The Causal Effects of Zoning Regulations

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Abstract

This paper estimates the causal effects of municipal zoning changes on housing markets. We construct a novel panel covering over 30 regulatory dimensions across more than 3,000 municipalities, using large language models to extract changes at scale from municipal zoning codes. We interpret the results through a spatial equilibrium model which generates three empirically distinguishable channels for supply, demand, and option value shifts which raise prices while lowering rents. Combining synthetic difference-in-differences estimates of regulatory treatment effects with a calibrated model, we find that some regulations such as use liberalization operates through supply, while other regulations such as infill regulations like ADU legalization primarily operate through option value. Regulatory loosening almost uniformly raise demand and amenity values. The results suggest that the conventional treatment of housing regulations solely through supply is incomplete, and that demand feedback and dynamic development considerations are essential ingredients to understand how zoning changes impact housing markets.

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1 Introduction

Land use regulations are central to the functioning of housing markets. A large literature argues that zoning and other regulations constrain the supply of housing in high-productivity cities (Hsieh and Moretti, 2019; Glaeser and Gyourko, 2018), while also affecting housing demand by altering local amenities and neighborhood desirability (Turner et al., 2014), as well as the option value of redevelopment (Titman, 1985). Yet despite broad agreement that housing regulation matters, we know much less about the causal effects of specific policies on housing markets. The challenge is that the distinct mechanisms through which housing regulations operate imply different, and sometimes offsetting effects on prices, rents, and quantities which make it difficult to isolate their individual contributions to market outcomes.

In this paper, we address these challenges through two contributions. First, we produce novel causal estimates of a comprehensive sample of municipal housing regulatory shifts on housing markets. We develop this large panel index of city-level regulatory changes using generative AI methods applied to the scalable analysis of regulatory texts, building on the generative regulatory measurement framework pioneered in Bartik et al. (2025). We then use a synthetic difference-in-differences framework (Arkhangelsky et al., 2021) to the complete set of these regulatory changes, generating causal estimates across a granular set of policy treatments on housing market outcomes including house prices, rents, housing units, and population.

Second, we develop a spatial equilibrium model that provides a theoretical framework for classifying the distinct mechanisms through which housing regulations operate. The model incorporates three key ingredients: Cobb-Douglas household preferences, agglomeration externalities which link local wages to population, and a developer option value channel through which zoning relaxation raises property values by expanding the set of feasible future land uses. This model generates three empirically distinguishable signatures in the joint behavior of prices, rents, and quantities.

The model identifies *supply shifts* as regulations which constrain the quantity of housing. Relaxing these regulations increases housing supply, which puts downward pressure on rents and house prices while increasing the housing stock and population. By contrast, *demand shifts* are regulations that affect the composition of demand and hence the distribution of local amenities. Relaxing these regulations serves to increase the quantity of housing units and population; but leads to increases in rents and house prices. A distinctive prediction in our framework is the existence of a third set of effects through *option value* effects. These refer to regulations which expand the highest and best use of land, and so raise the option

value of redevelopment. This option value generates a divergence between house prices, which increase because of the redevelopment option, and rents which decrease due to higher housing supply. We apply this framework in interpreting the causally estimated effects of housing regulatory shifts on house prices, rents, housing units, and population into these three categories.

First, we find that one cluster of regulations corresponds to supply increases, which increase housing quantities while lowering prices and rents. An important category of regulations with this feature relate to use liberalization, such as allowing multi-family building or mixed-use buildings. The ability to directly permit and build new housing types results in an increase in the supply curve.

Second, we find that another cluster of regulations results in an increase in option value. These regulations increase housing quantities, lower rents, but interestingly *increase* house prices. We reconcile these effects in a framework in which these regulatory shifts expand the option value of what can be built on existing parcels. Consistent with this interpretation, the regulations that fall into this category typically relate to infill and incremental density: we observe the strongest effects for policies legalizing Accessory Dwelling Units (ADUs), but also observe effects for allowing townhomes and flexible zoning by right. Increasing district counts, which may accompany creating new districts with liberalized regulations, also tends to increase option value by raising prices much more than rents. By generating a clear pathway for future development on site, these regulatory shifts create additional value for existing landowners, while also adding incremental supply to the market, lowering rents.

We find one regulation associates with possible demand effects: regulations easing permit caps or phasings. These are regulations used for the purpose of growth management which intrinsically limit the number of total units which can be built in a given municipality. Lifting such restrictions, therefore, may send a pro-growth signal which attracts more households and firms who sort into the area based on the expected future neighborhood trajectory. This produces a demand shift from forward-looking households who interpret the cap removal as indicating the shift in urban form towards a denser, more urban, and amenity-rich environment over time. If this demand dominates the supply effect, it can result in increases in rents and house prices alongside increases in quantity. We also find some regulations act as supply reductions, such as reducing front setback requirements or lot coverage requirements in the form of lower quantities and higher prices and rents, perhaps because they enable teardowns which replace structures which are rebuilt with lower density than before.

We also consider other regulations which do not so cleanly fall into these categories. Most prominent are changes in regulations which have dimensional requirement, such as changes in minimum lot sizes, lot coverage, and so forth. While we estimate that such regulatory

shifts do result in price and quantity effects, their impacts are varied and challenging to categorize. We hypothesize that one key reason for this is that changes in dimensional regulations only result in impacts on the built form with a lag. Typically, tightening these restrictions grandfathers in existing housing units, so we do not necessarily expect large supply restrictions in the short-run. At the same time, loosening these restrictions only expands housing supply to the extent that existing lots are subdivided or new subdivisions are built conforming to different regulations. Therefore, the dynamic construction problem that is altered under these regulatory shifts is different. We leave for future work a closer examination of these regulatory policies.

To discipline the structural interpretation, we develop a sufficient-statistic calibration strategy. On the demand side, we recover the distribution of implied amenity shifts across municipalities using observed changes in population shares, rents, and wages, combined with externally calibrated preference and agglomeration parameters. Together, these imputed structural shifts allow us to decompose observed reduced-form effects into demand, supply, and option value components.

We find that regulatory shifts almost uniformly increase amenity value or demand. On the supply side, we recover the distribution of implied policy intensity changes from the market-clearing condition, and also find most regulations increase the supply option value.

One important caveat to these results is that our analysis of price and quantity effects is local to the municipality engaged in treatment effects. However, regulatory treatments likely spillover to nearby areas in complicated ways. In particular, regulations which result in population in-migration likely *decrease* rents in origin locations. Our framework focuses on the local effects of housing regulation shifts, and abstracts from the general equilibrium consequences.

Our work connects to three literatures. First, one literature has argued that housing regulation has large effects on housing supply and welfare (Hsieh and Moretti, 2019; Glaeser and Gyourko, 2018; Saiz, 2010; Glaeser et al., 2005; Albouy and Ehrlich, 2018; Ganong and Shoag, 2017; Van Nieuwerburgh and Weill, 2010; Duranton and Puga, 2023). We contribute to this literature through detailed measurement of specific regulatory changes which enables a comprehensive quasi-experimental analysis of the impacts of regulatory changes on housing supply and demand. One branch of this literature has focused specifically on the value of the development option, such as Titman (1985); Capozza and Li (1994).

We connect more closely to a literature exploring regulatory shifts in the housing market through causal inference methods (Freemark, 2020; Liao, 2022; Mast, 2019). We provide much more comprehensive and detailed data on regulatory shifts, which we use to produce estimates for a larger and more granular set of regulations. Since we estimate across a broad

national panel, we can also assess the external validity of our estimates relative to prior single-city studies. We also interpret the findings in the context of a theoretical model that accounts for differing effects on margins of house prices versus rents.

Finally, we link to a literature measuring and estimating the effect of regulation on markets (Singla, 2023). We build on prior work in Bartik et al. (2025) by extending our framework on generative regulatory measurement to capture changes in housing regulation on housing market outcomes.

2 Data and Empirical Strategy

Our empirical strategy proceeds in three steps. First, we use large language models to extract a comprehensive set of regulatory changes from a panel of municipal zoning ordinances. Second, we estimate the causal effect of each regulatory change on housing market outcomes using synthetic difference-in-differences. Third, we classify the estimated effects through the lens of the model developed in Section 3.

2.1 Zoning Dataset

Our analysis draws on what is, to our knowledge, the largest panel dataset of municipal zoning ordinances assembled to date. The dataset covers approximately 3,000 municipalities across the United States, yielding nearly 70,000 municipality-by-year observations. This scale and frequency are made possible by the institutional structure of how modern municipalities maintain and publish their zoning codes.

As documented in Bartik et al. (2025), a large share of American municipalities outsource the maintenance of their legal codes to third-party ordinance aggregators. The largest of these is Municode, which hosts a living, publicly accessible copy of each client municipality's code as well as any amendments passed since the latest code. Municode encourages municipalities to recodify regularly, consolidating amendments into the code, and collects a fee for doing so each time. On average, municipalities recodify annually (Appendix Figure A.I) providing frequent snapshots of the regulatory environment.

Figure 1 summarizes the geographic and temporal scope of our data. Panel A shows that our coverage spans much of the country, with particularly dense coverage in parts of California, the Midwest, and the South. Coverage is thinner in some states, notably New Jersey and Pennsylvania, where competing aggregators such as eCode360 are more prevalent; we are currently in the process of expanding our sample to incorporate these additional sources. Panel B plots the cumulative entry of municipalities into our sample

over time. While the earliest observations date to the mid-2000s, adoption of online code hosting accelerated sharply in the early 2010s. From approximately 2013 onward, we observe nearly 2,000 municipalities with close to annual zoning data, providing over a decade of high-frequency regulatory panel coverage through the present day.

2.2 Measuring Regulatory Changes

We apply the exact generative regulatory measurement procedure designed in Bartik et al. (2025) to measure the level of regulation for each ordinance vintage. Specifically, we use Retrieval Augmented Generation (RAG) to identify the relevant portion of each vintage for a given question. We then provide the LLM with this relevant portion of code along with detailed guidance on how to answer the question at hand. We then measure changes in regulation by identifying changes in the level of regulation in subsequent vintages.

We define a *treatment event* as a municipality that switches its answer to a given regulatory question from "No" to "Yes" (for binary regulations) or experiencing a discrete change in the value of a numeric regulation. To ensure clean identification, we restrict the treatment sample to municipalities that change their answer exactly once during the sample period (from "No" to "Yes"), and we drop municipalities that exhibit multiple switches or reversals.

For binary regulations, we define treatment as the more frequently observed direction of change across municipalities in our sample. In most cases, this corresponds to regulatory easing rather than tightening. Regardless of the direction of change, we consistently interpret the treatment effects in the direction of regulatory easing to facilitate common interpretation.

We use two sets of questions for this analysis. The first set was initially validated in Bartik et al. (2025) on the basis of human responses to questions initially conducted by the Pioneer Institute. We built a second set of questions, again in partnership with the Pioneer Institute, and conducted a similar validation exercise on this corpus of text. Some example questions are "Does the municipality require site plan review?", "What is the maximum height allowance?", "Does the municipality allow accessory dwelling units?".

We show the scope of our regulatory changes in Table 2. We observe 3,630 regulatory changes in our sample across 31 treatments in 2,991 total municipalities. Each treated municipality is matched to a synthetic control composed of a weighted average of selected control municipalities where controls are drawn from the pool of municipalities without any regulatory changes, producing 33,328 control observations (municipalities may appear repeatedly as controls). Municipalities change different types of regulations with widely varying frequency. For example, the most frequently changed regulatory feature is the number of zoning districts, where 52% of municipalities have some treatment change over our sample. Conversely,

other regulations, such as the permit caps, almost never change treatment status.

2.3 Housing Data

Our housing data draws on two main sources: Zillow housing market data and American Community Survey (ACS) data on population, housing units, and incomes.

Housing Market Outcomes. We use house price data from the Zillow Home Value Index (ZHVI), which measures the typical home value at the municipality level, and similarly draw on rental data from the Zillow Observed Rent Index (ZORI). Both series are available at monthly frequency and are seasonally adjusted. We aggregate to an annual frequency.

Census Data. We use ACS data for population, total housing units, vacancy rates, median household income, and rent-to-income ratios. These data are available at the municipality (place) level and provide the quantity-side outcomes as well as the inputs for the structural calibration.

3 Spatial Equilibrium Model

In this section, we develop a spatial equilibrium model of zoning which generates empirically testable implications about how different types of housing regulations affect prices, rents, quantities, and incomes. The model features a household location problem with heterogeneous preferences, endogenous wage setting reflecting agglomerative externalities, and a dynamic developer problem featuring an option value of construction. We derive the model's comparative statics, which provide us a classification system for interpreting the heterogeneous treatment causal effects estimated in our empirical analysis.

3.1 Household Demand

We model households indexed by i choosing across locations a in order to maximize Cobb-Douglas utility over consumption ($C_{i,a}$), housing ($H_{i,a}$), and a location-specific amenity factor (A_a):

$$U_{i,a} = A_a C_{i,a}^{1-\beta} H_{i,a}^{\beta} = A_a C_a^{1-\beta} H_a^{\beta} \varepsilon_{i,a} \tag{1}$$

where $\beta \in (0, 1)$ is the housing expenditure share, and $\varepsilon_{i,a}$ is an idiosyncratic preference shock that captures heterogeneity in households' tastes for locations. We assume $\varepsilon_{i,a}$ follows

a Fréchet distribution with shape parameter $\theta > 0$, following quantitative spatial economics literature (Ahlfeldt et al., 2015; Redding and Rossi-Hansberg, 2017). The parameter θ governs the dispersion of idiosyncratic preferences: a larger θ implies less taste heterogeneity, so that households are more responsive to differences in real wages and amenities across locations.

Given Cobb-Douglas preferences and a budget constraint assuming no savings technology:

$$C_{i,a} + R_a H_{i,a} = W_{i,a}$$

where R_a is the rental price and $W_{i,a}$ is income, the household spends a fixed share β of income on housing. Aggregate housing demand in location a is therefore:

$$H_a^D = N_a \cdot \frac{\beta W_a}{R_a}, \tag{2}$$

where N_a is the population and W_a is average income for location a.

3.2 Wage Setting

We model average wages W_a as dependent on local population to capture productive spillovers from agglomeration:

$$W_a = \overline{W}_a N_a^{\gamma} \tag{3}$$

where $\overline{W}_a$ is an exogenous productivity shifter and $\gamma > 0$ captures the strength of agglomerative spillovers. Individual wages are

$$W_{i,a} = W_a \cdot \varepsilon_{i,a} = \overline{W}_a N_a^{\gamma} \varepsilon_{i,a}.$$

The agglomeration channel creates a key feedback loop: supply-side zoning relief that attracts more residents (increases N_a) endogenously raises local wages (W_a), which in turn increases housing demand. Because of homothetic preferences, income gains are spent proportionally on housing, driving rents upward and partially offsetting the direct supply-expansion effect. This feedback explains why some supply-side reforms may not reduce rents by as much as a partial-equilibrium analysis would suggest.

Location Choice Under the Fréchet assumption, the share of the total population $\bar{N}$ choosing location a is:

$$n_a \equiv \frac{N_a}{\bar{N}} = \frac{\left(A_a \cdot W_a \cdot R_a^{-\beta}\right)^{\theta}}{\sum_{a'} \left(A_{a'} \cdot W_{a'} \cdot R_{a'}^{-\beta}\right)^{\theta}}. \tag{4}$$

This expression captures the idea that households sort into locations offering high amenities, high wages, and low housing costs, with the degree of sorting governed by θ.

3.3 Housing Supply and Market Equilibrium

The housing supply side of the model is represented with a reduced-form supply function to capture the regulatory environment:

$$Q_a^S = \Phi_a R_a^\eta, \tag{5}$$

where $\eta > 0$ is the housing supply elasticity and $\Phi_a > 0$ is a supply shifter that captures the regulatory environment. A higher Φ_a corresponds to a less restrictive zoning regime: a given increase in rents results in a larger supply response when regulations are loose.

Equating aggregate demand (Equation (2)) with supply (Equation (5)) pins down the market-clearing rent:

$$R_a^* = \left(\frac{N_a \cdot \beta \cdot W_a}{\Phi_a} \right)^{\frac{1}{1+\eta}}. \tag{6}$$

This equation captures the two competing forces following a supply-side zoning reform (which relaxes Φ_a): first there is a direct supply effect, which reduces equilibrium rents, and second an agglomerative offset, which raises local wages and hence housing demand (which is proportional to local income), partially offsetting the initial rent decrease. The net effect on rents of a supply shock is therefore ambiguous in general and depends on the relative magnitudes of the supply curve slope, the agglomeration parameter, and the degree of population sorting.

3.4 Developer Option Value

The empirical literature on housing regulation typically examines either house prices or rents, but rarely examines their joint behavior. However, these objects measure two fundamentally different things. Rents capture the flow value of occupying an existing structure, while property prices are forward looking asset values which capitalize both the expected value of future rents as well as the value of the land's future development taking into consideration regulatory constraints. Zoning changes that expand the set of feasible land uses can drive a wedge between the value of the existing structure (the rents) and the value of the land underneath it (house prices). We formalize this by considering the developer's problem with an option value of redevelopment.

Specifically, let the property price $P_{a,t}$ reflect the present value under the optimal de-

velopment strategy: the owner chooses whether to continue earning rents from the existing structure or to exercise the option to redevelop at a future date τ:

$$P_{a,t} = \max_{\tau \geq t} \mathbb{E}_t \left[\int_t^\tau e^{-r(s-t)} R^*_{a,s} \, ds + e^{-r(\tau - t)} \left(V(R^*_{a,\tau}, \Phi_a) - K \right) \right], \tag{7}$$

where r is the discount rate, $V(R^*_{a,\tau}, \Phi_a)$ is the value of a newly developed structure (which depends on both the prevailing rent level and the regulatory environment), and K is the fixed cost of redevelopment.

The central insight is that V depends directly on Φ_a: more permissive zoning expands the set of feasible structures a developer can build, raising the "highest and best use" land value. An upzoning (increase in Φ_a) therefore has two potential effects on property prices: it decreases construction through a rental channel, if increased supply lowers current rents, but it may increase prices through an option value effect, if the expanded development options raise the value of the development option. When the option value dominates the rental effect, we expect to see property prices rise even as rents fall, i.e. an increase in the price-to-rent ratio.

3.5 Comparative Statics and Classification of Regulatory Effects

The model generates three distinct patterns in the joint response of population, rents, prices, and wages to regulatory shocks, summarized in Table 3.

These three patterns form the basis for our empirical classification strategy. By plotting estimated effects on prices against estimated effects on quantities and rents, we can assign each regulatory change to the channel that best matches its empirical signature. A *demand/amenity* regulation will appear in the quadrant where both prices and quantities rise. A *pure supply* regulation will appear where quantities rise but prices fall. A regulation that operates through the *option value* channel will show rising house prices, falling rents, and rising quantities.

4 Causal Estimates

In this section we present our main empirical estimates on the causal impact of housing regulations on outcomes. We first consider outcomes on price (house prices and rents), and next consider changes in quantities (population and unit counts). All regulatory changes are normalized so they can be interpreted as the causal effect of easing the regulation in question. We then interpret these outcomes in light of the theoretical model in 3.

4.1 Synthetic Difference-in-Differences

We estimate the causal effect of each regulatory change using the synthetic difference-in-differences (SDID) estimator of Arkhangelsky et al. (2021). For each regulatory question q, the SDID estimator constructs a weighted combination of control municipalities that matches the pre-treatment trajectory of the treated municipalities, then estimates the treatment effect as the difference between the post-treatment outcome and the synthetic control.

Let $Y_{a,t}$ denote an outcome of interest (e.g., log house prices, log rents, log housing units) in municipality a at time t, and let $D_{a,t}$ be a treatment indicator equal to one if municipality a has adopted regulation q by time t. The SDID estimator solves:

$$\hat{\tau}_q^{SDID} = \min_{\tau,\mu,\alpha,\delta} \sum_{a,t} \left(Y_{a,t} - \mu - \alpha_a - \delta_t - \tau D_{a,t}\right)^2 \hat{\omega}_a \hat{\lambda}_t, \tag{8}$$

where $\hat{\omega}_a$ are unit weights chosen to match the pre-treatment trajectory and $\hat{\lambda}_t$ are time weights. The SDID estimator combines the strengths of synthetic control methods (flexible pre-treatment matching) with difference-in-differences (adjusting for parallel trends).

One complication is that different municipalities change zoning regulations in different years, which would bias treatment effect estimates unless it is taken into account. To address this issue, we run this estimation separately for each regulatory question, each outcome variable, and treatment-year cohort, yielding a matrix of treatment effects $\hat{\tau}_q^{SDID}$ across regulatory changes, treatment cohorts, and outcomes. We aggregate these estimates to the question, output level by taking their weighted average. This approach allows us to characterize the heterogeneity in regulatory effects without imposing any restriction on the relationship between regulation types and their impacts and avoids empirical challenges associated with staggered treatment roll out.[1]

4.2 Effects on House Prices, Rents, and Affordability

We first begin by highlighting the impacts of different regulations on housing affordability, as measured by house prices, rents, the price-to-income ratio, and the price-to-rent ratio (Table 4 for binary questions, and Table 5 for continuous questions). House prices and rents are measured in logs. We see a few general patterns.

First, the price and rent effects of regulatory easing frequently move in different directions. This is contrary to simple and static models of housing, for instance a user cost model, in

[1] Let C_q be the set of treatment cohorts for regulatory question q. We construct standard errors for the overall treatment effects as $\widehat{SE}_{\text{overall},q} = \sum_{c \in C_q} \left(\frac{N_{1,q,c}}{N_{1,q}}\right)^2 \left(\hat{se}_{q,c}^{SDID}\right)^2$.

which the house price should simply be a constant multiple of rents. A prominent example of one such regulatory shift is the impact of allowing Accessory Dwelling Units (ADUs). Municipalities which allow these housing units see a statistically significant 2.3% increase in house prices while rents decline by a marginally significant 2.1%. Incomes rise faster than rents, resulting in a substantial increase in housing affordability with a 4.1% reduction in rental burdens measured as rent-to-income. We observe similar patterns with some other regulations, such as allowing townhomes, as well as zoning district counts and other changes in bulk regulations. This observation helps to motivate our incorporation of an option value channel in Section 3, which can account for such divergent effects.

Second, other regulations show price effects that move in a concordant manner across both rents and prices. These include use liberalization measures, such as allowing multifamily buildings, mixed-used buildings, which see both prices and rents decrease modestly. On the other hand, we see that some regulations, particularly easing permit caps or phasing, result in increased house prices and rents in tandem.

4.3 Effects on Housing Units and Population

To disambiguate whether housing regulatory changes are associated with demand, supply, or option value requires considering both quantities and prices, which we do in Table 6 for binary questions and Table 7 for continuous questions.

Among binary questions, ADU legalization stands out as a policy associated with a substantial and statistically significant shift in housing units by 1.5%, about half of which shows up as an increase in population. Use liberalization policies, such as allowing mixed-use buildings, conversion to multifamily, and allowing townhomes, show modest positive magnitudes for housing units and population, though these shifts are not significant in isolation. Inclusionary zoning provisions are generally associated with declines in housing units, and sometimes in population as well. Somewhat surprisingly, easing bulk regulations such as setback requirements typically show up as negative for the number of housing units.

4.4 Classification of Regulatory Effects

With our estimates on prices and quantities in hand, we are now able to classify regulations in terms of their precise mechanisms through the lens of the spatial equilibrium model. Recall from Section 3 that the model classifies supply shifts as those regulations which decrease house prices and rents while quantities rise; demand shifts increase house prices, rents, and quantities; while option value shifts increase house prices while decreasing rents, alongside quantity increases. The reverse signs correspond to declines along each of these channels.

We organize the regulations into families based on the nature of the policy instrument, which produces a natural mapping from instrument type to dominant economic mechanism.

Figure 2 plots the house price (blue) and rent treatments (red) effects against the quantity effects across all regulations. The dispersion of points across all four quadrants confirms that housing regulations do not operate through a single channel. Regulations in the upper-right quadrant (prices up, quantities up) are candidates for the demand value channels, while those in the lower-right quadrant (prices down, quantities up) correspond to the supply channel. Regulations for which house price effects show up in the top-right quadrant while rental effects are in the top-left quad ar candidates for option value effects, since the house price effects are positive while rental effects are negative in this case.

We also pool regulations within each quadrant to test for their significance jointly. Table 8 reports the results. We focus on the two quadrants with positive quantity responses, which correspond to the model's predictions for regulatory easings that successfully expand housing production.

The first row combines all regulations in the upper-right quadrant of Figure 2: those where easing is associated with both rising prices and rising quantities. This quadrant contains the infill and incremental density regulations (ADUs, townhouses, flexible zoning by right) as well as growth management easings (permit caps). The pooled estimates confirm that these regulations produce significant increases in housing units, population, and house prices.

The second row pools regulations in the lower-right quadrant: those where easing is associated with falling prices and rising quantities. This quadrant contains the use liberalization regulations (multifamily allowed, mixed-use buildings). The pooled estimates show a significant population increase and a significant decline in rents, though the effect on declining house prices is more imprecise. The effect on unit counts is also more imprecise than the one one population, but of a comparable magnitude.

This pattern is what the model predicts for a pure supply expansion: the outward shift of the supply curve lowers the market-clearing rent, prices fall in tandem, and the price-to-rent ratio is roughly stable because neither the option value channel nor the demand channel is generating a wedge between prices and rents. The contrast between the two quadrants validates the model's core prediction that the joint behavior of prices, rents, and quantities is informative about the underlying mechanism.

4.4.1 Use Liberalization and Supply

Regulations that directly permit new housing types in previously restricted zones provide the clearest example of a supply-side mechanism. These include regulations which allow

multifamily housing, which is associated with negative price and rental effects along with positive housing unit impacts. Easing mixed-use buildings are also associated with lower price and rent effects and positive housing unit impacts.

These regulations most straightforwardly associate with supply shifter Φ_a, shifting the housing supply curve outward and putting downward pressure on the market-clearing rent. While directionally consistent with the supply channel, the magnitudes of these shifts are still modest. This could relate to the amount of land in a given municipality which is zoned for such uses, or else other background frictions (binding constraints on construction costs, land availability, or demand) which limits the realized supply response.

4.4.2 Infill and Incremental Density and Option Value

The model's most distinctive prediction relates to the option value channel realized for regulations which reduce rents while increasing house prices. We see this pattern in three regulations which fall under a broader category of infill and incremental density. Allowing ADU is the cleanest case; as discussed in the previous sections, this regulation is associated with the largest statistical signal for higher prices, lower rents, along with increases in housing stock. Allowing townhomes and flexible zoning by right also generate similar qualitative patterns. This cluster of regulations is also generally associated with worsening affordability in prices (price/income) but easier affordability measured by rents (rent/income).

The economic logic connecting these regulations to the option value channel is that they expand what can be built on existing residential parcels as infill or incremental density without requiring land assembly. An important feature of this cluster is that it operates on the intensive margin of existing parcels. By contrast, the use liberalization cluster operates largely on the extensive margin, enabling entirely new development projects which shift the supply curve without generating the same option value for existing landowners (as relatively few existing residential units may be good targets for large multi-family or mixed-use developments).

Among continuous variables, zoning district counts also exhibits similar patterns. Note the baseline direction for this variable has the interpretation that easing this variable lowers district count, and is associated with negative house price effects along with negative quantity effects. Equivalently, increasing zoning districts raises house prices more than rents, while population increases. The creation of new zoning districts is frequently associated with generation of new use districts which permit increased development activity in already existing corridors. In that sense, increasing district count can be interpreted as another example of an infill or incremental density regulatory instrument.

4.4.3 Growth Management and Demand

One regulation clearly fits a demand-side interpretation: easing permit caps or phasing requirements. Easing this regulation shows prices rising, rents rising, and quantities also rising. While permit caps and phasing seem on face to be a supply constriction, there are a few features which may be consistent with a demand and amenity value interpretation. First, permit caps and phasing requirements are among the most visible growth-management tools a municipality can adopt. Their removal sends a strong pro-growth signal that may attract forward-looking households and firms who sort into the area based on expected future changes in neighborhood form.

Second, the model's agglomeration channel provides a structural mechanism for this result. Even if cap removal initially operates as a supply reform, the resulting population increase can raise local wages through agglomeration externalities, which feed back into higher housing expenses through homothetic preferences. Aggregate caps at the city level may be more likely to lead to these feedback effects because they unlock more construction and development across the entire municipality and signal future releases from the constraint, as opposed to legalizing only certain housing types or development in certain areas.

4.4.4 By-Right versus Discretionary Flexibility

We also generally see another contrast in our results comparing flexible zoning versus changes only by right (although the estimates are somewhat imprecise). Flexible zoning changes generally fall into the option value category, showing increases in house prices and decreases in rents along with rising quantities. By contrast, flexible zoning obtained through discretionary permits displays a different pattern: prices are approximately flat while rents increase and quantities increase.

This difference is also consistent with an option value interpretation. By-right provisions grant the development option in the land value: the owner knows with certainty that the expanded use is permitted, enabling it to be capitalized into house prices. Discretionary provisions, by contrast, introduce uncertainty about whether a given project will receive approval. This uncertainty attenuates the capitalization of the development option into land prices, even as actual development proceeds through the permit process.

This distinction has implications for housing policy. If the goal is to both expand housing supply and maintain or increase property values, by-right reforms appear more effective than discretionary permit-based approaches. By-right provisions align incumbent homeowner incentives with pro-housing reform by generating both supply expansion (rents down, quantities up) and property value appreciation (prices up).

4.4.5 Dimensional and Bulk Regulations

Regulations governing the physical form of buildings through bulk regulations—setbacks, minimum lot sizes, height limits, lot coverage, and frontage requirements—are the most heterogeneous cluster in our sample and do not map cleanly to a single theoretical channel. The effects are often large in magnitude and statistically significant, but the sign patterns are varied. There are two important economic points to bear in mind in interpreting these results.

Dimensional regulations primarily operate on the intensive margin of the built form rather than the extensive margin of new unit creation. Relaxing a front setback permits a larger footprint on an existing lot because a homeowner can extend a structure closer to the street, but it does not necessarily allow new unit construction. This increases the value and potential square footage of existing structures without adding to the housing stock, which is consistent with the observed combination of rising prices, significant price-to-rent divergence, and declining housing units. Relaxing such dimensional regulations in conjunction with other regulatory changes that allowed more units might have different effects. We leave such interactions between regulatory changes to future work.

Dimensional changes may also interact with teardown-rebuild dynamics: developers may demolish older, smaller homes and replace them with larger, higher-value single-family structures that maximize the newly relaxed building envelope, reducing the net housing stock even as property values increase. This is consistent for instance with results on some bulk regulations such as front setback requirements and lot coverage.

Finally, changes in dimensional regulations may only affect the built form with a substantial lag. Tightening typically grandfathers existing structures, so there is no immediate supply restriction. Loosening only expands supply to the extent that existing lots are subdivided or new construction conforms to the relaxed standards, which typically are dynamic effects which take time to realize and may only happen in sufficiently growing markets. The dynamic construction problem altered by dimensional changes is therefore qualitatively different from the binary use-permission changes, and we also leave for future work a closer examination of the time-varying effects of these regulations.

5 Calibration

In this section, we estimate and calibrate the model based on regulatory shifts, and back out the implied distribution of parameter changes from the model through a sufficient-statistic approach. This allows us to recover the implied amenity and policy shifts across

municipalities as a result of the observed regulatory shifts.

5.1 Calibration Strategy

The calibration strategy exploits the fact that first-order condition together with market clearing split demand and supply sides nicely. Specifically, We are able to identify demand-side and supply-side moments separately through households optimal locational choice and housing market clearing.

Demand-Side Identification. Taking logs and differencing the population share expression (Equation (4)), the implied change in amenities is:

$$\Delta \ln A_a = \frac{1}{\theta}\Delta \ln n_a + \beta \Delta \ln R_a - \Delta \ln W_a. \tag{9}$$

or equivalently:

$$\Delta \ln A_a = \frac{1}{\theta}\Delta \ln n_a + \beta \Delta \ln R_a - \gamma \Delta \ln N_a, \tag{10}$$

We recover the structural parameters from cross-sectional and time series data calibrated from the American Community Survey (ACS). θ is estimated by fitting a Fréchet distribution to the cross-metropolitan wage distribution; β is calibrated from the median rent-to-income ratio; and γ is estimated from the cross-sectional relationship between median income and population at MSA level. Given these parameters, we can compute the distribution of imputed amenity shifts $\Delta \ln A_a$ across municipalities. This helps us account for some cases in which prices rise but rents appear to be flat in response to regulatory shifts. The amenity relationship absorbs a residual which cannot be explained through population sorting and wage shifts.

Supply-Side Identification. Through the equilibrium condition for rents, we get

$$\Delta \ln \Phi_a = \Delta \ln N_a + \Delta \ln W_a - (1+\eta) \cdot \Delta \ln R_a^* \tag{11}$$

For prices, we assume that the log change in price can be reflected in log change in rent and log change in supply shifter Φ_a:

$$\Delta \ln P_a = \alpha_a \cdot \Delta \log R_a + \omega_a \cdot \Delta \ln \Phi_a \tag{12}$$

We estimate in the time series the elasticity of price with respect to rent for a given place, α_a, using data for the past 5 years, and plug it into the above equation to get an expression

of price elasticity with respect to supply curve slope:

$$\omega_a = \frac{\Delta \ln P_a - \alpha_a \cdot \Delta \ln R_a}{\Delta \ln \Phi_a} \tag{13}$$

The option value in housing price change is expressed as $w_a \cdot \Delta \ln \Phi_a$. This interaction term represents price movements not explained by rent changes. A positive ω_a means that the option value part takes the lead in housing valuation, and thus a positive supply shifter yields a higher price; a negative ω_a implies that the substitution effect between existing structure and new construction in the future dominates the price dynamic, and thus prices move the opposite direction of supply shifter controlling for rent changes.

5.2 Distribution of Model Implied Moments

We compute the model-implied moments for all municipalities in our sample and examine how they differ between treated and control municipalities for each regulatory question. This allows us to assess whether the structural decomposition corroborates the reduced-form classification in Section 3. Figure 3 plots, for each regulatory question, the difference in average implied amenity change between treated and control municipalities (x-axis) against the difference in average implied option value (y-axis). This two-dimensional representation is a structural analogue to the reduced form mapping of regulations to price and quantity effects, but instead maps these regulations along the dimensions of amenity shifts and option value.

We observe several patterns which corroborate and extend our reduced form results. First, the amenity changes ($\Delta \ln A$) associated with regulatory shifts are heterogeneous. While several easings show positive amenity shifts, a considerable number of regulations are associated with negative amenity changes. This suggests that the impact on local desirability depends heavily on the specific nature of the reform, where certain types of development may trigger negative externalities or compositional shifts that outweigh the benefits of growth.

Second, the option value component is similarly varied. While the largest positive option values are concentrated in specific clusters, nearly half of the analyzed regulations show a neutral or negative shift in option value.

Third, there is a visible positive correlation between the two channels for most points: regulations that significantly boost amenity value often see a corresponding rise in option value. Conversely, for regulations in the lower-left quadrant (e.g., age-restricted provisions and wetland restrictions), both amenity and option values decline. Exceptions are affordable incentives, permit caps, permit-based flexible zoning, and on the side setback for single family home.

The largest imputed option values are concentrated in infill and incremental density regulations, which were also identified in the reduced form analysis as the set of regulations with the largest price-rent divergence. However, some regulations, such as the ADU liberalization, are associated with both positive amenity shifts and positive option value. Figure 5 focuses specifically on this regulation and shows the full distribution of calibrated moments for the municipalities treated with ADU liberalization versus controls, illustrating that the municipalities treated experience a shift to the right in both amenity and option value distributions. This implies that the reduced form estimates on rent reflect the combined force of two economic channels: a positive amenity shift which increases rents, and a supply channel which reduces them. These combined shifts may partially cancel out, helping to account for the mixed significance of some of our results. However, the structural decomposition is able to recover their underlying mechanism.

For permit cap easing, the negative option value in Figure 3 also corroborates the reduced-form demand interpretation developed in Section 3: cap removal operates primarily through the amenity and demand channel rather than by expanding the set of feasible development projects.

For affordable incentives, which are viewed as tightening instead of easing zoning policies, Figure 4 shows that treated municipalities experience a concentration of the option value distribution towards zero and negative territory, consistent with the interpretation that these mandates—while potentially improving local amenity through affordable housing provision—make development harder to execute, reducing the value of the development option.

Finally, and notably, no regulatory easing in our sample produces the combination of negative amenity and negative option value. This null result suggests that the zoning reforms observed in practice are not associated with deterioration on both margins simultaneously. Municipalities that liberalize their zoning environments appear to generate either amenity improvements, option value gains, or both—even when the specific transmission mechanism varies across regulatory types.

6 Conclusion

This paper develops an LLM-assisted methodology which enables the scalable analysis of large-scale causal shifts in housing regulations. This results in a panel dataset of a large set of housing regulatory shifts across a comprehensive set of American municipalities, which we draw on for a synthetic difference-in-differences analysis. This allows us to analyze a substantially broader set of housing regulatory shifts than has been previously considered.

We interpret our findings in the context of a spatial equilibrium model with agglomeration

and developer option value which generates three empirically distinct channels: supply shifts, demand/amenity shifts, and option value shifts.

Our findings suggest that the conventional treatment of housing regulations as primarily affecting housing supply constraints is incomplete. Many regulations do operate primarily through a housing supply channel, particularly regulations liberalizing use (such as allowing multi-family buildings). However, some regulations appear to have effects on demand as well. In our calibration, almost all policies easing housing regulations have some positive impact on amenities, consistent with a role for agglomerative effects of production or endogenous amenity provision.

Another distinctive and novel result in our context is the prevalence of option value effects which result in house price increases even as rents fall. We typically see these effects for regulations which ease infill and incremental density development frictions, such as legalizing ADUs. We also find important differences in the form of regulatory relief. By-right regulatory changes appear to have a greater option value impact than those by discretion, pointing to a role for regulatory clarity in capitalization into development options.

Our results point to important considerations for economic models of housing regulation, suggesting that demand feedback loops through amenities as well as dynamic supply considerations are essential considerations on top of a standard static supply and demand framework. They help to reconcile estimates in prior literature by providing a unifying framework which can accommodate differing estimates for house prices and rents. And they also point to important opportunities and challenges for policy efforts focusing on liberalizing land use. While zoning regulatory shifts generally have positive effects on housing quantities, the measured effects on rents and house prices are far more heterogeneous, reflecting endogenous reactions through demand and supply forces.

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Tables

Table 1: Summary Statistics

	Obs.	(Units)	Mean	Median	Std. Dev.
House Prices	65,792	(2,902)	237	177	222
Rents	9,755	(1,682)	1.65	1.52	0.67
Population	43,612	(2,928)	29	9	83
Housing Units	43,612	(2,928)	12	4	35
Vacancy Rate	43,612	(2,928)	13	11	12
Income	43,563	(2,928)	58	50	31

Coverage: House Prices '00-'25; Rents '15-'25; ACS Outcomes '09-'23. All rows at municipality level. Statistics are computed by matching the regulatory question panel universe to raw outcome data, prior to any sample restrictions or regression processing. *Sources*: House Prices: Zillow (ZHVI); Rents: Zillow (ZORI); Population, Housing Units, Vacancy Rate, Income: ACS. *Units*: House Prices, Rents, Population, Housing Units, and Income are reported in thousands.

Table 3: Model Predictions: Comparative Statics of Regulatory Shocks

Shock Type	**Pop** (N)	**Rent** (R)	**Price** (P)	**Wage** (W)
Demand/amenity shift ($A_a \uparrow$)	$\uparrow$	$\uparrow$	$\uparrow$	$\uparrow$
Pure supply shift ($\Phi_a \uparrow$, no option value)	$\uparrow$	$\downarrow$	$\downarrow$	$\uparrow$
Supply shift with option value ($\Phi_a \uparrow$)	$\uparrow$	$\downarrow$	$\uparrow$	$\uparrow$

Notes: Comparative statics derived from the spatial equilibrium model. The demand/amenity shock increases local amenities A_a. The pure supply shift relaxes zoning ($\Phi_a \uparrow$) in a model without option value. The supply shift with option value allows property prices to rise through the redevelopment option even as rents fall.

Table 2: Summary Statistics: Regulation Changes

	Type	N_0	N_1	Avg. Change	Avg. T_1 Year	Never Change
Zoning District Count	Num	1,415	415	2.257	2020	48%
Multifamily Allowed	Bin	436	271	0.140	2018	89%
Mixed-Use Buildings	Bin	1,151	270	0.822	2019	66%
Conv. To Multifamily	Bin	2,675	35	0.164	2022	93%
Townhouses Allowed	Bin	1,229	219	0.611	2019	73%
Age Provisions	Bin	2,071	121	0.550	2020	79%
ADUs Allowed	Bin	1,802	284	0.574	2020	75%
FZ By Right	Bin	2,630	42	0.204	2020	92%
FZ By Permit	Bin	787	195	0.922	2019	66%
Affordable Incentive	Bin	2,363	137	0.261	2020	88%
Permit Cap Or Phasing	Bin	2,638	22	0.250	2022	91%
Wetlands Restrictions	Bin	2,613	38	0.211	2020	92%
Longest Frontage	Num	1,942	327	1.084	2019	67%
Highest Min Lot Size	Num	1,939	325	1.058	2020	67%
Mean Min Lot Size	Num	1,191	317	2.834	2020	41%
Lowest Min Lot Size	Num	1,853	342	1.165	2020	64%
Variances for Res. Use	Bin	353	6	0.108	2022	95%
Any IZ	Bin	273	20	0.190	2021	89%
Any Mand. IZ	Bin	358	8	0.080	2021	95%
Mand. IZ Municipality	Bin	356	10	0.085	2021	94%
Alternative to AH	Bin	347	10	0.095	2021	94%
ADU Family Members	Bin	377	1	0.044	2012	98%
Flexible Zoning	Bin	164	24	0.501	2018	75%
Mobile Homes	Bin	89	20	0.321	2020	83%
Min. Num. for AH	Num	382	5	0.270	2020	98%
Largest Front Setback	Num	298	41	0.638	2019	77%
Largest Side Setback	Num	283	38	0.908	2019	73%
Highest Height	Num	285	39	0.863	2019	73%
Lowest Lot Coverage	Num	299	40	0.712	2019	77%
Growth Rate	Bin	383	1	0.013	2019	99%
Phased Growth	Bin	346	7	0.159	2019	92%

Notes: The sample covers the period 1999–2025. N_0 (control observations) and N_1 (treatment observations) are defined at the municipality level. Treatment is defined using a cutoff year of 2015 for ACS and Zillow ZHVI outcomes, and 2018 for Zillow ZORI outcomes. "Bin" denotes binary variables and "Num" numerical variables. "FZ" denotes flexible zoning, "IZ" inclusionary zoning, and "AH" affordable housing. For binary questions, N_0 includes municipalities that always report "No," while N_1 includes those that switch exactly once from "No" to "Yes." For numerical questions, N_0 includes municipalities whose values never change or are always missing, and N_1 those whose values change exactly once in either direction. "Avg. Change" denotes the average number of response changes per municipality across all survey waves within a question panel. "Avg. T_1 Year" denotes the average treatment year among treated municipalities. "Never Change" denotes the fraction of municipalities whose responses never change or are always missing.

Table 4: Estimates of Housing Regulatory Changes on Prices, Binary Questions

	House Prices			Rents			Price/Income			Price/Rent			Rent/Income		
	N_0	N_1	ATT (SE)	N_0	N_1	ATT (SE)	N_0	N_1	ATT (SE)	N_0	N_1	ATT (SE)	N_0	N_1	ATT (SE)
Multifamily Allowed	267	90	-0.003 (0.016)	38	13	-0.017 (0.020)	—	—	—	38	13	-0.035 (0.021)	41	12	0.033 (0.040)
Mixed-Use Buildings	625	164	-0.012 (0.011)	106	18	-0.018 (0.021)	950	220	0.025* (0.015)	106	18	-0.018 (0.017)	111	17	-0.002 (0.022)
Conv. To Multifamily	1641	22	-0.001 (0.021)	349	4	0.050 (0.047)	2297	21	0.062 (0.041)	349	4	-0.015 (0.051)	349	3	0.038 (0.062)
Townhouses Allowed	693	147	0.004 (0.011)	89	19	-0.030* (0.018)	—	—	—	89	19	-0.014 (0.017)	96	18	-0.029 (0.025)
Age Provisions	1173	92	0.004 (0.014)	233	12	-0.003 (0.026)	1736	119	0.004 (0.020)	233	12	-0.012 (0.024)	239	11	-0.031 (0.032)
ADUs Allowed	1038	181	0.023** (0.011)	176	37	-0.021* (0.012)	1535	216	0.019 (0.013)	176	37	-0.004 (0.017)	189	30	-0.041** (0.019)
FZ By Right	1603	21	0.009 (0.019)	330	7	-0.039 (0.030)	2241	34	0.008 (0.036)	330	7	0.030 (0.033)	334	3	0.046 (0.048)
FZ By Permit	438	105	-0.002 (0.015)	85	13	0.018 (0.018)	636	153	0.005 (0.019)	85	13	-0.029 (0.029)	87	15	-0.034 (0.027)
Affordable Incentive	1352	104	0.022 (0.014)	239	19	-0.012 (0.021)	2005	107	-0.012 (0.021)	239	19	0.026 (0.018)	246	12	-0.004 (0.032)
Permit Cap Or Phasing	1585	14	0.015 (0.036)	328	4	0.043 (0.033)	2255	14	0.115*** (0.038)	328	4	-0.042 (0.036)	330	2	0.051 (0.050)
Wetlands Restrictions	1563	27	0.020 (0.029)	330	1	0.022 (0.062)	2228	35	0.011 (0.029)	330	1	-0.009 (0.058)	329	1	0.061 (0.075)
Variances for Res. Use	228	3	0.012 (0.036)	—	—	—	300	3	0.083 (0.056)	—	—	—	—	—	—
Any IZ	159	11	0.019 (0.033)	37	5	-0.039 (0.033)	226	13	0.006 (0.045)	37	5	0.024 (0.033)	38	4	-0.006 (0.051)
Any Mand. IZ	223	5	0.011 (0.038)	60	4	0.015 (0.041)	302	6	0.065 (0.049)	60	4	-0.026 (0.035)	61	4	0.063 (0.059)
Mand. IZ Municipality	225	6	0.047 (0.064)	59	5	-0.016 (0.031)	304	5	0.043 (0.097)	59	5	0.014 (0.020)	63	1	0.024 (0.113)
Alternative to AH	215	7	-0.033 (0.028)	57	3	-0.001 (0.046)	296	7	-0.038 (0.067)	57	3	-0.030 (0.043)	59	2	-0.026 (0.070)
ADU Family Members	—	—	—	—	—	—	320	1	0.041 (0.174)	—	—	—	—	—	—
Flexible Zoning	93	18	-0.001 (0.037)	26	2	0.016 (0.068)	131	19	0.000 (0.043)	26	2	0.059 (0.049)	27	2	-0.003 (0.079)
Mobile Homes	72	13	-0.064 (0.042)	22	1	-0.008 (0.101)	80	17	-0.120*** (0.045)	22	1	0.050 (0.067)	22	1	0.032 (0.104)
Growth Rate	247	1	0.098* (0.052)	—	—	—	325	1	0.006 (0.123)	—	—	—	—	—	—
Phased Growth	218	8	0.072 (0.051)	61	2	-0.005 (0.066)	293	8	0.079 (0.068)	61	2	-0.023 (0.041)	61	2	-0.029 (0.073)

Notes: N_0 denotes control municipalities and N_1 treated municipalities across treatment cohorts. ATT estimates are sign-adjusted so that positive values correspond to regulatory relaxation. Standard errors are reported in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. "FZ" denotes flexible zoning, "IZ" inclusionary zoning, and "AH" affordable housing. House prices and rents are measured in logs.

Table 5: Estimates of Housing Regulatory Changes on Prices, Continuous Questions

	House Prices			Rents			Price/Income			Price/Rent			Rent/Income		
	N_0	N_1	ATT (SE)	N_0	N_1	ATT (SE)	N_0	N_1	ATT (SE)	N_0	N_1	ATT (SE)	N_0	N_1	ATT (SE)
Zoning District Count	1553	96	-0.027 (0.024)	320	29	0.001 (0.042)	2166	130	-0.058 (0.042)	320	29	0.045*** (0.015)	316	29	-0.022 (0.062)
Longest Frontage	1573	173	-0.018 (0.017)	321	49	0.049*** (0.018)	2195	227	-0.007 (0.024)	321	49	-0.027 (0.020)	320	48	0.063* (0.037)
Highest Min Lot Size	1582	94	-0.064 (0.049)	325	22	-0.015 (0.062)	2194	133	-0.020 (0.033)	325	22	0.168*** (0.036)	333	19	-0.023 (0.035)
Mean Min Lot Size	1596	51	-0.100 (0.082)	327	13	0.057 (0.117)	2206	66	-0.022 (0.120)	327	13	0.136** (0.058)	328	13	0.045 (0.037)
Lowest Min Lot Size	1558	23	0.054 (0.158)	318	20	-0.025 (0.096)	2194	15	0.156*** (0.028)	318	20	0.054 (0.079)	324	28	-0.120* (0.063)
Min. Num. for AH	248	4	0.141*** (0.017)	67	2	-0.042 (0.032)	326	3	0.091*** (0.018)	67	2	0.120*** (0.032)	68	1	0.157*** (0.041)
Largest Front Setback	225	23	0.040* (0.022)	64	5	0.011 (0.024)	289	35	0.034 (0.027)	64	5	0.101*** (0.032)	58	11	0.024 (0.022)
Largest Side Setback	225	25	0.143*** (0.040)	63	6	-0.115** (0.047)	297	28	0.019 (0.013)	63	6	0.705*** (0.056)	63	6	-0.050** (0.024)
Highest Height	228	10	-0.437*** (0.048)	56	9	0.113** (0.052)	299	10	-0.094 (0.221)	56	9	-0.237*** (0.039)	57	8	-0.083 (0.055)
Lowest Lot Coverage	223	27	0.085*** (0.014)	57	12	0.087*** (0.032)	300	26	0.035** (0.017)	57	12	0.017 (0.027)	58	11	0.120*** (0.029)

Notes: N_0 denotes control municipalities and N_1 treated municipalities across treatment cohorts. ATT estimates are sign-adjusted so that positive values correspond to regulatory relaxation. Standard errors are reported in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Continuous treatment variables are standardized by dividing by twice their standard deviation following (Gelman, 2008). To mitigate measurement error, observations with treatment magnitudes below 0.1 standard deviations are excluded. "AH" denotes affordable housing.

Table 6: Estimates of Housing Regulatory Changes on Quantities, Binary Questions)

	N_0	N_1	Housing Units	Population	Vacancy Rate
Multifamily Allowed	467	122	0.004 (0.014)	-0.006 (0.016)	-0.228 (0.467)
Mixed-Use Buildings	1160	197	0.011 (0.009)	0.011 (0.009)	-0.168 (0.253)
Conv. To Multifamily	2657	23	0.014 (0.022)	0.011 (0.023)	-0.343 (0.758)
Townhouses Allowed	1243	169	0.018 (0.012)	0.009 (0.011)	0.179 (0.416)
Age Provisions	2068	111	-0.009 (0.010)	-0.012 (0.011)	-0.130 (0.415)
ADUs Allowed	1837	213	0.015** (0.007)	0.008 (0.009)	-0.150 (0.325)
FZ By Right	2604	35	0.008 (0.018)	0.002 (0.020)	0.007 (0.619)
FZ By Permit	796	148	0.005 (0.012)	-0.003 (0.014)	0.483 (0.409)
Affordable Incentive	2370	91	-0.004 (0.011)	0.007 (0.015)	-0.064 (0.409)
Permit Cap Or Phasing	2614	16	0.033 (0.027)	-0.009 (0.027)	0.017 (0.918)
Wetlands Restrictions	2590	29	-0.008 (0.022)	0.023 (0.026)	-1.107 (0.736)
Variances for Res. Use	348	3	-0.001 (0.034)	-0.005 (0.047)	-1.696 (1.870)
Any IZ	273	14	-0.018 (0.034)	-0.050 (0.041)	-0.669 (0.913)
Any Mand. IZ	352	7	-0.022 (0.045)	0.010 (0.056)	-0.333 (1.226)
Mand. IZ Municipality	354	4	-0.021 (0.044)	0.018 (0.059)	-0.705 (1.388)
Alternative to AH	346	7	-0.025 (0.042)	-0.012 (0.071)	0.546 (1.696)
ADU Family Members	—	—	—	—	—
Flexible Zoning	163	16	0.035 (0.029)	0.004 (0.026)	0.193 (1.040)
Mobile Homes	87	17	-0.009 (0.021)	-0.002 (0.027)	-0.649 (0.904)
Growth Rate	376	1	0.078 (0.115)	0.042 (0.121)	-0.059 (3.069)
Phased Growth	342	8	-0.005 (0.044)	0.023 (0.046)	-0.194 (1.623)

Notes: N_0 denotes control municipalities and N_1 treated municipalities across treatment cohorts. ATT estimates are sign-adjusted so that positive values correspond to regulatory relaxation. Standard errors are reported in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. "FZ" denotes flexible zoning, "IZ" inclusionary zoning, and "AH" affordable housing.

Table 7: Estimates of Housing Regulatory Changes on Quantities, Continuous Questions)

	N_0	N_1	Housing Units	Population	Vacancy Rate
Zoning District Count	2500	149	-0.029 (0.017)	-0.026* (0.014)	-0.320 (0.782)
Longest Frontage	2536	258	0.000 (0.013)	-0.002 (0.015)	-0.082 (0.381)
Highest Min Lot Size	2543	146	-0.055 (0.050)	-0.040 (0.037)	0.102 (0.385)
Mean Min Lot Size	2542	75	-0.030 (0.050)	-0.029 (0.051)	0.062 (5.109)
Lowest Min Lot Size	2541	17	-0.065* (0.035)	-0.061** (0.027)	0.667 (0.606)
Min. Num. for AH	377	3	-0.055*** (0.009)	0.007 (0.006)	-0.757 (0.513)
Largest Front Setback	337	37	-0.088** (0.038)	-0.053 (0.034)	-0.403 (0.632)
Largest Side Setback	345	31	-0.128*** (0.039)	-0.074*** (0.025)	0.530 (0.486)
Highest Height	347	12	-0.022 (0.209)	-0.295 (0.203)	1.054 (2.284)
Lowest Lot Coverage	347	29	-0.021 (0.016)	-0.007 (0.016)	0.042 (0.231)

Notes: N_0 denotes control municipalities and N_1 treated municipalities across treatment cohorts. ATT estimates are sign-adjusted so that positive values correspond to regulatory relaxation. Standard errors are reported in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Continuous treatment variables are standardized by dividing by twice their standard deviation following (Gelman, 2008). To mitigate measurement error, observations with treatment magnitudes below 0.1 standard deviations are excluded. "AH" denotes affordable housing.

Table 8: Quadrant-Pooled Effects of Regulatory Changes

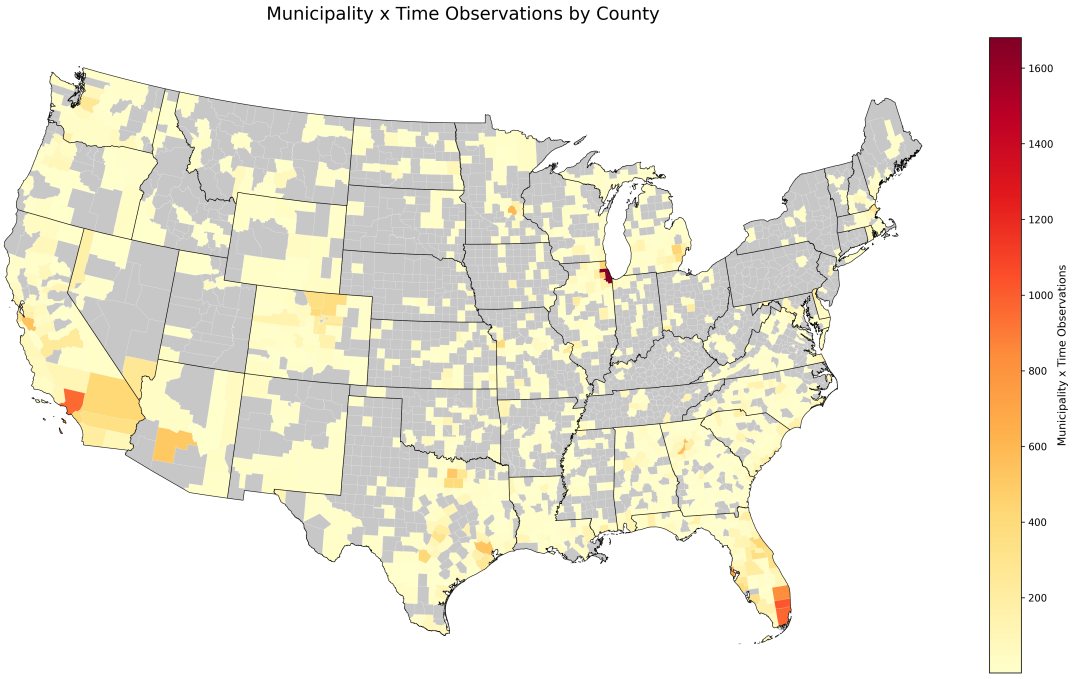
	ACS			Zillow		
	Units	Population	Vacancy Rate	ZHVI	ZORI	Price-to-Rent
↑ Price, ↑ Qty	0.0085**	0.0081*	0.4494**	0.0138**	0.0403***	0.0415***
	(0.0038)	(0.0048)	(0.1995)	(0.0060)	(0.0132)	(0.0065)
	[10,270 / 762]	[9,463 / 614]	[7,619 / 359]	[5,181 / 349]	[1,896 / 28]	[356 / 9]
↓ Price, ↑ Qty	0.0118	0.0125***	0.0358	-0.0124*	-0.0240***	-0.0171
	(0.0079)	(0.0048)	(0.1688)	(0.0070)	(0.0071)	(0.0113)
	[11,603 / 173]	[14,314 / 51]	[6,676 / 57]	[8,266 / 409]	[739 / 94]	[2,279 / 113]

Notes: Municipality-level TWFE replication (per cohort ATT estimation, weighted aggregation up to a single ATT akin to staggered Synthetic DiD, Gelman-standardized and relaxing SD cutoff for numerical questions) pooling question IDs by price-quantity quadrant on the basis of Figure 2. Control / treatment observation counts shown in brackets. Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

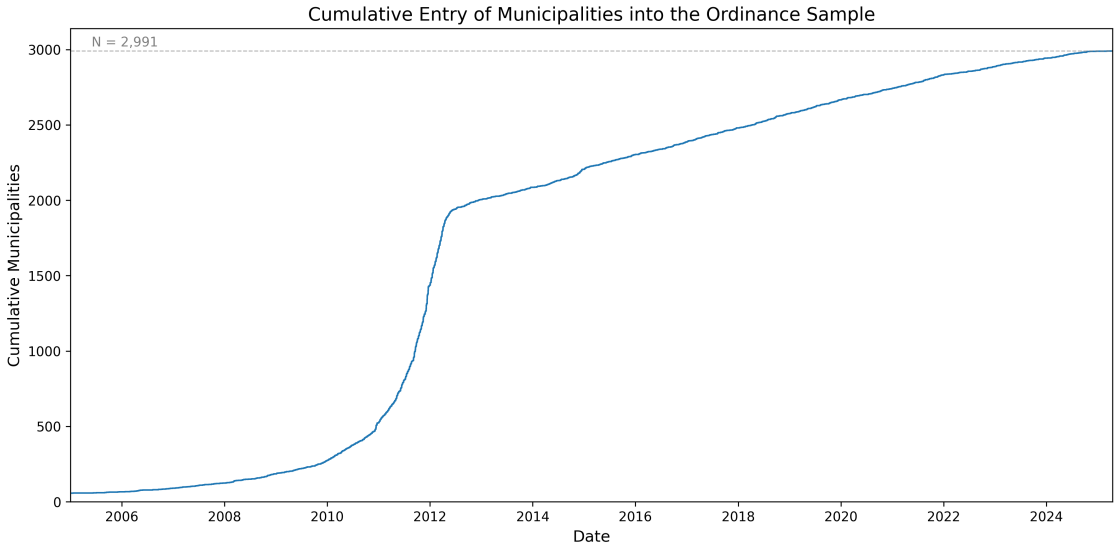
Figures

Figure 1: Geographical and Time-Series Coverage of Municipal Ordinances

Panel A: Geographical Coverage



Panel B: Time-Series Coverage



Notes: Panel A shows Geographic distribution of zoning ordinance coverage by county. Counties are shaded by the total number of municipality-by-time observations in the ordinance panel. Grey counties contain no matched municipalities. Panel B shows the cumulative number of municipalities entering the zoning ordinance sample over time. Each municipality is counted from the date of its first observed ordinance.

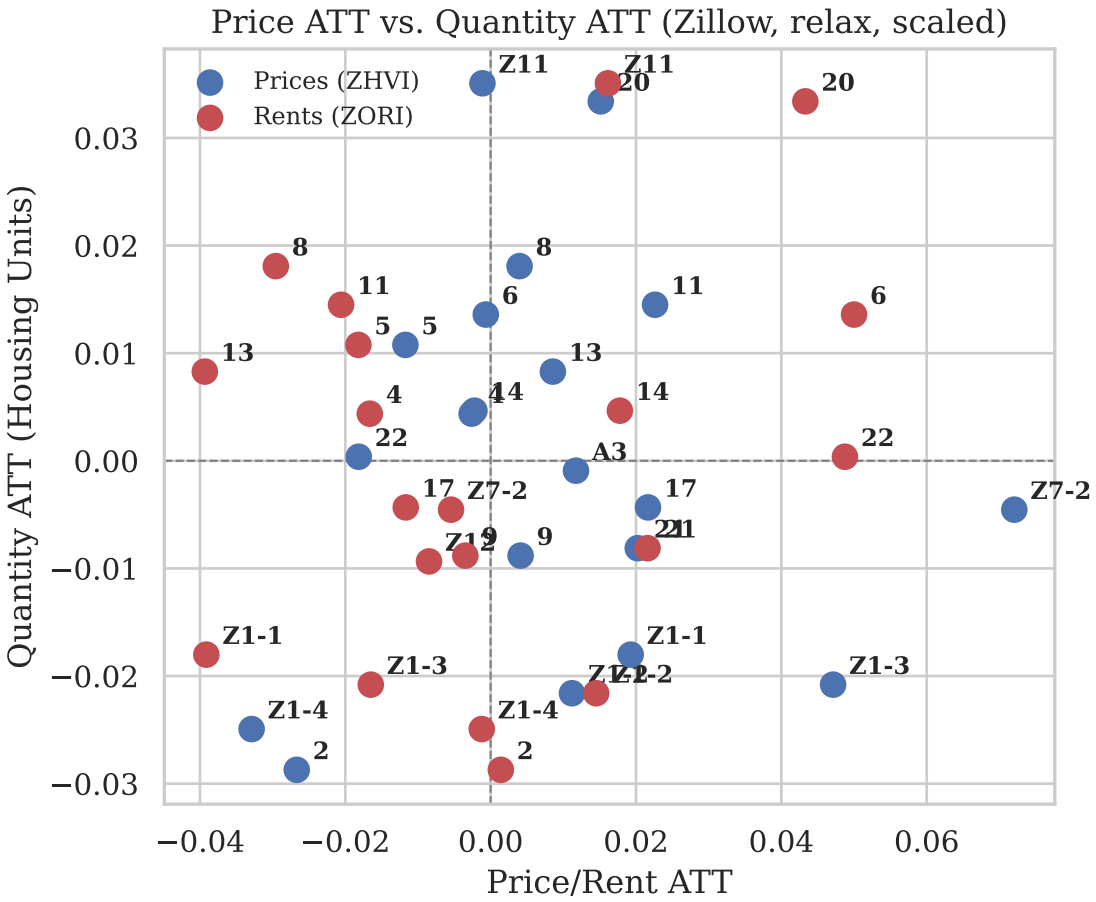


Figure 2: Price vs. Quantity Effects Across Regulations

The figure plots ZHVI housing price and ZORI rent estimates against ACS housing unit estimates. The sample is restricted to observations whose estimated coefficients lie within [-0.06,0.08] for price and [-0.03,0.04] for quantity. See Appendix Table A.I and A.II forlookups of specific regulatory questions.

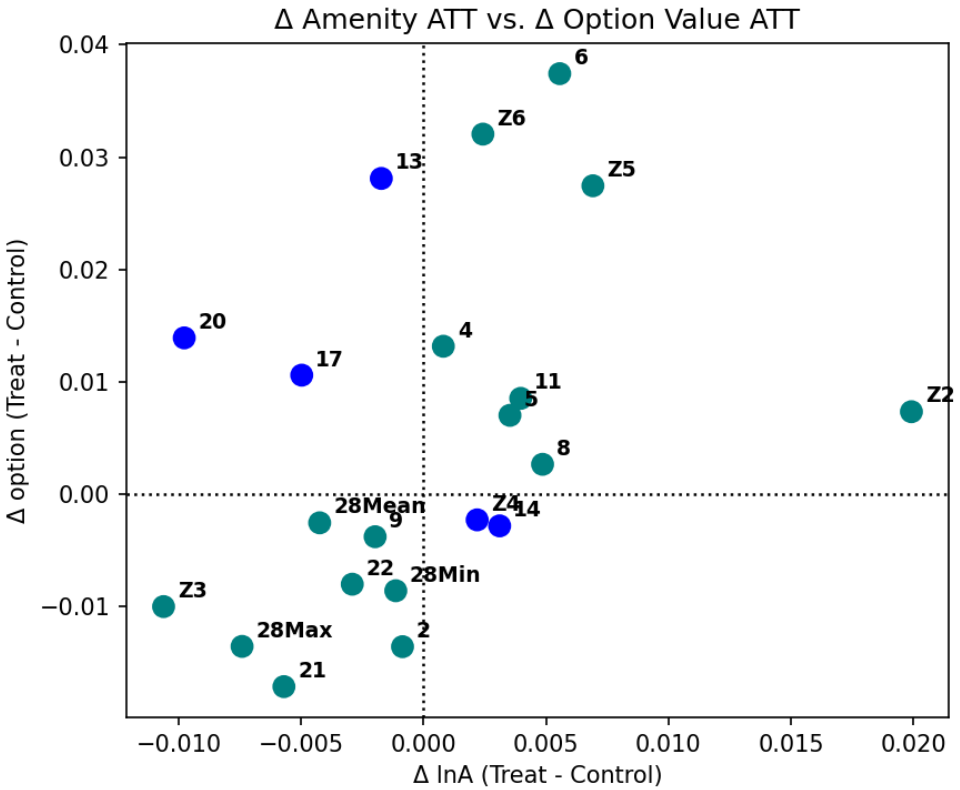
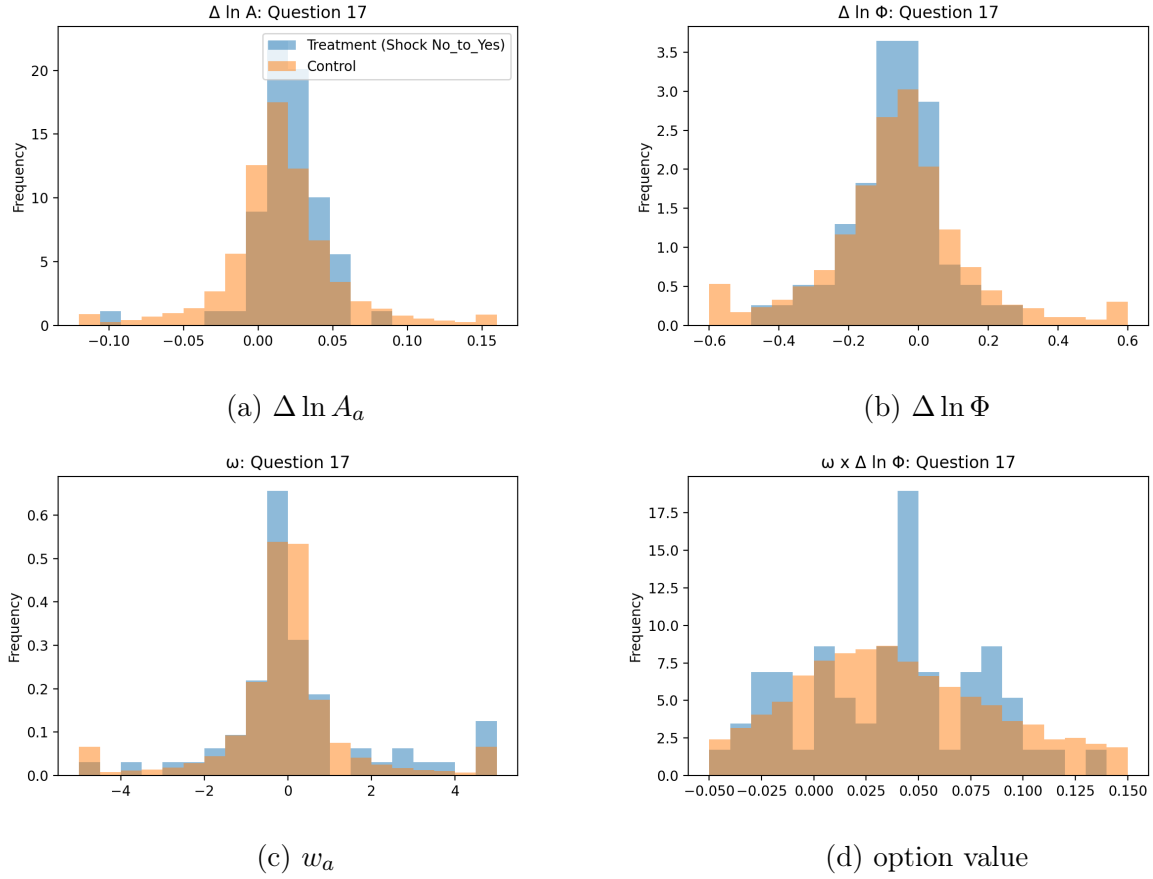


Figure 3: Change in Implied Amenity and Option Value

The figure plots the ATT for model implied amenity change (x-axis) and option value change (y-axis) for each policy easing.



(a) $\Delta \ln A_a$

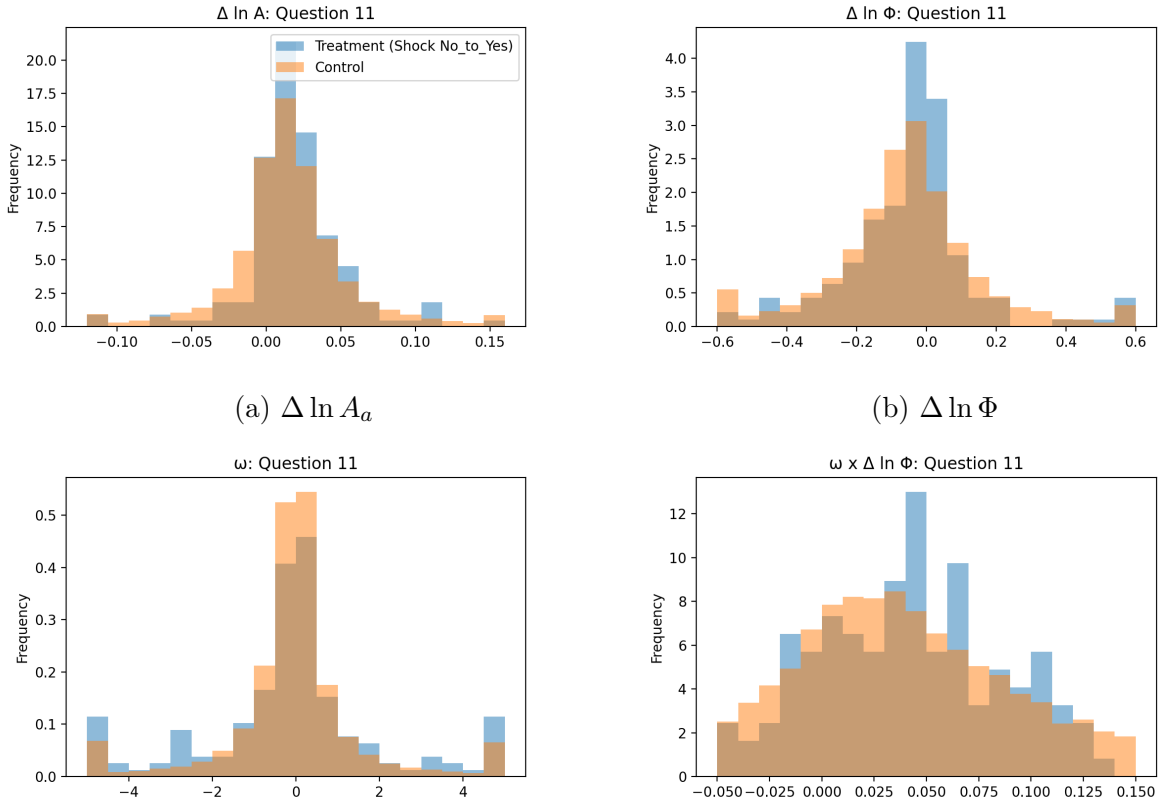
(b) $\Delta \ln \Phi$

(c) w_a

(d) option value

Figure 4: Distribution for Calibrated Moments: Affordable Incentive and Mandate

Notes: This figure plots distributions of model-implied structural moments for municipalities that adopted affordable incentive and mandate provisions (treatment, blue) versus municipalities that did not (control, orange). Panel (a) shows the implied change in log amenity $\Delta \ln A_a$ from equation (9). Panel (b) shows the implied change in the log supply shifter $\Delta \ln \Phi_a$ from the market-clearing condition. Panel (c) shows the estimated price-supply elasticity ω_a, which captures how property prices respond to changes in the regulatory environment conditional on rent changes. Panel (d) shows the implied option value contribution $\omega_a \cdot \Delta \ln \Phi_a$.



(a) $\Delta \ln A_a$

(b) $\Delta \ln \Phi$

(c) w_a

(d) option value

Figure 5: Distribution for Calibrated Moments: ADU

Notes: This figure conducts a similar exercise as Figure 4, but restricted to policies which ease the development of Accessory Dwelling Units (ADUs).

Additional Results

Table A.I: Question Lookup: Binary Questions

Question ID	Short Label	Full Question
4	Multifamily Allowed	Is multi-family housing allowed, either by right or special permit (including through overlays or cluster zoning)?
5	Mixed-Use Buildings	Are apartments above commercial (mixed use) allowed in any district?
6	Conv. To Multifamily	Is multi-family housing listed as allowed through conversion (of either single family homes or non residential buildings)?
8	Townhouses Allowed	Are attached single family houses (townhouses, 3+ units) listed as an allowed use (by right or special permit)?
9	Age Provisions	Does zoning include any provisions for housing that is restricted by age?
11	ADUs Allowed	Are accessory or in-law apartments allowed (by right or special permit) in any district?
13	FZ By Right	Is cluster development, planned unit development, open space residential design, or another type of flexible zoning allowed by right?
14	FZ By Permit	Is cluster development, planned unit development, open space residential design, or another type of flexible zoning allowed by special permit?
17	Affordable Incentive	Does the zoning bylaw/ordinance include any mandates or incentives for development of affordable units?
20	Permit Cap Or Phasing	Is there a town-wide annual or biannual cap on residential permits issued, and/or is project phasing required?
21	Wetlands Restrictions	Are there restrictions on counting wetlands, sloped land or easements in lot size calculations?
Z1-1	Any IZ	Under inclusionary zoning, do developers have alternatives to building affordable units on site?
Z1-2	Any Mand. IZ	Does the municipality have an inclusionary zoning program that is mandatory for every applicable project?
Z1-3	Mand. IZ Municipality	Does the mandatory inclusionary zoning policy apply throughout the municipality?
Z1-4	Alternative to AH	Under mandatory inclusionary zoning, do developers have alternatives to building affordable units on site in at least one district?
Z7-1	Growth Rate	Does the zoning bylaw indicate a planned or targeted growth rate that limits the annual number of residential permits issued in the municipality?
Z7-2	Phased Growth	Does the municipality require phased growth for large new housing developments?
Z10	ADU Family Members	Is residence in an accessory dwelling unit restricted to family members of the primary unit's occupants?
Z11	Flexible Zoning	Is multi-family housing allowed under any form of flexible zoning, such as cluster development, planned unit development (PUD), or open space residential design (OSRD)?
Z12	Mobile Homes	Are mobile homes or manufactured housing a permitted use in any district?
A3	Variances for Res. Use	Can variances be granted to allow residential uses that are not otherwise permitted?

Notes: Binary questions have Yes/No answers.

Table A.II: Question Lookup: Numerical Questions

Question ID	Short Label	Full Question
2	Zoning District Count	How many zoning districts, including overlays, are in the municipality?
22	Longest Frontage	What is the longest frontage requirement for single family residential development in any district?
28Max	Highest Min Lot Size	What is the highest residential minimum lot size?
28Mean	Mean Min Lot Size	What is the mean residential minimum lot size?
28Min	Lowest Min Lot Size	What is the lowest residential minimum lot size?
Z2	Min. Num. for AH	What is the minimum number of residential units required for affordability mandates to apply?
Z3	Largest Front Setback	What is the largest front setback requirement for a single family residential development in a single-family district?
Z4	Largest Side Setback	What is the largest side setback requirement for a single family residential development in a single family district?
Z5	Highest Height	What is the highest maximum height allowance for any residential development in any district?
Z6	Lowest Lot Coverage	What is the lowest maximum lot coverage by a residential building in any district?

Notes: Numerical questions have continuous answers.

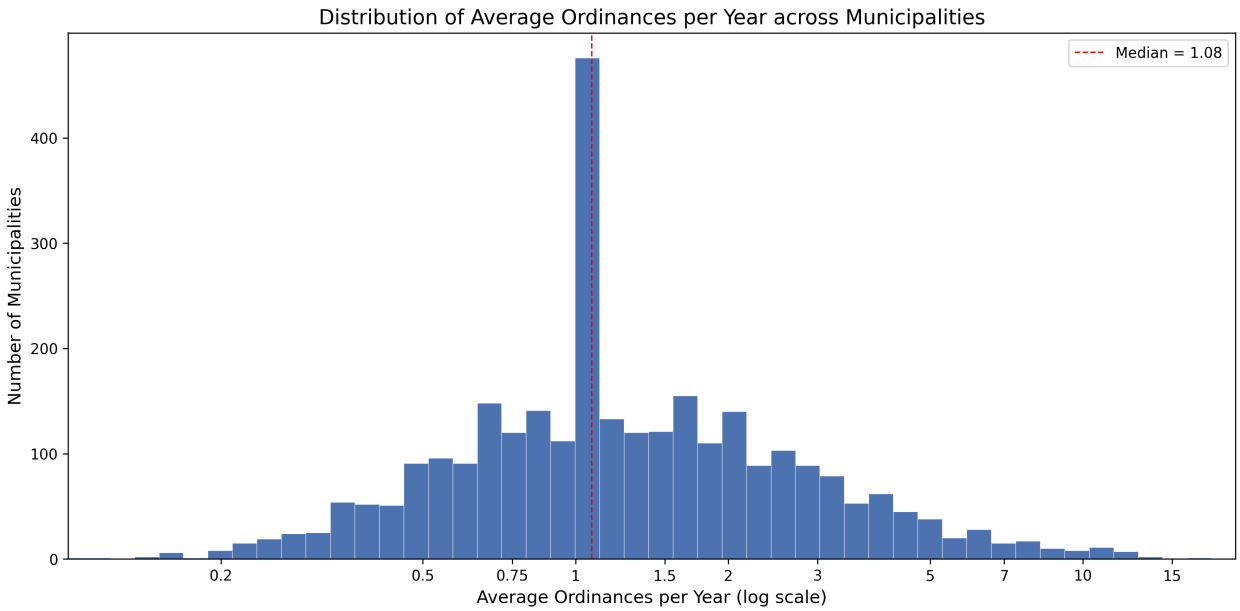


Figure A.I: Distribution of average annual ordinance frequency across municipalities. For each municipality, the frequency is computed as the total number of ordinances divided by the time span (in years) between its first and last observed ordinance. The x-axis is displayed on a log scale.