How to Build Affordable Housing? The Role of Local Barriers to Building Multi-Unit Housing

Nick Chiumenti[a] Amrita Kulka[b] Aradhya Sood[c]

[a]Federal Reserve Bank of Boston [b]University of Warwick [c]University of Toronto

July 28, 2021
NBER SI

Introduction

Housing is becoming increasingly unaffordable in the Greater Boston Area

- Increases in prices (49%) and rents (17.4%) in last 10 years
- Supply did not keep up: (new units 2000-19: 11,308; 1950-69: 11,908)
- Little vacant space: 1.9% of lots undeveloped

What can be done?

1. Relaxing local barriers: land-use regulations
2. Inclusionary Zoning, Chapter 40B
3. Vouchers

What Can be Done?

1. **Relaxing local barriers: land-use regulations**
   - Building multi-unit housing (50% of residential land only for single family)
     - Minneapolis: Abolishing SF zoning without relaxing height or density restrictions
     - Seattle: Allowing ADUs without increasing maximum unit size
   - Relaxing **combinations** of regulations
2. Inclusionary Zoning, Chapter 40B
3. Vouchers

- Affordability defined broadly: reduction in prices and increased supply in units (targeted at 80% AMI)

This Paper

1. How do local land use regulations affect the supply of single-family, multi-family and affordable housing?
2. How do they affect rental and housing prices?
3. Which regulation or combination of regulations increases supply/ decreases prices the most?
4. What is households' willingness to pay for residential density?

Literature and Contribution

1. Effect of **individual** land use regulation on **single family homes** (Glaeser & Gyourko (2002), Glaeser and Ward (2009), Zabel & Dalton (2011), Brueckner & Singh (2020), Kulka (2020), Gyourko & Krimmel (2021))
   - (**Combinations** of) land-use regulations on all housing including **multi-family**
2. Study interaction of regulations with other factors that affect housing affordability (Einstein et al (2019), Soltas (2020), Hankinson & Magazinnik (2021))
   - Inclusionary zoning **Chapter 40B** (Fisher (2007))
3. Affordable housing mostly studied in context of **federal subsidies** targeting very poor households (Diamond et al. (2019a, 2019b), Diamond & McQuade (2017), Schuetz et al. (2009), Greene & Ellen (2020), Mast (2019), Galiani et al(2015))
   - Focus on **broad** affordability
4. Methodology: Bayer, Ferreira & McMillan (2007), Turner, Haughwout, & Van Der Klaauw (2014), Katz (2017)

Outline

1. **Regulatory Framework for Multi-Unit Housing and Data**
2. Empirical Framework
3. Results
    a) Supply
    b) Rents and home values
    c) Willingness-to-pay for residential density
4. Policy Effects and Welfare

Data Sources

1. Our sample: 79 towns in GBA [2010-2018] Sample Map
2. House prices and characteristics Rent imputation
   - Warren Group: Universe of buildings, assessor values [1987-present] ACS validation
   - CoStar: rent data [2001-2019], building characteristics Rental Data Imputed Rents
   - DHCD: MA's Chapter 40B policy (address level)
   - HUD: LIHTC buildings, other HUD subsidy (address level)
3. Local Barriers:
   - MAPC [parcel level]: Dupac, building heights, MF by-right
4. Amenities:
   - School attendance areas: SABINS project
   - ACS (block group), CBP, crime, school district, environment

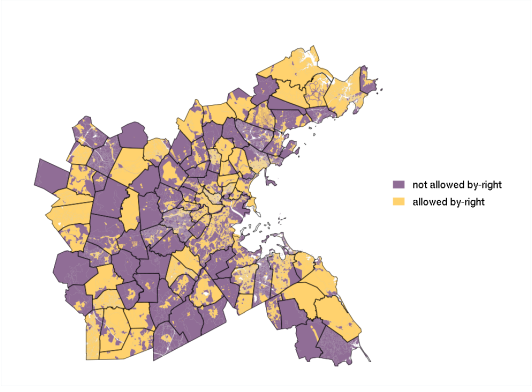
Regulatory Environment for Multi-Family Housing

Multi-family land-use regulations:

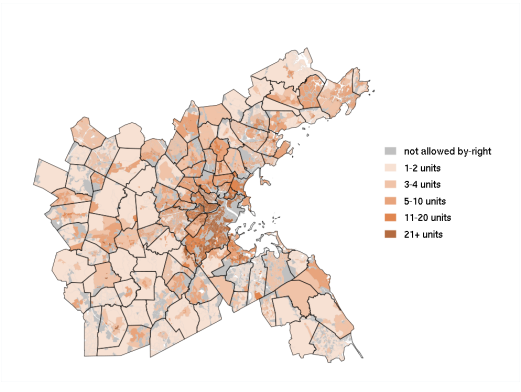
- Dwelling units per acre (Dupac), by-right Dupac
  - Maximum allowable units + minimum lot size
  - Changes the **density** of buildings
- Height restrictions, by-right height
  - Change the **size/floor area** of building
- By-right multi-family
  - Changes the **type** of building

Variation in Regulation

Multi-Family By-Right Zoning



Dwelling Units Per Acre



MF | Dwelling units per acre | Height restrictions

Outline

1. Regulatory Framework for Multi-Unit Housing and Data
2. **Empirical Framework**
3. Results
    a) Supply
    b) Rents and home values
    c) Willingness-to-pay for residential density
4. Policy Effects and Welfare

Endogeneity

1. Direct effects of **land use regulations** on prices and supply of MF housing
2. **Spillover effects** of residential density

- Both are correlated with unobserved quality of that location
- **Causal** effects need variation orthogonal to unobserved amenities
- Addressing endogeneity: Boundary discontinuity design
  - Zoning regulation boundaries within towns and school attendance areas
  - Building heights restrictions in Boston (1893); comprehensive zoning code (1956)
- Identifying Assumptions:
  1. On both sides of boundary, type of housing & density changes
  2. Close to boundary, unobserved quality of the neighborhood does not change
  3. Continuous: public amenities, municipal services, distance to schools

Mechanisms

Four different effects of relaxing regulation on house prices and rents:

1. Supply effect $\downarrow$
2. Option value (home value only) $\uparrow$
3. Demand effect $\uparrow$
4. Spillovers: $\downarrow$ if households dislike density

Mechanisms: Supply and Price Effects of different regulations

		Single Δ Reg.			Multiple Δ Reg.		
		MF	H	DU	MF+DU	MF+HE	DU+HE
Units		–	–	↑	↑	–	↑
Prices	Supply	–	–	↓	↓	–	↓
	Option Value (SF)	↑	↑	↑	↑	↑	↑
	Spillovers	↓	–	↓	↓	↓	↓

Empirical Specification

- RD gives consistent estimates of:
  - Residents' valuation of surrounding density
  - Hedonic price regressions: causally study the effects of MF regulation on housing price

$$Y_h = \rho_0 + \rho_1 \mathbb{1}\{\text{Regulation}_h\} + \rho_2 \theta_h^{HD} + \rho_3 \theta_h^{GD} + \rho_4 x_h + f_h(\text{dist}) + \lambda_h^{seg} + \epsilon_h$$

- $Y_h \in \{\text{Owner cost/rent of unit } h, h \text{ 2-3Fam/4+ Fam}\}$
- Regulation_h: Dupac $(\Delta, \mathbb{1})$, height $(\Delta, \mathbb{1})$, MF by-right $(\mathbb{1})$, or combination
- $f_s(\text{dist})$: polynomial on distance to boundary segment *seg*
- λ_h^{seg}: boundary segment fixed effect
- x_h: unit level characteristics (year built, lot size, building area)
- θ_h^{HD}: Share of "high density" (4+ family homes) in an 0.1 mile radius around h
- θ_h^{GD}: Share of "gentle density" (2-3 family homes) in an 0.1 mile radius around h

Regulation Scenarios

Regulation Scenarios	Multi-Family Changes	Height Changes	DUPAC Changes	Rent (% Obs.) (Multi-Family)	House Prices (% Obs.) (Single-Family)
Scenario 1	X				3.0
Scenario 2		X		2.8	2.6
Scenario 3			X	30.8	55.5
Scenario 4	X	X		1.0	1.5
Scenario 5	X		X	22.0	20.2
Scenario 6		X	X	24.0	8.4
Scenario 7	X	X	X	19.4	8.8

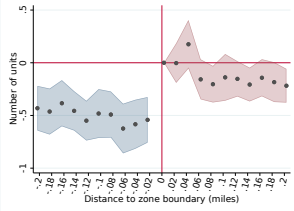
Regulation Boundaries across Space

Outline

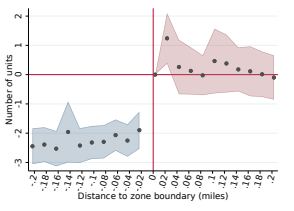
1. Regulatory Framework for Multi-Unit Housing and Data
2. Empirical Framework
3. Results
    a) **Supply**
    b) Rents and home values
    c) Willingness-to-pay for residential density
4. Policy Effects and Welfare

Supply: Number of units

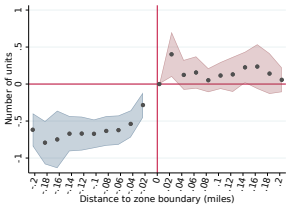
Only Dupac changes



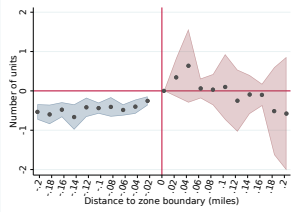
Dupac and height change



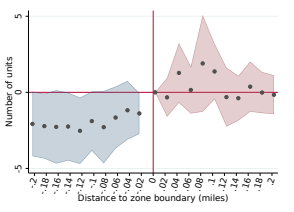
MF and Dupac change



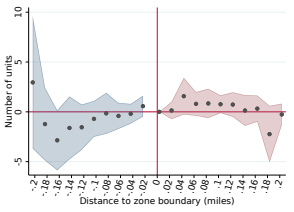
Only MF allowed changes



MF and height change



Only height changes



Placebo checks

Linear Probability Model: Supply of Gentle and High Density Buildings

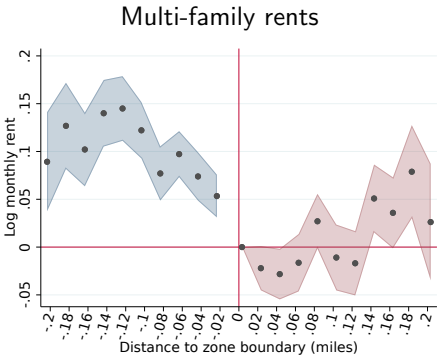
	2-3 units (Gentle Density)				4+ units (High Density)			
	Only MF	Only DUPAC	MF & DUPAC	All	Only MF	Only DUPAC	MF & DUPAC	All
MF allowed	**0.286**		-0.0752	**0.646**	**0.0473**		0.0421	0.0791
	(0.0573)		(0.0510)	(0.179)	(0.0222)		(0.0445)	(0.104)
			MF= **63%**				MF= **110%**	
Height (H)				0.0081				0.0044
				(0.0201)				(0.0113)
BR DUPAC		-0.0199	-0.0772			0.0010	0.0333	
		(0.0401)	(0.0504)			(0.0051)	(0.0434)	
DUPAC (DU)		**0.0018**	-0.0058	**0.0079**		**0.0010**	0.0008	**0.0043**
		(0.0006)	(0.0033)	(0.0028)		(0.0004)	(0.0008)	(0.002)
MFXBR DU			0.0972				-0.0434	
			(0.0561)				(0.0464)	
MFXDU			**0.0103**	**-0.0148**			**0.0022**	-0.005
			(0.0025)	(0.0046)			(0.0009)	(0.0027)
HXDU			DU= **1.89%**	**-0.0028**			DU= **15%**	0.00003
				(0.0009)				(0.0005)
MFXHXDU				0.0043				-0.0003
				(0.0012)				(0.0008)
N	4,543	95,316	31,351	11,864	4,268	93,440	28,928	10832
$\mathbb{E}(y)$	0.278	0.128	0.238	0.376	0.028	0.019	0.020	0.067

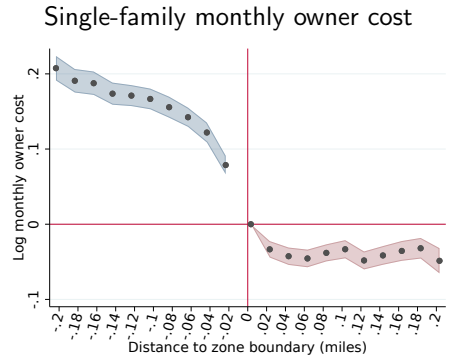
No supply effects from height, DU X height, MF X height All Regressions 2-3 All Regressions 4+ Density

Outline

1. Regulatory Framework for Multi-Unit Housing and Data
2. Empirical Framework
3. Results
    a) Supply
    b) **Rents and home values**
    c) Willingness-to-pay for residential density
4. Policy Effects and Welfare

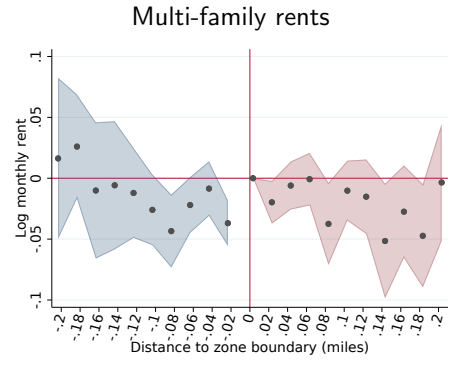
Price Effects: Only Dupac Changes

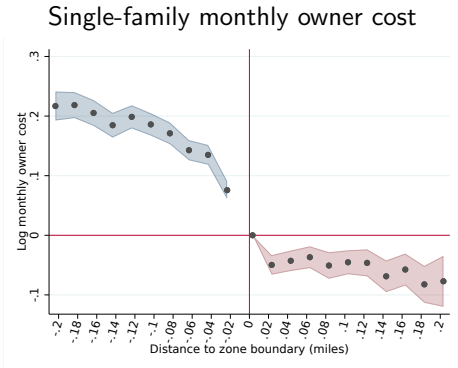




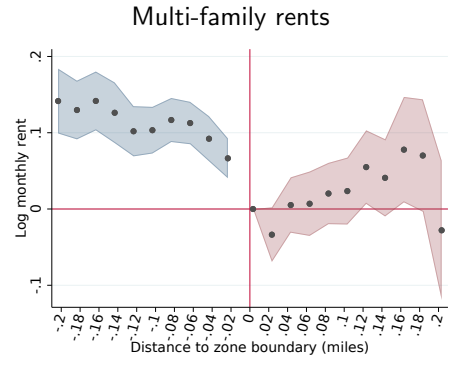
Only MF Only Height

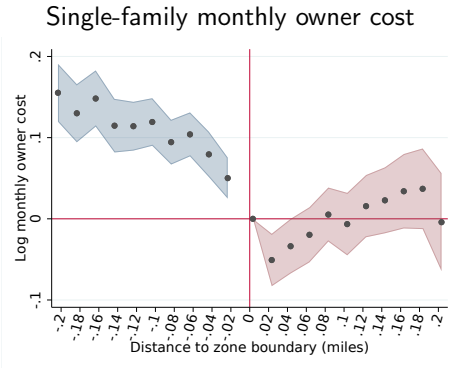
Price Effects: DUPAC and MF Allowed Change





Price Effects: DUPAC and Height Change





Effect on Log Rents and Owner Cost of Housing

	Multi-family (rents)				Single-Family (housing costs)			
	Only DU	MF & DU	DU & H	All	Only DU	MF & DU	DU & H	All
MF allowed		**0.162**		0.0488		0.0277		-0.0137
		(0.0760)		(0.104)		(0.035)		(0.099)
BR Height		MF **1.0%**	0.0625				-0.0023	
			(0.0953)				(0.040)	
Height (H)			-0.0002	0.0008			0.00036	0.0068
			(0.0113)	(0.0106)		BRD **-0.01%**	(0.0074)	(0.0088)
BR DUPAC	**0.0662**	0.105	0.0591		**0.0563**	**0.0825**	0.0477	
	(0.0258)	(0.0551)	(0.0653)		(0.0179)	(0.0263)	(0.0347)	
DUPAC (DU)	-0.0005	**-0.0029**	**-0.002**	0.0014	**-0.0018**	**-0.0029**	-0.0013	0.0026
	(0.0006)	(0.0011)	(0.0006)	(0.0017)	(0.0005)	(0.0008)	(0.0007)	(0.0017)
MFXBR DU		**-0.190**	DU **-0.16%**			**-0.0887**		
		(0.0747)				(0.0386)		
MFXDU		0.0027		-0.0001		**0.0033**		-0.0023
		(0.0016)		(0.0034)		(0.0009)		(0.0034)
HXDU		DU **-0.18%**	0.0001	-0.0004		DU **0.28%**	0.00012	-0.0004
			(0.0001)	(0.0004)			(0.0001)	(0.0004)
MFXHXDU				-0.0003				0.0005
				(0.0009)				(0.0008)
N	188,943	134,737	147,439	118,984	1,083,736	394,545	163,174	172,040
$\mathbb{E}(y)$	$1,076	$1,026	$1,007	$892	$2,133	$1,713	$1,455	$1,434

All Regulations MF1 | All Regulations MF2 (all characteristics) | All Regulations MF3 (no characteristics) | All Regulations SF

Outline

1. Regulatory Framework for Multi-Unit Housing and Data
2. Empirical Framework
3. Results
    a) Supply
    b) Rents and home values
    c) **Willingness-to-pay for residential density**
4. Policy Effects and Welfare

WTP for Residential Density: Negative Density Spillovers

	Only Dupac	MF & Dupac	Dupac & Height	All
		Multi-Family (rents)		
θ^{HD}	**-0.407**	**-0.249**	**-0.329**	**-0.420**
	(0.079)	(0.102)	(0.082)	(0.077)
θ^{GD}	**-0.109**	**-0.089**	0.030	**-0.102**
	(0.039)	(0.038)	(0.041)	(0.042)
N	188,943	134,737	147,439	118,984
$\mathbb{E}(y)$	$1,076	$1,026	$1,007	$892
$\mathbb{E}(\theta^{HD})$	0.0994	0.0447	0.1112	0.0847
$\mathbb{E}(\theta^{GD})$	0.4033	0.4014	0.5227	0.4836
		Single-Family (housing costs)		
θ^{HD}	**-0.125**	**-0.115**	0.0477	-0.0203
	(0.0455)	(0.0516)	(0.0540)	(0.0555)
θ^{GD}	**-0.227**	**-0.172**	**-0.072**	**-0.24**
	(0.0295)	(0.0340)	(0.0318)	(0.0441)
N	1,081,116	394,460	163,021	172,040
$\mathbb{E}(y)$	$2,133	$1,713	$1,455	$1,434
$\mathbb{E}(\theta^{HD})$	0.0287	0.0257	0.0805	0.0548
$\mathbb{E}(\theta^{GD})$	0.1416	0.2393	0.4046	0.3466

Robustness (Donut RD) Density across Space All Regulations Share plots

Outline

1. Regulatory Framework for Multi-Unit Housing and Data
2. Empirical Framework
3. Results
    a) Supply
    b) Rents and home values
    c) Willingness-to-pay for residential density
4. **Policy Effects and Welfare**

Welfare and Policy Effects

- Effect of change in regulations on rents and house prices:
  1. Direct effect: supply $\downarrow$ or demand $\uparrow$ effects, option value (home owners only)
     - Estimated causal parameter (ρ_1) of regulation changes from hedonic price model
  2. Density spillover:
     - Change in regulation $\rightarrow$ change in supply of GD and HD (LPM model estimates)
     - Increased GD and HD supply $\rightarrow$ negative desnity amenity parameters (θ_{GD} and θ_{HD})
- Thought experiment: Turner et al (2014) and Diamond & McQuade (2017)
  - **Local** welfare changes for renters and owners
  - Block groups (near transit stops, Schuetz et al (2020)) in suburban counties: Essex, Middlesex, Norfolk
  - Change Dupac or Dupac + Height, **holding fixed** unobserved amenities

	Only Dupac		Height and Dupac			
	Renters	Owners	Renters		Owners	
			Dupac	Height	Dupac	Height
Waltham (Middlesex County)						
Average Δ *Regulation* ($)		-3.69				-4.98
Induced Δ θ_{GD} ($)	-3.32	-1.02				
Δ annual rent/owner cost $ (%)	**-40 (-0.27%)**	**-56 (-0.13%)**				**-60 (-0.14%)**
Gloucester (Essex County)						
Average Δ *Regulation* ($)						-7.96
Induced Δ θ_{GD}		-27.32		-258.26		-31.98
Δ annual rent/owner cost $ (%)		**-328 (-0.75%)**	**-3,099 (-7.24%)**		**-479 (-1.09%)**	
Sharon (Norfolk County)						
Average Δ *Regulation* ($)	8.40	-0.92				
Induced Δ θ_{GD} ($)			215.31		-84.88	
Δ annual rent/owner cost $ (%)	**101 (0.25%)**	**-176 (-0.44%)**	**2,584 (6.44%)**		**-16,193 (-40.35%)**	

Conclusion

Conclusion

- Supply effects of regulation(s):
  - DUPAC regulations, alone or with relaxing height and single-family zoning, have largest effect $\uparrow$ MF supply
  - Relaxing MF regulations only (Minneapolis), much less effects on $\uparrow$ MF supply
- Price effects of regulation(s):
  - Supply effects mostly outweigh option value for SF home prices
  - Combinations of DUPAC & other regulations are most effective $\downarrow$ MF rents
  - SF home owners' and renters' WTP for gentle and high density is negative; outweighs direct regulation effects
- Welfare effects are heterogeneous across space:
  - Driven by both distance to CBD and average area income

Thanks!

Please send comments or questions to:

amrita.kulka@nyu.edu
aradhya.sood@utoronto.ca
nick.chiumenti@bos.frb.org

Appendix

Chapter 40B, HUD, and Land Regulations

- Two types of 40B (693):
  - Comprehensive permits (485): denied at local level; overridden by state zoning board
  - Non-Comprehensive permits (208): counted as affordable although not denied
  - Both important as counted towards 10% cut-off
  - HUD (691)
- Interaction between 40B and land use regulation:
  - Substitute: 40B override is more likely in more regulated areas
  - Complement: 40B override is less likely in more regulated areas

Chapter 40B and Land Regulation (All Regulations Change)

	All 40B	Comp 40B	HUD
MF allowed	**-0.334**	**-0.337**	-0.0135
	(0.165)	(0.158)	(0.0207)
Height (in 10 ft)	0.0034	0.0031	-0.0006
	(0.0032)	(0.0033)	(0.0032)
DUPAC	0.00001	-0.0001	0.0001
	(0.0004)	(0.0004)	(0.0005)
MF X Height	**0.0812**	**0.0764**	0.0047
	(0.0356)	(0.0331)	(0.0056)
MF X DUPAC	**0.0069**	0.0070	-0.0007
	(0.0034)	(0.0034)	(0.0009)
Height X DUPAC	-0.0004	-0.0005	-0.0001
	(0.0002)	(0.0003)	(0.0002)
MF X Height X DUPAC	**-0.0013**	**-0.0012**	0.0003
	(0.0005)	(0.0005)	(0.0003)
N	6,272	6,272	6,272
$\mathbb{E}(y)$	.0049	.0044	.0064

- MF Allowed: **-4.420** pp
- Height X MF = 1: **6.673** pp
- Dupac X MF = 1: **0.109** pp

Effect on rents (full controls)

	Only height	Only DUPAC	MF & Height	MF & DUPAC	DUPAC & height	All
MF allowed			0.114	0.0721		0.0346
			(0.0867)	(0.0792)		(0.0881)
BR Height	-0.0769		0.242		0.0237	
	(0.0981)		(0.140)		(0.0844)	
Height (in 10 ft)	**0.0141**		**-0.0592**		0.0031	-0.0043
	(0.0064)		(0.0250)		(0.0112)	(0.008)
BR DUPAC		**0.0887**		0.0567	0.0631	
		(0.0168)		(0.0355)	(0.0539)	
DUPAC		-0.0003		**-0.0017**	-0.0001	-0.0016
		(0.0004)		(0.0007)	(0.0006)	(0.0013)
MF X BR DUPAC				-0.120		
				(0.0791)		
MF X DUPAC				0.0019		0.0033
				(0.001)		(0.0031)
Height X DUPAC					-0.0001	**0.0006**
					(0.0001)	(0.0003)
BR (Height X DUPAC)					-0.0117	
					(0.0782)	
MF X Height X DUPAC						-0.0012
						(0.0008)
N	17,060	188,943	6,097	134,737	147,439	118,984
$\mathbb{E}(y)$	\$875	\$1,076	\$819	\$1,026	\$1,007	\$892

Back to

Effect on Log rents for MF homes (bandwidth = 0.5 miles)

	Only height	Only DUPAC	MF & Height	MF & DUPAC	DUPAC & height	All
MF allowed			**0.412**	**0.162**		0.0488
			(0.117)	(0.0760)		(0.104)
BR Height	-0.155		**0.542**		0.0625	
	(0.104)		(0.219)		(0.0953)	
Height (in 10 ft)	**0.0399**		-0.0631		-0.0002	0.0008
	(0.0140)		(0.0359)		(0.0113)	(0.0106)
BR DUPAC		**0.0662**		0.105	0.0591	
		(0.0258)		(0.0551)	(0.0653)	
DUPAC		-0.0005		**-0.0029**	**-0.002**	0.0014
		(0.0006)		(0.0011)	(0.0006)	(0.0017)
MF X BR DUPAC				**-0.190**		
				(0.0747)		
MF X DUPAC				0.0027		-0.0001
				(0.0016)		(0.0034)
Height X DUPAC					0.0001	-0.0004
					(0.0001)	(0.0004)
BR (Height X DUPAC)					0.0251	
					(0.0916)	
MF X Height X DUPAC						-0.0003
						(0.0009)
N	17,060	188,943	6,097	134,737	147,439	118,984
$\mathbb{E}(y)$	\$875	\$1,076	\$819	\$1,026	\$1,007	\$892

Back to

Effect on rents (no controls)

	Only height	Only DUPAC	MF & Height	MF & DUPAC	DUPAC & height	All
MF allowed			0.0740	**0.184**		0.202
			(0.251)	(0.0789)		(0.184)
BR Height	-0.188		0.247		0.151	
	(0.118)		(0.162)		(0.0859)	
Height (in 10 ft)	0.0270		-0.0257	-0.007	0.0031	
	(0.0176)		(0.0264)	(0.0105)	(0.0114)	
BR DUPAC		**0.0725**		0.118	0.0097	
		(0.0270)		(0.0604)	(0.0916)	
DUPAC		-0.00086		**-0.0032**	**-0.0023**	0.00004
		(0.0006)		(0.0013)	(0.0008)	(0.003)
MF X BR DUPAC				**-0.207**		
				(0.0785)		
MF X DUPAC				0.0029		-0.0022
				(0.002)		(0.004)
Height X DUPAC					0.0001	0.0001
					(0.0001)	(0.0008)
BR (Height X DUPAC)					0.0227	
					(0.111)	
MF X Height X DUPAC						-0.0004
						(0.001)
N	17,620	192,098	6,324	135,981	149,351	120,820
$\mathbb{E}(y)$	\$875	\$1,076	\$819	\$1,026	\$1,007	\$892

Back to

Effect on Log Prices of Single-Family Houses (bandwidth = 0.5 miles)

	Only MF	Only height	Only DUPAC	MF & height	MF & DUPAC	DUPAC & height	All
MF allowed	-0.0201			-0.450	0.0367		-0.0142
	(0.0159)			(0.234)	(0.0348)		(0.089)
BR height		0.122		**-0.168**	MF= **-1.7%**	0.0153	
		(0.0948)		(0.077)		(0.0383)	
Height (in 10 ft)		-0.0114		-0.108		-0.0015	0.0037
		(0.0228)		(0.0567)	BRD= **-1.1%**	(0.0069)	(0.009)
BR DUPAC			0.0338		**0.0780**	0.0486	
			(0.0180)		(0.0232)	(0.0347)	
DUPAC			**-0.0016**		**-0.0026**	-0.0013	0.0022
			(0.0004)		(0.0007)	(0.0007)	(0.0016)
MF X BR DUPAC					**-0.0893**		
					(0.0370)		
MF X DUPAC					**0.0028**		-0.0015
					(0.0007)		(0.0029)
Height X DUPAC					MFD= **-0.15%**	0.0001	(-0.0002)
						(0.0001)	(0.0004)
BR (Height X DUPAC)						-0.0281	
						(0.0399)	
MF X Height X DUPAC							0.0003
							(0.0007)
N	59,314	50,223	1,081,116	28,435	394,460	163,021	172,040
$\mathbb{E}(y)$	$1,821	$1,968	$2,133	$1,661	$1,713	$1,455	$1,434

Back to

WTP for Residential Density: Negative Density Spillovers

Back to

	Only MF	Only height	Only Dupac	MF height	MF & Dupac	Dupac & height	All
MF homes							
θ^{HD}		**-0.364**	-0.0355	0.171	0.0280	-0.00789	-0.0931
		(0.107)	(0.0660)	(0.122)	(0.0850)	(0.0570)	(0.0681)
θ^{GD}		-0.184	**-0.0737**	0.0706	-0.0355	0.0461	**-0.0665**
		(0.114)	(0.0315)	(0.116)	(0.0263)	(0.0323)	(0.0337)
N	26,439	17,060	188,943	6,097	134,737	147,439	118,984
$\mathbb{E}(y)$	\$1,025	\$875	\$1,076	\$819	\$1,026	\$1,007	\$892
Single Family							
θ^{HD}	0.0720	-0.396	**-0.110**	0.0112	**-0.128**	0.0438	-0.0521
	(0.180)	(0.231)	(0.0452)	(0.145)	(0.0469)	(0.0531)	(0.0474)
θ^{GD}	-0.0308	**-0.467**	**-0.213**	**-0.171**	**-0.145**	**-0.0698**	**-0.195**
	(0.046)	(0.126)	(0.0267)	(0.0495)	(0.0282)	(0.0297)	(0.0326)
N	59,314	50,223	1,081,116	28,435	394,460	163,021	172,040
$\mathbb{E}(y)$	\$1,821	\$1,968	\$2,133	\$1,661	\$1,713	\$1,455	\$1,434
$\mathbb{E}(\theta^{HD})$	0.0169	0.1107	0.0287	0.0246	0.0257	0.4046	0.0548
$\mathbb{E}(\theta^{GD})$	0.1358	0.1825	0.1416	0.155	0.2393	0.0805	0.3466

For SF: $\mathbb{E}(\theta^{GD}) \in [-0.47; -0.07]$, $\mathbb{E}(\theta^{HD}) \in [-0.13; -0.11]$

For MF: $\mathbb{E}(\theta^{GD}) \in [-0.073; -0.067]$, $\mathbb{E}(\theta^{HD}) \in [-0.364]$

Supply of 2-3 Units Homes

Back to

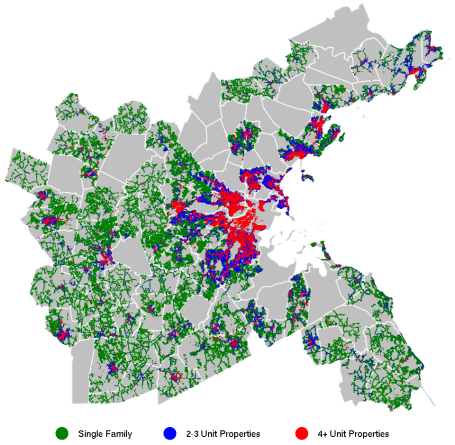
	Only MF	Only height	Only DUPAC	MF & Height	MF & DUPAC	DUPAC & height	All
MF allowed	**0.286**			0.0462	-0.0752		**0.646**
	(0.0573)			0.575	(0.0510)		(0.179)
BR Height		0.101		0.0287	MF= **15.0 pp**	0.0209	
		(0.0957)		(0.454)		(0.0574)	
Height (in 10 ft)		-0.0236		-0.0554		-0.0074	0.0081
		(0.0308)		(0.148)	BRD= **2.0 pp**	(0.0115)	(0.0201)
BR DUPAC			-0.0199		-0.0772	0.134	
			(0.0401)		(0.0504)	(0.0764)	
DUPAC			**0.0018**		-0.0058	0.0006	**0.0079**
			(0.0006)		(0.0033)	(0.0022)	(0.0028)
MF X BR DUPAC					0.0972		
					(0.0561)		
MF X DUPAC					**0.0103**		**-0.0148**
					(0.0025)		(0.0046)
Height X DUPAC					MFD= **0.45 pp**	0.0001	**-0.0028**
						(0.0002)	(0.0009)
BR (Height X DUPAC)						-0.129	
						(0.0817)	
MF X Height X DUPAC							**0.0043**
							(0.0012)
N	4,543	3,953	95,316	1,970	31,351	9,920	11,864
$\mathbb{E}(y)$	0.278	0.173	0.128	0.158	0.238	0.433	0.376

Supply of 4+ Units Homes

Back to

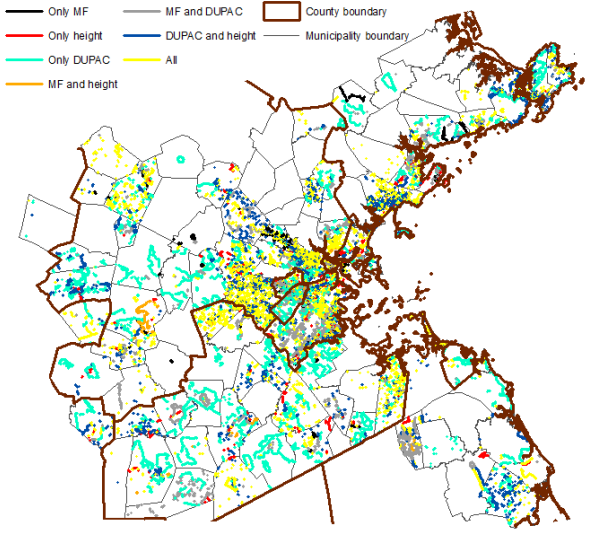
	Only MF	Only height	Only DUPAC	MF & Height	MF & DUPAC	DUPAC & height	All
MF allowed	**0.0473**			-0.249	0.0421		0.0791
	(0.0222)			(0.173)	(0.0445)		(0.104)
BR height		0.0850		0.109	BRD = **2.2 pp**	-0.0255	
		(0.0644)		(0.0643)		(0.0420)	
Height (in 10 ft)		-0.0317		-0.0893		0.0043	0.0044
		(0.0206)		(0.0575)	BRD = **-1.01 pp**	(0.0084)	(0.0113)
BR DUPAC			0.0010		0.0333	0.0421	
			(0.0051)		(0.0434)	(0.0629)	
DUPAC			**0.0010**		0.0008	0.0021	**0.0043**
			(0.0004)		(0.0008)	(0.0015)	(0.002)
MF X BR DUPAC					-0.0434		
					(0.0464)		
MF X DUPAC					**0.0022**		-0.005
					(0.0009)		(0.0027)
Height X DUPAC					MFD= **0.30 pp**	-0.00001	0.00003
						(0.0001)	(0.0005)
BR (Height X DUPAC)						-0.0441	
						(0.0695)	
MF X Height X DUPAC							-0.0003
							(0.0008)
N	4,268	3,914	93,440	1874	28,928	8,664	10832
$\mathbb{E}(y)$	0.028	0.091	0.019	0.023	0.020	0.094	0.067

Density across Space



Back to

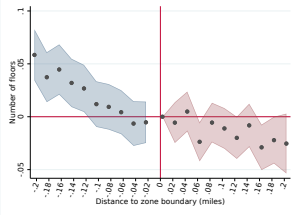
Regulation Boundaries across Space



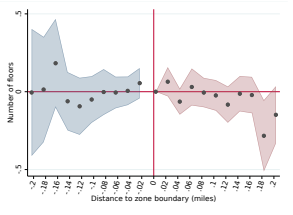
Back to

Supply: Number of floors

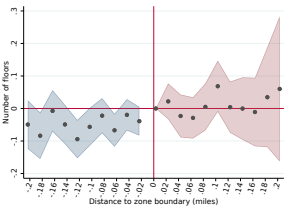
Only Dupac changes



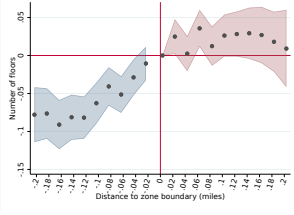
Only height changes



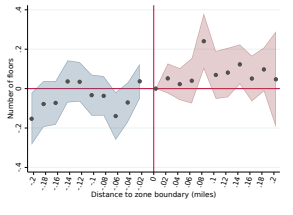
Only MF allowed changes



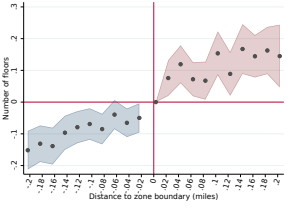
MF and Dupac change



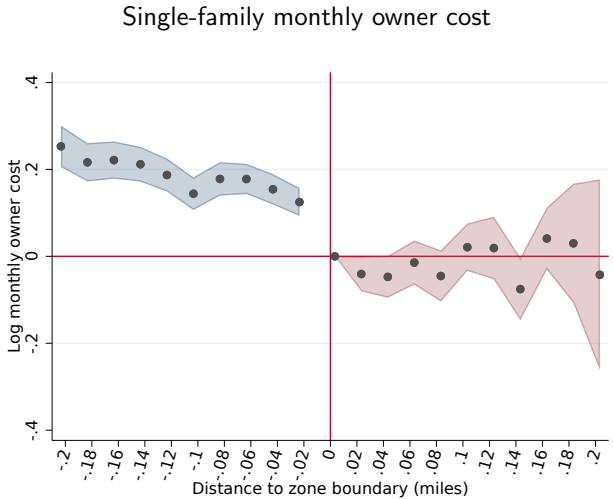
MF and height change



Dupac and height change

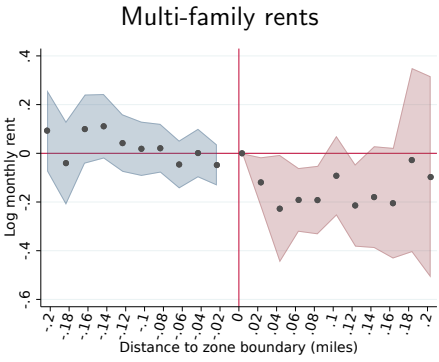


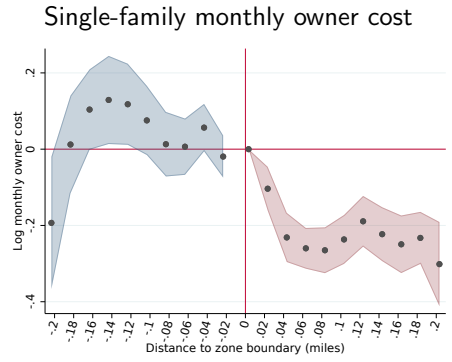
Price Effects: Only MF Allowed Changes



Back to

Price Effects: Only Height Changes



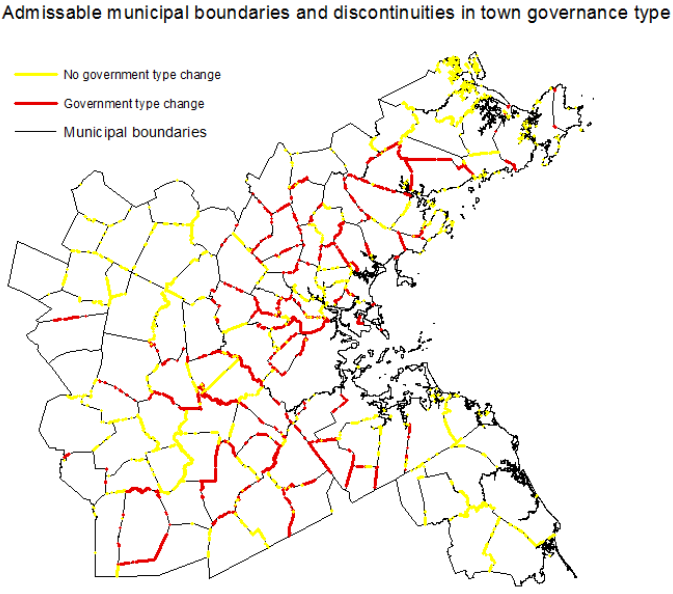


Back to

Regression Discontinuity Across Towns

- Effect of **local governance structures** on all prices and supply of MF housing
- Town boundaries offer variation
  - Compare houses where land regulations don't change
  - Remove boundaries that cross highways, rivers
- Identifying Assumptions:
  1. On both sides of boundary: type of housing, density changes with governance
  2. Close to boundary on both sides: unobserved location quality doesn't change
  3. Continuous at boundary: distance to transit and amenities schools
  4. Control: taxes, public spending, town-level land regulations, school quality

Across Town Variation in Local Governance



Towns Included in Analysis

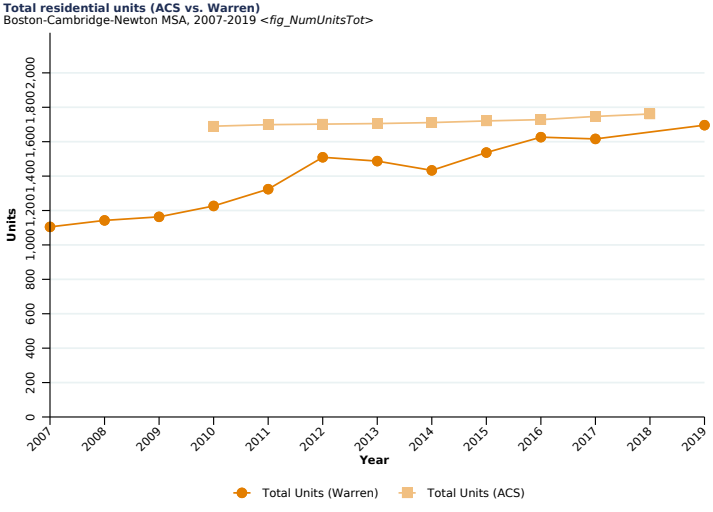
Back to

WTP for Residential Density (Donut $0.1 \leq BW \leq 0.5$)

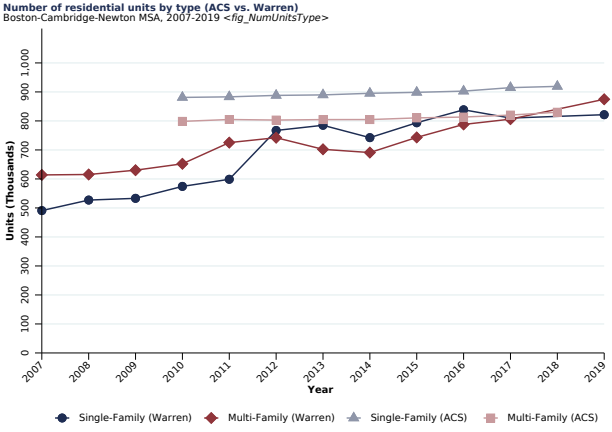
	Only MF	Only height	Only Dupac	MF height	MF & Dupac	Dupac & height	All
All Homes							
θ^{HD}	-0.165	**-1.060**	-0.109	-0.0520	-0.221	0.134	**-0.262**
	(0.247)	(0.282)	(0.0662)	(0.160)	(0.146)	(0.115)	(0.123)
θ^{GD}	-0.0778	-0.483	**-0.201**	-0.124	**-0.195**	0.00425	**-0.214**
	(0.0726)	(0.320)	(0.0542)	(0.0836)	(0.0495)	(0.0411)	(0.0668)
N	29,307	29,362	654,321	18,951	223,706	117,540	118,897
$\mathbb{E}(y)$	$1,821	$1,955	$2,128	$1,655	$1,710	$1,446	$1,439
Single Family							
θ^{HD}	-0.357	-0.512	-0.132	0.155	**-0.152**	-0.0812	-0.0183
	(0.267)	(0.257)	(0.0813)	(0.122)	(0.0569)	(0.0679)	(0.0880)
θ^{GD}	0.164	**-0.482**	**-0.201**	-0.163	**-0.203**	-0.0568	**-0.232**
	(0.0929)	(0.236)	(0.0411)	(0.0974)	(0.0407)	(0.0379)	(0.0508)
N	24,894	23,382	604,110	16,973	188,389	77,731	86,844
$\mathbb{E}(y)$	$1,821	$1,968	$2,133	$1,661	$1,713	$1,455	$1,434
$\mathbb{E}(\theta^{HD})$	0.0170	0.1466	0.0106	0.0153	0.0158	0.0524	0.0304
$\mathbb{E}(\theta^{GD})$	0.1357	0.1220	0.0754	0.1001	0.148	0.3035	0.237

Back to

Validation of Warren Group Data



Validation of Warren Group Data



Note(s): Single family units from ACS include all 1 unit housing units (attached and detached). Single family units in Warren include property address with 1 unit listed. All other types counted as multi-family. Counts only Massachusetts counties.

Source(s): ACS 5-year; Warren Group.

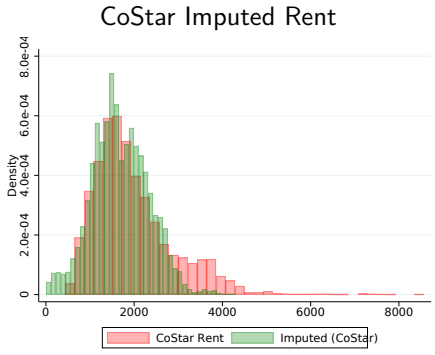
Back to

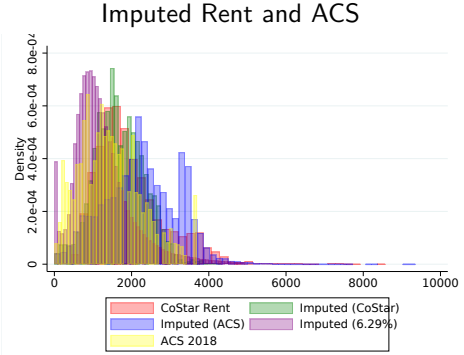
Universe of Buildings and Prices

1. Buildings:
   - Collected and geocoded extensive data of all housing (Co-star, 40B, HUD)
   - Standardize residential use-codes across towns
   - Assign condos based on number of units
2. House prices:
   - Single-family:
     - Yearly tax assessor data
     - Owner cost of housing at 6.29% (BLS, 2017)
   - Multi-family:
     - Owner cost of housing at 6.29% (BLS, 2017)
     - Co-star historic rent [n=6,616]
     - Imputed rent with ACS and detailed Co-star characteristics [n=12,628]
     - Imputed rent with ACS characteristics [n=2,050,745]

Back to

Validating Imputed Rents





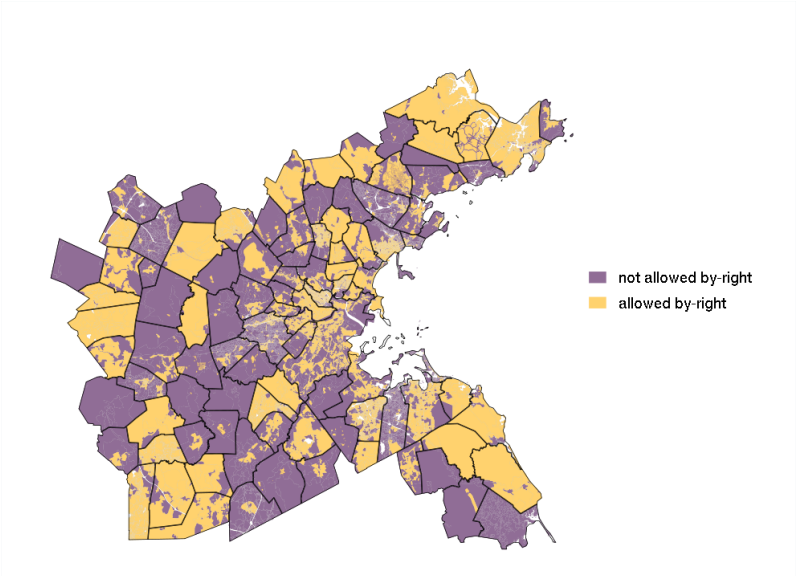
Monthly rent for multi-family:

Owner cost of housing (6.29%) + Co-star rents

Owner cost of housing (6.29%) + Co-star rents + Imputed rent (Co-star)

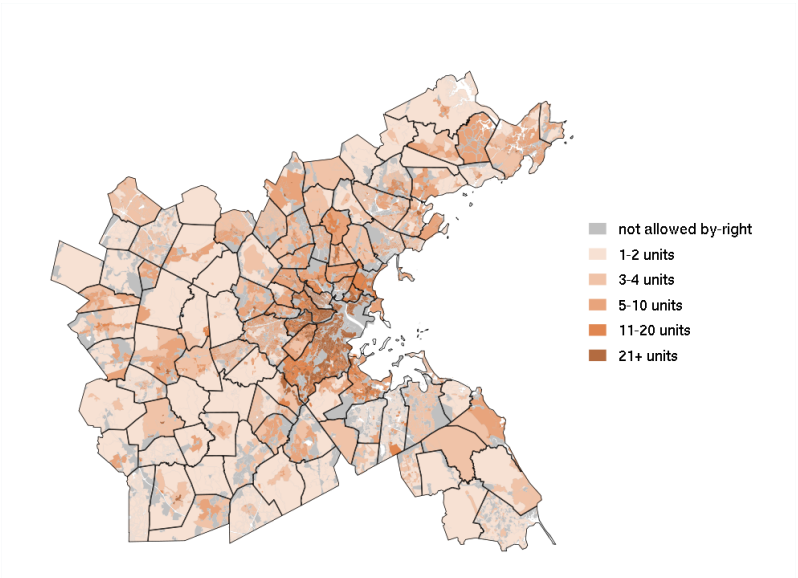
Back to

Multi-Family By-Right Zoning



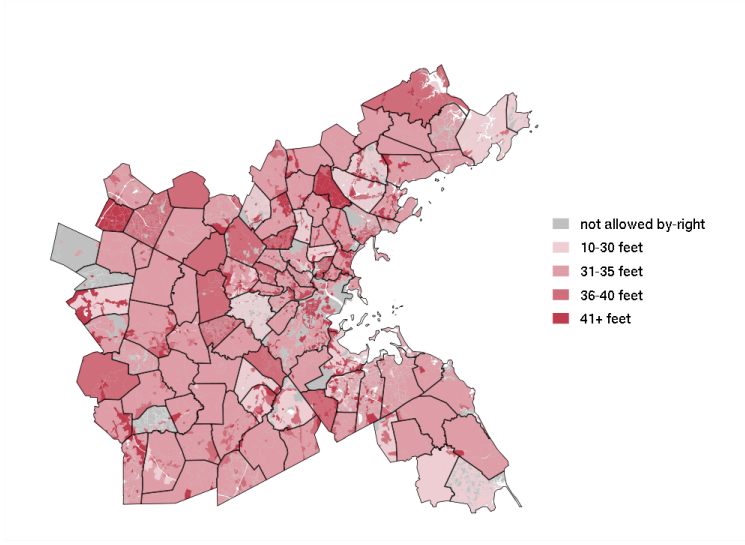
Back to

Dwelling Units Per Acre



Back to

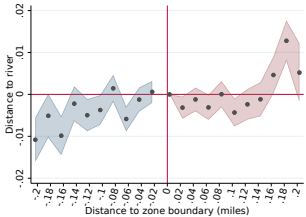
Height Restrictions



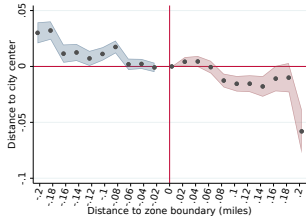
Back to

Distance to Amenities is Continuous at Boundaries

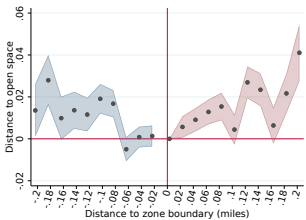
Distance to River or Lake (Dupac)



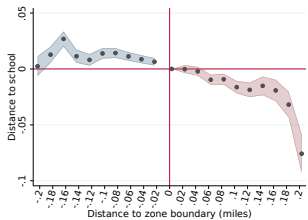
Distance to Center (MF + Dupac)



Distance to Open Space (Dupac)

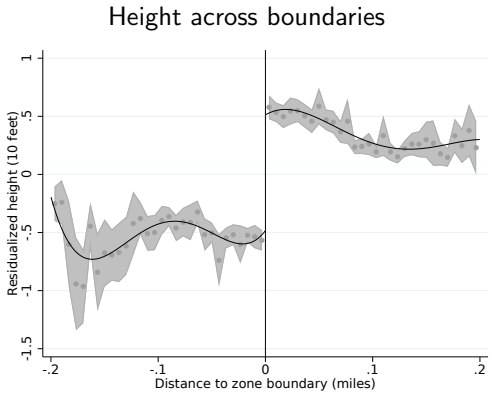


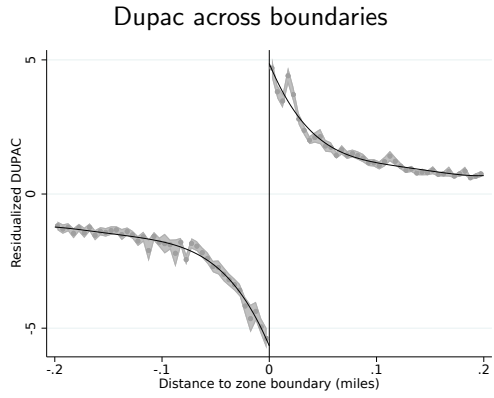
Distance to School (MF + Dupac)



Back to Average regulation change

Regulation Changes across Boundaries

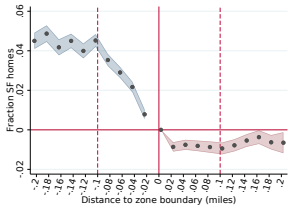




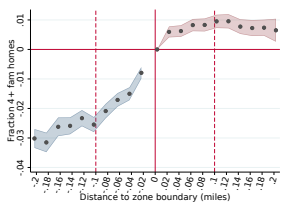
Back to

Residential Density: Gentle and High Density

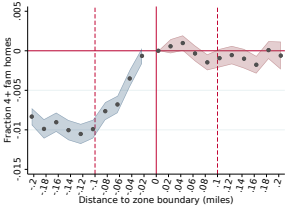
SF (Dupac)



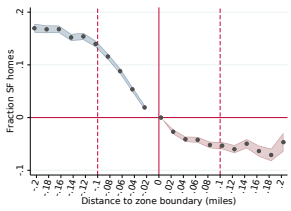
Gentle Density (Dupac)



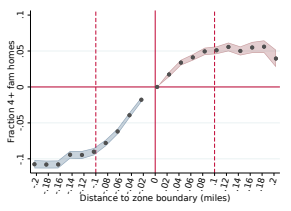
High Density (Dupac)



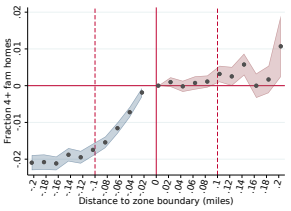
SF (MF + Dupac)



Gentle Density (MF + Dupac)



High Density (MF + Dupac)



Back to

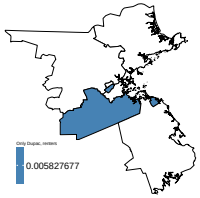
Spatial Heterogeneity in Price Effects

- Different effects of relaxing regulations on house prices across different areas:
  1. Demand effect $\uparrow$: dominates in downtown and CBD (Ring 1)
  2. Supply effect $\downarrow$: dominates in suburbs (Ring 2: easy commute)
  3. Spillovers: $\downarrow$ if households dislike density differently in different locations
- Hypothesis:
  1. Ring 1 (close to CBD, $\leq$ 30 mins): no significant effects/increase in rents and house prices
  2. Ring 2 (commutable to CBD, $\leq$ 1h):
     - 2a) Middle income suburbs: fall in rents and house prices
     - 2b) High income suburbs: strong fall in house prices due to stronger distaste for density

Back to

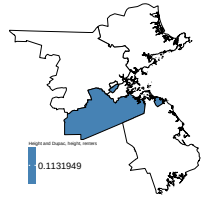
Spatial Heterogeneity in Price: Direct Effects

Rents (Dupac)

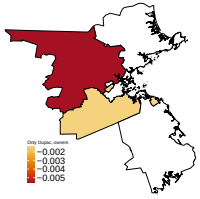


Rents Dupac (DU + H)

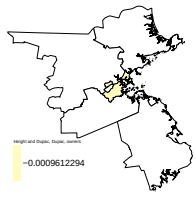
Rents Height (DU + H)



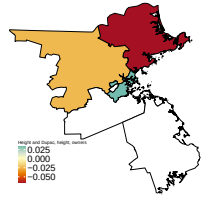
SF prices (Dupac)



SF prices Dupac (DU + H)



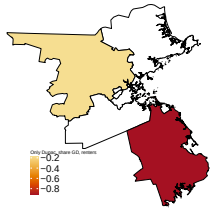
SF prices Height (DU + H)



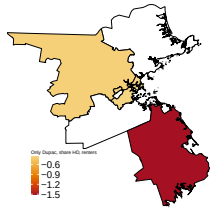
Back to

Spatial Heterogeneity in Price: Distaste for Density

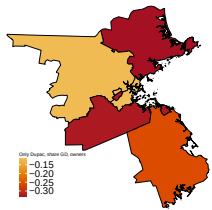
Share GD, renters (Dupac)



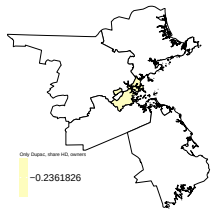
Share HD, renters (Dupac)



Share GD, owners (Dupac)



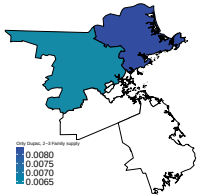
Share HD, owners (Dupac)



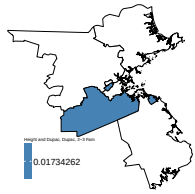
Back to

Spatial Heterogeneity in Supply Effect

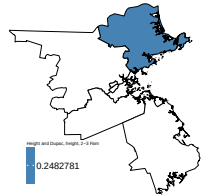
2-3 Fam (Dupac)



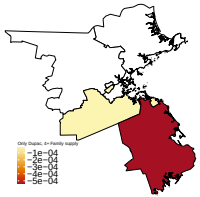
2-3 Fam Dupac (DU + H)



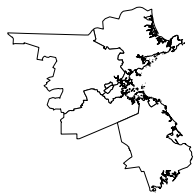
2-3 Fam Height (DU + H)



4+ Fam (DU)



4+ Fam Dupac (DU + H)



4+ Fam Height (DU + H)

Back to

Density across Boundaries

	Density Units				Density Area (sqft)			
	Only MF	Only DUPAC	MF & DUPAC	All	Only MF	Only DUPAC	MF & DUPAC	All
MF allowed	**0.251**		-0.351	-29.92	**0.179**		-0.136	8.329
	(0.079)		(2.044)	(32.09)	(0.042)		(0.187)	(6.373)
Height (H)				-0.540				0.094
				(1.801)				(0.142)
BR DUPAC		-1.294	-1.684			-0.327	**-0.394**	
		(0.771)	(1.361)			(0.287)	(0.166)	
DUPAC (DU)		**0.106**	0.303	-0.362		0.002	**0.020**	0.034
		(0.041)	(0.257)	(0.574)		(0.002)	(0.006)	(0.031)
MFXBR DU			-1.830				0.539	
			(5.285)				(0.351)	
MFXDU			0.402	1.395			-0.016	-0.201
			(0.405)	(1.111)			(0.010)	(0.158)
HXDU				0.098				0.001
				(0.113)				(0.005)
MFXHXDU				-0.518				0.047
				(0.471)				(0.039)
N	326	5274	1791	563	312	4775	1486	450
$\mathbb{E}(y)$								

Back to

Regression Discontinuity Within Towns (1/2)

- We are interested in:
  - Effect of **land use regulations** on all housing prices and supply of MF housing
  - **Spillover effects** of residential density
- Both are correlated with unobserved quality of that location
- To identify **causal** effects need:
  - Variation that determines mix of housing
  - Variation that is orthogonal to unobserved amenities
- Addressing endogeneity: Boundary discontinuity design

Regression Discontinuity Within Towns (2/2)

- Zoning regulation boundaries within towns offer variation
  - Building heights restrictions, minimum lot size first adopted in 1893 in Boston, 1918 in other towns; with rare changes afterwards
- Compare houses within school attendance zones
- Remove boundaries that cross highways, rivers
- Identifying Assumptions:
  1. On both sides of boundary: type of housing, density changes with regulations
  2. Close to boundary on both sides: unobserved location quality doesn't change
  3. Continuous at boundary: public amenities, distance to transit, schools
  4. Mean boundary segment is 0.1 miles (0.04 miles median) [8,313 unique boundaries]

Effect on Log Rents and Owner Cost of Housing

	Multi-family (rents)				Single-Family (housing costs)			
	Only DU	MF & DU	DU & H	All	Only DU	MF & DU	DU & H	All
MF allowed		**0.162**		0.0488		0.0367		-0.0142
		(0.0760)		(0.104)		(0.0348)		(0.089)
BR Height			0.0625				0.0153	
			(0.0953)				(0.0383)	
Height (H)			-0.0002	0.0008			-0.0015	0.0037
			(0.0113)	(0.0106)			(0.0069)	(0.009)
BR DUPAC	**0.0662**	0.105	0.0591		0.0338	**0.0780**	0.0486	
	(0.0258)	(0.0551)	(0.0653)		(0.0180)	(0.0232)	(0.0347)	
DUPAC (DU)	-0.0005	**-0.0029**	**-0.002**	0.0014	**-0.0016**	**-0.0026**	-0.0013	0.0022
	(0.0006)	(0.0011)	(0.0006)	(0.0017)	(0.0004)	(0.0007)	(0.0007)	(0.0016)
MFXBR DU		**-0.190**				**-0.0893**		
		(0.0747)				(0.0370)		
MFXDU		0.0027		-0.0001		**0.0028**		-0.0015
		(0.0016)		(0.0034)		(0.0007)		(0.0029)
HXDU			0.0001	-0.0004			0.0001	(-0.0002)
			(0.0001)	(0.0004)			(0.0001)	(0.0004)
MFXHXDU				-0.0003				0.0003
				(0.0009)				(0.0007)
N	188,943	134,737	147,439	118,984	1,081,116	394,460	163,021	172,040
$\mathbb{E}(y)$	$1,076	$1,026	$1,007	$892	$2,133	$1,713	$1,455	$1,434

All Regulations MF1 | All Regulations MF2 (all characteristics) | All Regulations MF3 (no characteristics) | All Regulations SF