Preliminary
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Housing Supply and Affordability

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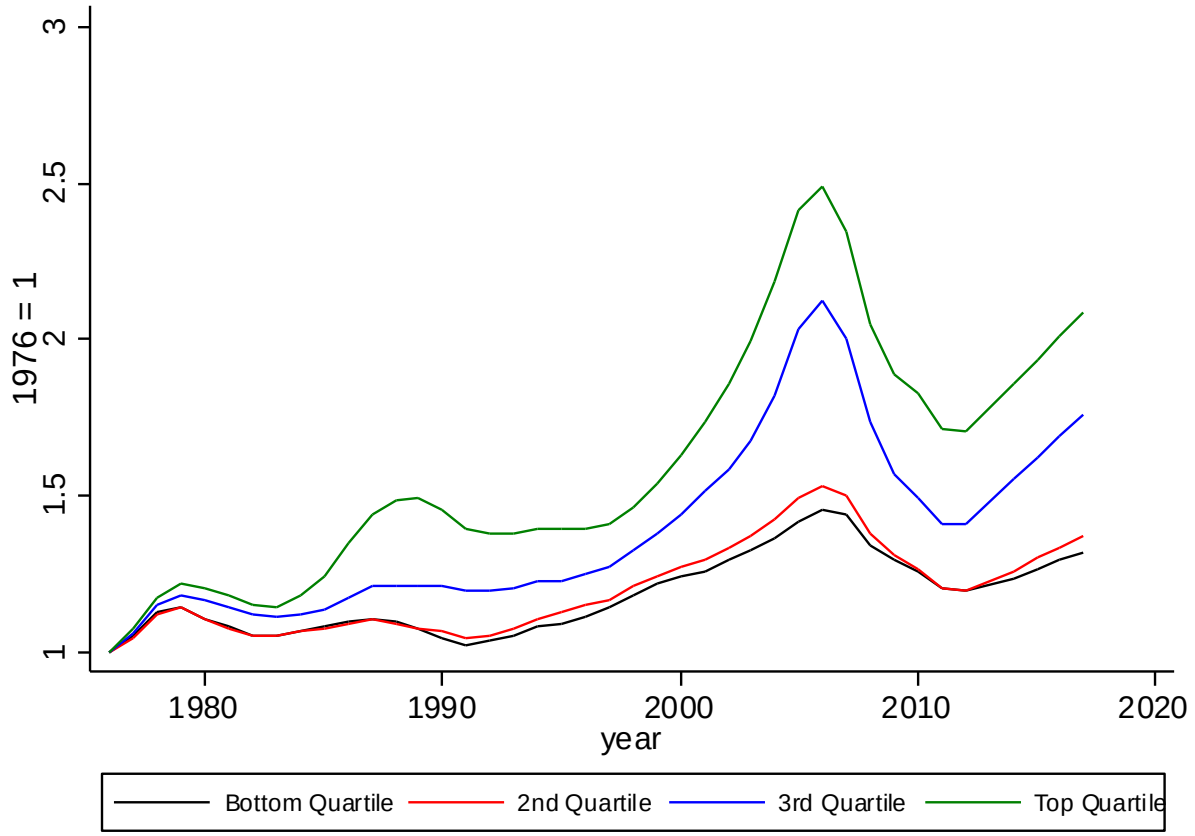
Supply and Affordability

- Since the mid-20th Century, house prices have risen substantially more than incomes in many US metro areas.
- Regulatory restrictions on the housing supply are frequently identified as a contributing factor because they raise the average price of housing
  - Survey by Quigley and Rosenthal (2005), Zabel and Dalton (2011), Ihlanfeldt (2007), Jackson (2016)
- How do supply constraints affect *housing affordability*?

Supply and Affordability

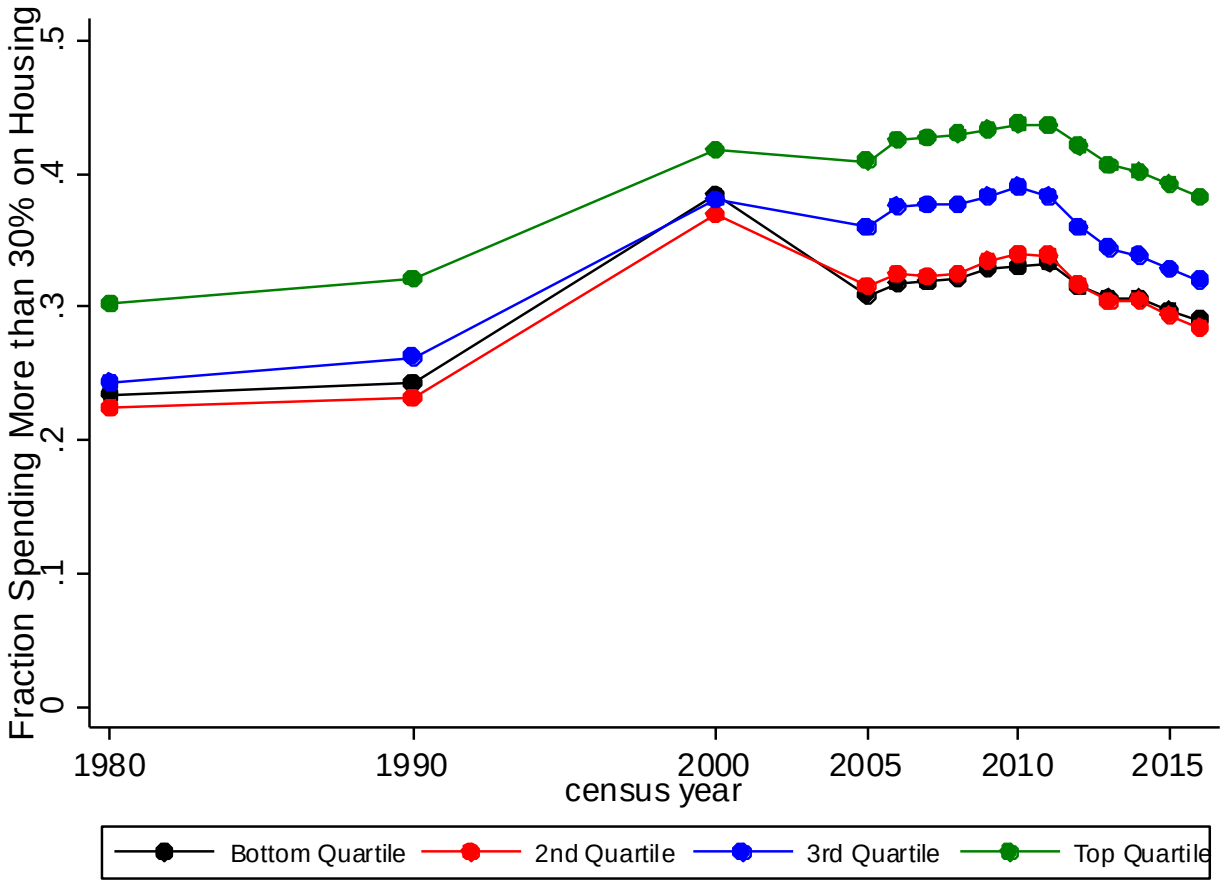
- We define “affordability” as the price of a quality-adjusted unit of housing services
- Price of housing services is what matters for household welfare (not the price to purchase the asset)
- Measurement challenge: Price of housing services can be measured with rents, but rents are not observed for owner-occupied homes
- Price of housing services will affect housing consumption choices:
  - Quantity of housing consumed
  - Location choice
  - → Share of income spent on housing

Real House Price Growth by Quartile of Housing Supply Regulation



Source: CoreLogic for house price index; Wharton Residential Land Use Regulation Index for regulation (Gyourko, Saiz and Summers 2008).

Housing Expenditure Shares by Quartile of Housing Supply Regulation



Source: 1980 Census and 2012-2016 American Community Survey for housing expenditures/income; Wharton Residential Land Use Regulation Index for regulation (Gyourko, Saiz and Summers 2008).

Supply and Affordability

- Are the effects of supply constraints on the price of housing services as large as the effects on house prices?
- Do people respond to higher prices by reducing the quantity of housing consumed?
- Or by choosing to live in a lower-priced area?
- We answer these questions using theory and US housing data spanning the past four decades.

Our Findings

- Theory: Supply constraints should raise the price of housing services by much less than the price of purchasing a home
  - Intuition: Constraints raise expected future rent growth as well as current rents. House prices reflect both effects.
  - Empirical evidence:
    - Much smaller effect of supply constraints on rents than on house prices.
    - Supply constraints have only reduced the affordability of one- and two-bedroom apartments by a small amount.
    - Consistent with the (few) other papers that also find smaller effects on rents than on prices (Malpezzi 1996, Malpezzi and Green 1996, Green 1999, Xing, Hartzell and Godschalk 2006).

Our Findings

- Theory: Supply constraints should (weakly) reduce the quantity of housing consumed and cause lower-income households to move out
  - Intuition: Higher price of housing services should reduce quantity of housing consumed.
  - Predicted effects depend on the type of constraint being considered
  - Empirical evidence: We estimate no negative effect on unit size or lot size, and only small effects on sorting across metros.

Our Findings

- Theory: Supply constraints should raise housing expenditures relative to income
  - Intuition: higher price of housing services is only partly offset by changes in the quantity consumed.
  - Predicted effect is not large because:
    - Effect on price of housing services is less than effect on house prices
    - Households partly offset the higher price of housing services by reducing other consumption
  - Empirical evidence: We find a small positive effect.

Outline

- Simple model to illustrate effects of supply constraints on prices versus rents
- Empirical identification strategy
- Causal estimates of effects on house value and rents
- Richer model showing effects on housing unit size, lot size, location choice, and housing expenditure shares
- Causal estimates

Simple Model

- One city, continuous time.
  - House price = p_t^{own}
  - Rent = $p_t^{rent} = u_t p_t^{own}$
  - (real) User cost = $u_t = r_t + \tau - g_t$
- Initially:
  - p_0^{own} = construction cost
  - $g_0 = 0$ (growth rates of prices and rent = inflation)
  - $u_0 = r_0 + \tau$

Simple Model

- At t = 1, the city unexpectedly imposes a supply constraint, causing rent and house prices to increase at rate g every period in the future.

$$\Delta lnp^{rent} = gt$$

$$\Delta lnp^{own} = \Delta lnp^{rent} - \Delta lnu$$

$$\approx gt - ln\left(\frac{r_t + \tau - g_0}{r_0 + \tau - g_0}\right) - ln\left(\frac{r_t + \tau - g}{r_t + \tau - g_0}\right)$$

$$\approx gt - ln\left(\frac{r_t + \tau - g}{r_t + \tau - g_0}\right)$$

Simple Model

Assumptions (similar to Himmelberg, Mayer, Sinai 2005):

- Real risk free rate = 0
- Risk premium = 2%
- Depreciation = 2%
- Property tax = 1.5%
- Tax deductions for mortgage interest and property tax = .25*(1.5%+6%)

$$\Delta lnu \approx ln\left(\frac{r_t + \tau - g}{r_t + \tau - g_0}\right)$$

$$\approx\left(\frac{3.625-g}{3.625}\right)$$

Simple Model

- $$\Delta lnp^{own} \approx \Delta lnp^{rent} - \left(\frac{3.625 - g}{3.625}\right)$$

t	Δlnp^{rent}	Δlnp^{own}	$\frac{\Delta lnp^{rent}}{\Delta lnp^{own}}$
g = 0.01			
1	0.01	0.33	0.03
20	0.20	0.52	0.38
35	0.35	0.67	0.52
g = 0.02			
35	0.70	1.50	0.47
g = 0.03			
35	1.05	2.81	0.37

Simple Model

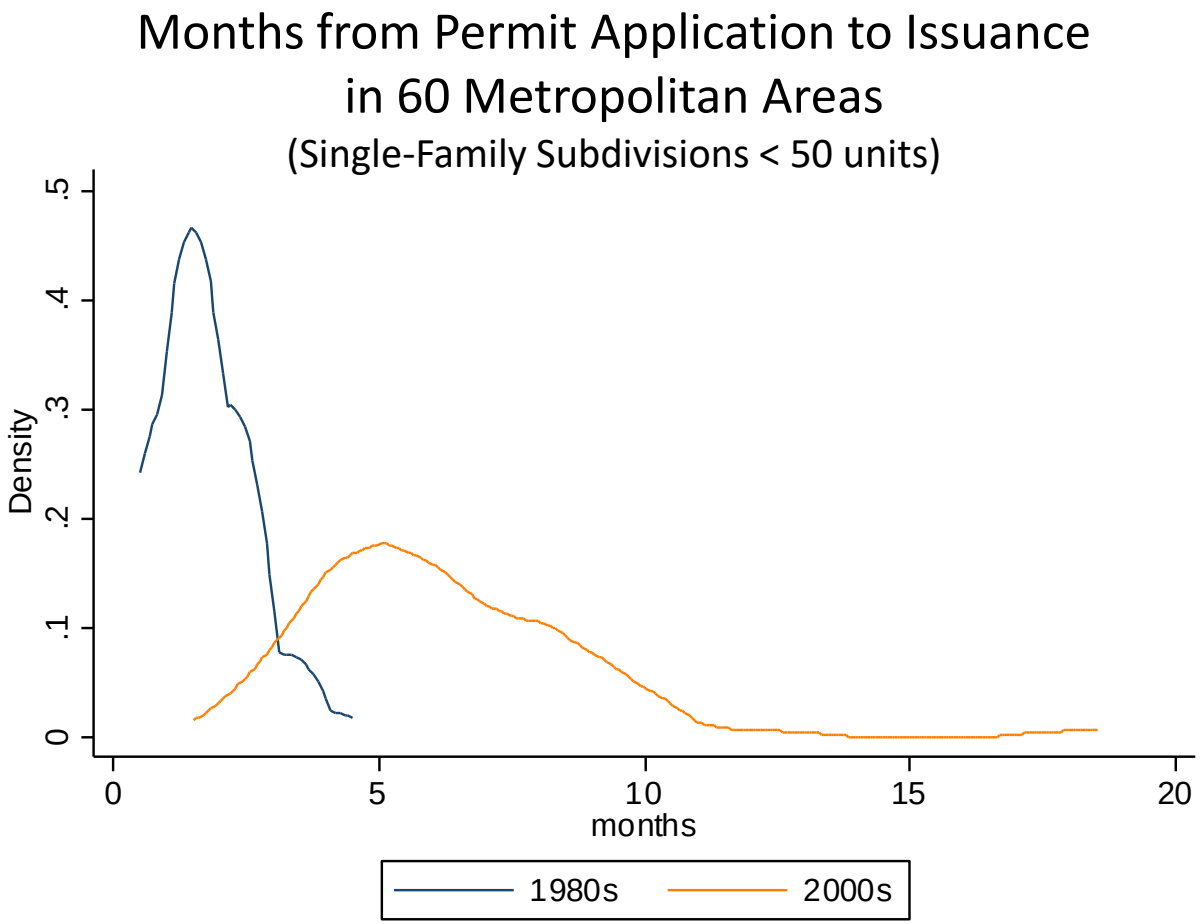
$$\Delta lnp^{own} \approx \Delta lnp^{rent} - \left(\frac{r_t + \tau - g}{r_t + \tau}\right)$$

$r + \tau$	Δlnp^{rent}	Δlnp^{own}	$\frac{\Delta lnp^{rent}}{\Delta lnp^{own}}$
g = 0.01, t=35			
3.625	0.35	0.67	0.52
1.5	0.35	1.45	0.24
6.5	0.35	0.52	0.68

Identification Strategy

- We test model predictions using data for metropolitan areas in the US—lots of variation in the restrictiveness of the regulatory environment and supply of land.
- Endogeneity problem: Regulations and geography are correlated with many other factors that also affect housing and location choices
- Solution:
  - Focus on the *change* in outcomes from 1980 (when regulations didn't bind much) to 2010s.
    - Ganong and Shoag (2017), Glaeser and Ward (2006), Jackson (2016)
  - Control for other factors that reflect changes in productivity and amenities
  - Exclude metropolitan areas with low housing demand

Identification Strategy



Surveys by Wharton School of Business: Linneman, Summers, Brooks and Buist (1990); Gyourko, Saiz and Summers (2008)

Identification Strategy

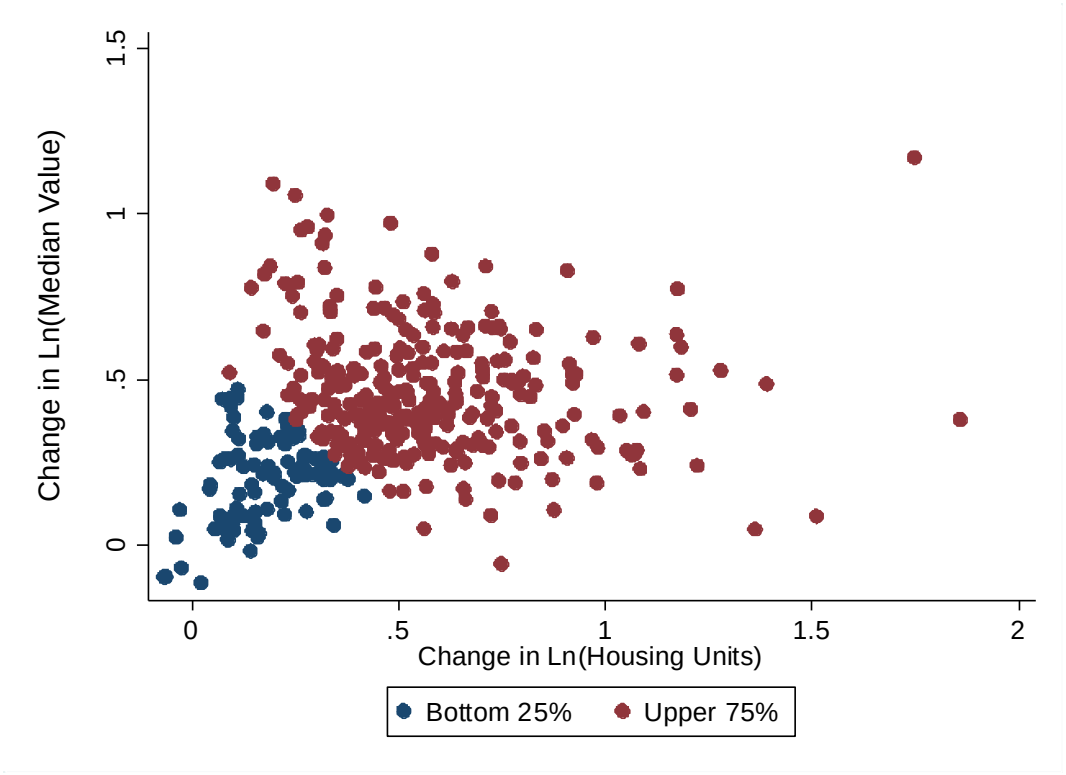
Controls:

- Productivity
  - Share of population age 25+ with at least 4 years of college (in 1980)
  - Share of employment (in 1990) in industries that experienced high wage growth 1990 to 2016.
    - Top 10% of 3-digit NAICS-based industries
- Amenities
  - Average January temperature (1981-2010)
  - Share of employment (in 1980) in industries related to the production of consumption amenities
    - Eating/drinking places, amusement & recreation services, museums & zoos
  - Share of housing units that were vacant for seasonal use in 1980

Identification Strategy

Identifying low-demand metropolitan areas:

- Demand = Δln(house price) + Δln(housing stock) 1980 to 2016
- "Low-Demand" = bottom 25%



Measuring Supply

- Land use regulation data from Wharton survey (Gyourko, Saiz and Summers 2008)
  - Length of time from permit application to approval
    - Results similar for aggregate regulation index
  - Minimum lot size (at least 1 acre somewhere in metro)
- Geographic constraint data from Saiz (2010)
  - Fraction of land that was unavailable for building because it was under water or on a steep slope.
- All three measures standardized to have mean = 0, standard deviation = 1

Measuring Outcomes

- Ideal data: market price and price of housing services in a large, representative set of housing units in 1980 and today
- We use: 1980 Census and 2012-2016 American Community Survey
  - Prices: Owner-reported house values of owner-occupied single-family homes
  - Rents: Rent of renter-occupied homes.
  - Control for housing unit characteristics: # rooms, # bedrooms, building age

Empirical Specification

$$Y_{imt} = \delta_m + \delta_t 1_{t=2016} + \beta_z 1_{t=2016} Z_m + \beta_x X^H_{imt} + \beta_x 1_{t=2016} X^M_{im} + \epsilon_{imt}$$

Y_{imt} = ln(value) or ln(rent)

$1_{t=2016}$ indicator for being in the 2012-2016 ACS

Z_m includes three supply constraints

X^H_{imt} includes controls for housing unit characteristics

X^M_{im} includes controls for changes in productivity and amenities

Results – House Value and Rents

	Value SF Homes	Rent SF Homes	Rent MF	Rent All HU
2012-2016 Indicator	0.460 (0.025)	0.486 (0.016)	0.459 (0.014)	0.482 (0.014)
Indicator interacted with:				
Permit Time	0.104 (0.020)	0.029 (0.010)	0.052 (0.010)	0.045 (0.009)
Minimum Lot Size	0.022 (0.017)	0.000 (0.009)	-0.002 (0.010)	-0.002 (0.009)
Geographic Constraints	0.098 (0.019)	0.020 (0.011)	0.038 (0.012)	0.033 (0.011)
Other Controls	Yes	Yes	Yes	Yes
Metro FE	Yes	Yes	Yes	Yes
# observations	2.3 million	0.4 million	0.8 million	1.2 million

Note. Standard errors are clustered by metropolitan area. Dependent variables are expressed relative to the price index for personal consumption expenditures.

Housing Types of Low Income Households

Percent of Households with Income Between 20th and 30th Percentile of their Metro Area Living in:

	0 Bed	1 Bed	2 Bed	3 Bed	4+ Bed
Multifamily	3.0	**17.1**	**18.9**	4.5	0.8
Single-Family	0.3	2.7	**16.4**	**27.3**	9.1

Results – Rent of "Low-Income" Housing Types

	Apt 1-Bed	Apt 2-Bed	SF 2-Bed	SF 3-Bed
2016 Indicator	0.433 (0.015)	0.444 (0.017)	0.485 (0.016)	0.484 (0.018)
Indicator interacted with:				
Permit Time	0.048 (0.013)	0.064 (0.010)	0.030 (0.011)	0.032 (0.011)
Minimum Lot Size	-0.001 (0.013)	-0.003 (0.011)	0.013 (0.010)	-0.009 (0.010)
Geographic Constraints	0.047 (0.012)	0.031 (0.013)	0.016 (0.012)	0.031 (0.013)
Other Controls	Yes	Yes	Yes	Yes
Metro FE	Yes	Yes	Yes	Yes
# observations	0.34 mil.	0.35 mil.	0.11 mil.	0.17 mil.

Note. Standard errors are clustered by metropolitan area. Dependent variables are expressed relative to the price index for personal consumption expenditures

Summary

- Effect of a supply constraint on rents is ¼ to ½ of the effect on house prices after ≈ 35 years
  - Consistent with a model in which regulation raises expected future rent growth as well as current rent.
- Effect on affordability of housing types typically consumed by low income households is fairly small.
  - A metro with 2-SD longer permit time experienced 13pp more growth in the price of housing services of a 2-bedroom apartment from 1980 to mid-2010s.
  - Equivalent to 0.38pp faster growth per year, compared with an average increase of 1.3 percent per year in this sample
  - Effects on rent of other low-income housing types even smaller

Housing Consumption

- Especially difficult to assess effect of supply constraints on affordability of housing types that tend to be owner-occupied
- Further evidence: effects on housing consumption
  - Unit size
  - Lot size
  - Household location - sorting across metros
    - Sorting within metros will be discussed at the end of the presentation
  - Housing expenditures relative to income

Model - Setup

- Two cities. F (free) is unregulated. R (regulated) can impose three different types of constraints:
  - Reduce the amount of land available for construction
  - Impose fixed cost per new house
  - Impose minimum lot size
- Household utility is Cobb-Douglas over housing services and other consumption, with a randomly-distributed taste for R.
- Households endowed with income y.
  - Income does not depend on location
  - All households are renters.

Model - Setup

- Competitive developers supply housing using land and capital, with a Cobb-Douglas production function
  - Epple, Gordon and Sieg (2010); Ahlfeldt and McMillen (2014); Combes, Duranton and Gobillon (2016)
- Developers minimize costs subject to constraints and households maximize utility subject to rents.

Model – land constraints

- Reducing the amount of available land raises land prices, and therefore rent.
- Some households reduce the amount of land consumed to offset the higher price of housing services.
- Others (with a weaker preference for R), move to F.
- Housing unit size and housing expenditure share remain the same.

Model – fixed costs

- Housing expenditures for households who choose to live in city R increase.

$$\text{Housing expenditure share} = \alpha + \frac{(1-\alpha)t_R}{y_i}$$

- Because the fixed cost acts like a reduction in income, households with a given income reduce their consumption of land and housing structure.
- Households with income < fixed costs will choose city F, raising average income in city R
- Average housing expenditure share in city R increases, but net effects on average unit size and lot size are ambiguous.

Model – minimum lot size

- For households for whom the restriction binds:
  - The lower income households will choose to live in F
  - The households who still choose R will consume more land than they would have otherwise.
  - In order to offset the higher expenditures on land, they choose a smaller housing unit and reduce other consumption.
- Since the restriction is more likely to bind on poorer households, expenditure shares will increase more for poorer households.
- On average, lot size and housing expenditure shares increase in R. Effect on average unit size is ambiguous.

Measuring Outcomes

- Housing unit characteristics (parcel level)
  - Unit square footage of single-family homes
  - Lot square footage of single-family homes
  - Single-family indicator (larger lot)
- Household sorting (metro level)
  - Fraction of people with high or low incomes
  - Other measures of permanent income:
    - Fraction of people age 25+ with at least 4 years of college
    - Occupation score
- Housing expenditures / income (household level)

Data Sources

- Property tax records of single-family homes in 2014 (CoreLogic)
  - Unit square footage
  - Lot square footage
  - Compare homes built in 1970s to home built post-2000
- 1980 Census and 2012-2016 American Community Survey
  - Single-family indicator
  - Housing expenditure shares
  - Metro-level outcomes

Empirical Specification

- $Y_{imt} = \delta_m + \delta_t 1_{t=recent} + \beta_z 1_{t=recent} Z_m + \beta_x 1_{t=recent} X_{im} + \epsilon_{imt}$

Recent indicator:

- Built in 2000s when using property tax data
- 2012-2016 ACS when using Census/ACS data

X_{im} includes:

- Controls for changes in productivity and amenities
- Controls for decade built when using property tax data
- Controls for household income
  - Median tract income when using property tax data
  - Actual household income when using Census/ACS data

Results – Housing Unit Characteristics

	Ln(Unit Size)	Ln(Lot Size)	SF Indicator
Recent indicator	0.297 (0.069)	0.201 (0.180)	0.103 (0.006)
Indicator interacted with:			
Permit time	0.035 (0.009)	0.106 (0.042)	0.012 (0.008)
Minimum lot size	-0.000 (0.009)	0.022 (0.028)	0.000 (0.004)
Geographic constraints	0.009 (0.011)	0.034 (0.042)	-0.014 (0.006)
Control for income	Yes	Yes	Yes
# observations	10.7 million	10.7 million	3.8 million

Standard errors are clustered by metro area.

Results – Sorting

$$\bar{Y}_{m,2012-2016} - \bar{Y}_{m,1980} = \beta_z Z_m + \beta_x X_{im} + \epsilon_m$$

Fraction of Individuals by Quintile of the National Income Distribution

	Bottom 20%	20th to 40th	40th to 60th	60th to 80th	Top 20%
Permit time	0.001 (0.003)	-0.005 (0.002)	-0.000 (0.002)	-0.003 (0.002)	0.005 (0.002)
Minimum lot size	0.000 (0.002)	-0.001 (0.001)	-0.002 (0.001)	-0.001 (0.001)	0.002 (0.001)
Geographic constraints	0.001 (0.003)	0.005 (0.002)	0.001 (0.003)	-0.001 (0.002)	-0.002 (0.002)
# observations	133	133	133	133	133

Results – Sorting

Fraction of Individuals with Characteristics Associated with Higher Permanent Income

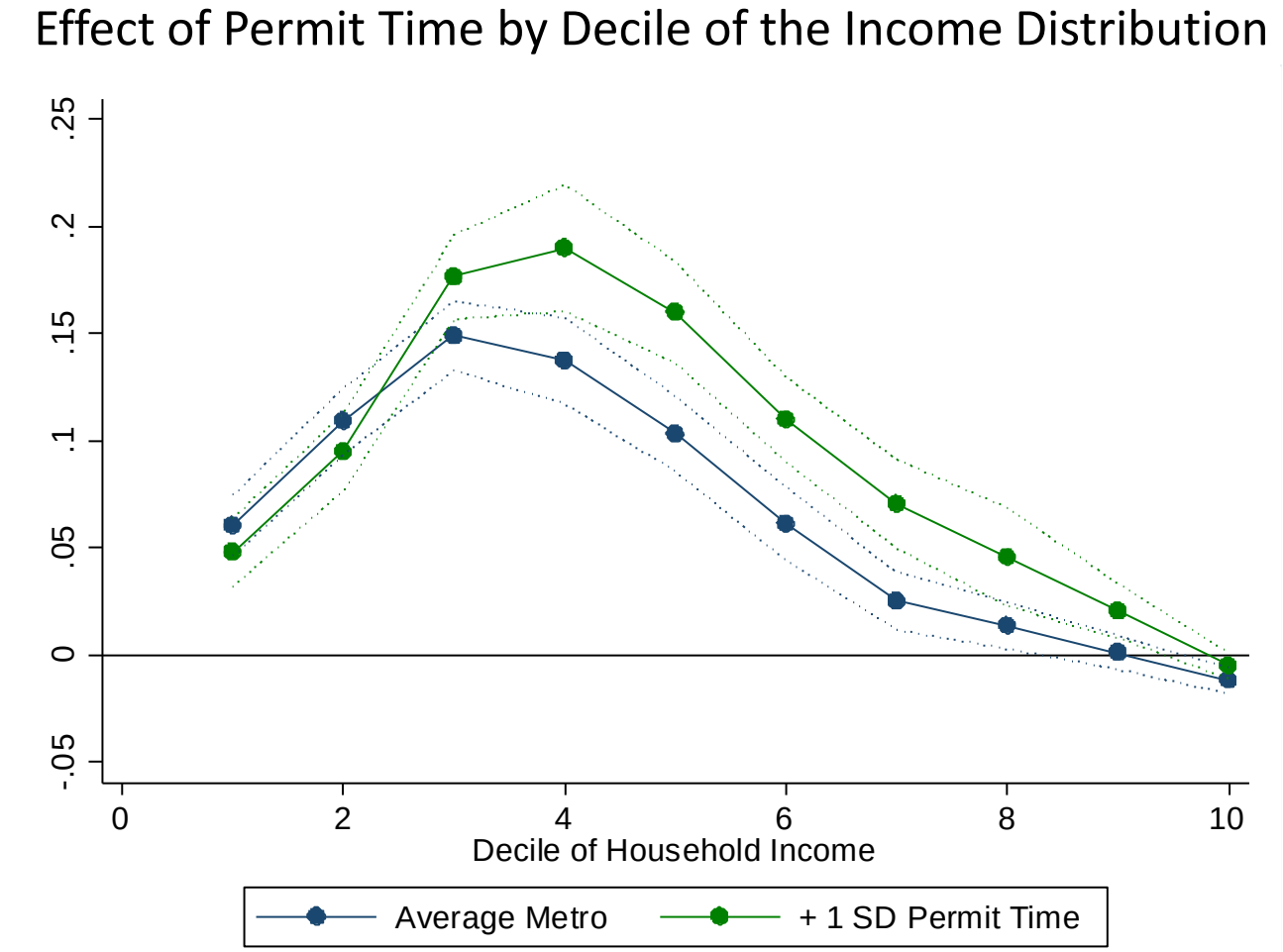
	4+ Years College	Occupation Score
Permit time	0.010 (0.004)	0.002 (0.001)
Minimum lot size	0.003 (0.003)	0.000 (0.001)
Geographic constraints	-0.005 (0.004)	-0.003 (0.001)
# observations	133	133

Results – Expenditure Share

Dependent Variable = Indicator for Expenditures > 30% of Income

	Controls for Income	No Controls for Income
2016 indicator	0.136 (0.012)	0.054 (0.003)
Indicator interacted with:		
Permit time	0.025 (0.005)	0.011 (0.003)
Minimum lot size	0.003 (0.004)	-0.001 (0.003)
Geographic constr.	0.016 (0.004)	0.018 (0.004)
Controls for income	Yes	No
# observations	3.6 mil.	3.6 mil.

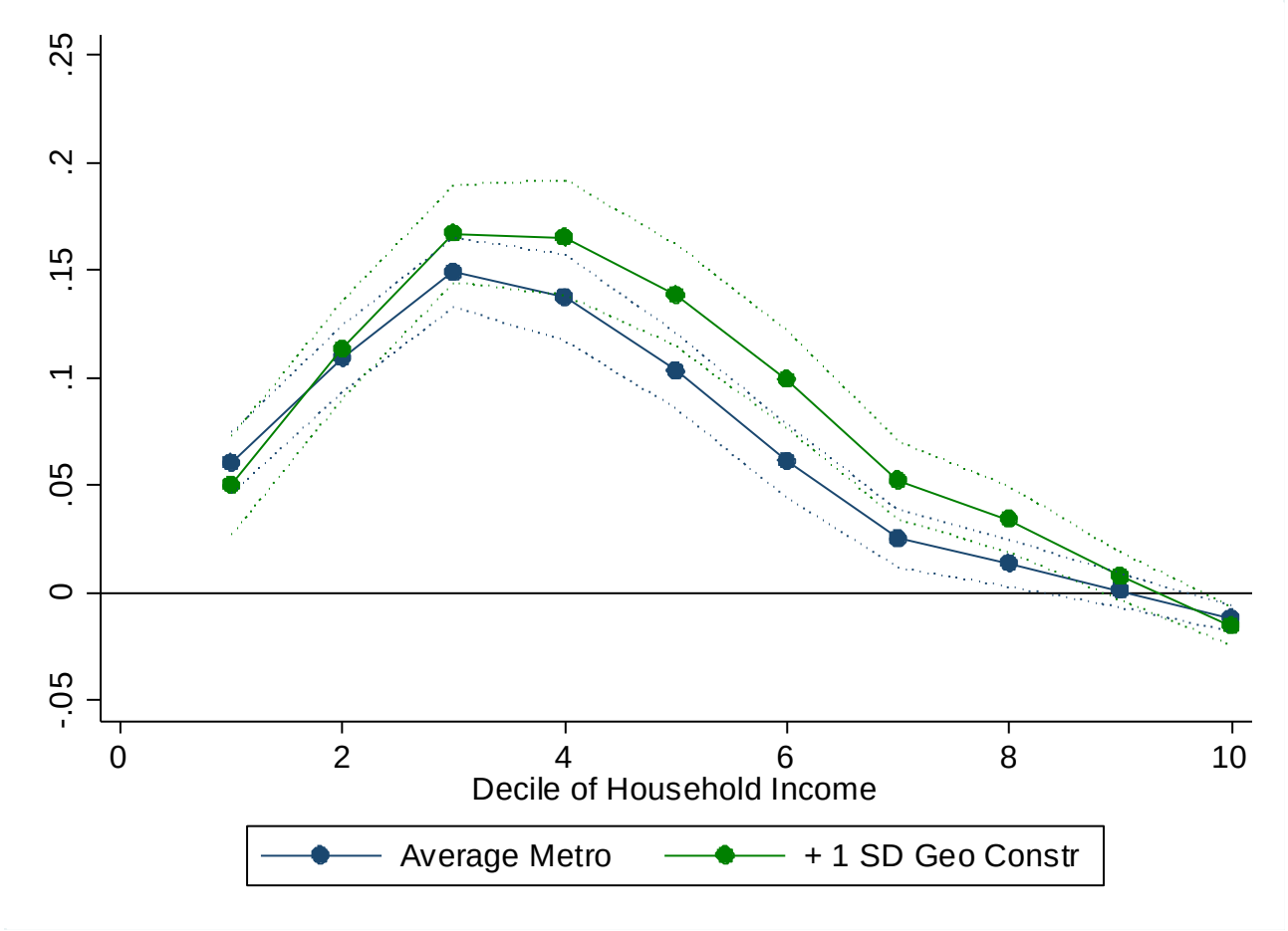
Results – Expenditure Share



Dotted lines show 95% confidence interval.

Results – Expenditure Share

Effect of Geographic Constraints by Decile of the Income Distribution



Dotted lines show 95% confidence interval.

Summary of Results on Housing Consumption

- Supply constraints do not cause people to consume smaller homes or smaller lots.
- Supply constraints cause a small amount of sorting by income
  - This effect can only explain a small portion of the differential changes in metro-level outcomes.
  - But sorting does partly explain why we don't see larger differences in average expenditure shares across areas.
- Supply constraints increase housing expenditures relative to income, mostly for households in the middle of the income distribution.

Other Ways Supply Constraints Could Affect Household Housing Consumption

- Households may choose to live in low-demand locations within the metro.
  - In the property tax data, we find little evidence that supply constraints boost construction in low-demand Census tracts (distance to CBD, commute time, crime, school quality)
- People may choose to live in larger households.
  - In the Census/ACS, we do find small positive effects of delays and geographic constraints on the fraction of households with multiple adults.

Overall Summary

- Housing supply constraints have much smaller effects on housing affordability and housing consumption choices than we expected going into this project.
- Theory shows this is because:
  - Effects on rents are smaller than effects on house prices
  - Households react to higher prices and rents by reducing other consumption as well as housing consumption.

Thank You!

Illustration of ID Strategy

Dependent Variable = Rent of 2-Bedroom Apartment

	2016	Panel: 1980 and 2016			
Permit Time	0.180 (0.018)	--	--	--	--
Minimum Lot Size	-0.033 (0.023)	--	--	--	--
2016 Indicator	--	0.467 (0.014)	0.468 (0.015)	0.423 (0.014)	0.444 (0.017)
Indicator interacted with:					
Permit Time	--	0.102 (0.011)	0.090 (0.015)	0.067 (0.011)	0.064 (0.010)
Minimum Lot Size	--	-0.015 (0.013)	-0.005 (0.014)	0.003 (0.011)	-0.003 (0.011)
Geographic Constraints	--	--	0.026 (0.019)	0.018 (0.013)	0.031 (0.013)
Other Controls	No	No	No	Yes	Yes
Exclude Low-Demand	No	No	No	No	Yes

Note. Standard errors are clustered by metropolitan area. Dependent variables are expressed relative to the price index for personal consumption expenditures. All regressions control for building age.

Illustration of ID Strategy

Dependent Variable = Change in Ln(CoreLogic House Price Index/PCE Price Index)
1980 to 2016

	(1)	(2)	(3)	(4)
Permit Time	0.140 (0.019)	0.100 (0.018)	0.097 (0.019)	0.083 (0.020)
Minimum Lot Size	0.037 (0.019)	0.047 (0.017)	0.014 (0.019)	0.016 (0.021)
Geographic Constraints	--	0.138 (0.018)	0.112 (0.019)	0.189 (0.022)
Constant	0.326 (0.019)	0.326 (0.017)	0.316 (0.019)	0.350 (0.022)
Other Controls	No	No	Yes	Yes
Exclude Low-Demand	No	No	No	Yes
# observations	259	258	217	154

Results – Single-Family Homes, HH Head ≤ 40

	Value	Rent
2016 Indicator	0.356 (0.025)	0.445 (0.016)
Indicator interacted with:		
Permit Time	0.107 (0.024)	0.026 (0.010)
Minimum Lot Size	0.014 (0.017)	-0.009 (0.010)
Geographic Constraints	0.093 (0.020)	0.028 (0.012)
Other Controls	Yes	Yes
Metro FE	Yes	Yes
# observations	0.4 million	0.2 million

Note. Standard errors are clustered by metropolitan area.

Housing Types of High Income Households

Percent of Households with Income Between 70th and 80th Percentile of their Metro Area Living in:

	0 Bed	1 Bed	2 Bed	3 Bed	4+ Bed
Multifamily	0.5	4.1	8.4	3.6	0.7
Single-Family	0.1	0.8	**10.4**	**44.8**	**26.7**

Results – Single-Family Indicator

	Full Sample	Owners	Renters	Young Owners	Young Renters
Recent indicator	0.103 (0.006)	0.039 (0.003)	0.090 (0.008)	0.016 (0.005)	0.068 (0.008)
Indicator interacted with:					
Permit time	0.012 (0.008)	0.003 (0.003)	0.002 (0.004)	-0.016 (0.005)	-0.001 (0.004)
Minimum lot size	0.000 (0.004)	-0.001 (0.002)	0.007 (0.006)	-0.004 (0.003)	0.009 (0.006)
Geographic constraints	-0.014 (0.006)	-0.005 (0.003)	-0.017 (0.006)	-0.012 (0.004)	-0.025 (0.006)
# observations	3.8 mil.	2.5 mi.	1.3 mil.	0.5 mil.	0.6 mil.

Standard errors are clustered by metro area.

Results – Housing Unit Characteristics

	Ln(Unit Size)	Ln(Lot Size)	SF Indicator
Recent indicator	0.417 (0.062)	0.478 (0.155)	0.077 (0.005)
Indicator interacted with:			
Permit time	0.038 (0.010)	0.060 (0.036)	0.017 (0.008)
Minimum lot size	-0.004 (0.008)	0.023 (0.029)	0.003 (0.004)
Geographic constraints	-0.021 (0.012)	-0.018 (0.042)	-0.012 (0.006)
Control for income	No	No	No
# observations	10.7 million	10.7 million	3.8 million

Standard errors are clustered by metro area.

Results – Expenditure Share

Dependent Variable = Indicator for Expenditures > 30% of Income

	Full Sample	Owners	Renters	Young Owners	Young Renters
2016 indicator	0.136 (0.012)	0.082 (0.003)	0.185 (0.019)	0.042 (0.014)	0.171 (0.019)
Indicator interacted with:					
Permit time	0.025 (0.005)	0.021 (0.004)	0.023 (0.004)	0.020 (0.005)	0.032 (0.006)
Minimum lot size	0.003 (0.004)	0.004 (0.004)	-0.000 (0.005)	0.003 (0.004)	-0.003 (0.006)
Geographic constr.	0.016 (0.004)	0.018 (0.004)	0.009 (0.006)	0.013 (0.006)	0.011 (0.007)
Controls for income	Yes	Yes	Yes	Yes	Yes
# observations	3.6 mil.	2.4 mil.	1.2 mil.	0.4 mil.	0.6 mil.

Summary of Model Predictions

for a household with a given level of income

	Fixed Cost	Reduction in Land Supply	Minimum Lot Size
Unit size	–	0	0/–
Lot size	–	–	0/+
Housing expenditure share	+	0	0/+

average outcome in the city

	Fixed Cost	Reduction in Land Supply	Minimum Lot Size
Unit size	?	0	?
Lot size	?	–	+
Housing expenditure share	+	0	+
Income	+	0	+