Housing Supply and Housing Affordability

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Handbook of Regional and Urban Economics Volume 6

Overview

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- Broad recognition that expanding supply by lowering the total cost of housing development (construction costs and improving access to land) will improve affordability.
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- The decline in housing affordability represents one of the great challenges of our time
- Broad recognition that expanding supply by lowering the total cost of housing development (construction costs and improving access to land) will improve affordability.
  How? By how much? Where? What does this depend on?
- Nonetheless, there exists only limited overviews of facts and conceptualizations of the data generating processes that generate these facts (and what exists has not been sufficiently read).

Other Reasons to Care About Housing Supply

- Price dynamics with variation in demand
- Efficacy of place-based policies
- Subsidized housing policies
- Impacts of changes in infrastructure, local amenities, and/or local labor demand conditions
- Urban growth

High-Level Considerations

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  $\rightarrow$ filtering and assignment models
  $\rightarrow$ GE with demand side in a quantitative spatial framework and other "top down" approaches (macro models)

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- Policies: Land use regulation; difficulties in the construction sector; subsidized housing on the supply side (e.g. LIHTC) versus demand side (e.g. Section 8 vouchers) but no systematic coverage of policies.

Practical issues

- Chapter draft available at Nate Baum-Snow's website
- Part 1
  - Facts
  - Accounting
  - Construction
- Part 2
  - Dynamics of supply
  - Assignments models
  - Filtering (i.e., dynamics and assignment)
  - Externalities
- Part 3
  - Estimating supply elasticities
  - GE modeling

Overview

Key Facts

- Housing costs and affordability
- Prices, rents, and construction costs
- Housing quantities and depreciation rates
- Spatial patterns in housing density and regulation over time

Housing Costs and Affordability

- Goal is to show the most unfiltered data possible while comparing different types of locations over time

- Use micro data from 1980, 1990, 2000 censuses and 2005-2022 ACS to calculate nominal self-reported values, gross rents and household incomes for four spatial aggregations in each year

- Regions are: all large central cities (49m), metro suburbs (126m), small metros/rural areas (107m), superstar central cities (15m - New York, LA, San Francisco, Washington, Boston, Seattle, and San Diego)

- Index all to small/rural locations in 2000

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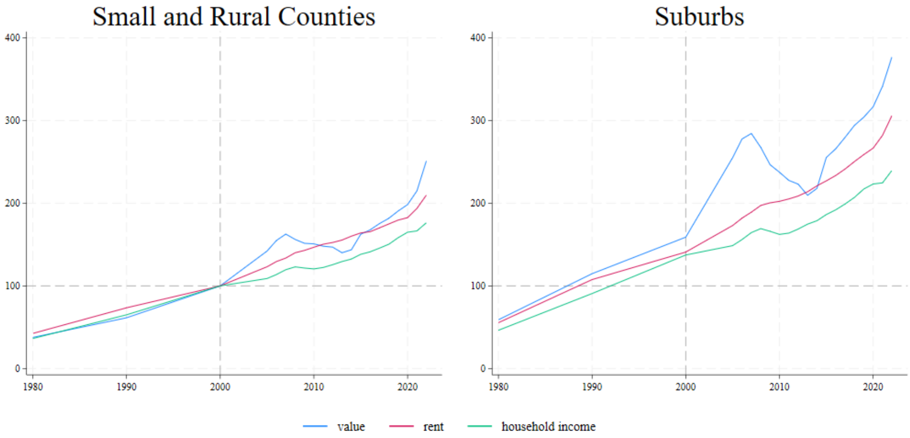
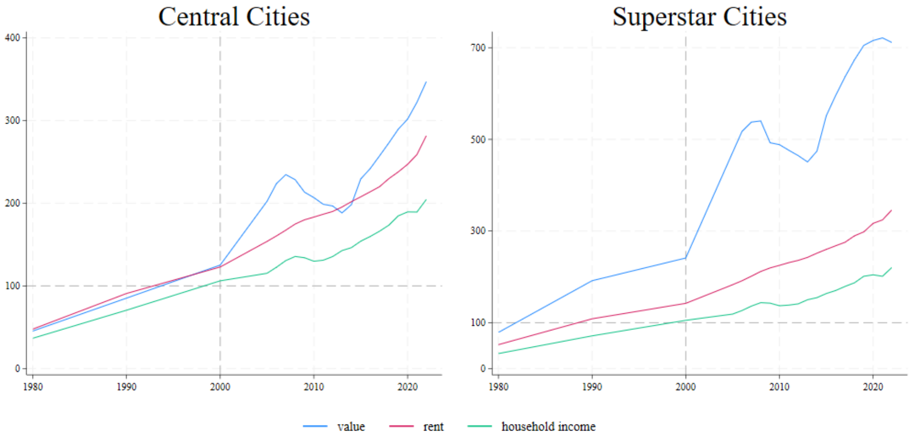
- A housing market is such that P_j is the common price of a unit of housing services.
- This aggregation is problematic if housing is indivisible or consumers define housing services differently.
- Most readily available data report values: $P_{jt} h_{ijt}$ where P_j is forward-looking.
- Changes in H_j have four sources: (i) new developments, (ii) redevelopments, (iii) teardowns, and (iv) renovations.

Declining Affordability, Even in Small Counties



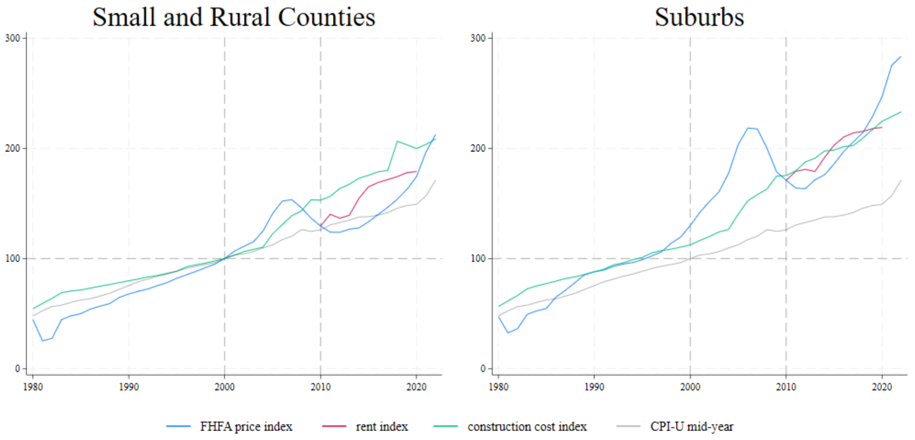
And More So in Cities, Especially Higher Cost Ones



Prices, Rents, and Construction Costs

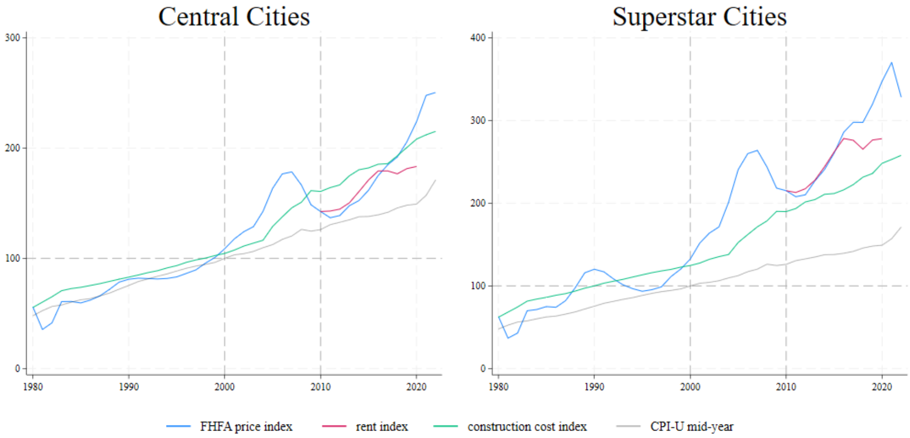
- Home values (prices) have grown more rapidly and are much more volatile than rents (more renting as a channel for enhancing affordability?)
- Does more proper indexing change conclusions about trends in prices and rents?
  - FHFA Price Index (RS index for single-family detached homes only),
  - Zillow Rent Index (repeat-rent index for property listings since 2010 only)
- How much of rapidly rising prices can be explained by rising construction (absent land and permitting) costs? RSMeans data

Rising Construction Costs Partly Explain Affordability Declines



Glaeser & Gyourko's (2018) Ratio of Replacement Cost to Price ratio (RC/P) is at or below 1 in 2000 for the majority of housing units in small/rural areas.

Diverging Prices and Construction Costs Evident in Superstar Cities

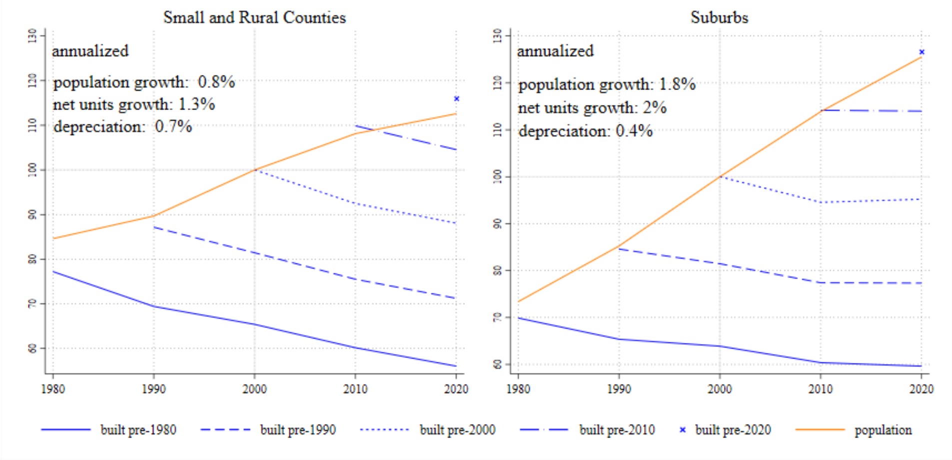


Housing Quantities and Depreciation Rates

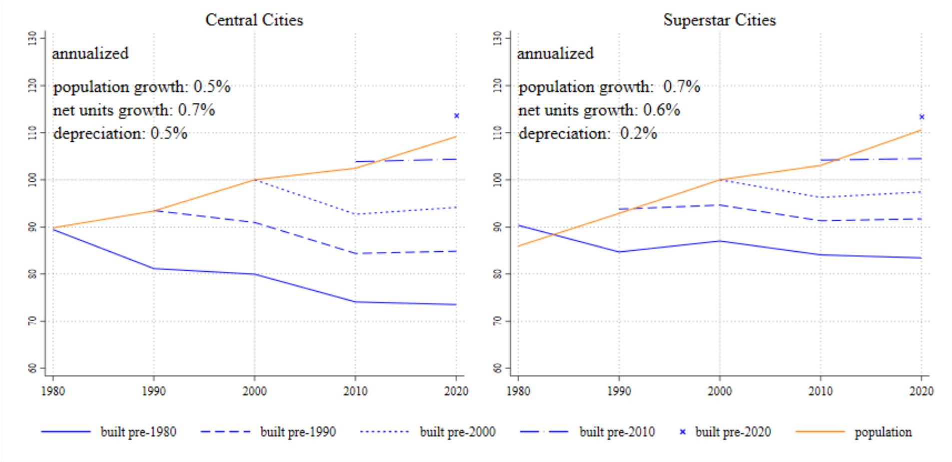
- Higher construction costs imply that growth in demand increasingly implies higher prices rather than larger quantities (decreasing supply elasticities).
- Higher construction costs are also expected to lead to increased maintenance of existing properties and lower depreciation rates in high-demand markets (Baum-Snow and Han, JPE 2024)

- Explore a cohort analysis, tracking (full) depreciation of housing units that existed in 1980, 1990, 2000, and 2010 plus decadal new construction
- Use census and ACS tract aggregate data on stocks and year of construction

Weaker Demand Growth → Greater Depreciation, Reduced Crowding



Particularly True in Superstar Cities



Depreciation Rates, HH Formation, and Unit Size

- Household sizes are getting smaller. This means fewer people per housing unit and perhaps more smaller housing units are needed (the "missing middle").
- Depreciation rates appear to be related to demand. They may also be related to construction and redevelopment costs (including permitting frictions and land use regulation).

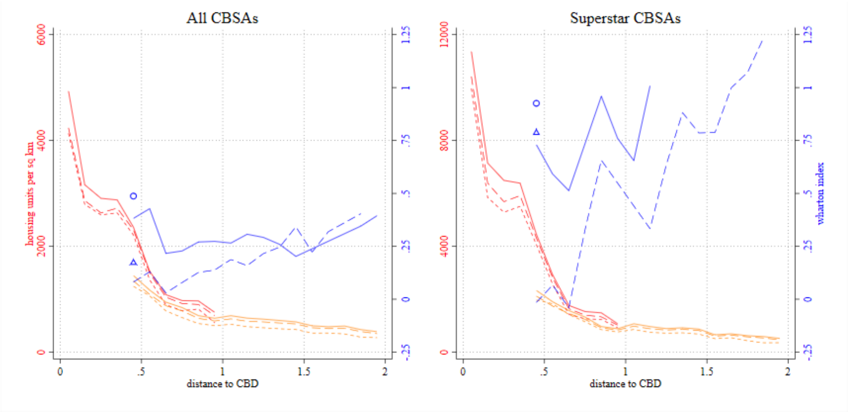
- Despite declining family sizes, average housing unit sizes have been increasing over time.
- Use census, ACS, (and CoreLogic data) to document this.

Where Has Housing Unit Density Increased?

- Big reduction in new constructions after 2000, especially in suburbs.
- Broad consensus about the benefits of infill development.
- Yet minimum lot size (MLS) zoning is pervasive, leading to lower densities than justified by demand conditions in many neighborhoods

- Document average housing unit density by distance to central business districts (CBDs) in 1980, 2000, and 2020 for central cities and suburbs (census data).
- Also document tightening regulation using the municipality level Wharton Land Use Regulation Index for 2006 and 2018.

Housing Unit Densities and Regulation



Housing Construction and Regulation

- Rising regulations constraining housing supply over time
- Higher regulations in more geographically constrained cities
- Greatest densification has been in central cities, but this does not represent much land or many new housing units
- Lots of opportunity for increased densification

Overview

Housing Supply Elasticities

Long Run:
Most naturally thought of in terms of cross-sectional comparisons

$$\epsilon_P^H(t) = \epsilon_P^h(t) + \epsilon_P^L(t)$$

Intensive (building) and extensive (land development) margins

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Short or Medium Run:
Most naturally thought of in terms of comparisons over time

$$\epsilon_P^H(t,t') = \epsilon_P^h(t,t') + \epsilon_P^L(t,t') = R(t,t'|\mathbf{P}) \times \epsilon_P^h(t) \; + \epsilon_P^L(t,t')$$

This section: Consider the data generating process for $\epsilon_P^h(t)$ - how much is developed, conditional on development

Modeling Challenges

We are in an environment in which each unit of housing services has price P_j in market j. These units are perfect substitutes across dwellings within the market and divisible within dwellings. There is a common housing production function.

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- Only expenditure (price times quantity) is observed in the data.
- High-quality data separating land from capital and/or labor in construction is still the exception.
- Housing is heterogeneous in both prices and quantities across properties and locations.
- Parcels differ greatly in their cost of housing development (slope, groundwater, regulation, etc.)

Builder's Environment

- Based on Muth (1969, 1975), Combes et al. (2021), and Baum-Snow & Han (2024).
- Timing: 1. parcels are delineated, 2. builder chooses whether to build, and 3. how much to build when building.

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- First-order condition:

$$P_j \frac{\partial h(k, l_i)}{\partial k} = r_j$$

Builder's Environment

- Zero profit $\Rightarrow$ capitalization into land values:

$$q_{ij} \equiv q_j(l_i) = P_j h(k_i, l_i) - r_j k_i - c_{ij} = (1 - \alpha_i) P_j h(k_i, l_i) - c_{ij}$$

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- Alternatively, use the dual:

$$(1 - \alpha_i) P_j h(k_i, l_i) = C_j(h_i) \left(\frac{\mathrm{d} \log C(h_i)}{\mathrm{d} \log h_i} - 1 \right) = \frac{1 - \alpha_i}{\alpha_i} C_j(h_i)$$

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- Note: (i) silent about how the construction of housing is divided across dwellings, (ii) no construction occurs if c_{ij} is above a threshold defined by $q_{ij} = 0$, (iii) regulation will affect construction beyond c_{ij}.

Estimating the Housing Production Function

- Assume Cobb-Douglas production:

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$$\log (P_j h_{ij}) = \alpha \log(r_j k_i) + \beta \log q_{ij} + (\log B_j + \epsilon_i)$$

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  where ϵ_i is an added shock.
- Identification issues: missing variables in ϵ and simultaneity with P.

Data: land values

- Data providers (e.g. CoStar): selected in size and likely location - can correct for that but tradeoff with measurement error...
- Appraised values: often used but noisy and likely systematically biased
- High-quality land values are rare: Thornes (1997) and Combes et al. (2021).

Estimating the Housing Production Function 1

- Assume CRS production of $P \times H$ and calibrate or regress input cost shares as just described.
- Example: Albouy (JPE 2009) calibration with three factors (land, capital, and labor)
- Land share: 0.23; Capital share: 0.15; Labor share: 0.62
- Same identification problem as in the generic case: Endogenous factor usage and prices correlated with B

Estimating the Housing Production Function 2

- Maybe Cobb-Douglas is not a good approximation of the housing production function. CES is a more flexible form:

$$h = B_j \left(\upsilon k^{(\sigma-1)/\sigma} + (1-\upsilon) l^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)} ,$$

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- Problem 1. Land prices and capital investment are jointly decided: capital is often measured as a residual assuming zero profits.
- Problem 2. Land prices are likely mismeasured.

$\Rightarrow$ Estimates all over the map: 0.1 to 1.1...

Estimating the Housing Production Function 3

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- Still does not solve the two previous problems.
- A general issue so far: No consensus estimate. Why are results so different?
  - Identification challenges remain
  - Sample heterogeneity (Ahlfeldt & McMillen 2013)
  - Land price data
    - Results are often sensitive to land prices.
    - Often low quality.
    - High-quality land prices are extremely noisy (overly so?).

Estimating the Housing Production Function 4

- Non-parametric estimations separating prices from quantities: Epple, Gordon & Sieg (AER, 2010) and Combes, Duranton, & Gobillon (JPE, 2021).
- Assume one capital price, no fixed cost.
- First-order condition for capital $\Rightarrow P_j = r/h_k(k, l_i)$.
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- Zero profits $\Rightarrow q(k, l_i) = P_j h(k, l_i) - rk$.
- Combining to eliminate P yields the key condition:

$$\frac{\partial \log h_i}{\partial \log k_i} = \frac{r\, k_i}{r\, k_i + q(k_i, l_i)}$$

Estimating the Housing Production Function

- Solve the resulting differential equation conditional on parcel size l_i:

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- Use data on l, k, and q to recover h separately from P.
- Then regress h on k for each l (slightly more complicated, more soon).

Identification

Why would two homes on parcels of the same size have different land prices and receive different capital amounts?

- Housing demand conditions (good variation)
  - Neighborhood quality gets capitalized into land values.
  - Those in nicer neighborhoods may demand more capital-intensive homes per unit land.

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- Housing demand conditions (good variation)
  - Neighborhood quality gets capitalized into land values.
  - Those in nicer neighborhoods may demand more capital-intensive homes per unit land.
- Land quality differences (fixed cost of development). Worse parcels in need of more k for the same h. Worse parcels also capitalize this into a lower $q(l)$.
- Labor cost differences $\rightarrow$ in low-cost labor markets, homes with the same (k, l) probably provide more housing services.

$\Rightarrow$ Challenge: Estimate supply (production function) using demand variation.

Empirical Implementation

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- Kernel smooth q across nearby values of k and l to get triplets of (r, k, l) on a grid.

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- Regress q, rk (and l) on supply factors Y and demand factors X.
- Predict out q, rk (and l) for the average Y only using identifying variation in X.
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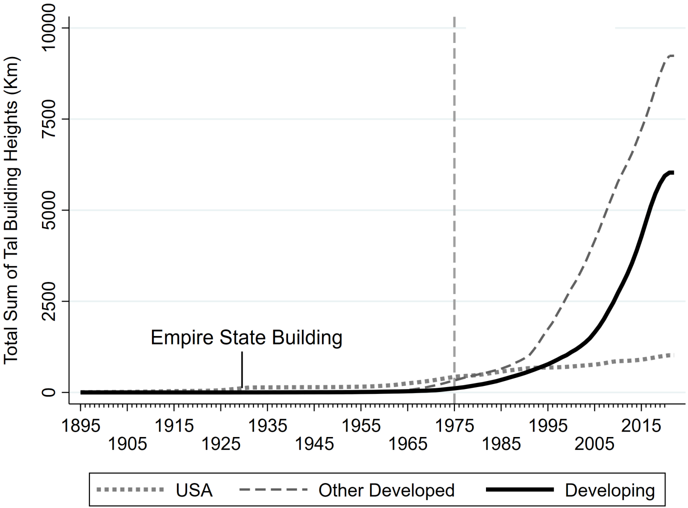
Results:

- Share of capital of about 0.65, elasticity of substitution close to 1, and close to constant returns, i.e. Cobb-Douglas is a good approximation

$\Rightarrow$ Elasticity of supply conditional on development $\epsilon_P^h = \frac{\alpha}{1-\alpha}$ is about 2.

Exponential Growth in World Tall Building Stocks



Mostly residential construction worldwide

Tall Buildings and Multi-Unit Structures

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- Initial analysis of Ahlfeldt, Baum-Snow and Jedwab (2024) using the same tools as above
  - Reframe in terms of observed heights $g_i = h_i / l_i$.
  - The "cost of height" $\theta_i \equiv \frac{\mathrm{d} \log C_i(h_i)/h_i}{\mathrm{d} \log g}$.
  - For Cobb-Douglas, $\theta = \frac{1-\alpha}{\alpha} \approx 0.5$.
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  - Ahlfeldt & McMillen (REStat, 2018) independently estimate 0.5 by regressing k/h on g using tall building data from Chicago.
- Key differences relative to single-family houses:
  - Prices depends on height and location: elasticity of price wrt to height is 0.03 (residential) to 0.07 (commercial).
  - θ depends on bedrock depth, ranging from 0.2 to 0.8, generating supply side variation in city aggregate heights.

Restrictions on Tall Building

- Glaeser, Gyourko, & Saks (2005) "Regulatory Tax": $P_j / C'(h^{max}) > 2$ in NYC. Higher in London offices (Cheshire & Hilber, 2008).

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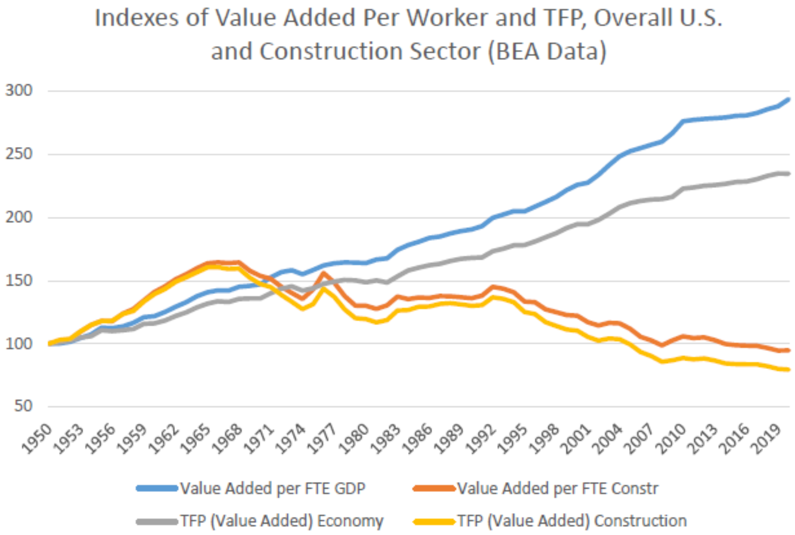
  - Use cross city variation in θ given bedrock depths $\rightarrow$ tall buildings allow cities to host more population and reduce their footprints.
  - Calibrated monocentric model for all cities worldwide indicates only $\approx$ one-quarter of potential welfare gains from heights realized.
  - Land values fall with relaxing restrictions.
- Brueckner, Fu, Gu & Zhang (2017)
  - Theory indicates $\frac{\partial \log q}{\partial \log FAR}$ indicates stringency of height regulation.
  - Solve for implied k^{max}/k .
  - Binding FARs found in Chinese and US cities.
- Brueckner, Leather, & Zercero (2024): Bunching estimator for NYC showing FAR causes 10% less floorspace.

Declining Housing Productivity



Goolsbee and Syverson, WP 2023

The Productivity Problem in Construction

- Anecdotal evidence: Empire State Building vs. One World Trade Center.
- This is not a failure to invest by the construction industry, nor does it reflect input costs.
- This is (mostly) not a statistical artifact due to using the wrong deflators, unobserved quality, etc.
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- This reflects a productivity issue (i.e. TFP).
- We observe it in growing costs of constructions in the RSMeans data, keeping quality constant.
- Positive correlation between construction costs and unionization and regulation (Gyourko & Saiz, 2006).
- The construction industry has many small firms, with the number proportional to population and little innovation (Gyourko & Saiz, 2006).
- Large macroeconomic/welfare implications.

Land Use Regulations and Scale Economies

D'Amico et al. (WP 2024): Argue that land use regulations impede the exploitation of scale economies in the construction sector.

- Document higher housing production costs in more regulated cities, especially project-level fixed costs.
- Labor productivity in construction declined with the timing of expanding land use regulation.
- Many small construction firms, especially in the most regulated cities.

The Productivity Problem in Construction

Three further elements:

- The ‘industrialization’ of construction has been regulated out.
- Beneath ever more stringent land use regulations is increased (local) citizen voice... (or perhaps increased voice of some citizen)
- Same issue with infrastructure construction (Brooks & Liscow, AEJ 2023)

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Lingering questions:

- Why is the estimated effect of housing code restrictions, unions, etc. so small?
- How much does the lack of easily available land account for the productivity decline in construction?
- How much is explained by the maintenance and expansions of existing homes?

Overview

Housing Durability

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⇒ Option value of waiting (Titman, 1985)

- Two sub-literatures
  - Analyze complex development decisions in isolation using tools from financial economics (reviewed in Duranton and Puga, 2015).
  - Analyze development decisions and the supply feedback they create.

A Simple Two-Period Model

Develop in period 0 ($d = 0$) with unknown price in period 1 and irreversible development.

- Expected profit:

$$\pi(d=0) \equiv \pi(P_0, k_0) + \mathbb{E}(\pi(P_1, k_0)) = P_0 k_0^{\alpha} + \mathbb{E}(P_1) k_0^{\alpha} - k_0$$

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- Take FOC in k_0.
- Substituting into the profit function:

$$\pi(d=0) = (1-\alpha)\alpha^{\alpha/(1-\alpha)} \left(P_0 + \mathbb{E}(P_1)\right)^{1/(1-\alpha)} .$$

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- The gains from delay depend on the variance of P_1 (not its mean).

- While adding periods is easy, it is unclear what happens with an infinite horizon.

An Infinite Horizon Framework: Environment

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- Over time: $L_{jt+1} = L_{jt} - d_{jt}$ (number of developed parcels).

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- For each undeveloped parcel, two decisions every period: (i) whether to develop and, if yes, (ii) how much to develop (irreversible).
- Rental income if developed with $h_{ij\bar{t}}$ units of housing services at time $\bar{t}$: $P_{jt}h_{ij\bar{t}}$ for every period $t \geq \bar{t}$, discounted by $0 < 1 - \delta < 1$.
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- Evolution of housing stock: $H_{jt+1} = H_{jt} + h_{jt}$ with $h_{jt} \equiv \sum_i d_{ijt} \, h_{ijt} = d_{jt} h_{ijt}$.

Decision Values

- Ex-ante value of (undeveloped) parcel i:

$$V_{ijt} = \mathbb{E}\left(\max_{d \in \{0,1\}} v_{ijt}^{d} | \Xi_{ijt} \right)$$

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$$v_{ijt}^{1} = \max_{h_{ijt}} \left\{ P_{jt}\, h_{ijt} - r_t\, h_{ijt}^{\frac{1}{\alpha}} - c_{ijt} + (1-\delta)\,\mathbb{E}(\Pi_{ijt+1}|\Xi_{ijt}) h_{ijt} \right\}$$

where the expected unit value is

$$\Pi_{ijt+1} \equiv P_{ijt+1} + \mathbb{E}\left(\sum_{\tau=t+2} (1-\delta)^{\tau-t-1}\, P_{ij\tau} | \Xi_{ijt} \right) .$$

Solving and Estimating: Optimal Development

- Rewrite v_{ijt}^1:

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- Estimation: regress log housing built on log unit price.
  - Challenging for the usual reasons: unobserved productivity (hidden here) and how to measure units of housing separately from prices.
  - Also: prices are usually observed when the dwelling is sold, not when the builder decides to build (hidden lag).
  - Peng (2023) estimates a more complicated version of this regression after allowing for redevelopment.
  - Murphy (2018): indirect approach to isolate prices making parametric assumptions.

The Development Decision

- Standard optimal stopping decision. With c_{ijt} following a Type 1 Extreme Value distribution (with scale parameter χ):

$$P\left(d_{ijt} = 1 | \Xi_{ijt}\right) = \frac{\exp\left(\frac{1}{\chi} v^1_{ijt}\right)}{\exp\left(\frac{1}{\chi} v^0_{ijt}\right) + \exp\left(\frac{1}{\chi} v^1_{ijt}\right)}$$

- This expression:
  - Can be aggregated across all (remaining) vacant parcels.
  - Loosely corresponds to the extensive margin supply elasticity ϵ^L_P
  - Depends on the price of housing relative to the price of vacant land

Estimating the Development Decision

- It requires knowledge of development at t
- It also requires knowledge of the conditional value functions v_{ijt}^0 and v_{ijt}^1
  - Optimal development h_{ijt} in v_{ijt}^1 is known from the previous estimation. Hence, v_{ijt}^1 depends only on the observed unit price of housing, estimated parameters of the cost function, and the logit error term c_{ijt}.
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  - v_{ijt}^0 is the continuation value for vacant land, i.e., the price of a vacant parcel (Kalouptsidi 2014). This ignores χ.
- Hsiao (2023) follows a similar strategy with an IV for local property prices
- Same for Peng (2023), but she allows for redevelopment
- Murphy (2018) uses a different approach. First, estimate period profit $v_{ijt}^1 - v_{ijt}^0$. Then, insert the output into the regression implied by logit (following Arcidiacono & Miller 2011).
- Full-solution methods (e.g., Rust 1987) seem out of reach.

Estimation Payoffs

1. Cost function with variable cost and fixed cost
    - Murphy (2018): variable costs close to RSMeans data and large, highly dispersed fixed costs of development that increase over time.
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2. Propensity to develop (or redevelop) at the extensive margin to compute the long-run supply elasticity.
   - Murphy (2018): large wedge between short and long-term supply elasticities driven by price expectations $\Rightarrow$ long development lags
   - Peng (2023): also slow construction response in NYC.

Additional Considerations

- Add further dimensions beyond development and redevelopment? Endogenous depreciation, different building technologies.
- Multiple equilibria with demand or supply complementarities?
- Asymmetry between growth and decline (Glaeser & Gyourko 2005).

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  $\Rightarrow$ The equilibrium cannot equate market demand and market supply to obtain a price, which, in turn, determines individual quantities.
  Instead, the housing market determines the price of each dwelling and allows each household to be assigned to a dwelling.
- Other key issues: These bundles differ in terms of how much housing services they offer. (Horizontal differentiation so far mostly ignored, see Zhang 2022)
- The housing market is better modeled as an assignment mechanism.
- It becomes difficult to study supply separately from demand as we have done until now.
- Small literature: Sweeney (1974), Maattanen & Tervio (2014), Landvoigt et al. (2015).

Economic Environment in a Simple Setting

- We study the assignment of a set of households of unit mass with income $w \in [\underline{w}, \overline{w}]$ with cumulative $F(w)$ to a fixed stock of houses of unit mass with "quality" $h \in [\underline{h}, \overline{h}]$ with cumulative $G(h)$.

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- This condition is satisfied by households of different income levels along the distribution of dwellings $\Rightarrow$ no reason for $\partial P(h)/\partial h$ to be constant and, consequently, for $P(h)$ to be proportional to h (and both the distribution of housing quality and wealth matter).

Positive Assortative Matching

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Proof:

- MRS_{hc} decreases in housing (concave utility)
- In turn, richer households have a higher willingness to pay for dwellings offering more housing
  (fully differentiate the MRS with respect to w after substituting in the budget constraint for c)

$\Rightarrow$ In any equilibrium, richer households occupy better dwellings (PAM)

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- This depends on $G(h)$ and $F(w)$ (e.g. increasing w by 10% for everyone leads to a steeper price gradient for housing quality)
- Asymmetry in how prices trickle up but not down

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- Using this matching function to solve for the pde above:

$$P(h) = a_0 + (1-\eta)a_1\,h - c_1\,h^{-\frac{1-\eta}{\eta}}$$

with $c_1 = a_0\,\underline{h}^{(1-\eta)/\eta} + (1-\eta)a_1\underline{h}^{1/\eta}$ for $P(\underline{h}) = 0$

- $P(h)$ is increasing and concave.

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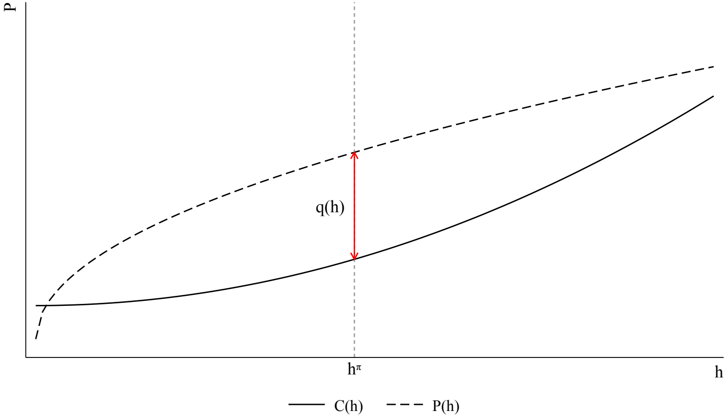
- The price of dwellings $h < h_0$ declines (to zero at the bottom)
- No change in assignment for dwellings $h > h_0$ but lower prices.
- Caveat 1: Relaxing no mobility: newcomers will arrive (and be selected)
- Caveat 2: The housing stock may increase through redevelopment and can adversely affect some households
- Caveat 1+2: Gentrification

Adding Endogenous Supply

- Assume profit-maximizing builders with $h = B\,k^{\alpha} l^{1-\alpha}$ and fixed cost



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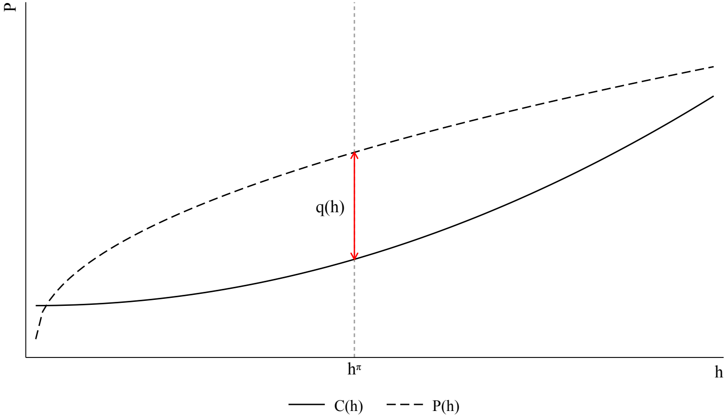

$\Rightarrow$ New housing is supplied at a unique (and presumably high) level of quality.

Empirics of Assignment Models

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  Strong correlation between quantiles of house prices and quantiles of income (Epple et al., 2020, Maattanen and Tervio 2014, Wang 2022 – but not rental value and permanent income).

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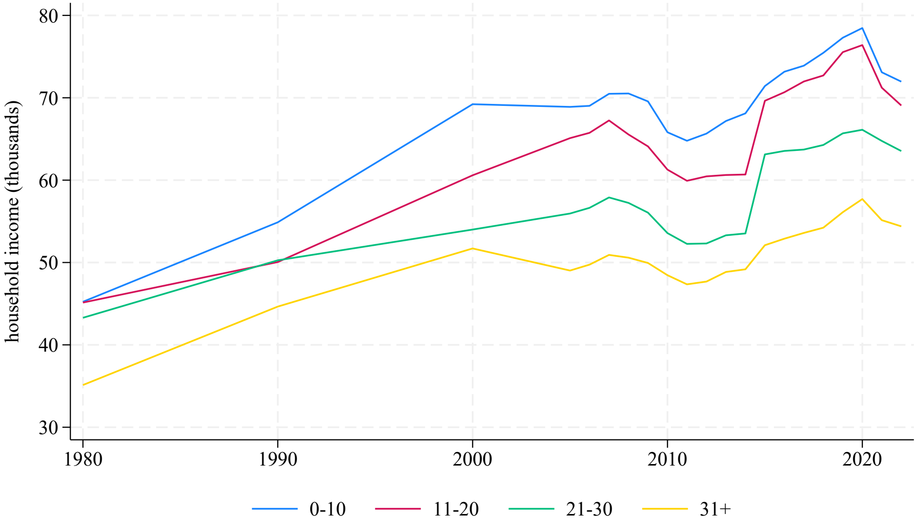
- Moving chains: Mast (2023), French and Gilbert (2024), Bratu et al. (2023).
- Take assignment seriously and treat housing quality as a latent variable (Epple et al., 2020).
- What is the market? (Dwellings *only* differ in quality in the model.)

Dynamics and Assignment Together: Filtering



Sketch of a Filtering Steady-State

- Depreciation of each dwelling by $(1-\delta)$ every period.
- With no other change, $G(h)$ shifts to the left. So does the price schedule.
- In steady-state, the stock of housing is replenished from above at $\overline{h}$, which is also the level of quality chosen by builders.
- The supply of new housing is highly inelastic outside of the top quality. Missing middle? If no new housing for the rich, no new housing for the poor? Runaway quality when the rich diverge?

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- Decay is usually measured in annual percentages change in quantiles: 0.5% is low (22% after 50 years) while 2.5% is large (70% over 50 years).
  This metric informs filtering, not actual (physical) decay.
- Rosenthal (2014): Repeat income model for dwellings (properties). He finds low filtering rates for owner-occupied housing (0.5%) and high filtering rates for rentals (2.5%) pre 2010.
  Acknowledging that owner-occupied dwellings often convert to rentals, he estimates an overall annual decay of 1.9%.

How much filtering and Endogenous Decay

- Decay is arguably endogenous and responds to incentives (Arnott, 1995).
- Decay is usually measured in annual percentages change in quantiles: 0.5% is low (22% after 50 years) while 2.5% is large (70% over 50 years).
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  Acknowledging that owner-occupied dwellings often convert to rentals, he estimates an overall annual decay of 1.9%.
- Spader (2024): with the same analysis as Rosenthal (2014), he finds that filtering essentially stops after 2011.
- Liu et al. (2022) find an apparent correlation between filtering and land use regulations (filtering is +0.7% in SF).

Housing Externalities

- Changes in housing supply can be magnified by housing externalities (either through supply effects and/or through demand effects).
- Externalities linked to construction:
  - Open space externalities (with non-trivial effects at the city equilibrium, Turner, 2005)
  - Traffic congestion and other traffic externalities.
  - Cost of infrastructure and service provision.
- Externalities from redevelopment:
  - Through the residents it attracts (Diamond and McQuade 2019)
  - Improvements beget improvements (Rossi-Hansberg et al. 2010, Hornbeck and Kenington, 2017)

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- However, evidence of countervailing "gentrification spillovers" Li (2021).
- Spillovers open the door to coordination failures and multiple equilibria (Owens et al., 2020).
- Spillovers are internalized by HOA very locally (Clarke and Freedman, 2019)? Or obvious focal points determined by geography (Guerrieri et al., 2013)?

We need some general equilibrium modeling to understand these effects further.

Overview

Why so little new supply?

So far:

- Evidence of a productivity problem in construction.
- The productivity problem in construction may explain what happens in small and rural counties but is less convincing for suburbs, not to mention superstar cities.
- And, the estimated supply elasticities (*when building*) seem inconsistent with observed long-run supply elasticities.

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- And, the estimated supply elasticities (*when building*) seem inconsistent with observed long-run supply elasticities.
- The extensive margin of development likely plays a role as suggested by dynamic models.
- We need to understand land unavailability, either because of regulations or geography.

Land Development Elasticities

Return to our original framework but with unit lot size for simplicity

- Distribution of development costs in market j is $F_j(x)$.

$\Rightarrow$ Develop if the fixed development cost c_{ij} is sufficiently low.

- The development cutoff is given by zero profit conditional on optimal development:

$$\overline{c}_j(P_j) = \left(\frac{\mathrm{d}\log C_j[h_j^s(P_j)]}{\mathrm{d}\log h} - 1\right) C_j[h_j^s(P_j)] - \underline{q}_j$$

- Resulting fraction of developed land is $F_j(\overline{c}_j)$.

Land Development Elasticities: A Cobb-Douglas Frechet Example

- Assume the usual Cobb-Douglas production function with shares α and $1-\alpha$, as always, and $\underline{q}_i = 0$.
- Assume $F_j(x)$ is Fréchet distributed with shape parameter λ and scale parameter Γ_j (to capture how much land is available).

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- Assume $F_j(x)$ is Fréchet distributed with shape parameter λ and scale parameter Γ_j (to capture how much land is available).
- Then the land development elasticity is:

$$\epsilon_P^L = \frac{\mathrm{d}\log F_j(\overline{c}_j(P_j))}{\mathrm{d}\log P_j} = \theta_j(P_j)\epsilon_P^h \frac{f_j(\overline{c}_j(P_j))}{F_j(\overline{c}_j(P_j))} P_j h_j^s(P_j) = (1-\alpha)^{-1-\lambda}\lambda\rho_j^{-\lambda} P_j^{-\frac{\lambda}{1-\alpha}}\Gamma_j$$

- Key are the thickness of the right tail of the fixed cost distribution and the revenue associated with developing the marginal lot
- Note the depletion effect for P_j and the cluster of parameters $\rho_j(B_j)$, $\rho' > 0$
- Markets with more land available for development have higher Γ_j

Estimation of Supply Elasticities

- Multiple floorspace and units margins of supply, in addition to land supply elasticities.
- The response of each margin to price growth can be estimated with the same exogenous positive demand shocks.
- Allow for variation in response to these shocks to depend on land availability and regulation Z.

$$\Delta Q_j^s = X_{j2000}\phi + \gamma(Z_{j2000})\Delta \log P_j + u_j$$

Evidence I

Saiz (QJE, 2010): Metro Area Level 1970-2000.

- Runs reverse regression (ΔP on ΔQ) to estimate the inverse-elasticity.
- Immigration and Bartik shocks instrument for changes in quantity.
- Non-standard Christian religious affiliations and government spending patterns instrument for regulation.
- Finds elasticities between 0.6 and 5 for US metros; Average $= 2.6$; Population-weighted average $= 1.6$.

Evidence II

Baum-Snow and Han (2024): Neighborhood level 2000-2010.

- Use variation in employment growth in commuting destinations (market access to employment) to instrument for changes in housing prices.

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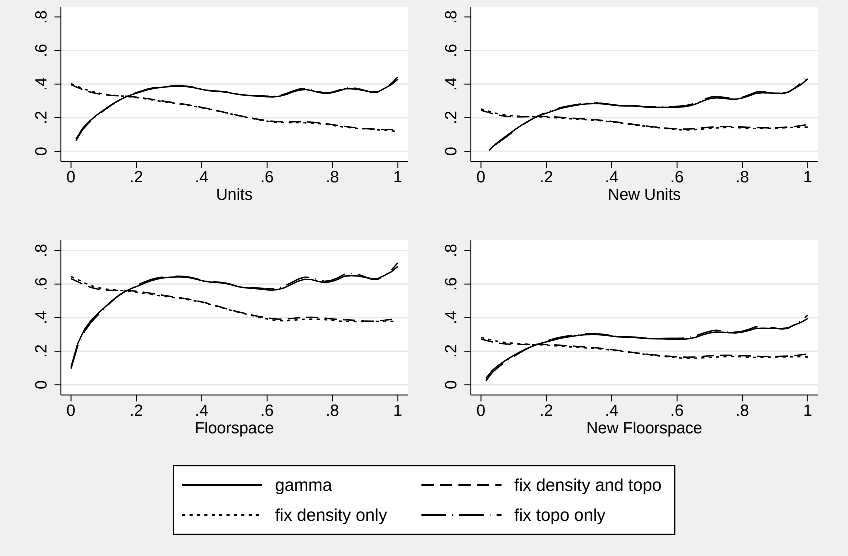
Gorback & Keys (2024): Zip code level 2010-2020.

- Find even smaller supply elasticities, using variation in foreign investment for identification.
- A lot of heterogeneity within and between cities.

See also Autor et al. (2014), Hilber and Vermeulen (2016), Buchler et al. (2021), Aastveit et al. (2023).

Average Supply Elasticities by Distance TO CBD



Time Intervals

Over a period of T years, the steady state housing stock H satisfies:

$$H = (1 - \delta_T)H + A\,P^{\epsilon_P^H(t,t+T)} \tag{1}$$

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The "long-run" supply elasticity is then:

$$\frac{\Delta \log H}{\Delta \log P} = \frac{\epsilon_P^H(t, t+T)}{1 - (1 - \delta_T)}. \tag{2}$$

If the annual depreciation rate is 3.5%, $1 - \delta_{10} = (1 - 0.035)^{10} = 0.7$.
$\rightarrow$ Long-run elasticity is 3.33 times a 10-year elasticity and 1.5 times a 30-year elasticity.
$\rightarrow$ Falling supply elasticities in US supply-constrained markets only (from comparing Baum-Snow & Han with Saiz).

Aggregation

Aggregate supply elasticities across markets j into collection r are by definition:

$$\epsilon^H_{Pr} \equiv \frac{\sum_{j\in r} \omega_j \, \epsilon^H_{Pj} \, \Delta \log P_j}{\sum_{j\in r} \omega_j \, \Delta \log P_j} \tag{3}$$

where $\sum_{j\in r} \omega_j = 1$, often using $\omega_j = H_j / H_r$.

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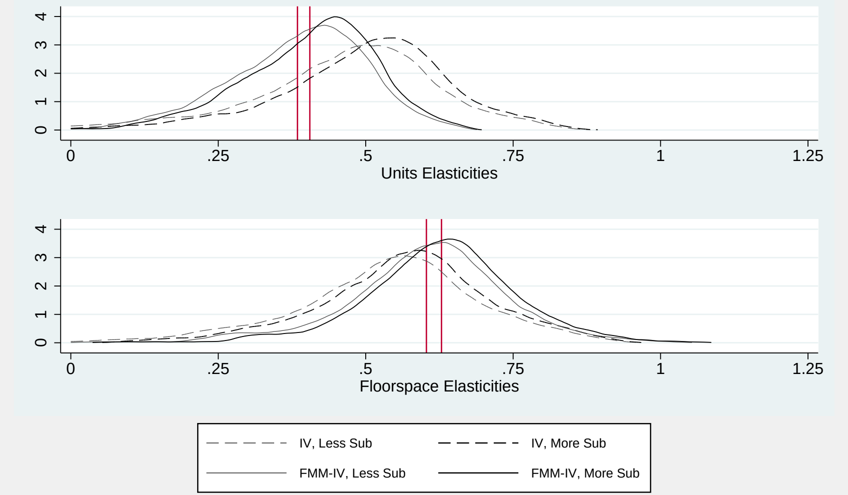
where $\sum_{j\in r} \omega_j = 1$, often using $\omega_j = H_j/H_r$.

- Markets that are perfect substitutes: aggregate elasticity is the weighted average elasticity (choice of weights can matter, though).
- Markets that are fully segmented: Aggregate elasticity only reflects the market(s) hit by demand shocks.
- Imperfect substitutes case: Even more unclear, as every mix of demand shocks is different.

Resulting Metro Region Supply Elasticities



Standard deviation of units elasticity: 0.11.
Standard deviation of floorspace elasticity: 0.13

The need for general equilibrium, at least sometimes

- The effects of many policies often percolate through migration with neighborhood changes and amenity and productivity effects.
- Such general equilibrium effects / aggregate effects are potentially large.
- Consider, for instance, that we were able to increase TFP in construction by 20% - a simple back-of-the-envelope calculation suggests +2.6% in welfare after 10 years.
- The subject was popularized by Hsieh and Moretti (2019) with some controversies. Other works by Duranton & Puga (2023) and Parkhomenko (2023).

Duranton & Puga (2023)

- Many heterogeneous sites with differing productivity (and geography).
- Cities, where they exist, enjoy agglomeration economies but also face urban costs as they grow larger $\Rightarrow$ consumption per capita is hump-shaped in the population of a city.

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- OLG model where human capital leads to productivity, is accumulated through learning, and further increased through experience, with returns to experience that differ across cities. Learned human capital is passed on to the next generation.
- Key question: how are cities determined?
    - The most productive sites are occupied first (as they should).
    - Incumbent residents maximize consumption with respect to the population they take and use a permitting cost to implement it (a la Fischel). $\Rightarrow$ Cities end up at the top of their hump-shape.
    - There is a residual rural sector.

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- Each city sets its population to be at its private maximum, but the allocation of population across cities is inefficient.

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- Each city sets its population to be at its private maximum, but the allocation of population across cities is inefficient.
- Large cities are not large enough.
  (Allowing for one more resident from a rural area generates a first-order gain and only a second-order loss for the city, given that consumption is flat at the equilibrium.)
- There are two many small cities.

Duranton & Puga (2023)

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$\Rightarrow$ 18 million more residents (including 7.5 in NY MSA).

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$\Rightarrow$ 18 million more residents (including 7.5 in NY MSA).

- US output +8% following relocations to more productive places, agglomeration gains, higher rural output.
- Consumption +2.1% as much of the additional output is dissipated in urban costs.
- Incumbent residents of superstar cities lose, but very little -0.05%.
- Inequalities decline (a little).

How big are the inefficiencies caused by land use restrictions?

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- Glaeser and Gyourko (2018), in a JEP review, take issue with these results. Their argument is that labor demand curves slope downwards (fairly steeply). As a result, small changes in population would lead to large wage adjustments.
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- The problem is that the labor demand elasticities they use from the labor literature are in partial equilibrium.
  They ask: How many fewer workers would a firm hire if the wage was 1% higher?
  In the urban world, incoming workers also demand what local firms produce, thus shifting the labor demand curve.

How big are the inefficiencies caused by land use restrictions?

- This said, the queue to go to NYC may not be infinite as in the more extreme thought experiments.
  Use heterogeneous preferences as in Diamond (2016)?

- Workers are heterogeneous, and zoning is also used to keep unwanted workers out (as they perhaps generate negative amenity effects). Macek (2024) finds that this greatly reduces the productivity gains from weakening land use regulations, though affordability gains remain.

Overview

Key message

Central fact: deteriorating housing affordability, especially in the most prosperous parts of the country.

- Dismal construction productivity (making the supply curve higher, not less elastic).
- Increasingly stringent land use regulations (in the US).
- Scarcer land around large cities.

$\Rightarrow$ There is a large gap between the supply elasticity of construction and the overall supply elasticity.

Other important messages

Housing supply is often poorly understood. The housing market is not a monolith.

- Construction is essentially an irreversible investment before a slow (endogenous) decay.
- Housing is highly differentiated, especially along the vertical dimension.
- These two features have important implications for when new housing is supplied and which new housing is supplied (filtering).
- The supply of new housing is rife with externalities (leading to neighborhood change).
- Changes in housing supply are associated with changes in population across locations $\Rightarrow$ general equilibrium is needed to assess the full effect of these changes in housing supply.

What we want to learn more about

- Why is construction so unproductive?
- How much land is available around US cities?
- Which land use regulations are really binding?
- Deeper understanding of the wedge between the supply elasticity of construction and the overall supply elasticity.

Methodological challenges

- Dynamics and understanding the large fixed costs of development and redevelopment.
- Housing heterogeneity (different submarkets and horizontal differentiation)
- In some cases, demand is hard to separate from supply (e.g., assignment), and we know much less about housing demand than housing supply.
- General equilibrium - better models needed, especially within cities.

Thank You!