Highlights

Upzoning and Residential Transaction Price in Nashville

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- We analyze the effects of Nashville's 2010 upzoning on housing prices from 2000-2023.
- The study uses matching methods and quantile difference-in-differences for estimation.
- Upzoned parcels saw significant price increases compared to similar untreated parcels.
- Results further imply heterogeneous effects across market segments.
- High-end parcels decreased in price, while low-end parces had price increases.

Upzoning and Residential Transaction Price in Nashville

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Abstract

The impact of upzoning policies on housing affordability remains controversial, as targeted investment, migration, and amenity patterns lead to mixed results. This paper uses difference-in-differences and matching methods to analyze the effects of the 2010 upzoning of downtown Nashville over the period 2000-2023. We find a significant increase in the average price of the treated parcels relative to similar untreated parcels. Estimated quantile treatment effects suggest that house price declines are concentrated at the upper end of the house price distribution, while upzoned parcels at the lower end experience price increases due to positive amenities and retained investment. Our results highlight the importance of heterogeneity in the design and evaluation of upzoning policies.

Keywords: Upzoning, Housing Prices, Natural Experiment

1. Introduction

To date, empirical research on the relationship between changing zoning regimes, levels of housing production and prices has produced mixed results. Coming from an era in which zoning regimes in the United States functioned as a form of both economic and racial discrimination (Maantay, 2002; Rothwell and Massey, 2009; Shertzer et al., 2016; Whittemore, 2017, 2021), much of the early economic analysis of zoning policies tended to focus on the relation between strict zoning regimes and increased housing prices (Glaeser et al., 2005; Quigley and Raphael, 2005; Ihlanfeldt, 2007; Zabel and Dalton, 2011; Gyourko and Molloy, 2015). More recently, however, there has been an increasing focus on upzoning in relation to emerging patterns of urban growth and displacement (Angotti and Morse, 2016; Rodríguez-Pose and Storper, 2020; Lowe and Richards, 2022).

Freemark (2023)'s in-depth literature review highlights the lack of consensus on the relationship between upzoning and housing affordability, importantly drawing attention to the diversity of policy outcomes depending on different spatial, temporal, and regulatory contexts. The potentially path dependent causal chain between long-term house prices and changes in zoning regimes (including potential and varying effects on housing supply in different market segments, neighborhood investments, amenity effects, and migration flows) makes it challenging to isolate a causal determination regarding the promotion of successful zoning policies. In particular, it can be difficult, if not impossible, to disentangle the relationship between up-zoning and the development of amenity structures (such as proximity to employment and leisure activities, as well as *'sense of place'* which can be endogenous to urban density) that drive both urban growth and the demand for housing (Clark et al., 2002). Nevertheless, recent empirical efforts in a variety of geographical and political configurations have exploited heterogeneity within various zoning policies to assess the impact of zoning changes on both housing construction (supply) and housing prices.

Table 1 summarizes the literature on upzoning policies. Studies that examine 1-4 years after upzonings find increases in house prices, in the case of both single-family (in Minneapolis, Kuhlmann (2021) and Auckland, Fernandez et al. (2021)) and multi-family (in Chicago, Freemark (2020)) upzonings. Studies examining the effect of adding accessory dwelling units (ADUs) to single-family zoning in the context of Los Angeles Liu et al. (2024) and Vancouver Davidoff et al. (2022) find heterogeneous effects. In general, house price increases due to ADUs were associated with low-value areas where investment effects could be observed, while price decreases were associated with high-value areas where a combination of supply effects and negative amenity effects (such as increased traffic or negative aesthetics) may have occurred.

Studies of which examine 5-9 years after the upzonings have produced a variety of results. Findings include property values decreases (São Paulo, Anagol et al. (2021)), increases (Phoenix, Atkinson-Palombo (2010)), and no effect (San Jose, Gabbe et al. (2021)). Mixed results may reflect variance in the amount and market segment of additional housing supply that may result from upzonings. Over a longer period, the structure of both housing supply and demand may be path dependent on varied forms of investment and migration, potentially leading to the variety of observed policy outcomes.

To date, the longest studies on the effects of upzoning have examined 10-13 years after implementation. Research at both neighborhood level (Zurich, Büchler and Lutz (2021)) and state level (Brisbane, Murray and Limb (2023)) have found higher prices as the result of upzoning. Only one paper has examined zoning in relation to prices over this time horizon in North America. Gnagey et al. (2023)'s 20 year repeated cross-sectional analysis of ADUs in Ogden, Utah found no effect on property values. Our paper extends this literature by providing the first empirical study of the effect of upzoning on house prices in the Southern United States and for the longest time period. We examine the effect of Nashville's transformative 2010 downtown upzoning (BL2009-586 allowed for unrestricted -by unit density, height, and parkin- mixed use development), on housing parcel transaction prices using repeated cross-sectional data from Davidson County between 2000 and 2023. In the absence of rent data, we use residential transaction prices as a proxy for our more general analytic of housing affordability, as in Freemark (2020).

Combining a hedonic price model with a difference-in-differences approach, we estimate the average treatment effect (ATE) of BL2009-586 on housing prices in Nashville. Our analysis attempts to isolate variation among upzoned multifamily units in which density limits were increased, and 'by-type' zoning was suspended. Our initial estimates yield heterogeneous results, motivating further exploration of ATE through matching methods. Following Büchler and Lutz (2021) and Dong (2024), we use matching to identify control parcels that display similar covariate profiles as treated parcels, removing geographic bias and improving covariate balance. Using synthetic control parcels created with Propensity Score Matching, Generalized Boosted Matching, and Random Forest Matching, we provide evidence of increased prices among upzoned parcels, as compared to the most similar control parcels in Davidson County. Our results are robust to changes in sample size and protracted DiD analysis. Finally, to account for market price segmentation and heterogeneous effects, we apply quantile difference-in-differences as in (Ortiz-Villavicencio et al., 2024). Estimating the quantile treatment effects among three market segments, we present evidence for heterogeneous treatment effects. In particular, we observe increased prices for low-end housing in conjunction with decreasing prices on the high-end of the market. These observations are in line with the growing supply of luxury apartments within the treatment zone, potentially contributing towards supply side effects for high-end parcels while simultaneously exerting positive amenity effects on low-end parcels.

Our findings have important implications for urban practitioners with relation to land use and housing affordability. We provide evidence for the potential limitations of upzoning as a tool to increase housing affordability, emphasizing the segmented nature of both housing supply and demand. Importantly, we continue to draw attention to the path-dependent nature of upzoning policies, acknowledging the constellation of factors, including zoning regimes, migration patterns, mortgage rates, and amenities structures which contribute to specific forms of housing production and consumption in a given place at a given time. The rest of the paper is organized as follows: Section 2 discusses the background of the DTC policy in Nashville, Section 3 presents our data and empirical strategies, Section 4 provides our empirical results and Section 5 concludes.

2. Background

Figure 1: Downtown Code Zoning District and Subdistrict Boundaries

Figures/DTC_Subdistrict_Map.pdf

Notes: This map is sourced from **?***, an attachment to Ordinance No. BL2009-586 as adopted on February 02, 2010.*

Over the past twenty years, Nashville has undergone a remarkable transformation, earning the title of 'Best Real Estate Prospect in the U.S.' for the past three years (Luis Quintero, 2021; Lawson, 2023). As recently as the 1990s, however, downtown Nashville was facing 40 years of decline, lacking a centralized business core or residential areas (Lloyd and Christens, 2012). Fuelling Nashville's urban growth, the intensification of urban density has coincided with a dynamic zoning regime, providing a new model for the city as a hub of urban prosperity and attracting the attention of urban planners across the country (Luis Quintero, 2021). As a critical component of capital investment and residential development, in 2009 the Nashville Metro Council unanimously passed BL2009-586, rezoning all land north of I-40 and south of Jefferson Street to the Downtown Code Zoning District (DTC), shown in Figure 1. Though the implementation of DTC zoning varied slightly due to historic overlays and aesthetic subdistricts, the policy had three major implications: elimination of 'by-type' zoning (allowing mixed-use development), removal of building height limitations, and removal of minimum parking requirements. Effectively, the policy loosened residential density restrictions to the extent that there has never been an '*spot upzoning*' in the DTC since, allowing for residential densities in excess of 1,000 units per acre.[1] Since February 2010, when BL2009-586 was passed, the DTC has been amended fifteen times (nearly on an annual basis), ensuring that land use is maximally taken advantage of in the downtown area. These amendments have meant, that since 2010, there has not been a single 'on-spot' zoning within the DTC, implying that DTC has been flexible enough to not require individual deviations.

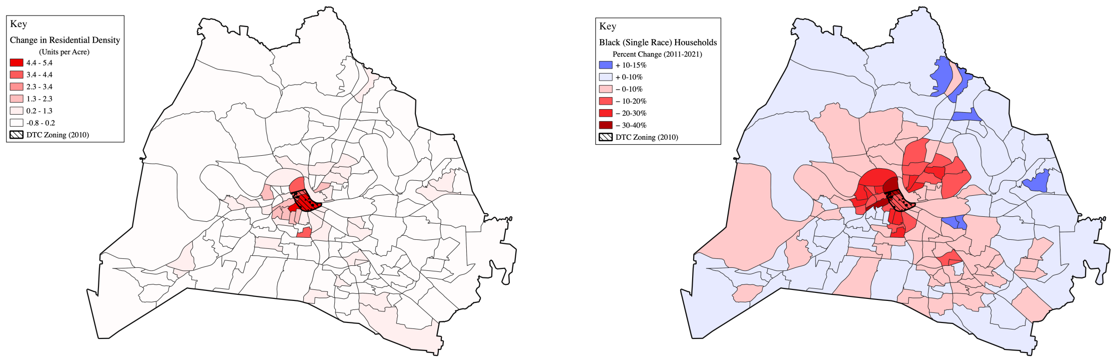
Since 2010, Nashville's downtown has undergone a dramatic transformation, evolving into a hub of economic, cultural, and residential activity. The city's population boom, coupled with a surge in tourism and business investment, has driven the development of high-rise residential towers, mixed-use spaces, and entertainment venues. The Broadway corridor has solidified its reputation as a national destination for live music and nightlife, while areas like the Gulch and SoBro (previously industrial parking lots and never before areas of downtown living) have become hotspots for upscale living and dining for Nashville's affluent class. Through these changes, the DTC has played a crucial role in guiding Nashville's urban growth towards a densification never before seen in the music city, sharply contrasting decades of urban blight and sprawl.

US Census data on residential density (Figure 2a) reflects this relatively rapid intensification of urban residential density in Nashville's core. The recent infill of lux-

[1]While mixed use zoning and the elimination of parking requirements us universal throughout the DTC, height and residential density limits do vary among sub-districts. Height limits range from 6 stories to unlimited, but the DTC now predominately consists of limits above 20 stories. For more information, see **?**.

Figure 2: Residential Density and Racial Change in Davidson County

(a) Residential Density (2010-2020) (b) Racial Change (2011-2021)



Notes: Residential density data sourced from U.S. Census Bureau (2010b, 2021a). Demographic data sourced from U.S. Census Bureau (2010a, 2021b). Map produced by author using QGIS.

ury apartments and even entirely new neighborhoods, such as the Gulch in downtown Nashville, has coincided with ongoing patterns of displacement and peripheralization. Similar to other contemporary urban growth stories, the stunning transformation of Nashville's built environment over the past 15 years has coincided with a consistent and growing affordable housing crisis. (Thurber et al., 2014; Open Table, 2017; Florida, 2017; Johnson, 2018; DCMO, 2021; Commission, 2018a,b, 2019; Carrier, 2021; Tatian et al., 2023). In particular, Nashville's historically black semi-periphery of single-family homes, once considered an area of low amenity, affordable housing, has become some of the hottest real estate on the market, leading to well-documented processes of gentrification and displacement Lockman (2019); Thurber et al. (2021). The displacement of black communities in urban Nashville has been well documented throughout the city in neighborhoods immediately north (Hightower and Fraser, 2020), south/west (Hatfield, 2018; Lockman, 2019) and east (Lloyd, 2011; Miller, 2015) of Nashville's urban core. Peripheralization of Nashville's Black households can be seen in Figure 2b. These patterns of displacement are by no means unique to Nashville, as the resurgence of housing prices in urban cores and the corresponding displacement have been a consistent pattern across American cities in the 21^{st} century (Orfield, 2019).

Given these displacement trends and the continued use of land deregulation as a tool to create affordable housing, our analysis has particular relevance for policymakers considering major upzonings as a tool for increasing housing affordability.[2] To this end, this paper uses BL2009-586 as a quasi-experimental land-use reform to analyze the effects of increased density on housing prices.

To assess the impact of DTC zoning on housing prices, our analysis used records of residential transaction prices from 2000-2023, obtained from Davidson County Planning.[3] Transaction price data is complemented by additional property-level covariates such as parcel area and unit size. We also rely on time-dependent tract-level demographic data from the US Census.

3. Data and Empirical Strategy

3.1. Data

The focus of our empirical analysis is to estimate the effect of the 2010 implimentation of DTC upzoning on housing prices. Given that the prior zoning of the DTC was dominated by various forms of lower density multi-family housing, the variation we seek to capture is that of the effect of increased density limits on multi-family housing combined with potential amenity effects associated with the removal of 'by-type' zoning.[4] In addition, our analysis excludes approximately 800 parcels that underwent spot zoning changes during the same period.[5] In an attempt to estimate the treatment effect of the policy, our analysis attempts to capture the the effects of increased land utility, in the form of residential density increases, removal of height regulations and removal of by-type zoning.

To capture potential variation in house prices, our initial analysis compares the DTC (treatment area) with different geographically defined control areas: 1 km, 3 km, 5 km, and 10 km (see Figure 3). The control areas are broadly representative of Nashville's semi-periphery, both because of their separation from the core (they are

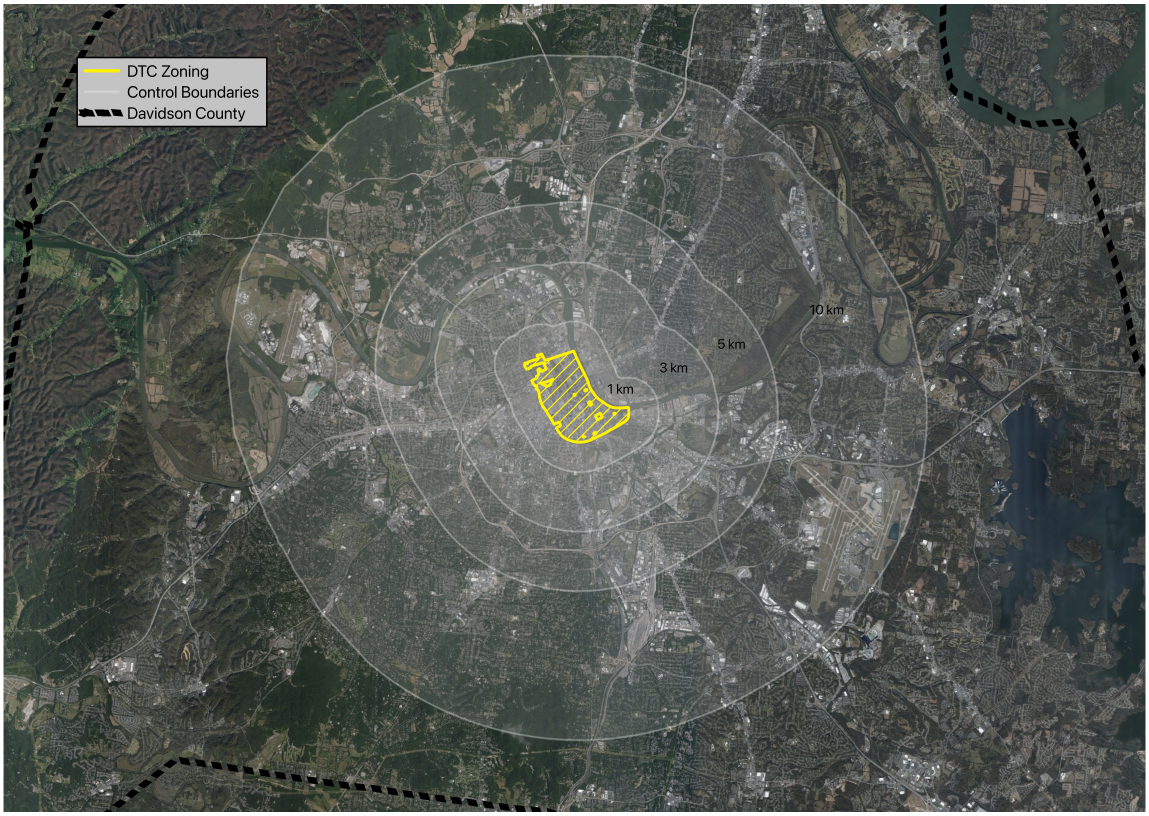
[2]This policy tool continues to gain relevance in the context of Nashville, as the Metro Council has continued to focus on land deregulation as a tool to create affordable housing, passing BL2024-187, which allows for adaptive housing developments, effectively eliminating 'by-type' zoning.

[3]For the average treatment effect (ATE) estimates, we drop observations with zero price and prices above 2.5 million. These observations are restored for the quantile treatment effect (QTE) estimates

[4]Due to the lack of single-family housing in the core prior to the policy intervention, the common trend assumption doesn't seem to hold when comparing the core to single-family housing.

[5]Due to the imprecision with which these zonings were recorded, it was unclear for many parcels whether the zoning change represented an increase in residential land utility or not, which in part led to their exclusion from our analysis.

Figure 3: Downtown Code (DTC) Zoning and Control Boundaries



Notes: Satellite image comparing the showing the Downtown Code Zoning district (in yellow) and various control boundaries in grey. Zoning shapefiles provided by Davidson County planning. Map produced by author using QGIS.

outside the highway loop surrounding the DTC) and because of their proximity to urban development over the past 20 years. Control areas of 3km and less (areas generally within Nashville's 440 highway loop) are traditionally defined by single-family housing and racial segregation. Many of the historically black neighborhoods lie directly east and north of the core, while the west and south are predominately majority white neighborhoods. The spurious and temporally dependent nature of Nashville's residential segregation pose a challenge to inner geographic controls, which is why they are supplemented by farther out control boundaries, representing a less segregated and variant form of Nashville residential housing stock.

3.2. Empirical Strategy

To assess the impact of Nashville's upzoning (BL2009-586) on house prices, we use a hedonic price differences-in-differences analysis that is commonly used in the empirical literature (Freemark, 2020; Kuhlmann, 2021; Gnagey et al., 2023). Our two outcome variables are sale prices and sale prices per square foot. We combine available parcel characteristics data with neighborhood level fixed effects (FE) to limit omitted variable bias.[6] The FE DiD model attempts estimate the ATE of the upzoning while addressing omitted variable bias over time as well as heterogeneity in housing stock across space though the following equation:

$$\ln(K_{pnt}) = \beta_0 + \beta_1 U_p + \beta_2 A_t + \beta_3 U_p A_t + \gamma X_p + \eta_n + \tau_t + \epsilon_{pnt} \tag{1}$$

where K_{pnt} measures the sale price of a residential parcel p in n and year t. A_t is a dummy variable indicating whether the transaction took place before or after the zoning change, and U_p is a dummy variable indicating whether the transaction took place in the DTC (treatment area).[7] X_p represents property level covariates (unit size ft^2, age). In addition to these covariates, η_n is a fixed effect variable for neighborhood effects (as represented by the census tract of the parcels) and τ_t is a fixed effect variable for time (the year of the transaction). β_3 is the main parameter of interest and captures the average effect of the DTC policy. Our DID estimation relies on the common trend assumption that in the absence of the DTC policy, prices of control parcels would follow a similar trend to those of treatment parcels. While this counterfactual remains unobservable, we attempt to assess its potential validity using parallel trends in pre-treatment prices through three primary methods: a visual inspection of annual transaction prices, a comparison of pre-treatment trends on a monthly basis, and a pre-treatment placebo regression analysis.

Figure 4a provides a basic visual comparison of the trend changes in the annual average prices of the control and treatment parcels. For the 3 km diameter control, the trends are broadly similar with a deviation in direction in only one of the 10 pre-treatment years.[8] Our visual inspection of average annual price trends is further supported at the monthly level, as shown in Figure 4b. This plot allows us to see the

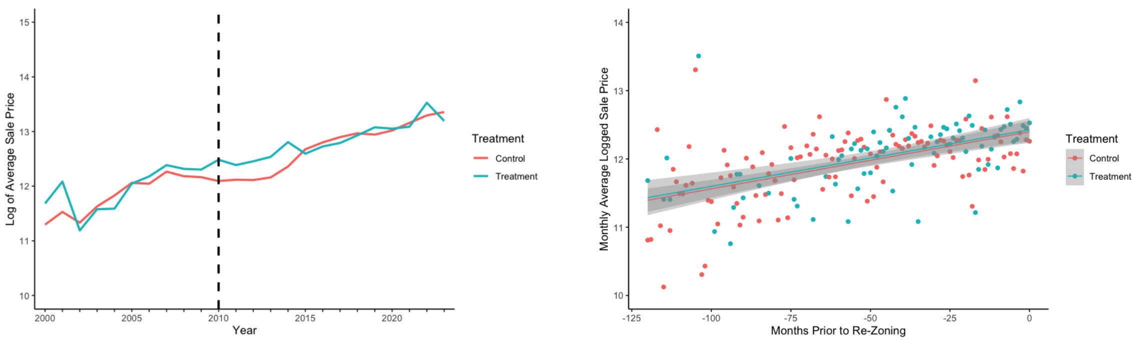
[6] Applying the Hausman specification test confirms the superior performance of fixed effects models over random effects which is consistent with the existing empirical literature on the topic.

[7] Estimates for sale price per square foot rely upon a manipulation of the hedonic model, moving unit size (ft^2) to the left hand side, making the response variable $\ln(K_{pnt}/Sqr.ft_p)$, and removing $Sqr.ft_p$ from the property level covariates X_p.

[8] While Figure 4a isolates the 3 km control group, all other control group trends can be found in the appendix.

Figure 4: Average Sale Price Trends Sale Price By Treatment (3km Control)

(a) Log of Sale Price (2000-2023) (b) Log of Sale Price (2000-2010)



congruence of the trendline fit between treatment and control monthly price averages in the pre-treatment period. The plotted standard error of our trend lines (shaded in the grey area) further demonstrates the similarity of trends between upzoned and control parcels in the pre-treatment period. Finally, we apply pre-treatment placebo regression analysis to identify possible discontinuities in pre-treatment trends. Using only pre-treatment data, we interact placebo treatment times with our treatment group. The results are shown in Figure A.8. Using 95% and 99% confidence intervals, we find no statistical significance in any of our pre-treatment placebo DiD indicators regardless of date. These results combined with Figure 4a support the common trend assumption.

To assess the robustness of the ATE estimates, presented in Section 4.1, and to further account for the heterogeneity of the control groups, we use covariate matching methods presented in Section 4.2. This allows us to create a control group that is similar to the treatment group based on physical and social characteristics of the parcels. This approach is common in the empirical literature on zoning regimes (Büchler and Lutz, 2021; Dong, 2024). Using R's "Matchit" package (Stuart et al., 2011) through Olmos and Govindasamy (2019)'s methodological approach, we attempt to achieve covariate balance between the control and treatment for five key variables: property age, square footage, racial composition (percentage of white residents in a parcel's census tract), educational attainment (percentage of college educated residents in a parcel's census tract), and prior neighborhood investment (census tract building permit frequency in the pre-treatment period). We apply covariate matching using three different matching techniques: Propensity Score Matching, Generalized Boosted Matching, and Random Forest Matching.

Finally, to account for heterogeneous price responses to the DTC policy, we estimate quantile treatment effects of upzoning using quantile difference-in-differences (QDiD), results presented in Section 4.3. Examining treatment effects beyond the mean is particularly useful for identifying potentially heterogeneous treatment effects that may arise due to the segmented nature of housing markets. Similar to Ortiz-Villavicencio et al. (2024), we estimate QDiD using a quantile version of equation (1). Another approach to estimating QDiD is the Change in Changes (CIC) method of Athey and Imbens (2006). However, CIC relies on strong distributional assumptions that are unlikely to hold for limited sample sizes. QDiD was used to estimate treatment effects at the first, second and third quartiles representing low, medium and high market value transactions.

4. Findings

4.1. Average Treatment Effect

Tables 3a and 3b provide estimates for the average treatment effect (ATE) using the four control areas (1 km, 3 km, 5 km, and 10 km) on both price and price per square foot. Starting with the comparison of sales prices of upzoned parcels and the 1 km control group, our estimates for the effect of upzoning (the interaction term) suggest a small negative effect, which is significant in the case of price per square foot. However, these results are not robust to changes in distance from the core, as neither the 3 km nor the 5 km controls yield negative estimates. Interestingly, for sale price, comparing treated parcels to a 10 km diameter control group leads to positive and significant estimates of the treatment effect. These results suggest that, on average, upzoned parcels became more expensive compared to the larger control group. These results are furthered by our 3km TWFE event study presented in Figure 3 which demonstrates an upward trend in housing prices in the five years after policy implementation, with waning increases as the years after implementation increases.[9]

[9] Complete event study figures for all control groups can be found in the appendix.

Figure 5: Staggered Treatment (TWFE), Log of Sale Price, 3km Control (2000-2022)

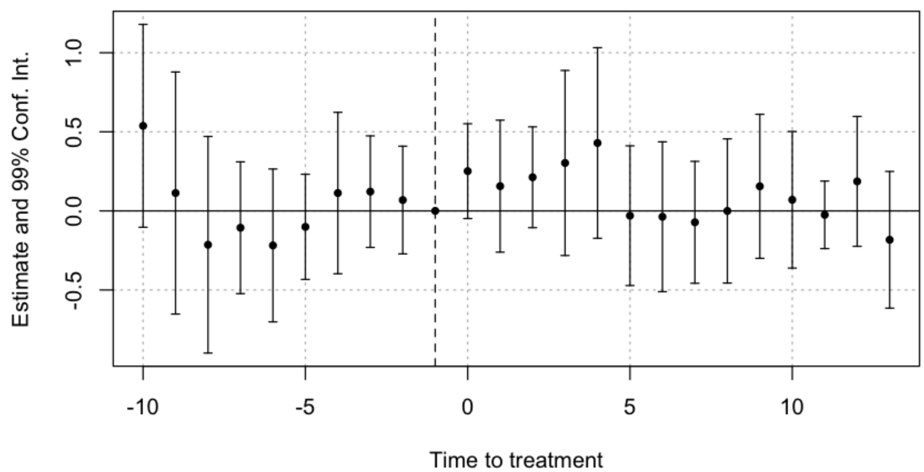


Table 1: Summary of Recent Research on Upzoning and Housing Price

Post-Treatment Study Period	**Summary of recent research findings**	**Recent studies**
1-4 years	Most studies conclude that upzoning increased housing costs as compared to non-upzoned areas. Studies focusing on heterogeneous trends tend to find this effect is largest among low-value units and small or even negative among higher market housing prices.	Freemark (2020); Fernandez et al. (2021); Greenaway-McGrevy et al. (2021); Kuhlmann (2021); Davidoff et al. (2022); Stacy et al. (2023); Liu et al. (2024); Ortiz-Villavicencio et al. (2024)
5-9 years	Mixed results, including property value decreases, no effect, and price increases.	Atkinson-Palombo (2010); Anagol et al. (2021); Gabbe et al. (2021)
10-13 years	A majority of estimates show that upzoning resulted in housing price increases. In the case of ADUs, there was no effect on housing prices.	Büchler and Lutz (2021); Gnagey et al. (2023); Murray and Limb (2023)

Source: Adapted from Freemark (2023)'s review of the scholarship. Detailed table located in the appendix.

Table 2: Comparison of Sale price by Group and Period

(a) Mean Sale Price

	Time	
Group	Before	After
Treatment (DTC)	233,111	593,831
1k Control	202,242	539,621
3k Control	215,191	523,991
5k Control	207,624	512,616
10k Control	192,719	495,268
All Davidson County	187,159	391,267

(b) Mean Sale Price Per Square Foot

	Time	
Group	Before	After
Treatment (DTC)	239.89	549.13
1k Control	170.82	340.80
3k Control	158.10	328.83
5k Control	149.85	298.69
10k Control	129.76	277.02
All Davidson County	130.45	233.92

Notes: Before and after, represent whether the parcel was transacted before or after treatment time (February of 2010). Control boundaries can be seen in Figure 3.

Table 3: Fixed Effects Difference-in-Differences with Geographic Control Groups

(a) Sale Price

	Dependent variable: log(Sale Price)			
Control Boundary:	(1 km)	(3 km)	(5 km)	(10 km)
DTC*Time Period	−0.088	0.029	0.055	0.131***
	(0.057)	(0.043)	(0.035)	(0.034)
DTC	0.168***	0.041	−0.003	−0.058
	(0.056)	(0.045)	(0.038)	(0.037)
Time Period	0.097	0.006	−0.093	0.032
	(0.150)	(0.111)	(0.082)	(0.064)
Finished Area	0.00004***	0.00004***	0.0001***	0.00001***
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Age	−0.016***	−0.009***	−0.010***	−0.013***
	(0.001)	(0.0004)	(0.0003)	(0.0002)
Tract FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	4,448	9,989	17,145	27,684
R^2	0.496	0.436	0.483	0.557
Adjusted R^2	0.491	0.432	0.480	0.554

(b) Sale Price Per Square Foot

	Dependent variable: log(Sale Price Per Sqr. ft)			
Control Boundary:	(1 km)	(3 km)	(5 km)	(10 km)
DTC*Time Period	−0.078*	0.046	0.115***	0.143***
	(0.046)	(0.038)	(0.030)	(0.027)
DTC	0.246***	0.176***	0.094***	0.079***
	(0.045)	(0.039)	(0.032)	(0.029)
Time Period	−0.106	−0.105	−0.232***	−0.169***
	(0.122)	(0.097)	(0.070)	(0.051)
Age	−0.013***	−0.009***	−0.006***	−0.007***
	(0.001)	(0.0004)	(0.0002)	(0.0002)
Tract FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	4,448	9,989	17,145	27,684
R^2	0.628	0.544	0.551	0.609
Adjusted R^2	0.625	0.541	0.548	0.608

*Note: This table uses fixed effects ordinary least squares to estimate the effect of upzoning on housing price. Each column represents a different control area (as depicted in Figure 3. The variable of key variable representing the effect of the policy is DTC*Time Period. *p<0.1; **p<0.05; ***p<0.01.*

The observed difference in ATE estimates may be related to the distribution of market segments present in each of the control groups (consistent with the descriptive statistics across control groups presented in Table 2). We observe that when the treatment is compared to areas of the city closer to the core (and closer to the urban amenities that drive up house prices), the effect appears to be negative. This contrasts with the 10 km control, which includes a greater variety of housing, particularly housing without amenities, where prices have remained lower over time. Overall, our estimates show different impacts of the DTC policy depending on the control group considered. In the following section, we use covariate matching techniques to assess their robustness.

4.2. Matching Methods

The matching methods allow us to construct synthetic post-treatment control groups with improved covariate balance for five major variables: property age, square footage, racial composition, educational attainment, and prior neighborhood investment. We then perform an FE OLS estimation on the post-treatment data to assess the effects of the policy relative to the synthetic control.[10] The sample sizes shown were chosen to maximize the balance of covariates between treatment and control parcels.

Table 4: Post Treatment Regression with Synthetic Matched Sample, Sale Price

	Dependent variable: log(Sale Price)		
	(Propensity Score Matching)	(Generalized Boosted Matching)	(Random Forest Matching)
DTC	0.193^{***}	0.187^{***}	0.137^{***}
	(0.021)	(0.038)	(0.026)
Finished Area	0.0003^{***}	0.0002^{***}	0.0002^{***}
	(0.00001)	(0.00001)	(0.00001)
Age	-0.019^{***}	-0.028^{***}	-0.023^{***}
	(0.001)	(0.001)	(0.001)
Tract FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	12,315	2,515	2,815
R^2	0.565	0.428	0.423
Adjusted R^2	0.560	0.424	0.419
Note:			*p<0.1; **p<0.05; ***p<0.01

[10] To test the robustness of these results, we additionally constructed samples that include pretreatment data and estimate the FE DiD model. The results are consistent in both relative magnitude and significance.

Table 5: Post Treatment Regression with Synthetic Matched Sample, Sale Price Per Sqr. ft

	Dependent variable: log(Sale Price Per Sqr. ft)		
	(Propensity Score Matching)	(Generalized Boosted Matching)	(Random Forest Matching)
DTC	0.151***	0.203***	0.163***
	(0.020)	(0.031)	(0.021)
Age	−0.008***	−0.020***	−0.017***
	(0.001)	(0.001)	(0.001)
Tract FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	12,315	2,515	2,815
R^2	0.596	0.415	0.427
Adjusted R^2	0.591	0.412	0.423
Note:			*p<0.1; **p<0.05; ***p<0.01

Tables 4 and 5 present FE OLS results from our post-treatment regression, comparing upzoned parcels with our synthetic matched samples. For all three matching methods, the ATE estimates are positive and significant. These results are robust to changes in sample size for all three matching methods. This provides strong evidence that, relative to the most similar counterfactual control units, upzoned parcels were more expensive in terms of both parcel price and parcel price per square foot.

4.3. Quantile Treatment Effects

The results shown in Tables 6a and 6b provide strong evidence of a heterogeneous treatment effect across quartiles. We observe that the treatment effect among transactions in the first quartile is consistently positive and significant across geographic controls. This implies that after upzoning, less expensive parcels tended to become more expensive than control parcels. This finding is similar to the results of Freemark (2020) and Kuhlmann (2021), who find that increased land utility has the potential to increase the speculative value of residential parcels, partly over shorter time periods.

Importantly, our results show that over longer periods, investment effects, combined with potential amenity effects associated with increased density, can reduce affordability, particularly at the lower end of the market. Second, we observe that third quartile transaction prices are significantly lower in the treated groups than in the untreated groups. This finding is consistent with Anagol et al. (2021), who find potential price reductions as a result of supply induction through upzoning. A ground perspective of downtown Nashville supports this contention, as a large supply of luxury housing has flooded the market, potentially leading to a negative effect on the price of high-end housing through supply-side mediation, coupled with upward pressure on low-value transactions through amenity effects. Overall, these results

Table 6: Quantile Difference-in-Difference, (2000-2023)

(a) Treatment Effect, Sale Price

	Dependent variable: log(Sale Price)			
tau	(1 km)	(3 km)	(5 km)	(10 km)
q=0.25	9.056***	0.896	0.535**	0.655***
	(1.521)	(1.095)	(0.252)	(0.092)
q=0.50	−0.180**	−0.083	-0.040	-0.092**
	(0.080)	(0.058)	(0.036)	(0.038)
q=0.75	−2.70***	-2.639***	−0.036	-2.585**
	(0.615)	(0.751)	(0.068)	(1.267)
Observations	4,358	6,918	9,860	17,125

(b) Treatment Effect, Price Per Square Ft

	Dependent variable: log(Sale Price Per Sqr. Foot)			
tau	(1 km)	(3 km)	(5 km)	(10 km)
q=0.25	2.334***	0.634***	0.127	1.22***
	(0.506)	0.218	(0.276)	(0.222)
q=0.50	0.068	0.051	0.032	-0.061
	(0.096)	(0.055)	(0.030)	(0.054)
q=0.75	−2.59**	-2.556**	0.087***	-2.546***
	(0.796)	(1.027)	(0.027)	(1.267)
Observations	4,358	6,918	9,860	17,125

Notes: Reported regressions include property covariates and quarter-by-year fixed effects. Due to multicollinearity, estimates are unable to be made with the addition of neighborhood fixed effects, as in the ATE DiD. *p<0.1; **p<0.05; ***p<0.01

are consistent with previous postulations regarding the differential distribution of market segmentation leading to differences in ATE estimates across control groups. As reflected in our descriptive data from Table 2, parcels closer to Nashville's core are more likely to be high value units due to their proximity to urban amenities, while the largest control contains a higher proportion of low amenity housing on Nashville's periphery.

5. Discussion and Conclusions

While researchers have largely concluded that in high-demand markets, such as Nashville, land use deregulation typically leads to higher property values in the short run, little research has examined the effects of upzoning over longer time horizons. We present evidence of increased house prices associated with increased density zoning. To our knowledge this study utilizes the longest time period of any upzoning analysis in the American context, examining 13 years after the DTC upzoning. Using a combination of difference-in-difference and matching methods, we estimate the effect of increased zoning restrictions on multifamily transaction prices in downtown Nashville over the period 2000-2023. We present two important findings with implications for the relationship between upzoning and housing affordability. First, using matching methods to identify a synthetic control with similar covariates to the treated parcels, we find evidence of increased housing prices. This finding is in line with Freemark (2020) and Kuhlmann (2021), demonstrating the potentially resilient effects of upzoning-induced investment and associated amenity structures. Second, we document evidence of heterogeneous treatment effects across housing market segments. Our QDiD estimates suggest that upzoning led to approximately 60% higher prices for low-end (first quartile) parcels and a price decrease for high-end (third quartile) parcels, consistent with Anagol et al. (2021). Our findings reflect the rapid development of large luxury apartments recently built in Nashville's core, potentially leading to a negative effect on the price of high-end housing through supply-side mediation, combined with upward pressure on lower-value transactions through amenity effects.

It is worth noting that our analysis does not compare single-family to multifamily as in Kuhlmann (2021), but rather focuses on the increase in density limits, in combination with the effects of eliminating 'by-type' zoning. Furthermore, when conducting research on housing prices, we must remain aware that there is a constellation of factors, including zoning regimes, migration patterns, financial incentive, and amenities structures which contribute to the production of sense of place which may be desirable to specific forms of housing production and consumption in a given place at a given time (and thus determine price). Such discrepancies are important to take into account, as the plurality of policy results are necessarily a consequence of the diversity of applications, histories and cultures in which policy regimes are enacted. Our finding that the price effects of DTC are not uniform across different segments of the housing market and can be moderated by amenity quality is of particular interest for future research. Further empirical research is needed on the link between public urban infrastructure and upzoning policies and their impact on housing affordability.

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Conflict of Interest: The authors whose names are listed certify that they have no affiliations with or involvement in any organization or entity with any financial, or non-financial interest in the subject matter or materials discussed in this manuscript.
Data Availability: The data and code that supports the findings of this study are available here or on request from the corresponding author.

Appendix A. Tables and Figures

Table A.7: Sale Price by Group and Period

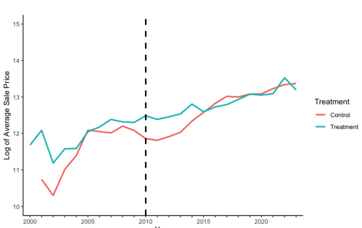
Statistic:	N		Mean		SD		P25		P50		P75	
Group	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Treatment (DTC)	318	2,315	233,111	593,831	132,044	465,547	146,050	320,000	207,347	425,000	295,500	670,000
1k Control	156	1,659	202,242	539,621	160,538	321,390	102,900	310,000	180,100	459,000	243,725	699,900
3k Control	650	6,706	215,191	523,991	170,981	311,220	119,225	320,000	187,847	459,000	258,302	659,900
5k Control	1,413	13,182	207,624	512,616	161,172	301,522	117,300	308,000	178,000	443,500	248,000	649,999
10k Control	2,690	22,365	192,719	495,268	174,820	333,208	90,000	274,900	150,000	421,250	229,375	634,900
All Davidson County	6,124	38,800	187,159	391,267	247,910	305,295	96,000	198,000	132,900	301,000	192,603	480,623

Table A.8: Sale Price Per Square Foot by Group and Period

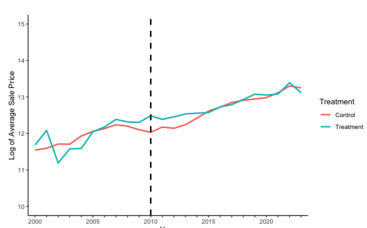
Statistic:	N		Mean		SD		P25		P50		P75	
Group	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Treatment (DTC)	318	2,315	239.89	549.13	84.56	297.90	183.93	376.87	243.34	486.42	302.04	622.48
1k Control	156	1,659	170.82	340.80	127.29	160.36	51.36	251.83	184.63	325.42	245.44	422.13
3k Control	650	6,706	158.10	328.83	98.13	202.78	80.02	226.84	160.66	293.50	217.36	384.81
5k Control	1,413	13,182	149.85	298.69	122.24	161.50	89.68	213.52	138.88	270.12	189.02	344.03
10k Control	2,690	22,365	129.76	277.02	108.71	173.98	65.94	193.31	110.50	252.48	166.66	321.18
All Davidson County	6,124	38,800	130.45	233.92	209.31	183.82	72.03	146.58	93.63	205.70	124.94	277.17

Figure A.6: Average Sale Price By Year and Treatment

(a) 1km Control



(b) 5km Control



(c) 10km Control

Note: From left to right, 1km, 3km, and 10k control bands are compared to the DTC.

Figure A.7: Event Studies Ln Price:

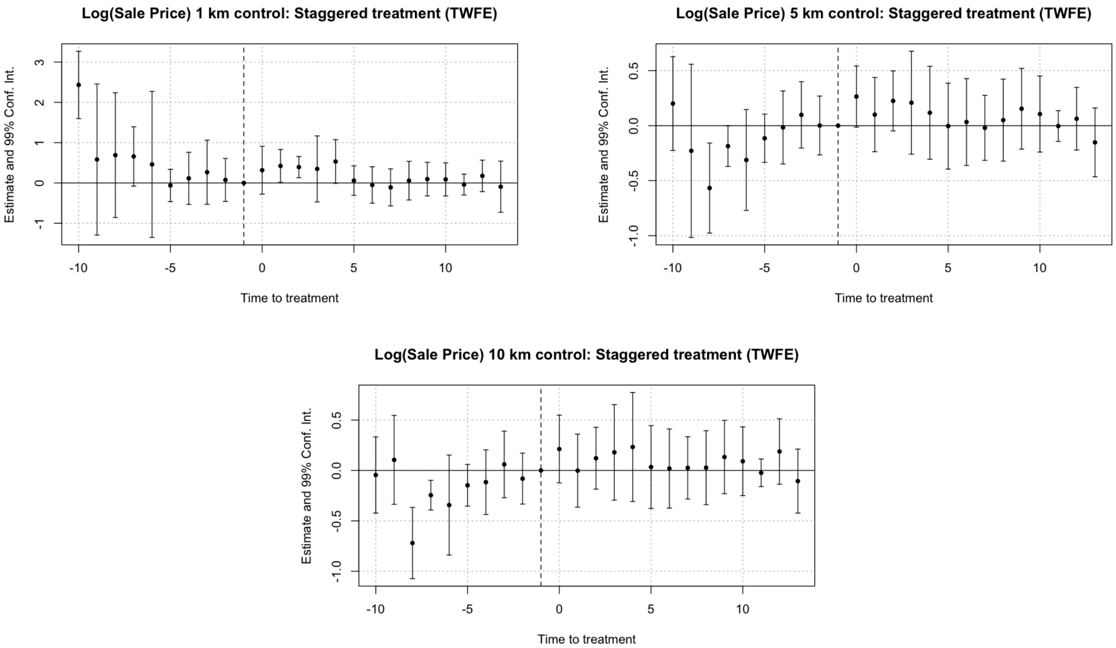
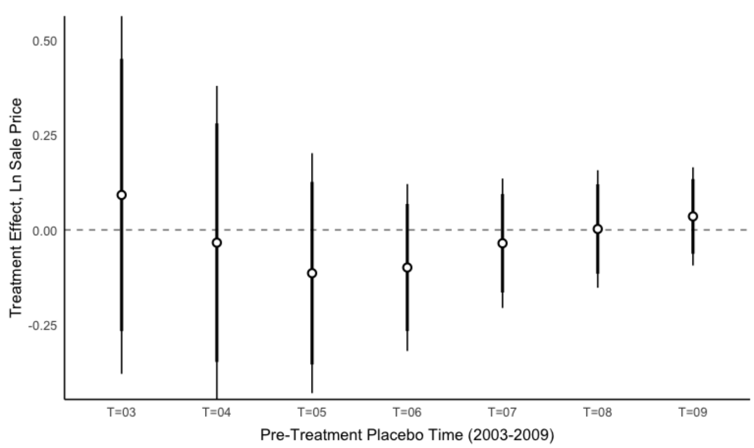


Figure A.8: Pre-Treatment Placebo, 3 km Control



Note: Plain lines represent 99% confidence interval, and Bold lines signify 95% confidence intervals.

Table A.9: Pre-Matching Balance

Variable	Treated Means	Control Means	Std. Mean Diff.
OLS Distance	0.174	0.049	1.335
Age	10.228	17.797	-0.957
Finished Area	1082.477	1791.024	-0.645
% White	61.026	67.458	-0.677
% Bachelors Degree	0.433	0.399	0.862
Building Permits	45.633	59.807	-0.625

Table A.10: Post-Matching Balance (Propesnsity Score Matching)

Variable	Treated Means	Control Means	Std. Mean Diff.
OLS Distance	0.193	0.186	0.242
Age	10.228	9.999	0.028
Finished Area	1082.477	1144.181	-0.056
% White	61.026	60.933	0.010
% Bachelors Degree	0.433	0.435	-0.047
Building Permits	45.633	44.773	0.037

Table A.11: Post-Matching Balance (Generalized Boosted Matching)

Variable	Treated Means	Control Means	Std. Mean Diff.
OLS Distance	0.8339	0.7690	0.7217
Age	10.2281	12.0940	-0.2359
Finished Area	1082.4773	1078.1540	0.0039
% White	61.0267	54.2466	0.7140
% Bachelors Degree	0.4332	0.4048	0.7172
Building Permits	45.6337	61.6860	-0.7078

Table A.12: Post-Matching Balance (Random Forest)

Variable	Treated Means	Control Means	Std. Mean Diff.
OLS Distance	0.174	0.767	0.740
Age	10.228	12.386	-0.273
Finished Area	1082.477	1128.612	-0.042
% White	61.026	54.227	0.716
% Bachelors Degree	0.433	0.406	0.960
Building Permits	45.633	61.618	-0.705

Table A.13: Summary of Recent Research on Upzoning and Housing Price

Years examined	Scale/Intensity	Effects	Study
2010-20	Block–level upzoning, São Paulo, Brazil. Average increase of 36% floor-to-area (FAR) ratio on blocks in city.	Translated into 1.9% increase in citywide housing stock. 0.5% reduction in citywide prices in resulting equilibrium model.	Anagol et al. (2021)
1995-2007	Upzoning overlay, Phoenix, Arizona. Ordinance allowed transit–oriented, mixed uses in areas near stations.	Overlay increases condo costs in mixed–use neighborhoods by 37%. In residential neighborhoods, single–family homes, condos lost value by 11–12%; single–family homes in mixed–use neighborhoods had no change.	Atkinson-Palombo (2010)
1995–2020	Numerous neighborhood–level upzonings in the Canton of Zurich, Switzerland.	Upzoning of 20% or more is associated with a 9.6–15.5% increase in supply, No significant differences in rents in upzoned versus other areas.	Büchler and Lutz (2021)
2012-17	Adding ADUs to single-family homes, Vancouver, Canada.	Find that ADUs negatively effect neighboring properties. This negative spillover is strongest for higher-valued properties and non-existent for median and lower-valued homes.	Davidoff et al. (2022)
2011-16	Upzoning throughout much of inner–suburban land in Auckland, New Zealand. Eliminated single–family zoning, increased overall development capacity by 300%.	Results indicate that the SHAs caused an average price increase of approximately 5% and did not contribute to increases in the likelihood of affordable transactions.	Fernandez et al. (2021)
2010–15, 2013-18	Multi-family homes, Chicago, Illinois. Building heights increases, parking requirement decrease on 6 percent of city land area.	Density upzoning led to 15–23.3% increase in transaction values compared to non–upzoned parcels.	Freemark (2020)
2005–19	Zoning map change, San Jose, California. Urban villages allowed different zoning frameworks to be applied to certain areas.	Finds no significant treatment effects on permits, transactions, and assessed values.	Gabbe et al. (2021)
1999–2019	ADU ordinance, citywide in Ogden, Utah in most but not all single–family neighborhoods.	No impact of allowing ADUs on property values in areas effected by change versus other neighborhoods.	Gnagey et al. (2023)

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Years examined	Scale/Intensity	Effects	Study
2010–17	Upzoning throughout much of inner–suburban land in Auckland, New Zealand. Eliminated single–family zoning, increased overall development capacity by 300%.	Increases property value of upzoned parcels by 1.5–4.2% depending on the model and area. Underdeveloped properties see larger price appreciation than already–developed properties, which decrease in value.	Greenaway-McGrevy et al. (2021)
2017-2019	Single-family homes, Minneapolis, Minnesota. Allows for up to three times the housing unit density.	Plan change associated with a 3–5 percent increase in price of properties. Price increases larger in inexpensive neighborhoods and underdeveloped properties.	Kuhlmann (2021)
2017-21	Adding ADUs to single-family homes, Los Angeles, California.	Find heterogeneous effects across zip codes, with price increases concentrated in areas with lower property values (in the range of 2 to 4%) and price decreases concentrated in areas with higher property (approximately -2%).	Liu et al. (2024)
1996–2016	State-level rezoning, Brisbane, Australia. Zoned capacity doubled over the 20–year study period.	Additional housing supply is associated with higher prices of about 2%.	Murray and Limb (2023)
2011-16	Upzoning throughout much of inner–suburban land in Auckland, New Zealand. Eliminated single–family zoning, increased overall development capacity by 300%.	The results show that the SHAs program failed to reduce housing prices across the distribution; and, even in some cases, prices increased. For new dwellings, the program decreased prices at the lower end of the distribution while increasing them at the upper end.	Ortiz-Villavicencio et al. (2024)
2008-17	180 upzoning and downzoning policies implemented in a sample of more than 1,000 municipalities in eight U.S. metropolitan regions.	Reforms loosening restrictions associated with a significant, 0.8% increase in citywide housing supply at least 3 years post–reform; found no statistically significant evidence that additional lower-cost units became available or moderated in cost in the years following reforms.	Stacy et al. (2023)

Source: Adapted from Freemark (2023)'s review of the scholarship.

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