Housing Supply

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Economics of Housing Supply

- We have extensively talked about the location choice problem of workers/firms
  - This can be considered as the analysis of housing demand in a particular location
- This lecture talks about the flip side of the coin: the housing supply
- Housing is (arguably) the most important congestion force
  - With agglomeration forces only, everyone lives in the same location
  - But usually, this does not happen because the housing price increases in larger cities
  - Recall Ahlfeldt and Pietrostefani's (2019 JUE) meta study on the elasticity of housing rents with respect to population density
- Understanding of housing supply is indispensable in understanding the spatial distribution of economic activities
  - Moreover, housing is important in itself.
  - Large spending share. Arguably the largest transaction for most households.
  - For many households, the wealth consists of (essentially) housing only

Economics of Housing Supply

- In my view, the analysis of housing supply is less organized than the analysis of housing demand
  - I am not aware of any model that incorporates all the salient features of the housing supply
  - In a spatial economic models, housing supply is often simply modeled either as perfectly inelastic or a upward-sloping supply curve.

- As such, I present several key ideas in the literature
  - Production function of housing: Combes, Duranton, Gobillon (2021 JPE)
  - Housing cost elasticity with respect to city size: Combes, Duranton, Gobillon (2019 RES)
  - Determinants of housing cost elasticity (housing supply elasticity)
    - Geography and regulation: Saiz (2010 QJE)
    - Durability of housing: Glaeser and Gyourko (2005 JPE)
    - Construction technology advancement: Ahlfeldt and McMillen (2018 REStat)

- While the above literature considers perfect competition, recent evidence shows that imperfect competition in housing market also matters:
  - Oligopolistic competition among housing developers: Quintero (2023 RSUE R&R)
  - Transaction costs and historical conditions: Yamasaki, Nakajima, Teshima (2023 wp)

Combes, Duranton, Gobillon (2021 JPE)

- How does a housing supply function look like?
  - Use land and capital to produce housing (floor space).
- Combes, Duranton, Gobillon (2021) proposes a flexible (non-parametric) way to estimate it
  - Perfect competition among developers + zero profit conditions are assumed for separating unit price of housing and the effective units of housing
  - Housing supply under imperfect competition may be an under-explored topic
- They estimate the elasticity of housing production with respect to capital
  - If the production function is Cobb-Douglas $H = AK^{\alpha}T^{\beta}$, then this elasticity is constant α
  - But more generally, this elasticity depends on the plot size T and the level of capital K

Combes, Duranton, Gobillon (2021 JPE)

- Using French data, they find almost constant elasticity of housing production with respect to capital: Around 0.65
  - Constant elasticity irrespective of parcel size
  - Precise speaking, slightly log-convex (but not robust, as quality adjustment of land reverses this)
  - Overall the Cobb-Douglas production function is a good approximation of reality

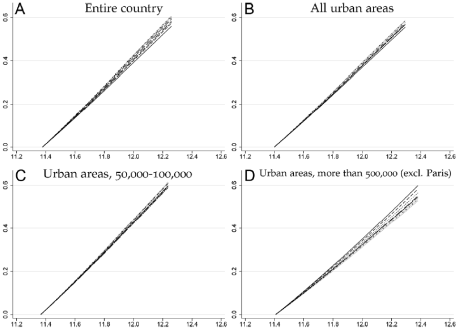


FIG. 2.—Log housing production as a function of log capital, nonparametric estimates. The log of housing production is represented on the vertical axis, and the log of capital investment is represented on the horizontal axis. To ease the comparison across deciles of parcel size, we normalize $\log H(\underline{K})$ to zero for all deciles. There are 386,177 observations for the entire country and 218,767 for urban areas.

Combes, Duranton, Gobillon (2021 JPE)

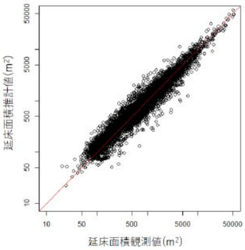
- Solving the cost minization problem under the Cobb-Douglas production function $H = AK^{\alpha}T^{\beta}$ and imposing the zero profit condition, the unit housing price P satisfies

$$\ln P = \beta \ln R + \text{constant},$$

- Housing price (P) and the land price (R) have the log-linear relationship, where β is the input share of land in housing production
  - This facilitates the tractability of spatial models (c.f., see Ahlfeldt et al. 2015)
  - A theoretical justification for interchangably using the log land prices and log housing prices in the hedonic analysis
- The paper also tests the constant-returns-to-scale ($\alpha + \beta = 1$ in the Cobb-Douglas function), finding that this assumption is not very bad.
  - But they formally reject the constant-returns-to-scale.
  - Decreasing-returns-to-scale for large parcels as seen in the decreasing unit land price with respect to the plot size.

What about Japanese housing production function?

- I am not aware of many examples of estimating Japanese housing production functions
  - Let me know if you know some. I may be missing some studies in engineering or old economics studies
  - If this literature is indeed scarce, maybe an opportunity for further research
- One example is Kii et al. (2022) that estimates a Codd-Douglas housing production function
  - Use microdata of Statistical Survey of Construction Starts (*kenchiku chakkou toukei*) in 2019
  - Limit the sample to residential buildings
- Estimates: $\alpha = 0.829$, $\beta = 0.205$. Close to constant-returns-to-scale.
- The model fits well:



Combes, Duranton, Gobillon (2019 RES)

- How does housing costs increase when city population rises?
  - It shouldn't increase much when housing supply is very elastic
  - It should increase when housing supply is inelastic
- Based on a simple monocentric city model, they estimate how urban costs, which comes from higher housing costs, increases with city size.

Combes, Duranton, Gobillon (2019 RES)

- Workers at distance l from the city center obtains the utility $U(h(l), x(l), M)$, under the budget constraint $W_c = P(l)h(l) + \tau(l) + Q_c x(l)$
  - The optimization yields the expenditure function $e(P(l), \tau(l), Q, M, \bar{U})$
  - P is the housing price, Q is the goods price, M is the residential amenity, and $\tau(l)$ is the commuting cost.

- Differentiating the expenditure function by city population N, the following quantifies urban costs (in the sense of compensation required for keeping utility constant at $\bar{U}$ when population rises):

$$\frac{dE}{dN} = h(P(l), Q, \bar{U})\frac{dP(l)}{dN} + \frac{d\tau(l)}{dN} + x(P(l), Q, \bar{U})\frac{dQ}{dN} + \frac{\partial E}{\partial M}\frac{dM}{dN}$$

Combes, Duranton, Gobillon (2019 RES)

- Now, they assume that $\partial \ln E / \partial \ln M = -1$ so that 1% change in amenities is always equivalent to 1% change in consumption.[1]
- Then, the elasticity of urban cost ($\epsilon_n^{UC}(l) = (dE/dN)(N/E)$) is written as

$$\epsilon_N^{UC}(l) = \underbrace{s_E^h(l)\epsilon_N^{P(l)}}_{\text{Housing cost}} + \underbrace{s_E^\tau(l)\epsilon_N^{\tau(l)}}_{\text{Commuting cost}} + \underbrace{s_E^x(l)\epsilon_N^Q}_{\text{Goods prices}},$$

where s_E^i represents the spending share of variable i and ϵ_N^i represents the elasticity of variable i with respect to population N.

[1] Note: The paper claims that this is just a normalization of the unit of amenities. Generally, such a normalization is feasible only at one point in a city. In the end, the paper focuses on the very center of the city $l = 0$ and we can think that the normalization happens at this point.

Combes, Duranton, Gobillon (2019 RES)

- We additionally assume
  - Q is constant because the numeraire good is freely traded
  - The commuting cost is zero at the city center ($\tau(0) = 0$)
- Then, the urban cost elasticity at the city center is simply the product of the elasticities of housing cost share and housing cost

$$\epsilon_N^{UC}(0) = s_E^h(0)\epsilon_N^{P(0)}$$

- Since utility equalizes for all location l in the city and the urban benefits (wages and amenities) are common in the city, the urban cost elasticity must also be the same across locations
  - Therefore, focusing on the city center is enough

Combes, Duranton, Gobillon (2019 RES)

- Investigates how housing prices and spending share for housing relates with city size
  - Regressions analogous to Ahlfeldt and Pietrostefani (2019 JUE) we discussed before.
- Urban cost elasticity rises with city size
  - It is around 0.03 for small cities. 0.08 for Paris
  - This may suggest that housing supply is more inelastic in larger cities

TABLE 7
The elasticity of urban costs

	City 1 (pop. 100,000)	City 2 (pop. 1m)	City 3 (pop. Paris)
Panel A. Population elasticity of prices			
Baseline (preferred OLS)	0.208	0.208	0.208
Non-linear population elasticity	0.205	0.288	0.378
12-year adjustment	0.780	0.780	0.780
Allowing for urban expansion	0.109	0.109	0.109
Panel B. Housing share			
Slope of the housing share	0.048	0.048	0.048
Share of housing in expenditure	0.159	0.269	0.390
Panel C. Urban costs elasticity			
Baseline	0.033	0.056	0.081
	(0.007)	(0.005)	(0.007)
Non-linear population elasticity	0.032	0.078	0.147
	(0.007)	(0.007)	(0.017)
12-year adjustment	0.124	0.210	0.304
	(0.036)	(0.047)	(0.069)
Allowing for urban expansion	0.017	0.029	0.043
	(0.004)	(0.003)	(0.005)

Notes: In panel A, row 1, the estimate of 0.208 is our preferred OLS estimate from column 8 of Table 4. In row 2, the three estimates are marginal effects computed from column 4 of Appendix Table 8 in separate Online Appendix G. In row 3, the estimate of 0.780 is for the 2000–12 difference from column 8 of Table 5. In row 4, we use the elasticity of 0.109 estimated in column 8 of Appendix Table 9 in separate Online Appendix H, which does not include land area as a control. In panel B, for the coefficient on log population in the housing share equation we use our preferred estimate from column 8 of Table 6. From these coefficients and the constant of the regression, we compute the predicted housing share in expenditure for our three hypothetical cities. Panel C reports the urban cost elasticity for the all combinations of housing share in expenditure and population elasticity of house prices. Standard errors in brackets are computed from the estimated coefficients and their variances using the following formula for the variance of their product: $var(XY)=var(X)var(Y)+var(X)E(Y)^2+var(Y)E(X)^2$.

Saiz (2010 QJE)

- What determines the housing supply elasticity?
  - Availability of developable land (steep land, water area etc are undevelopable)
  - Land use regulation
- Large variation in land availability and regulation across US cities
- How does it affect housing supply elasticity?
  - Specifically, Saiz estimates the elasticity of housing prices with respect to population $\beta_k^S \equiv \frac{d\tilde{P}_k}{dH_k}\frac{H_k}{\tilde{P}_k}$
  - The inverse of this $(\frac{dH_k}{d\tilde{P}_k}\frac{\tilde{P}_k}{H_k})$ is the housing supply elasticity wiht respect to housing price (by assuming that 1 person must use 1 unit of housing)

TABLE I
PHYSICAL AND REGULATORY DEVELOPMENT CONSTRAINTS (METRO AREAS WITH POPULATION > 500,000)

Rank	MSA/NECMA name	Undevelopable area (%)	WRI	Rank	MSA/NECMA name	Undevelopable area (%)	WRI
1	Ventura, CA	79.64	1.21	26	Portland–Vancouver, OR–WA	37.54	0.27
2	Miami, FL	76.63	0.94	27	Tacoma, WA	36.69	1.34
3	Fort Lauderdale, FL	75.71	0.72	28	Orlando, FL	36.13	0.32
4	New Orleans, LA	74.89	−1.24	29	Boston–Worcester–Lawrence, MA–NH	33.90	1.70
5	San Francisco, CA	73.14	0.72	30	Jersey City, NJ	33.80	0.29
6	Salt Lake City–Ogden, UT	71.99	−0.03	31	Baton Rouge, LA	33.52	−0.81
7	Sarasota–Bradenton, FL	66.63	0.92	32	Las Vegas, NV–AZ	32.07	−0.69
8	West Palm Beach–Boca Raton, FL	64.01	0.31	33	Gary, IN	31.53	−0.69
9	San Jose, CA	63.80	0.21	34	Newark, NJ	30.50	0.68
10	San Diego, CA	63.41	0.46	35	Rochester, NY	30.46	−0.06
11	Oakland, CA	61.67	0.62	36	Pittsburgh, PA	30.02	0.10
12	Charleston–North Charleston, SC	60.45	−0.81	37	Mobile, AL	29.32	−1.00
13	Norfolk–Virginia Beach–Newport News, VA–NC	59.77	0.12	38	Scranton–Wilkes-Barre–Hazleton, PA	28.78	0.01
14	Los Angeles–Long Beach, CA	52.47	0.49	39	Springfield, MA	27.08	0.72
15	Vallejo–Fairfield–Napa, CA	49.16	0.96	40	Detroit, MI	24.52	0.05
16	Jacksonville, FL	47.33	−0.02	41	Bakersfield, CA	24.21	0.40
17	New Haven–Bridgeport–Stamford, CT	45.01	0.19	42	Harrisburg–Lebanon–Carlisle, PA	24.02	0.54
18	Seattle–Bellevue–Everett, WA	43.63	0.92	43	Albany–Schenectady–Troy, NY	23.33	−0.09
19	Milwaukee–Waukesha, WI	41.78	0.46	44	Hartford, CT	23.29	0.49
20	Tampa–St. Petersburg–Clearwater, FL	41.64	−0.22	45	Tucson, AZ	23.07	1.52
21	Cleveland–Lorain–Elyria, OH	40.50	−0.16	46	Colorado Springs, CO	22.27	0.87
22	New York, NY	40.42	0.65	47	Baltimore, MD	21.87	1.60
23	Chicago, IL	40.01	0.02	48	Allentown–Bethlehem–Easton, PA	20.86	0.02
24	Knoxville, TN	38.53	−0.37	49	Minneapolis–St. Paul, MN–WI	19.23	0.38
25	Riverside–San Bernardino, CA	37.90	0.53	50	Buffalo–Niagara Falls, NY	19.05	−0.23

Saiz (2010 QJE)

- To analyze how housing supply elasticity varies with geography and regulation, let's posit that $\tilde{P}_k = CC + LC(H_k)$, where
  - $\tilde{P}_k$ is the housing price at city k
  - CC is the construction cost
  - $LC(H_k)$ is the land cost, which depends on city size (population level) H_k

- Totally differentiating this and define $\sigma_k \equiv CC/\tilde{P}_k$ (share of construction cost in housing prices), we obtain

$$\frac{d\tilde{P}_k}{\tilde{P}_k} = \sigma_k \frac{dCC}{CC} + \beta_k^S \frac{dH_k}{H_k},$$

- Given $dx/x = d\ln x$, we obtain the regression model:

$$\ln \tilde{P}_k = \sigma_k \ln CC + \beta_k^S \ln H_k,$$

Saiz (2010 QJE)

- Now, the housing supply elasticity β_k^S is assumed to depend on the share of developable land, land use regulation, and population level:

$$\beta_k^S = (1-\Lambda_k)\beta^{LAND} + (1-\Lambda_k)\ln(POP)\beta^{LAND,POP} + \ln WRI_k \beta^{REG},$$

  where Λ_k represents the share of undevelopable land and WRI_k is an index of regulation level.

- Substituting this into $\ln \tilde{P}_k = \sigma_k \ln CC + \beta_k^S \ln H_k$, Saiz estimates this model using the IV strategies.
  - Since we estimate the housing supply curve, we need housing demand shiftier
  - IVs for housing demand: Initial industry composition (Bartik IV), average sunshine in January, immigration inflow

- Estimate this model using the panel of US cities

Saiz (2010 QJE)

- Both unavailability of land and strict regulation reduce housing supply elasticity
- The unavailability of land matters more as the population gets larger

TABLE III
HOUSING SUPPLY: GEOGRAPHY AND LAND USE REGULATIONS

	$\Delta\log(P)$ (supply): 1970–2000					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\log(Q)$	0.650	0.336	0.305	0.060		
	(0.107)***	(0.116)***	(0.146)***	(0.215)		
Unavailable land $\times\Delta\log(Q)$		0.560	0.449	0.511	0.516	−5.329
		(0.118)***	(0.140)***	(0.214)***	(0.116)***	(0.904)***
Log(1970 population) $\times$ unavailable land $\times\Delta\log(Q)$						0.481
						(0.117)***
log(WRI)$\times\Delta\log(Q)$				0.237	0.268	0.301
				(0.130)*	(0.068)***	(0.066)***
$\Delta\log(Q)\times$ ocean			0.106			
			(0.065)			
Midwest	−0.099	−0.041	−0.022	−0.015	−0.009	0.002
	(0.054)*	(0.052)	(0.054)	(0.055)	(0.050)	(0.049)
South	−0.236	−0.170	−0.163	−0.129	−0.116	−0.115
	(0.065)***	(0.062)***	(0.062)***	(0.069)*	(0.050)**	(0.048)**
West	0.016	0.057	−0.022	0.059	0.069	0.035
	(0.076)	(0.072)	(0.054)	(0.072)	(0.063)	(0.046)
Constant	0.550	0.594	0.594	0.528	0.601	0.061
	(0.055)***	(0.052)***	(0.052)***	(0.058)***	(0.046)***	(0.045)***

Notes. Standard errors in parentheses. The table shows the coefficient of 2SLS estimation of a metropolitan housing supply equation. On the left-hand side, I try to explain changes in median housing prices by metro area between 1970 and 2000, adjusted for construction costs (see theory and text). On the right-hand side, the main explanatory endogenous variable is the change in housing demand [the log of the number of households – log(Q)] between 1970 and 2000. Some specifications interact that endogenous variable with the unavailable land share (due to geography) and the log of the Wharton Regulation Index (WRI), which we treat as exogenous in this table. The instruments used for demand shocks are a shift-share of the 1974 metropolitan industrial composition, the magnitude of immigration shocks, and the log of January average hours of sun. The identifying assumptions are that the covariance between the residuals of the supply equations and the instruments are zero. *significant at 10%; **significant at 5%; ***significant at 1%.

Saiz (2010 QJE)

- Based on such estimation result, Saiz provides a US city-level housing supply elasticity estimates

TABLE VI
SUPPLY ELASTICITIES (METRO AREAS WITH POPULATION > 500,000)

Rank	MSA/NECMA name	Supply elasticity	Rank	MSA/NECMA name	Supply elasticity
1	Miami, FL	0.60	26	Vallejo–Fairfield–Napa, CA	1.14
2	Los Angeles–Long Beach, CA	0.63	27	Newark, NJ	1.16
3	Fort Lauderdale, FL	0.65	28	Charleston–North Charleston, SC	1.20
4	San Francisco, CA	0.66	29	Pittsburgh, PA	1.20
5	San Diego, CA	0.67	30	Tacoma, WA	1.21
6	Oakland, CA	0.70	31	Baltimore, MD	1.23
7	Salt Lake City–Ogden, UT	0.75	32	Detroit, MI	1.24
8	Ventura, CA	0.75	33	Las Vegas, NV–AZ	1.39
9	New York, NY	0.76	34	Rochester, NY	1.40
10	San Jose, CA	0.76	35	Tucson, AZ	1.42
11	New Orleans, LA	0.81	36	Knoxville, TN	1.42
12	Chicago, IL	0.81	37	Jersey City, NJ	1.44
13	Norfolk–Virginia Beach–Newport News, VA–NC	0.82	38	Minneapolis–St. Paul, MN–WI	1.45
14	West Palm Beach–Boca Raton, FL	0.83	39	Hartford, CT	1.50
15	Boston–Worcester–Lawrence–Lowell–Brockton, MA–NH	0.86	40	Springfield, MA	1.52
16	Seattle–Bellevue–Everett, WA	0.88	41	Denver, CO	1.53
17	Sarasota–Bradenton, FL	0.92	42	Providence–Warwick–Pawtucket, RI	1.61
18	Riverside–San Bernardino, CA	0.94	43	Washington, DC–MD–VA–WV	1.61
19	New Haven–Bridgeport–Stamford–Danbury–Waterbury, CT	0.98	44	Phoenix–Mesa, AZ	1.61
20	Tampa–St. Petersburg–Clearwater, FL	1.00	45	Scranton–Wilkes-Barre–Hazleton, PA	1.62
21	Cleveland–Lorain–Elyria, OH	1.02	46	Harrisburg–Lebanon–Carlisle, PA	1.63
22	Milwaukee–Waukesha, WI	1.03	47	Bakersfield, CA	1.64
23	Jacksonville, FL	1.06	48	Philadelphia, PA–NJ	1.65
24	Portland–Vancouver, OR–WA	1.07	49	Colorado Springs, CO	1.67
25	Orlando, FL	1.12	50	Albany–Schenectady–Troy, NY	1.70

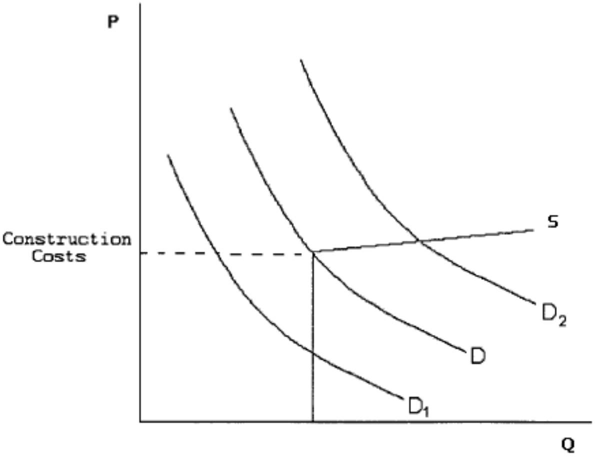
Saiz (2010 QJE)

- This US city-level housing supply elasticity is often used as an instrument for housing prices
- Examples:
  - Mian, Rao, Sufi (2013 QJE): Consumption elasticity with respect to housing wealth
  - Dettling and Kearney (2014 JPUBE): The effect of housing prices on fertility
  - Diamond (2017 AEJ Policy): Housing supply elasticity and political rent-seeking
- In the Japanese context, LaPoint (2021, wp) uses the municipality-level housing supply elasticity to analyze the feedback loop between corporate borrowing and commercial property investment, as in Kiyotaki and Moore (1997 JPE)
  - He shows that in the Japanese context, the floor-to-area ratio regulation matters a lot and his instrumental variable is based on it.
- Nakajima et al. tried to replicate Saiz (2010) in Japanese data, but this remains a beta version[2]
  - LaPoint (2021) finds that their estimates do not perform very well in Japanese context
  - I advise you to contact the authors before using their estimates for your research

[2] https://www.ier.hit-u.ac.jp/hit-refined/Japanese/database/elas.html

Glaeser and Gyourko (2005 JPE)

- Points out the durable nature of housing stock creases a "kink" in the housing supply curve
  - Elastic when population is increasing
  - Inelastic when population is declining, as the housing supply is held fixed due to durability



Glaeser and Gyourko (2005 JPE)

- Indeed many cities have housing prices less than the construction cost
- My take: Durability of housing should be considered more seriously as we face rapid population decline in near future
  - Research opportunity!
  - See Brueckner and Rosenthal (2009 REStat) and Suzuki and Asami (2019 Urban Studies) for a theoretical model along this line

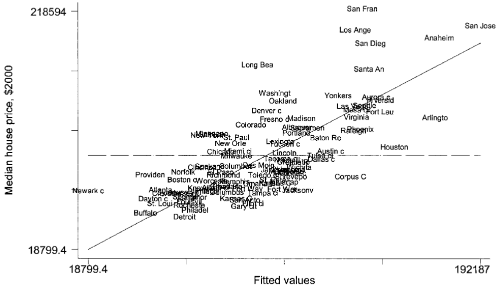


FIG. 2.—Median price regression and construction costs. The dashed horizontal line represents the $97,974 construction costs (in 2000 dollars) for a modest-quality, 1,200–square foot single-family home estimated by R. S. Means (2000*a*). The observation for Honolulu is not plotted for ease of presentation.

Ahlfeldt and McMillen (2018 REStat)

- Construction technology advancement shapes the housing supply
  - Skyscrapers as a salient example that massive capital investment addresses land shortage
- Ahlfeldt and McMillen (2018) estimates the production technology of skyscrapers
  - Use the data of skyscraper lists and land prices over 150 years in Chicago

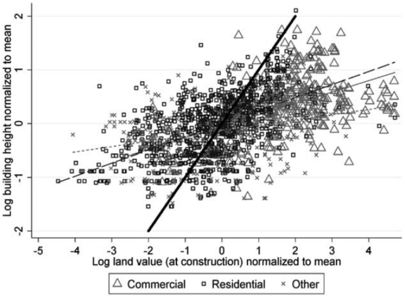
Ahlfeldt and McMillen (2018 REStat)

- The elasticity of building height (S) with respect to land price (r) is estimated by the regression model

$$\ln S_{it} = \alpha_t + \beta \ln r_{it} + \epsilon_{it}$$

- We find a positive elasticity (larger for commercial buildings), suggestive of substitution between capital and land

FIGURE 5.—ELASTICITY OF HEIGHT WITH RESPECT TO LAND PRICE: POOLED CORRELATIONS



Log heights and log land values are normalized to 0 means within decades. The thin solid (long-dashed) [short-dashed] line is the linear fit for commercial (residential) [other] buildings. The thick solid line is the 45-degree line.

Ahlfeldt and McMillen (2018 REStat)

- Indeed, we can infer from β the elasticity of substitution between land (L) and capital (K):

$$\sigma = \frac{d \ln \left(\frac{K}{L} \right)}{d \ln \left(\frac{\frac{\partial H}{\partial L}}{\frac{\partial H}{\partial K}} \right)},$$

  where H is the housing output.

- We denote by θ the elasticity of the construction cost per floor space with respect to building height
- We denote by γ the elasticity of the floor space per land with respect to building height
- Then, we can show that $\beta = \frac{\sigma}{1+\theta-\lambda}$ under the constant elasticity assumptions.
  - Higher substitutability (σ) facilitates skyscraper development as capital investment is effective for overcoming land shortage
  - Higher construction cost (θ) prevents skyscraper development
  - More effective provision of floor space per land area (λ), which may happen if common open space is less needed, facilitates skyscraper development

Ahlfeldt and McMillen (2018 REStat)

- The substituition elasticity σ is less than 1
  - If the production function is Cobb-Douglas, it should be 1.
  - Unlike Combes et al. (2021 JPE), Ahlfeldt and McMillen rejects the Cobb-Douglas for large buildings
  - Maybe intuitive? Land is more scarce in constructing tall buildings, so it is hard to compensate for the lack of land by capital

TABLE 7.—SUMMARY OF IMPLIED PARAMETER ESTIMATES

		Commercial (30 floors)		Commercial (20 floors)		Residential (20 floors)	
Elasticity	Parameter	OLS	IV	OLS	IV	OLS	IV
Height	β	47.8%	47.9%	47.8%	47.9%	31.3%	40.1%
		(3.8%)	(4.1%)	(3.8%)	(4.1%)	(2.9%)	(3.2%)
Const. cost	θ	75.0%	75.0%	53.3%	53.3%	61.1%	61.1%
		(6.1%)[a]	(6.1%)[a]	(3.6%)	(3.6%)	(4.1%)	(4.1%)
Extra space	λ	15.6%	15.6%	15.6%	15.6%	10.0%	10.0%
		(18.3%)	(18.3%)	18.3%)	(18.3%)	(2.2%)	(2.2%)
Substitution	$\sigma = \beta(1 + \theta - \lambda)$	76.2%	76.4%	65.8%	66.0%	47.3%	60.6%
		(18.14%)[a]	(19.14%)[a]	(17.32%)[a]	(18.09%)[a]	(4.42%)[a]	(5.61%)[a]

OLS height elasticity estimates are from table 4, column 4. IV estimates are from table 4, column 6. The commercial construction cost elasticity for thirty-floor buildings is computed by multiplying the per floor semielasticities reported in table 6, column 5 by thirty floors (approximately the median values for post-1950 commercial and residential tall buildings in Chicago). The other construction cost elasticities are from table 5, columns 6 and 7. Extra space elasticities are from table 6.

[a]Standard errors (in parentheses) bootstrapped in 1,000 iterations.

Imperfect competition in housing provision

- The studies we have seen so far mostly assume perfect competition among housing providers
  - We should be careful: some results in the above studies might also hold under imperfect competition, while other results might have to be modified.
- Recent but growing evidence suggests the presence of imperfect competition
  - And this would affect housing supply quantity, housing supply elasticity, welfare implications etc
- I mention two examples:
  - Oligopolistic competition among housing developerse (Quintero 2023 RSUE R&R)
  - Transaction costs and historical conditions (Yamasaki, Nakajima, Teshima 2023 wp)

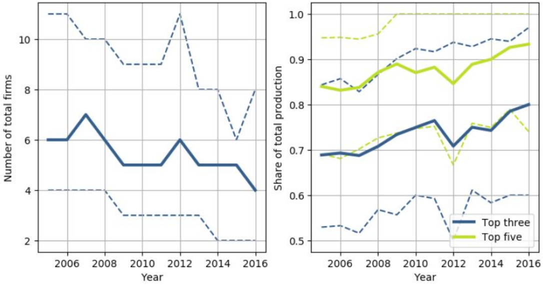
Quintero (2023 RSUE R&R)

- Oligopoly among housing developers may contribute to less provision of housing
- To illustrate a theoretical motivation, consider a simple Cournot model
  - Equilibrium total supply is smaller, and price is higher than the case of perfect competition
  - The discrepancy is larger when the number of firms is smaller,
  - Things converge to the perfect competition case as the number of firms approaches ∞ (Cournot limit theorem)
- Oligopoly is a central topic in IO, but it has received relatively small attention in considering housing supply
  - Oligopsony, which is just a mirror-image of oligipoly, is also a hot topic in labor economics.
- Quintero (2023) analyzes how market concentration of housing developers affects new housing supply

Quintero (2023 RSUE R&R)

- Significant concentration in the US local housing markets, and it is increasing over time

Figure 1: Evolution of Concentration in Local Housing Markets



Notes: Measures concentration in local housing markets. The left panel shows the umber of firms accounting for 90% of housing construction and the right panel shows the share of production accounted for by largest three and largest five firms in each market. The solid line shows the median market and the dashed lines show the first and third quartiles.

Quintero (2023 RSUE R&R)

- Regress housing supply on a measure of housing-market concentration
  - Market concentration is measured by the number of firms needed to account for 90% of total supply
  - IV: The construction behavior of *large national developers in other markets*.
- More concentration induces less supply, both in OLS and IV

Table 2: Regression results for the impact of competition on the volume of housing supplied.

	Total value		Square footage		Units	
	OLS	IV	OLS	IV	OLS	IV
Firms producing 90%	0.17***	0.87***	0.17***	0.91***	0.082**	0.62***
	(0.040)	(0.25)	(0.039)	(0.25)	(0.040)	(0.24)
Jobs within 50 miles	-2.97**	2.71	-2.58*	3.38	-1.04	3.33
	(1.41)	(2.58)	(1.37)	(2.55)	(1.43)	(2.46)
Construction cost	-0.44***	-0.43***	-0.33***	-0.32***	-0.32***	-0.32***
	(0.089)	(0.10)	(0.086)	(0.10)	(0.090)	(0.098)
Observations	927	927	925	925	927	927
R^2	0.572		0.497		0.530	
1^{st} Stage F		27.483		27.390		27.483
1^{st} Stage p-value		0.000		0.000		0.000

Standard errors in parentheses.

All specifications include market and year fixed effects.

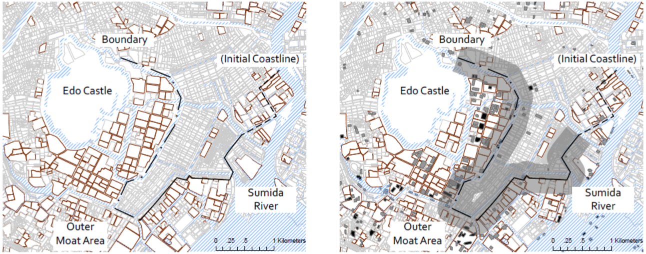
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Yamasaki, Nakajima, Teshima (2023 wp)

- While perfect competition assumes no transaction costs of changing land plot size, such a cost might be empirically substantial
- In the presence of transaction costs, availability of large land plot shapes the housing supply
  - Due to transaction costs, it can be hard to assemble or divide land plots
  - If so, having a historically large land plot may facilitate skyscraper development
- Local lords' house (*daimyo yashiki*) in Edo Japan left large land plots for a reason unrelated to modern economic conditions
  - What is the long-run impact of having a large land plot?

- Zoning in the Edo period implies that large plots exist inside the zoning border (*yamanote line* border)

Figure 1: Zoning in the Initially Developed Area



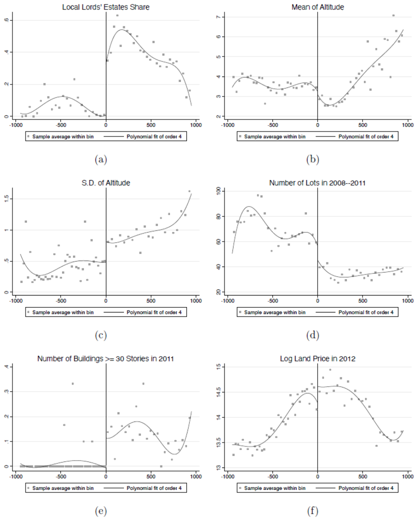
(a) (b)

Notes: Polygons with red borders are local lords' estates. The U-shaped line in both figures is the boundary between the local lords' estate zone (the outer side) and the commoners' zone (the inner side). The dash-dot part is the initial boundary between the zones. The solid and dash parts are the initial coastline. The solid part became part of the boundary after the second reclamation. The gray area in the right figure shows a 250-m buffer, which we use for the local randomization regression analysis. Another line in the right figure from south to north shows the overground railroad loop line (*Yamanote* line). In the right figure, we overlay high-rise buildings in 2011, indicated by black (more than or equal to 30 stories) and gray (15–29 stories) rectangles.

Yamasaki, Nakajima, Teshima (2023 wp)

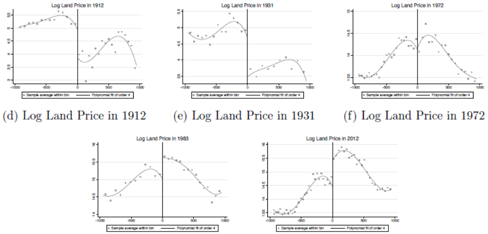
- Indeed, the land plots are larger in the local lords' area
- There are more tall buildings, and land prices are higher here.

Figure 4: Distribution along the Zoning Boundary



Yamasaki, Nakajima, Teshima (2023 wp)

- However, this "large plots premium" does not appear until 1980's.
  - It was the opposite of *"large plots penalty"* in earlier years!
- The authors interpret that the emergence of skyscraper technologies made the large plots valuable
  - In contrast, perhaps smaller plots are better for smaller housing developments
- Takeaway: Historical distribution of property rights, combined with construction technology, shapes the geography of housing supply.
  - Consistent with the presence of large transaction costs in changing land lot size



(d) Log Land Price in 1912 (e) Log Land Price in 1931 (f) Log Land Price in 1972

(g) Log Land Price in 1983 (h) Log Land Price in the 2010s

Notes: We use all cells within 1 km of the boundary in Figure 1 excluding cells within 50 m of the boundary to avoid mechanical attenuation effects. The x-axis is the distance from the boundary, which is represented by the dash-dot line in Figure 1, taking a positive and negative value in the local lords' estate zone and the commoners' zone, respectively. The points show the average of each outcome variable within each bin. The number of bins is chosen using the mimicking variance evenly spaced method using spacing estimators. The lines show the fourth-order polynomial fit for each zone.

Taking stock

- Housing production is reasonably approximated by the Cobb-Douglas technology
  - Easy to use in theoretical and empirical applications
  - But deviations from the Cobb-Douglas seems to be more serious for larger developments
- Housing costs increase with population, and the increase is larger in larger cities
  - Suggests that housing supply is not perfectly elastic
- Many things matter in shaping the housing supply elasticity
  - Availability of suitable land
  - Regulation
  - Durability of housing stock
  - Construction technology
- Imperfect competition also seems to matter
  - Oligopoly of housing developers
  - Transaction costs and the role of hisotical conditions
- Housing demand (location choice) is more extensively studied in urban and spatial economics, but we should never forget about the supply side!