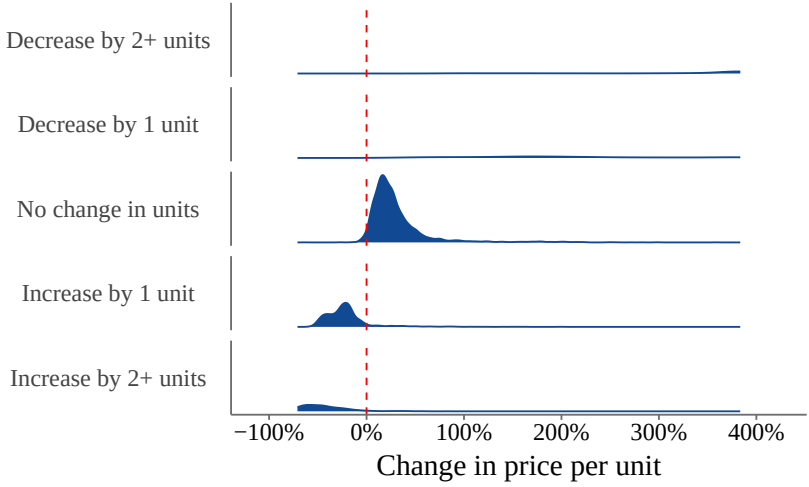
Redeveloped (2017)	(1)	Pairwise regression Estimate	SE	(2) Estimate	SE	(3) Estimate	SE
Census block group							
Population		−0.269	(0.314)				
Median income		2.214	(0.215)				
% white		1.440	(0.142)				
% college		2.532	(0.172)				
Median home value		6.277	(0.411)				
Distance to CBD		−3.993	(0.405)				
Parcel							
Lot SF				0.691	(0.334)	0.926	(0.394)
House SF				−2.739	(0.320)	−2.772	(0.319)
House age				3.471	(0.213)	3.578	(0.218)
# bedrooms / 1,000 SF				1.072	(0.213)	1.090	(0.208)
# bathrooms / 1,000 SF				0.291	(0.171)	0.257	(0.170)
# units				0.933	(0.275)	0.838	(0.276)
Zoning covariates						X	
Block group FE	X			X		X	
R^2	0.142			0.175		0.176	

Large share of observed redevelopments only increase quality



True even for properties where zoning is not a binding constraint

Restrict data to lots where zoning allows for more units than currently built



Goal: quantify the development potential of each parcel

- Intuitively, a parcel's development potential should depend on:
  1. What currently exists on the lot
  2. What could be built on the lot
  3. The cost of construction

- The more underbuilt a lot is, relative to zoning, the more potential for redevelopment

- Begin with a model-free measure of development potential:

$$(1): \textbf{ SF development intensity } = \frac{\text{Existing SF}}{\text{Max. allowed SF}}$$

$$(2): \textbf{ Unit development intensity } = \frac{\text{Existing units}}{\text{Max. allowed units}}$$

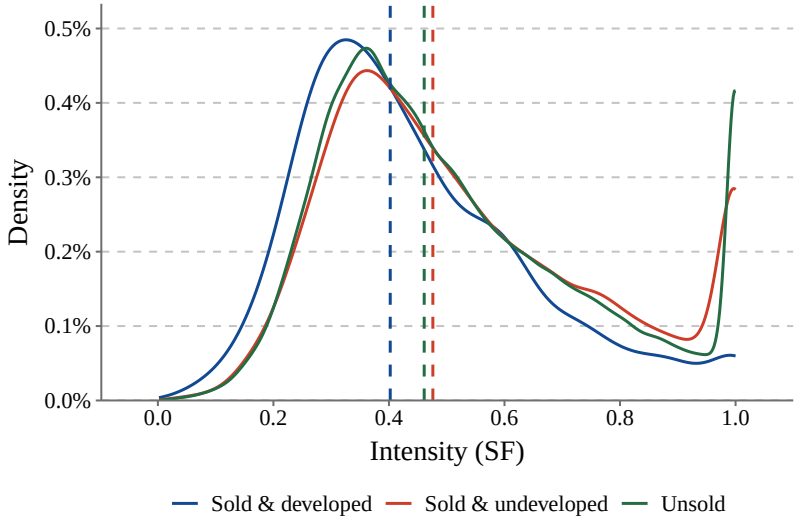
Determine maximum units/SF under current zoning

- Consider a 12,000 sqft. lot. With zoning rules:

Land use restriction	Value	Binding constraint
Min. lot size	5,000 sq. ft.	$\lfloor 12,000 \div 5,000 \rfloor =$ **2 lots, each 6,000 sq. ft.**
Max. FAR	0.4	$0.4 \times 6,000 =$ **2,400 sq. ft. building per lot**
Permitted use	Single-family	**1 unit per lot**
Min. lot size per unit	N/A	

- Assume developers lot split whenever possible and split evenly

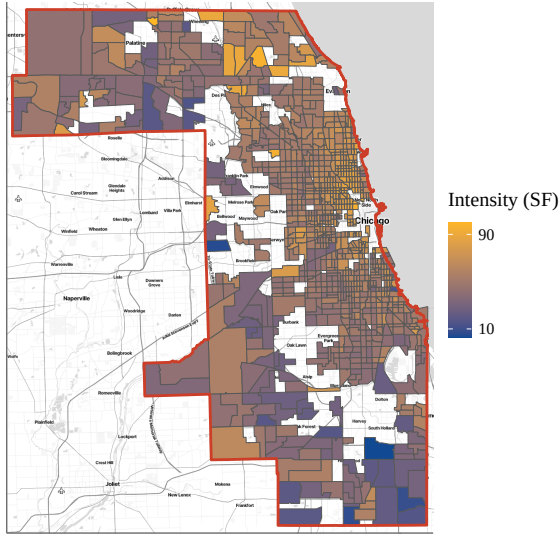
Developers buy properties that are less built up (SF Intensity)



Higher dev. intensity in high-end areas, lots with large/new homes

Development intensity (2017)	(1)	Pairwise regression Estimate	SE	(2) Estimate	SE	(3) Estimate	SE
Census block group							
Population		2.298	(0.882)				
Median income		2.888	(0.616)				
% white		1.780	(0.408)				
% college		5.921	(0.489)				
Median home value		15.487	(1.113)				
Distance to CBD		−14.949	(1.106)				
Parcel							
Lot SF				−5.688	(1.796)	−5.328	(1.891)
House SF				14.526	(0.668)	14.956	(0.569)
House age				−3.802	(0.294)	−3.868	(0.238)
# bedrooms / 1,000 SF				−3.757	(0.294)	−3.592	(0.187)
# bathrooms / 1,000 SF				0.053	(0.128)	0.012	(0.117)
# units				5.176	(0.481)	4.779	(0.387)
Zoning covariates						X	
Block group FE	X			X		X	
R^2	0.294			0.516		0.539	

Higher development intensity closer to CBD



Intensity (SF)

90

10

Structural Model of Housing Redevelopment

Set-up: Households

- Parcel i has existing housing with characteristics z_i^0
- Households exogenously put parcels up for sale
  - Households may sell to another household at $p\left(z_i^0\right)$ (hedonic price surface)
  - Alternatively, households may sell to a representative developer at p_i^*
- Households will sell to the developer whenever $p_i^* > p\left(z_i^0\right)$

Set-up: Developer

- The developer may buy parcel i and develop with intensity $j \in \{1, \ldots, J\}$
  - The new housing has characteristics $z_i^j = f\left(j, z_i^0\right)$
- After redevelopment, the developer can sell to a household and earn:

$$\underbrace{\pi_i^j}_{\text{Profit}} = \underbrace{p\left(z_i^j\right) - p_i^*}_{\text{Net revenue}} - \underbrace{C\left(j, z_i^j\right)}_{\text{Cost}} + \underbrace{\sigma\left(z_i^j\right)\varepsilon_i^j}_{\text{Cost shock}}$$

- If the developer passes on buying, they receive outside option: $\pi_i^{OO} = 0 + \varepsilon_i^{OO}$
- The developer buys if $\max_j \left\{\pi_i^j\right\} > \pi_i^{OO}$ and develops at intensity $j^* = \operatorname{argmax}_j \left\{\pi_i^j\right\}$

Nash bargaining equilibrium

- Suppose developer has bargaining power $1-\beta$ and households have bargaining power β
- Given development at intensity j, total surplus is:

$$S_i^H + S_i^D = p\left(z_i^j\right) - p\left(z_i^0\right) - C\left(z_i^j\right) + \sigma\left(z_i^j\right)\varepsilon_i^j - \varepsilon_i^{OO}$$

Nash bargaining $\Longrightarrow$

- In equiibrium, developer earns:

$$\pi_i^j = (1-\beta)\left[p\left(z_i^j\right) - p\left(z_i^0\right) - C\left(z_i^j\right) + \sigma\left(z_i^j\right)\varepsilon_i^j\right] + \beta\varepsilon_i^{OO}$$

- Key result: total surplus is a *sufficient statistic* for developer choice probabilities

Model-implied measure of parcel development potential

$$\textbf{Net revenue} = p\left(z^{max}\right) - p\left(z^{0}\right)$$

$p(\cdot)$: Hedonic price surface

z^0 : Existing property characteristics

z^{max} : Property characteristics of new construction, built to the zoning max

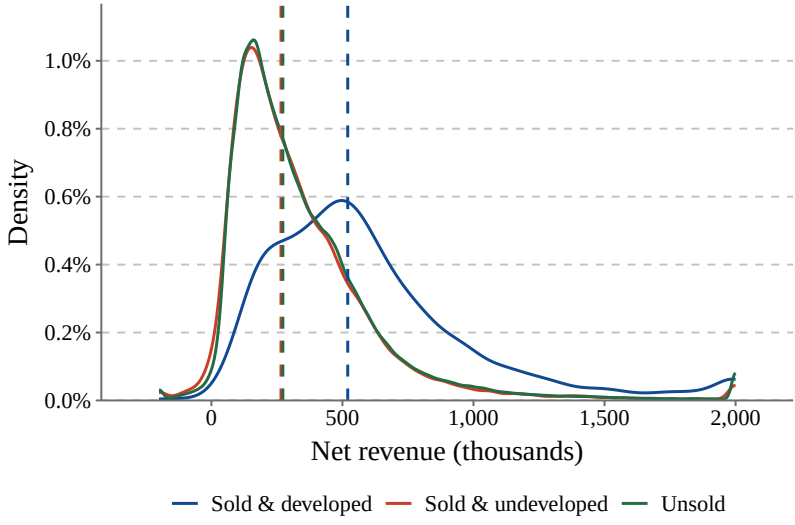
$\Longrightarrow$ Need hedonic price surface

Estimate hedonic model on non-redevelopment transactions

$$\underbrace{\log(p_{it})}_{\text{Price}} = \underbrace{\beta^t \mathbf{X}_{it}}_{\text{Year-varying covariates}} + \underbrace{\beta^d \mathbf{X}_{it}}_{\text{District-varying covariates}} + \underbrace{\lambda_{ct}}_{\text{Tract-year FE}} + \varepsilon_{it}$$

- i : transaction, t : year, d : commissioner district (n = 17), c : census tract
- Covariates:
  - Lot size, building size, building age, multi-family, # units
  - # bedrooms, # bathrooms, # stories
  - Type of garage, attic, basement, porch, and HVAC
- Correct for Jensen's inequality when converting prices into levels (assume log-normality)

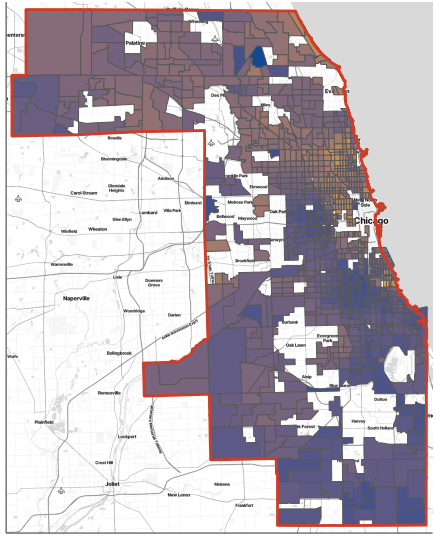
Developers buy properties that have higher net revenue



Low-quality housing in richer neighborhoods have highest net revenue

Net revenue / max SF (2017)	(1)	Pairwise regression Estimate	SE	(3) Estimate	SE	(4) Estimate	SE
Census block group							
Population		4.515	(1.861)				
Median income		34.462	(1.095)				
% white		26.952	(0.698)				
% college		40.479	(0.733)				
Median home value		81.403	(1.937)				
Distance to CBD		−39.996	(2.339)				
Parcel							
Lot SF				3.484	(1.230)	3.632	(1.363)
House SF				−17.488	(0.668)	−17.793	(0.603)
House age				18.505	(0.488)	18.124	(0.455)
# bedrooms / 1,000 SF				3.663	(0.223)	3.430	(0.184)
# bathrooms / 1,000 SF				−3.687	(0.128)	−3.565	(0.119)
# units				8.549	(0.489)	9.228	(0.438)
Zoning covariates						X	
Block group FE	X			X		X	
R^2	0.714			0.823		0.828	

Tracts closest to CBD have highest net revenue



Developer's construction costs

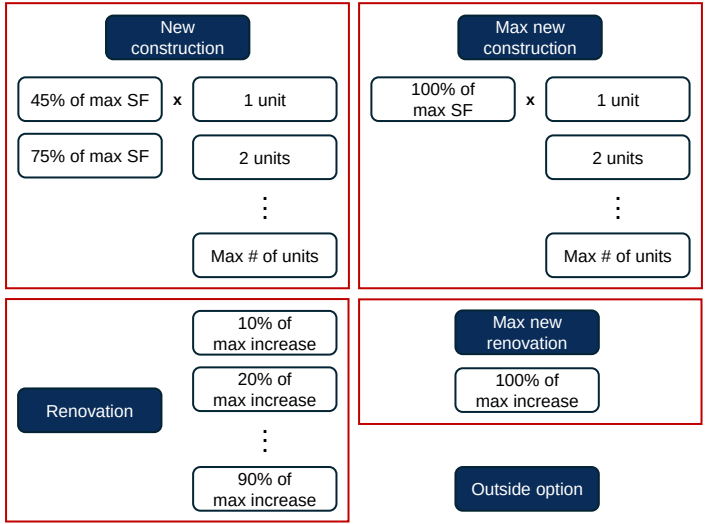
- **New construction:**
  - Developer lot splits, build new units, and build new square footage to the maximum
  - Housing age $= 0$

$$\underbrace{C^{NC}(S)}_{\text{Cost}} = \underbrace{\alpha^{NC}}_{\text{Variable cost}} \cdot \underbrace{S}_{\text{Building SF}} + \underbrace{FC}_{\text{Fixed cost}} + \underbrace{\alpha^{split} 1(\#\text{ lots} > 1)}_{\text{Lot split cost}}$$

- **Renovation:**
  - Developer can increase building size up to the maximum
    - Discretize into 10% bins, starting from existing square footage + 10% of maximal increase
  - Housing age stays the same

$$\underbrace{C^{R}(S)}_{\text{Cost}} = \underbrace{\alpha^{R}_{old}}_{\text{Variable cost}} \cdot \underbrace{S_{old}}_{\text{Existing building SF}} + \underbrace{\alpha^{R}_{new}}_{\text{Variable cost}} \cdot \underbrace{S_{new}}_{\text{Incremental building SF}} + \underbrace{FC^{R}}_{\text{Fixed cost}}$$

Developer's choice set

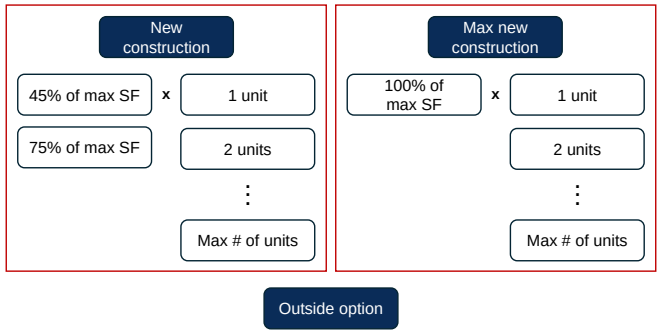


Vacant Land Development

- Owner considers developing land:
- Outside Option: $\pi_{jt}^{OO} = g\left(z_j^0\right) + \varepsilon_{jt}^{OO}$
- Develop the land:

$$\pi_{jt}^{n} = \underbrace{N_j^1 \cdot p_t\left(z_j^1, 0, S_j^{1n}, U_j^{1n}, L_j^1\right)}_{\text{Revenue from new development}} - \underbrace{C^{NC}\left(z_j^1, N_j^1, S_j^{1n}, U_j^{1n}\right)^{NC}}_{\text{New Construction Costs}} - \underbrace{f\left(z_j^0\right)}_{\text{Extra Cost, Vacant Land}} + \sigma\varepsilon_{jnt}^{NC}$$

- Choice Set:



Estimation: construction costs

- **Data:** arms-length transactions from 2001-2019
  - Parcel is redeveloped if we observe redevelopment within 5 years of transaction
  - Use property characterics to classify redevelopment type (and intensity if renovation)

- Normalize profits by maximum building square feet (heteroskedastic cost shocks):

- Assume $\left(\varepsilon_i^j, \varepsilon_i^{OO}\right)$ distributed generalized EV type I (nested logit)

Identification: construction costs

- **Intuition:** developer revealed preferences identify construction costs
  - e.g., fixed costs are large if developers only redevelop when increase in square footage is large

- **Key assumption:** $p\left(z_i^{NC}\right) - p\left(z_i^0\right) \perp \varepsilon_i^{NC}; p\left(z_i^R\right) - p\left(z_i^0\right) \perp \varepsilon_i^R$
  - i.e., net revenue cannot be correlated with unobserved cost shocks
  - Mechanically true, since net revenue predicted from hedonic model

- Explicitly modeling shadow costs due to zoning and land availability
  - Expect physical cost of construction to be relatively homogenous

- Additionally control for potential selection by allowing for heterogeneous costs
  - Single-family vs. multiplex, Chicago city vs. suburbs, pre vs. post-2007

Cost estimates: single-family

$ 2019	All county		City		Suburbs	
	2001-07	2008-19	2001-07	2008-19	2001-07	2008-19
New construction						
VC	219.7	262.9	191.5	226.5	229.0	257.9
	(8.1)	(9.4)	(11.2)	(11.9)	(9.6)	(11.3)
FC (000s)	282.5	336.6	312.1	379.7	200.7	276.8
	(20.2)	(22.6)	(26.8)	(28.7)	(23.7)	(30.8)
Lot split (000s)	430.6	371.8	418.2	375.8	425.2	467.2
	(43.4)	(47.0)	(50.8)	(53.4)	(72.8)	(88.6)
Renovation						
VC: existing	263.1	336.6	189.8	259.6	237.6	284.4
	(15.7)	(16.9)	(16.6)	(17.0)	(29.9)	(34.6)
VC: incremental	327.1	348.8	244.2	269.2	389.4	400.1
	(12.1)	(12.5)	(11.8)	(11.2)	(19.3)	(23.8)
FC (000s)	−8.4	−39.0	54.9	41.7	−11.5	−24.6
	(13.2)	(15.2)	(12.1)	(12.9)	(24.8)	(26.6)

2021 RS Means: $227.75 / sq. ft. for single-family homes

Cost estimates: multiplex

Table: Multi-family supply model estimates

$ 2019	All county			All county	
	2001-07	2008-19		2001-07	2008-19
New construction			Renovation		
VC	320.7	380.9	VC: existing	185.9	252.8
	(20.7)	(21.5)		(16.7)	(19.2)
Unit cost (000s)	44.0	24.1	VC: incremental	336.6	422.7
	(19.1)	(15.9)		(22.6)	(28.4)
FC (000s)	177.6	340.6	FC (000s)	60.6	61.4
	(39.5)	(35.7)		(26.9)	(29.6)
Lot split (000s)	518.1	560.3			
	(69.3)	(76.4)			

2021 RS Means: $345.16 / sq. ft. for apartments

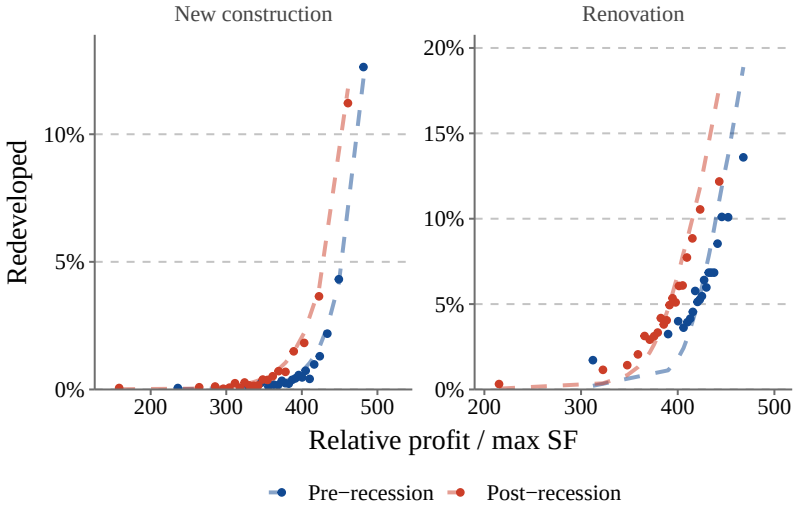
- Few multiplex in suburbs, so pool with city

Vacant Land, Extra Development Cost

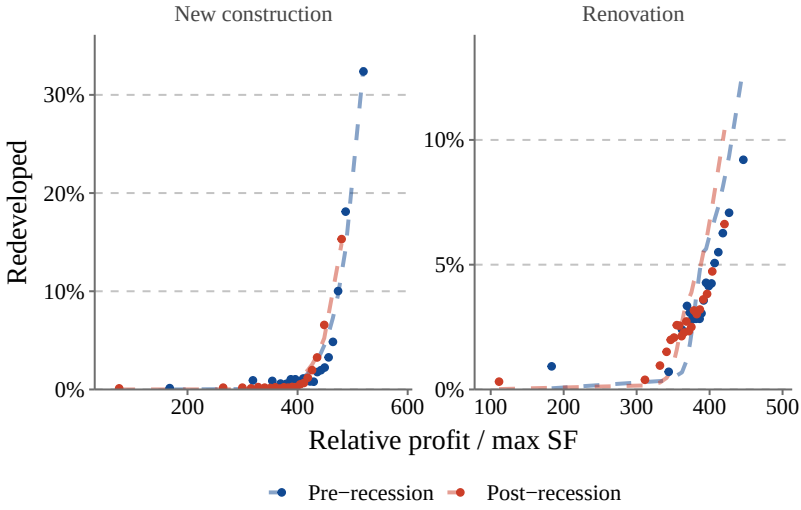
$ 2019	Vacant		Other	
	Pre-Recession	Post-Recession	Pre-Recession	Post-Recession
VC (per lot sqft)	10.1	36.6	65.7	128.4
	(4.0)	(7.9)	(28.5)	(28.3)
FC (thousands)	506.7	319.9	614.6	620.8
	(94.8)	(64.4)	(155.7)	(135.9)

- Other refers to parking lots, garages, farms.

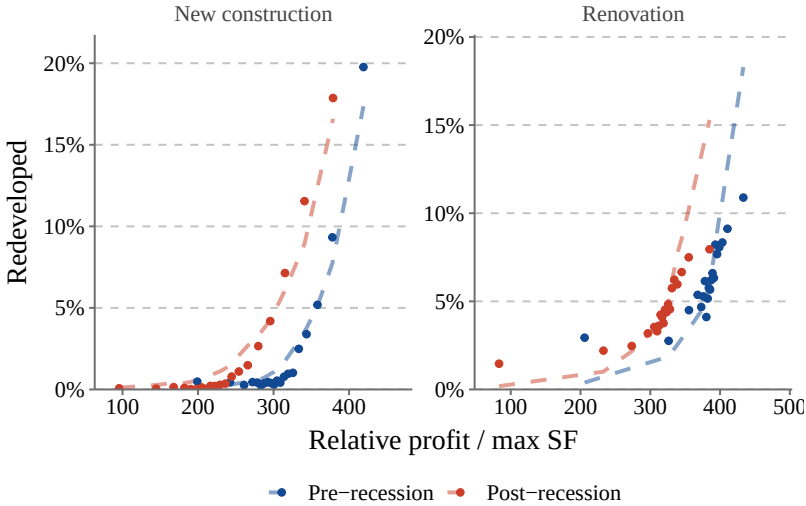
Model fit: Single Family, City



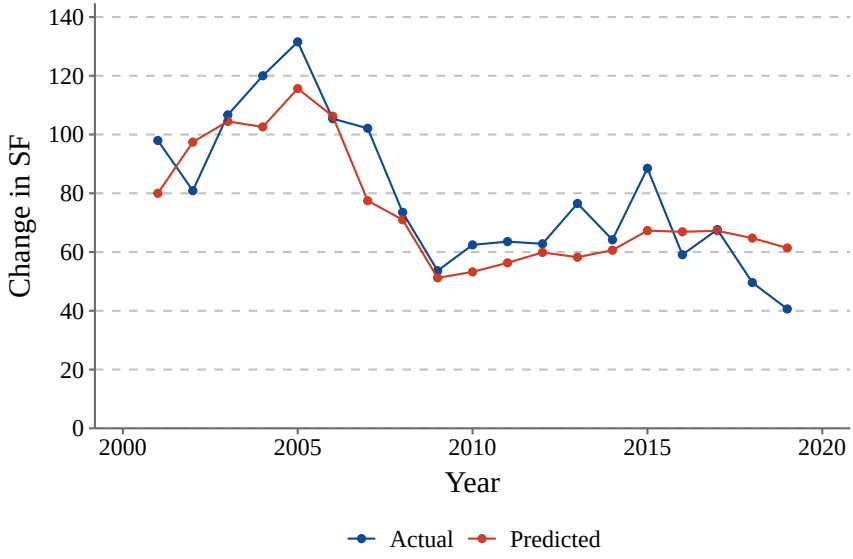
Model fit: Single Family, Suburb



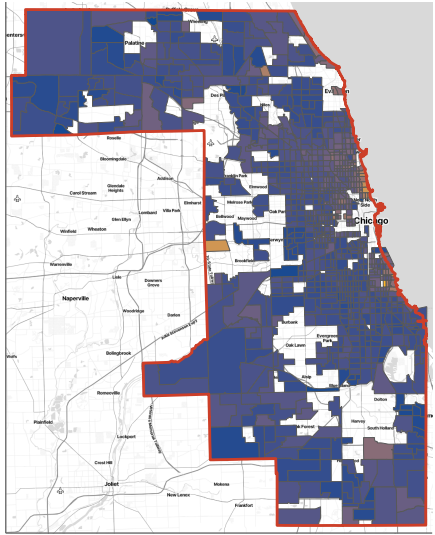
Model fit: Multi-family



Aggregate Redevelopment Over Time



Redevelopments most likely in central city and periphery



Development propensity

60

40

20

Identification: bargaining parameter

- **Intuition:** how much developers outbid households identifies bargaining parameter

- Nash bargaining $\implies$ developer pays mark-up:

$$\underbrace{p_i^* - p\left(z_i^0\right)}_{\text{Mark-up}} = \beta \cdot \underbrace{\left(p\left(z_i^j\right) - p\left(z_0^j\right) - C\left(z_i^j\right) + \sigma\left(z_i^j\right)\varepsilon_i^j - \varepsilon_i^{OO}\right)}_{\text{Total surplus}}$$

- Use estimated cost estimates to infer total surplus

- Take expectations on both size, use model-implied expected ε

- Estimated surplus split: 30% (2.6%) to property owners, 70% to developers

Counterfactuals

Evaluate counterfactual welfare of currently proposed policies in Chicago in partial equilibrium:

1. **Triplex:** set min. lot size per unit to 1/3 of min. lot size (i.e., allow for triplexes everywhere)
   - Try density bonus to allow more SF on lot.
2. **Fixed cost:** reduce fixed costs by 25%

Compare relative to expected construction: e.g. assume all parcels first come to market and developers build under current zoning rules.

Triplex Reform: 3-6% Supply Increase, More in Suburbs

	City			
	Status quo	**Expected**	**Triplex**	**Δ**
Price per unit	$197,172	$220,558	$217,070	−1.58%
Price per sq. ft.	$158.7	$162.1	$161.2	-0.59%
Sq. ft. per unit	1,242	1,313	1,302	-0.79%
Units	1.349	1.385	1.426	2.98%

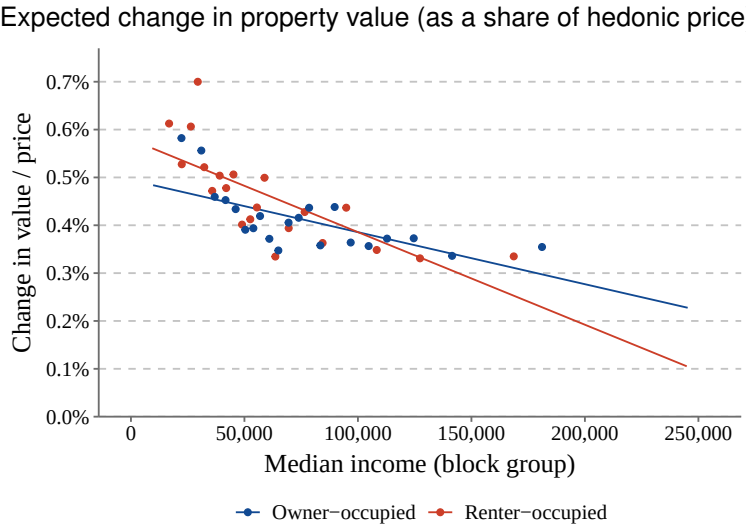
	Suburb			
	Status quo	**Expected**	**Triplex**	**Δ**
Price per unit	$310,866	$328,503	$336,738	2.51%
Price per sq. ft.	$179.9	$171.7	$169.7	-1.14%
Sq. ft. per unit	1,728	1,832	1,914	4.49%
Units	1.007	1.044	1.111	6.43%

Triplex Reform w/ Density Bonus: 5-10% Supply Increase

	City			
	Status quo	**Expected**	**Triplex + FAR**	**Δ**
Price per unit	$197,713	$220,558	$228,173	3.45%
Price per sq. ft.	$158.7	$162.1	$160.5	-1.02%
Sq. ft. per unit	1,242	1,313	1,351	2.90%
Units	1.349	1.385	1.452	4.86%

	Suburb			
	Status quo	**Expected**	**Triplex + FAR**	**Δ**
Price per unit	$310,865	$328,503	$342,067	4.13%
Price per sq. ft.	$179.9	$171.7	$161.7	-5.81%
Sq. ft. per unit	1,728	1,832	2000.8	9.23%
Units	1.007	1.044	1.155	10.64%

Triplex: poorer neighborhoods benefit more in percent appreiciation



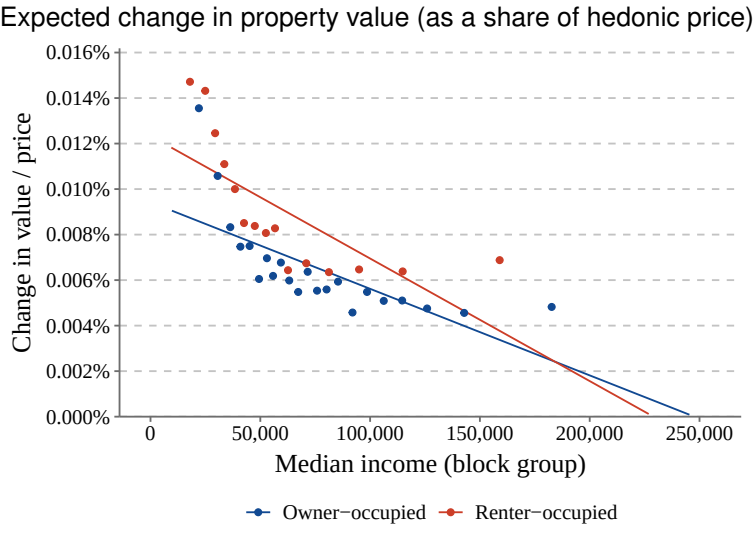
Expected Property value= Pr(Develop) $(\beta * \textit{Surplus} + \text{Hedonic Price}) + (1 - \textit{Pr}(\textit{Develop})) * \text{Hedonic Price}$

Cut fixed costs 25%: no units produced, 1% increase in avg price

	City			
	Status quo	**Expected**	**Fixed cost**	**Δ**
Price per unit	$197,173	$220,558	$227,268	3.04%
Price per sq. ft.	$158.7	$162.1	$164.4	1.40%
Sq. ft. per unit	1,242	1,313	1,329	1.24%
Units	1.349	1.385	1.385	0.01%

	Suburb			
	Status quo	**Expected**	**Fixed cost**	**Δ**
Price per unit	$310,866	$328,503	$331,552	0.93%
Price per sq. ft.	$179.9	$171.7	$172.3	0.34%
Sq. ft. per unit	1,728	1,832	1,842	0.57%
Units	1.007	1.044	1.045	0.12%

Fixed costs: richer neighborhoods benefit more in percent terms



Expected Property value= Pr(Develop) $(\beta * \textit{Surplus} + \text{Hedonic Price}) + (1 - \textit{Pr}(\textit{Develop})) * \text{Hedonic Price}$

Aggregate changes

Table: Aggregate change in housing stock by type of development

	Infill			Land		
	Expected	**Policy**	**Δ**	**Expected**	**Policy**	**Δ**
Triplex	812,224	827,616	15,392	23,273	41,222	17,949
Triplex + FAR $\times 1.25$	812,224	831,530	19,306	23,273	49,897	26,624
Triplex + FAR $\times 1.5$	812,224	833,193	20,968	23,273	53,956	30,582
Triplex + FAR $\times 2$	812,224	833,913	21,689	23,273	55,677	32,404
Triplex + FAR $\times 3$	812,224	834,247	22,023	23,273	55,981	32,708
FC	812,224	811,323	−901	23,273	24,535	1,261

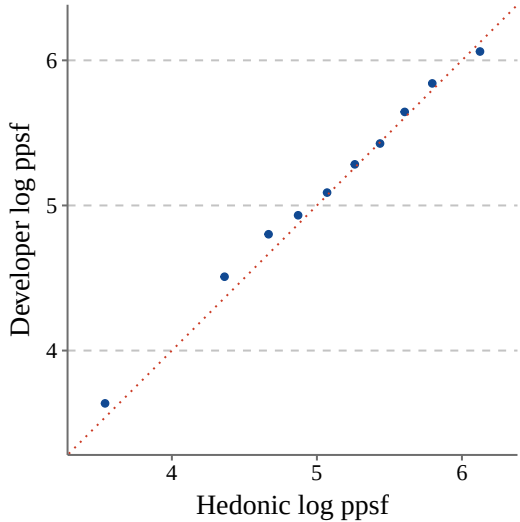
Conclusion

- New supply-side model of micro developer behavior
  - Lot-level zoning + before/after redevelopment lot characteristics directly reveal developer profit
  - Lot characteristics are as important as neighborhood in determining Pr(development)
  - Current Cook County zoning likely only to produce quality upgrading in the future

- Evaluate currently proposed Cook County Zoning Reforms
  - Rezoning to allow triplexes everywhere produces 3-10% more units, depending on density bonus. Most lots remain single family
  - Lowering fixed costs (cutting redtape, streamlining permitting): No effect on unit supply, increases unit prices, makes inframarginal units cheaper to build

- Future work: Framework can be used as laboratory for many types of evaluation
  - Policy effects: Inclusionary zoning, other zoning reforms
  - Cross-county comparisons: Collect data and redo in many other counties (big data lift)
  - Parcel-level housing supply elasticities to predict how specific type of price shocks effect supply

Developers outbid households, suggesting some surplus split



Estimation: bargaining parameter

- Observe mark-ups for redeveloped parcel, but not cost shocks

$$\underbrace{p_i^* - p\left(z_i^0\right)}_{\text{Mark-up}} = \beta \cdot \underbrace{\left(p\left(z_i^j\right) - p\left(z_0^i\right) - C\left(z_i^j\right) + \sigma\left(z_i^j\right)\varepsilon_i^j - \varepsilon_i^{OO}\right)}_{\text{Total surplus}}$$

- However, know cost shocks in expectation; denote $d_i = 1$ if a parcel is redeveloped:

$$\mathrm{E}_{i,\varepsilon}\left[\underbrace{p_i^* - p\left(z_i^0\right)}_{\text{Mark-up}} \mid d_i = 1\right] = \beta \cdot \mathrm{E}_i\left[\underbrace{\mathrm{E}_\varepsilon\left[\left(p\left(z_i^j\right) - p\left(z_0^i\right) - C\left(z_i^j\right) + \sigma\varepsilon_i^j - \varepsilon_i^{OO}\right)\right]}_{\text{Expected total surplus}} \mid d_i = 1\right]$$

- Estimate via method of moments: $\beta = 0.26$