Yes, Literally, In My Backyard: The Effect of “Gently” Upzoning Single-Family Neighborhoods

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Abstract

Single-family zoning protects the preferences of local residents but limits housing supply. I study an increasingly popular middle ground approach: allowing homeowners to build accessory dwelling units (ADUs) on their properties. In 2016, California deregulated permitting for ADUs on most single-family parcels. I exploit this variation in treatment between single- and multi-family parcels, which I aggregate to the Census tract level. I find permit deregulation had a statistically significant, but modest, effect on ADU construction: a Census tract exposed to ADU deregulation experienced one more ADU constructed per year than a non-exposed tract. Furthermore, I find that supply constraints predict ADU construction, suggesting ADUs are filling gaps in rental supply. However, an economic model and a linear panel event study show ADUs are insufficient to decrease rent. I do not find evidence that ADUs decrease neighboring property values. I compare properties sold near a constructed ADU to properties sold slightly farther away, and my confidence interval excludes effects more negative than a 3.6 percent reduction in property values.

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1 Introduction

Many desirable cities in the United States face housing affordability crises. As the economic consensus builds that this is an issue of supply, with one estimate placing the national shortage at 6.5 million homes,[1] increased attention is directed to local land use regulations and single-family zoning in particular (Gyourko and Krimmel, 2021). Single-family zoning protects the preferences of local residents but constrains housing supply. Reforming single-family zoning is difficult, as homeowners are concerned about congestion, privacy, and, of course, their own property values. A popular middle-ground policy is to allow homeowners to build Accessory Dwelling Units (ADUs), which are self-contained residential units on a lot with a primary residential unit. Interest in ADUs is growing: ADU permits in Portland, OR increased by almost 250% from 2019 to 2022, British Columbia's 2023/2024 provincial budget earmarks 91 million dollars toward encouraging ADU construction, and the White House held a panel on how to ease ADU construction (Ionescu, 2023; Depner, 2023; The White House, 2022).

Over the last decide, California enacted sweeping pro-ADU legislation, including preemption of local discretionary permitting. This goal of this "gentle" approach to increased density is to increase housing supply without drastically changing the landscape of single-family neighborhoods (Baca et al., 2019; Simpson, 2019). Proponents hope ADUs can help alleviate the state's affordability crisis by providing more affordable housing (Chapple et al., 2018, 2021; Garcia, 2017). However, Glaeser and Tarki (2023) argue that ADUs built by individual homeowners cannot close the gap in housing supply, and they instead support large-scale development from more efficient private firms. Furthermore, the central compromise of ADUs, that they pose minimal nuisance effects on local homeowners, is not well investigated.

In this paper, I study (i) the effect of permitting deregulation on ADU construction, (ii) the effect of increased ADU supply on rent, and (iii) whether ADUs impose nuisance effects on property values of neighboring homes. Question (i) is important because it isolates how much housing construction states can unlock with ADUs by removing local discretionary authority, as opposed to proactive subsidization. It is difficult to answer because permit deregulation was accompanied by other pro-ADU policies at the state level and a national increase in popularity of ADUs. Questions (ii) and (iii) are key parts of the policy debate regarding ADUs. The fundamental empirical challenge to questions (ii) and (iii) is that where ADUs are built is non-random. One is more likely to build an ADU where housing demand is growing, and thus ADUs may be correlated with increased rent. This is also a barrier to studying their effects on nearby property values because ADUs may be built where the presence of renters is increasing.

To overcome the challenges to (i) and (ii), I compare the effect of California's policies between

[1] See CNN (2023).

single- and two-, three-, and four-family zoned areas, which I refer to as multi-family zoned areas.[2] This is a natural comparison group because ADUs increase the density of single-family areas to more resemble areas with duplexes, triplexes, and fourplexes. In 2016, California established a right to build an ADU on a lot with a single-family home, overriding local regulations against such construction. I exploit the fact that this permitting deregulation only applied to parcels with single-family homes, while other policies did not apply differently to single- and multi-family parcels. I then use this exogenous supply-side variation, coupled with an economic model, to estimate the effect of ADUs on rent. To answer question (iii), I exploit variation in distance to a constructed ADU and the timing of constructions to estimate a nuisance effect.

I start by presenting a theoretical model of ADU construction in a housing market where developers build apartments, renters demand rental housing, and single-family homeowners are given the choice to build an ADU. Homeowners benefit from building an ADU through rental income but suffer nuisance and overcrowding from ADUs built by their neighbors. The model yields three key results. First, homeowners, when able to collectively choose the level of ADU production, will choose not to build ADUs. Homeowners without this coordination will build ADUs when there are supply constraints on rental housing from developers. Second, the effect of increased supply from ADUs on price can be estimated from the size of the supply increase. Third, the value of a property near versus slightly further away from an ADU differs only in the negative spillovers of density on nearby properties.

I then investigate the effect of permitting deregulation on ADU construction. I collect and merge building permit data from Anaheim, Los Angeles, San Diego, and San Francisco to create a novel dataset of all ADUs built within those cities. California's permitting reforms affected single-family parcels and multi-family parcels differently. Specifically, permits for ADUs on lots with single-family homes were approved without being subject to local discretionary permit approval processes. Because multi-family lots did not experience this zoning reform in 2016, but did experience most other pro-ADU forces in the state, they serve as a plausible comparison group to single-family lots. I aggregate this variation to the tract-level by determining what percent of a primarily residential census tract is single-family zoned. I then use this variation in a difference-in-difference strategy to estimate the effect of permitting deregulation on the construction of ADUs. I find a Census tract exposed to permit deregulation built one ADU per year more than a non-exposed tract. These results are driven by ADU construction in supply constrained areas. To illustrate this, I use the ratio of home values to home replacement costs as a measure of supply constraints and show that this ratio is highly correlated with ADU construction.

Turning to rent prices, I use tract-level rent data from the American Community Survey, com-

[2] Throughout, I use "multi-family" zones to refer to these two-, three-, and four-family zoned areas. I exclude areas zoned for large apartment buildings from my analysis.

bining this with ADU construction data from building permits. I apply a similar empirical strategy. Because "gentle" density aims to make single-family areas slightly denser so that they resemble two-, three-, and four-family areas, those multi-family zones are an intuitive "always treated" group for comparison of rent trajectories. Applying my linear panel model, I find a directionally consistent but not economically or statistically significant effect on rent prices, which lines up with the forecast from the model. I find little evidence of reductions in rent, and can rule out reductions in rent prices more negative than 2.2 percent. To establish a plausible range for reduction in rent prices due to ADUs, I use my economic model to forecast the effect of the quantity increase in housing due to ADUs on rent prices. Of course, new units in one neighborhood could lower rents in another. I address this issue by estimating my model's forecast at higher levels of geography, finding very similar results. My analyses in conjunction suggest a half to one percent decline in rents due to ADUs.

Lastly, I study whether ADUs decrease nearby property values. My estimation strategy is motivated by my theoretical framework, which describes how the nuisance effect from an ADU changes in distance to that ADU. I estimate whether the relationship of a property's value to its distance from the site of an ADU construction changes before and after the ADU is constructed, akin to Linden and Rockoff (2008) and Diamond and McQuade (2019). I find no effect on nearby property values and am able to exclude negative effects larger than 3.6 percent. I find slightly more negative point estimates in neighborhoods above median income, but they are still not statistically distinguishable from zero.

This paper contributes to the economic literature in two ways. First, this paper extends a robust economic literature on zoning to the context of "gently" upzoning, which allows homeowners to add rental units. Previous literature establishes that large scale upzoning increases housing supply (Büchler and Lutz, 2021; Greenaway-McGrevy and Phillips, 2022). Extending this literature, I show that "gently" upzoning also has a significant effect on homeowner-driven construction of rental housing. Isolating the effect of ADU permit streamlining is important because it quantifies the housing stock gains states can achieve by simply removing regulations.

Furthermore, my findings make apparent the degree to which land use regulation constrains rental supply (Gyourko and Molloy, 2015; Hsieh and Moretti, 2019).[3] Glaeser and Gyourko (2002) establish that regulations inhibit home construction in the U.S., specifically that regulations drive a mismatch between the cost of constructing a new home and the home's price. This paper extends these results by showing that homeowners build ADUs in the presence of supply constraints on rental housing.

Second, this paper contributes to the literature on the effects of new housing construction, both on rents and nearby property values. This paper is the first to study the effect of ADUs

[3] See Diamond et al. (2019) for a similar finding with rent control policies.

on rent, contributing to previous literature on the effect of large apartment buildings (Asquith et al., 2023; Li, 2019; Mast, 2023; Pennington, 2021). There is previous literature on the nuisance effect of ADUs; for example, Davidoff et al. (2022) use a cross-sectional estimation strategy that compares variation newly built homes with ADUs to newly built homes without.[4] They estimate a 3.8 reduction in transaction price, and a 5.7 reduction in high income neighborhoods. My paper has the advantage of exploiting both cross-sectional and temporal variance in ADU construction. My estimates suggest much smaller nuisance effects.

This paper's findings also are of interest to policymakers. To the best of my knowledge, this paper is the first to comprehensively study the last seven to ten years of ADU policy change in California. This paper establishes that, while deregulation is successful in increasing housing supply, the size of the supply increase from ADUs is insufficient to meaningfully lower rents. Similarly, the construction of ADUs had little effect on nearby property values, suggesting nuisance effects are overstated. My analysis on the policy is supplemented with original qualitative research on ADUs in California. I motivate and interpret a number of my results with interviews of field experts in residential development and contracting. I also interview State Senator Robert Wieckowski, who authored many of California's policy changes studied in this paper.

The rest of this paper proceeds as follows. Section 2 provides further background on the California's policy changes and Section 3 reviews data sources used. Section 4 then introduces an economic model that aides in my empirical estimation. Then, Section 5 studies the deregulation of ADUs. Section 6 covers the estimation of ADUs on rent prices and Section 7 investigates whether ADUs harm the property values of their neighbors. Section 8 concludes.

2 Background

The Accessory Dwelling Unit

An accessory dwelling unit is a self-contained residential unit on a lot with a primary residential unit. The primary residential unit may be of any type: a single-family home, a duplex, or even an apartment building. In a single-family home or duplex with a large backyard, an ADU might be a detached structure. With less backyard space, constructing an ADU might involve adding a new room on top of one's garage.[5] Crucially, the ADU must be an independent housing unit rather than, for example, a guest bedroom that is open for renters. An ADU generally must have its own

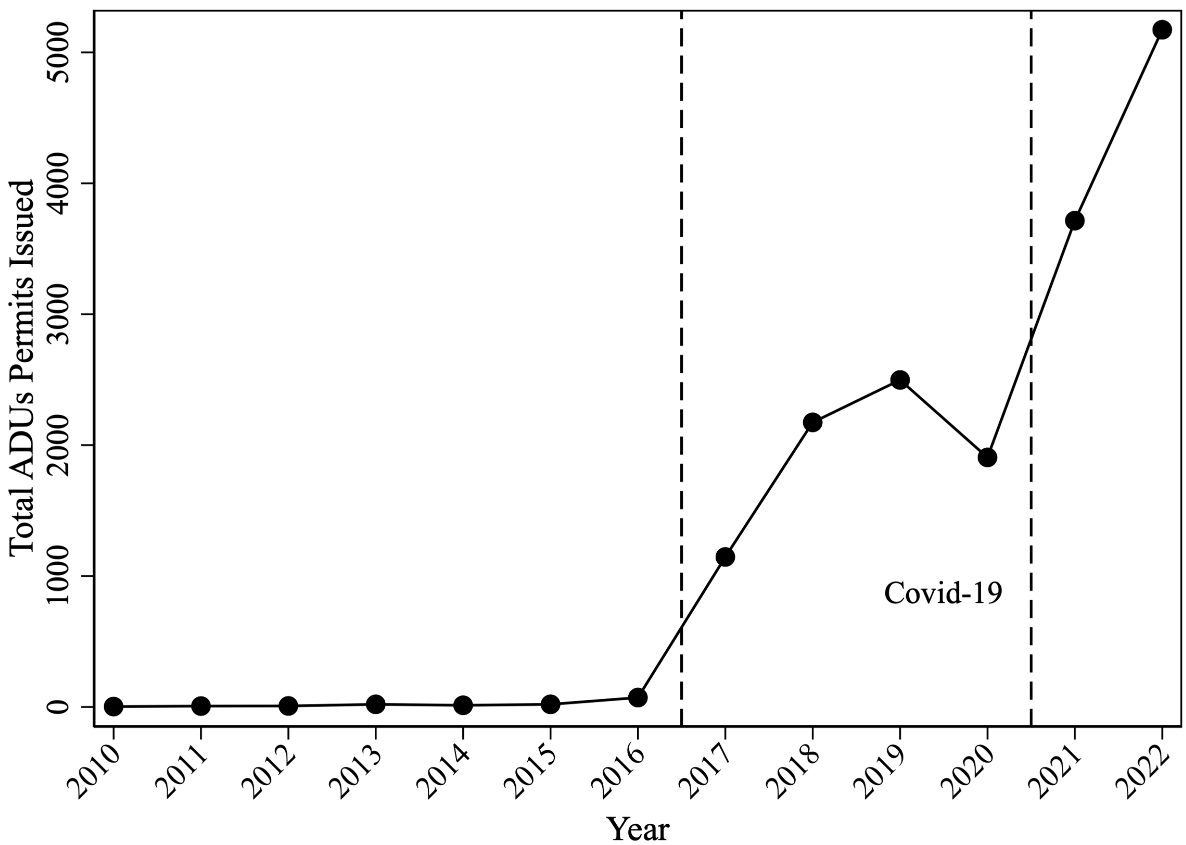
[4] Regarding the "own-lot" effect, Brueckner and Thomaz (2024) estimate that an ADU raises one's own property values by seven to nine percent.

[5] The options for infill differ based on the primary unit. An ADU could be built in the basement garage of an apartment building that sees little need for extra parking spaces. An ADU can be detached or attached to the primary unit, may have its own pathway and porch, or may simply be an extra bedroom converted into a studio apartment.

entrance, accessible without entering the primary residential unit. Appendix Figure B.1 depicts example detached ADUs, built in California homeowners' backyards (California Department of Housing and Community Development, 2022).

Since 2016, California's state government has passed a number of pro-ADU policies. Figure 1 displays the total number of issued ADU permits in Anaheim, Los Angeles, San Diego, and San Francisco. Prior to 2016, permits were rarely issued in these cities. Since then, the number issued rose dramatically, reaching over 5,000 in 2022.

Figure 1: ADUs Permitted Over Time



Notes: This figure plots the number of ADU permits issued in Anaheim, Los Angeles, San Diego, and San Francisco each year since 2010. I restrict to permits issued within zones in my sample, single- or multi-family residential zones.

The following paragraphs detail the relevant reforms, drawing from California Department of Housing and Community Development (2022). The 2016 reforms, primarily SB 1069 and AB 2299, addressed the two of the most significant barriers to permitting.

First, the 2016 reforms made an ADU permit *ministerial* or *by-right* on zones with single-family homes. This is the key reform I study: overriding local discretionary authority. In California, local regulatory authorities have strong power over the rules around housing construction in their jurisdiction. Prior to reforms, a local permitting authority's judgement on an ADU was discretionary. A local authority could object to the specifics of one's design, add onerous requirements, or simply outright outlaw extra units in certain zones. Permitting also takes a long time. In my conversation with a field expert who worked in an ADU-specializing contractor office, they mentioned that they regularly expected the process of approval to take months. It was standard for a permit to be rejected at least once so that the ADU could be redesigned to be in compliance.

Permitting deregulation meant that an ADU must be permitted if it met certain guidelines set by the state. Those guidelines capped the maximum size of a detached ADU to 1,200 square feet, and an attached ADU to the lesser of 1,200 square feet or half of the primary unit's floor area (California Department of Housing and Community Development, 2018). Note that the by-right permitting reform only applied to single-family homes. All other reforms in 2016 were, by and large, applied equally to all types of residential units. Specifically, the legislation reads:[6]

> [...] every local agency shall ministerially approve the creation of an accessory dwelling unit if the accessory dwelling unit complies with all of the following: [...] (C) The lot contains an existing single-family dwelling.

Second, the 2016 reforms lifted a number of other restrictions, including waiving parking requirements for all ADUs within half a mile of a transit stop and lifting passageway requirements (California Department of Housing and Community Development, 2018).

California's actions were a *preemption* of local authority: if a local authority's ADU ordinance was not in line with state requirements, it would be in violation of state law. This preemption is worth mentioning. Localities in California can be resistant to housing and can express this preference through a byzantine array of local regulations.[7] A legislative aide in the office of State Senator Wieckowski described the process of removing barriers to ADU construction as a "cat and mouse" game with local authorities. In our conversation, Senator Wieckowski described the preemptive nature of the policy – voiding local regulations – as one of the best aspects of the bill.

The 2020 reforms consisted primarily of AB 68, AB 881, and SB 13. The two largest regulatory changes were the banning of owner-occupancy requirements and the lifting of impact fees.[8]

[6] Legislation text accessed from California Legislative Information (2016).

[7] The City of Sonoma, for example, responded to state efforts to promote duplexes by requiring that a duplex lot must contain three mature trees (Alameldin and Garcia, 2022).

[8] An impact fee is a fee imposed by local authorities for adding residential density to the area. Given that a fire department, police department, DMV, or school's costs increase if more people move in, adding a new unit of residential housing would often incur thousands of dollars in extra fees for the owner. The motivation for the fee stems from the addition of people, not housing, so these fees would often be similar in magnitude to the ones incurred for building a primary residential structure. The 2020 laws waived impact fees for ADUs under 750 square feet and significantly reduced other impact fees by requiring them to be proportional to ADU size.

Furthermore, the wait time for approval of an ADU permit was reduced from 120 days to 60 days, with an ADU considered as automatically approved if a response was not issued in that time.

The 2020 laws extended the by-right capacity established in 2016. Homeowners now had by-right permitting access to one ADU and one JADU[9] on their property. The by-right reform was also extended to two/three-family properties. Therefore, duplexes and triplexes also gained the ability to add ADUs by-right.

Table 1 summarizes the main points of the above exposition.[10] This table only summarizes the reforms relevant to my empirical analysis. For a thorough review of all legislative changes in California over this time period, see Dubler (2022) and Gray (2024).

Table 1: Summary of ADU Reforms in California

Summary of Reforms		
Year	Main Bills	Summary of Reforms
2016	SB 1069, AB 2299, AB 2406	By-right permitting, reduced parking requirements, streamlined conversion. *Ministerial permitting only applied to single-family homes*.
2020	AB 68, AB 881, SB 13	No owner-occupancy requirement, 60 days to respond to permit, banned misc. restrictions, reduced impact fees. Establishes two by-right ADUs (1 ADU, 1 JADU) on single-family properties and a by-right ADU on multi-family properties.

Notes: This table summarizes legislative changes that occurred with regard to ADUs in California. The list of bills and reforms is not exhaustive. The main focus of this paper is the reforms of 2016 and 2020, so most reforms in other years are not listed.

[9] A Junior Accessory Dwelling Unit (JADU) is an ADU built within the existing structure of the primary unit, and must be less than 500 square feet. These have less stringent requirements regarding their independence – they may share central housing systems, bathrooms, etc. with the primary unit.

[10] A reform not mentioned in the table is SB 9. Passed in 2021 and taking effect in 2022, SB 9 allows for lot splits – which allow an owner to take a single-family lot and split it into two residential lots. This "duplex-es" single-family lots. Some argue that this, coupled with the ADU reforms, could theoretically result in a "four-plexing" of single-family homes in California, as the owner could first duplex the house and then build an ADU for each primary unit in the duplex (Metcalf et al., 2021). Such a change could transform single-family zones in California into two/three/four-family zones. However, given the length of construction and the availability of rental data, the study of SB 9 is out of the scope of this paper. Similar analyses to this paper could be conducted a few more years after SB 9's passage

ADUs as Affordable Housing Supply

The California Department of Housing and Community Development cites numerous benefits to building an ADU: they are cost-effective, provide extra space for extended family, and serve as housing for the elderly. However, the state's primary hope for ADUs is increased affordable housing supply. The Government Code Section 65852.150 of the California legislature lays out the state's motivations: [11]

> Allowing accessory dwelling units in single-family or multifamily residential zones provides additional rental housing stock [...] Accessory dwelling units offer lower cost housing to meet the needs of existing and future residents within existing neighborhoods, while respecting architectural character.

Therefore, it is useful to briefly review some facts about the rental characteristics of ADUs. First, ADUs are frequently rented out. Chapple et al. (2021) conducted a survey of 823 California homeowners who constructed ADUs. They found that 51 percent of ADUs serve as long-term rental units, and a further sixteen percent of ADUs house a relative of the primary homeowner at no cost.[12] Only eight percent of ADUs serve as short term rentals.

Second, proponents of ADUs argue that they contribute to affordable housing supply. Because ADUs "do not require paying for land, major new infrastructure, structured parking, or elevators," they can naturally serve as low to mid-range units for renters (California Department of Housing and Community Development, 2022).

Third, proponents of ADUs emphasize the ability of ADUs to infill empty space (e.g. backyards) in single-family parcels. Therefore, California's approach to formalizing such housing could be appropriate given the prevalence of single-family homes in California and the need for increased housing supply. Estimates from Wegmann and Chapple (2014) argue that in the Bay Area "Flatlands,"[13] ADUs could provide a comparable amount of housing to denser multi-family units. Indeed, State Senator Wieckowski suggested that adding a unit in a backyard is much easier than getting a large "acre-and-a-half" new housing development.

[11] Legislation text accessed from California Legislature (2017).

[12] Furthermore, the median rent of an ADU was \$2,000 in Los Angeles, \$2,150 in San Diego and Orange counties, and \$2,200 in San Francisco. This is generally affordable to the median-income two-person household in these areas.

[13] The Flatlands is a geographic area adjacent to, but not contained in, the areas of San Francisco studied in this paper.

3 Data

Measuring Residential Areas and Zoning

The main sample in this paper is single- and multi-family residential areas in Anaheim, Los Angeles, San Diego, and San Francisco. For each city, I access shapefiles of their zones and regulation information (Anaheim Open Data, 2022; Los Angeles Department of City Planning, 2021; City of San Diego, 2023; San Francisco Open Data, 2022). These maps contain polygons of each zone, with feature information such as the type of zone. I only focus on areas which are either low or medium density. I use the zoning codes of each city to define my sample. I define a parcel as "single-family" zoned if only one residential unit may be built. A parcel is "multi-family" zoned if around one to four units may be built. A parcel is "in-sample" if it is either single- or multi-family zoned. To summarize, my sample consists of residential areas where there are single-family homes, duplexes or triplexes, or townhomes. I exclude high-density residential areas, which typically contain very dense apartments.

Measuring ADUs

I use building permit data to measure ADU construction. Because I need to measure location and precise timing of ADUs, I am unable to use publicly available aggregations of ADU permits. Instead, I search building permits for text relating to ADUs. Anaheim, Los Angeles, San Diego, and San Francisco regularly publish building permit data, which I access (Anaheim Open Data, 2023; Los Angeles Department of Building and Safety, 2023; San Diego Development Services Department, 2023; San Francisco Department of Building Inspection, 2023). Each permit contains a description[14], through which I determine whether a permit is for the construction of an ADU.[15] I filter for ADU-related language, including terms relating to ADUs or the relevant ordinances and state bills.[16] When an ADU is constructed, the date of construction is noted and a completion variable is marked in the permit data, which I use to measure the timing and completion of ADU construction. I geolocate the ADU using the associated parcel number with each permit. I use shapefiles of parcels from each city to and merge each ADU permit based on the parcel number (OC Survey's Land Information Section, 2023; Public Works: Engineering OpenData, 2024; San Diego County Assessor/Recorder/County Clerk, 2024; City and County of San Francisco, 2023). I

[14] Example descriptions from San Francisco's October 2022 permits read: "bakyard landscape and front porch remodel [sic]," "remodel of (e) duplex: add a new garage, kitchen and bathroom remoel, add new deck, [sic]" and "detached garage: convert to adu. 1 story vertical addition with one bedroom and bathroom."

[15] Each observation also contains a permit identification number, the date submitted, the block and lot, coordinates, and a street address.

[16] I use other variables, such as a permit category variable, to filter for whether the permit is constructing a new ADU or merely updating its wiring.

also match each permit to its zone and determine whether it was issued in a single- or multi-family zone. The resulting dataset covers 16,074 permits from 2010-2022.[17]

Benchmarking Against Annual Progress Report Data. There is some public data on statewide ADU production from the Annual Progress Report (APR), which compiles information on whether cities are meeting housing construction goals (California Department of Housing and Community Development, 2022). Unfortunately, this data does not contain precise dates regarding the permit's status (issuance, completion) and only contains the status variable itself in 2021-2022, both of which are critical for my empirical analysis. However, I use the APR data in 2021-2022 to benchmark my data collection. In Appendix Table B.1, I report the number of permits issued in each city from my data construction against the number of permits "Approved" or "Complete" in the APR data.[18] The dataset I assemble is comparable to the APR data, and actually estimates more ADUs in each city and year. I suspect this is because the APR data's has poorer reporting of permit status.[19] Overall, this provides evidence I am accurately measuring ADU permit issuance and construction.

Rent and Neighborhood Characteristics

I use Census Tract data from the American Community Survey (ACS). I use ACS 5-year estimates of median income, population, median rent prices, and number of rental units. All dollar values are inflated to 2022 dollars. I merge each zone from the zoning data to measure what proportion of the tract is (a) in-sample and (b) single- versus multi-family zoned, as defined at the top of this section. I restrict to tracts that are at least 50 percent in-sample. I map each permit to a Census Tract and compute the number of ADUs permits issued and the number of ADUs constructed in each tract from 2010 to 2022. This results in a sample of 833 tracts from 2010-2022.

In Appendix Tables B.3 and B.4, I report summary statistics for my key variables in each year from 2015 to 2022, the key period for my analysis. In 2015, the mean number of ADUs built in a tract is 0.01, which rises to 3.33 in 2022. For context, the average number of rental units in 2015 is 901. Noticeably, the mean number of rental units (and mean population) sharply changes at 2020, most likely due to the pandemic.

[17] I do not extend out to permits after 2022 due to a censoring problem – because permitting takes a long time, only rapidly approved and constructed ADUs would be available in later years. Hence, I treat 2022 as the last year of my analysis.

[18] I assign my permits to the year in which they were issued. For the APR data, because dates for each status are not provided, I include both approved and completed permits because completion is inclusive of approval. The APR data's year variable comes from the year in which the permit was reported. Of course, to split by city, I constrain to the permits in both datasets that I can geolocate.

[19] To verify this, in Appendix Table B.2, I report permits issued in my data against any permit "Approved", "Complete", or "Pending" in the APR data. Here, the APR data is comparable in some cities, but has thousands more permits in others like Los Angeles.

Property Values

I construct a novel dataset of property sales through the San Francisco and Los Angeles assessor offices. I acquire San Francisco property sales data through email correspondence with the office. I match sale information with property characteristics like number of bedrooms using the parcel number of the sale and San Francisco's assessor roll (San Francisco Assessor, 2024). I scrape Los Angeles property values using the Los Angeles Property Assessment Information Map (Los Angeles County Assessor, 2023). This service allows a user to search for property information, which includes nearby sales in the last two years. [20] Therefore, I acquire all property sales from 2022 to 2024 in a 1000-foot radius around every ADU constructed in 2022 or 2023. I scrape the number of bedrooms, square footage, and year built for most of the sales.

Supply Constraints

Romem (2017) at BuildZoom, an online marketplace for contractors, constructs an index for the home value to replacement costs of a home. The author builds this index at the zip code level, drawing on data from the American Community Survey, Federal Housing Finance Agency, and the Census Building Permit Survey. They use data from 2011-2015 to construct a value of the ratio in 2016. I use their zip-code level measure as a proxy for supply constraints.

4 Theory

This section builds a simple model of a housing market with ADUs. The model describes the relationship between single-family homeowners, housing developers, and renters. The model has two purposes. First, I characterize the conditions under which ADUs are built. In particular, I show that ADUs are built in the absence of homeowner coordination and in the presence of supply constraints on rental housing. Second, I derive tools to estimate the supply effect of ADUs on rent and the nuisance effect on nearby properties. This section reviews the model, discusses implications, and concludes by addressing limitations. Proofs are in Appendix A.

[20] From the Building Permit Data, I take the parcel number and construction date for every ADU constructed in Los Angeles from 2022 to 2023. Using the service, I build a script using the Python packages Selenium and Beautiful Soup that iteratively enters each ADU-containing property into the service and records the transacted properties within a quarter-mile of it. Figure B.2 in the appendix depicts an example property search using the service.

4.1 Setup

4.1.1 Overview

In a housing market c, there are three groups: renters, homeowners, and developers.[21] There are two residential areas, one where homeowners live in single-family homes and one where renters live in apartment buildings.[22] I do not consider tenure choice – no individual can switch from homeowner to renter, or vice versa. Developers supply apartments and single-family homes. Homeowners may construct additional rental housing through ADUs on their single-family homes and can suffer nuisance through the presence of renters living in other homeowner's ADUs. Under regulation, homeowners may coordinate their ADU production. Under deregulation, homeowners produce ADUs taking the ADU production choices of their neighbors as given.

4.1.2 Developers

Let $\lambda_r, \lambda_s > 0$ be exogenous parameters governing the amount of land allocated to renters and homeowners respectively. Developers build apartments on λ_r, according to a production function $F_r(d_r) = d_r \lambda_r$. Here, $d_r \in \mathbb{R}_{\geq 0}$ is an intensity of housing production and can be thought of as how densely the developers build apartments. Similarly, developers build single-family homes on λ_s according to a production function F_s, which is specified by a choice of d_s. I constrain d_s to the unit interval because single-family homes are necessarily density constrained. Developers face convex cost functions $C_r(d_r) = \sigma_r \frac{d_r^2}{2} \lambda_r$, $C_s(d_s) = \sigma_s \frac{d_s^2}{2} \lambda_s$ for rental and single-family housing respectively, where $\sigma_r, \sigma_s > 0$ are exogenous construction cost parameters. Construction costs include physical costs of materials and labor, but also include the cost of potential government supply constraints or regulation. Developers solve

$$\max_{d_s, d_r} \left[p_r d_r \lambda_r - \sigma_r \frac{d_r^2}{2} \lambda_r + p_s d_s \lambda_s - \sigma_s \frac{d_s^2}{2} \lambda_s \right],$$

where p_r and p_s are the price of rental housing and single-family housing, respectively.

[21] I suppress c in my notation. In my empirical analysis, I take c to be a census tract, and it is plausible that people move between census tracts in response to increased housing supply. New supply in one market should drive down the rent price in other markets. I attempt to correct for this in my rent analysis. This limitation does not affect analysis on localized impacts like ADU production or nuisance effects.

[22] I assume that all housing units and land are homogenous. In particular, I include very little spatial richness in the model, which is prevalent in many other models of housing markets with zoning such as the mono-centric city model adapted by Büchler and Lutz (2021).

4.1.3 Renters

The renter derives utility from a numeraire good g_r and rental housing consumed h_r. I assume the renter's utility in housing is additively separable from the utility in the numeraire, and the utility from housing is of an isoelastic form: $u(h_r, g_r) = \frac{h_r^{1+\eta}}{1+\eta} + g_r$, where $\eta \in (-1, 0)$.[23]

The renter's budget constraint is $h_r p_r + g_r \leq w_r$, where p_r is the rent price and w_r is the renter's wage. Because the utility function is monotonically increasing in consumption of housing and g_r, the renter satisfies the budget constraint with equality. The renter solves

$$\max_{h_r, g_r} \left[\frac{h_r^{1+\eta}}{1+\eta} + g_r \right] \text{ such that } h_r p_r + g_r = w_r.$$

4.1.4 Homeowners

The homeowner consumes h_s of single-family housing, upon which the homeowner may choose to build an ADU. The homeowner must consume some single-family housing (i.e. $h_s > 0$). The homeowner has an ADU production function $F_h(a) = a h_s$, where $a \in [0, 1]$. Recall that the developers could build rental housing at any intensity level d_r because they build apartments. The homeowner's production intensity is instead bounded in the unit interval because only one ADU may be constructed on a unit of land. The homeowner faces cost of building an ADU $C_h(a) = \sigma_a \frac{a^2}{2} h_s$, where $\sigma_a > 0$ is an exogenous cost parameter. Note σ_a is different from the cost developers face when building rental housing σ_r. While the cost of materials might be similar, σ_a could reflect that homeowners now must spend time marketing their ADU or learning how to rent out a unit. It could reflect distaste from the presence of a renter in the homeowner's backyard.

The homeowner derives utility $v(h_s, g_h)$, which is a function of housing h_s and a numeraire good g_h. I again assume the utility is additively separable and given by

$$v(g_h, h_s) = \log(h_s) - h_s D + g_h.$$

The homeowner's utility in housing is a special case of the renter's utility function, where the elasticity parameter is set to one. D represents disutility from residential density, specifically from the presence of renters on λ_s living in ADUs built by other homeowners. For a homeowner i, D is given by:

$$D = O(\bar{a}) + \sum_{j \neq i} (1 - \delta_j) N(a_j),$$

where $\bar{a} := \sum_{j \neq i} a_j$ is the total intensity of ADU production and δ_j is the distance of neighbor

[23] The typical parameterization uses the form $\frac{h^{1-\eta}}{1-\eta}$ where η is positive, but my formulation is equivalent. I write it this way to interpret η as the inverse price elasticity of demand in later analysis.

j to homeowner i normalized to the unit interval. Note D consists of two effects: $O(\cdot)$ from overcrowding and $N(\cdot)$ from the nuisance of new neighbors. Both O and N have positive first and non-negative second derivative, and $O(0) = N(0) = 0$. Under regulation, homeowners may coordinate and chooses the same level of ADU production for the neighborhood: $a_i = a_j$ for all i, j. Absent zoning, the homeowner may not coordinate and optimizes over a_i, treating a_j as given. The homeowner faces budget constraint

$$\overbrace{\sigma_a \frac{a^2}{2} h_s}^{\text{ADU Cost}} + p_s h_s + g_h \leq w_h + \overbrace{a h_s p_r}^{\text{ADU Income}},$$

where w_h is the homeowner's wage. Because utility is monotonically increasing in the numeraire good, homeowners satisfy the budget constraint with equality. Thus, the homeowner solves

$$\max_{h_s, g_h, a} [\log(h_s) - h_s D + g_h] \text{ such that } \sigma_a \frac{a^2}{2} h_s + p_s h_s + g_h = w_h + a h_s p_r.$$

4.1.5 Equilibrium

I analyze the model under two different equilibrium conditions: one where homeowners may coordinate to set a collective level of ADU production, and one where the homeowners individually determine their level of ADU production.

1. Regulation. The first is the *regulation* equilibrium, reflecting local homeowner zoning. Because homeowners already live within the jurisdictions of local governments, zoning regulations frequently reflect their preferences rather than those of renters, who do not yet live there (Fischel, 2004; Glaeser, 2017).[24] Prior to state-level intervention, local homeowners could coordinate their level ADU production through zoning policies. Therefore, the first equilibrium focuses on what happens if homeowners are able to coordinate their preferred level of ADU production.[25] Because only incumbents can coordinate, this equilibrium is sequential. First, homeowners optimize ADU production, taking current housing consumption as given. Then, they optimize housing consumption, taking ADU production as given. Note $\tilde{D}$ is a function of a, and the homeowner does not take rental price as given because they collectively determine the rental supply from ADUs. Renters and developers optimize, taking prices as given, and markets clear.

2. Deregulation. Second is the *deregulation* equilibrium. After state-level intervention, homeowners were given by-right ADU construction ability and could no longer coordinate at the local

[24] The development of zoning as an expression of homeowner preferences is not limited to a distaste for renters. Indeed, zoning in the United States also has a history of racial disparity, as documented by Shertzer et al. (2016).

[25] This reflects a collective decision-making process amongst the homeowners already living in market c, which could take the form of a referendum or a political game between politicians and voters as in Calabrese et al. (2007). For further study into incumbent preferences and land use regulation, see Parkhomenko (2023).

level. Therefore, homeowners build ADUs, only taking into account their own benefits and costs to building an ADU and ignoring spillover effects of those ADUs onto neighbors. Formally, the homeowner optimizes over housing consumption and their personal level of ADU production, taking the ADU production of their neighbors as given and rental prices as given. Renters and developers optimize, taking prices as given, and markets clear.

4.2 Model Implications

4.2.1 Characterizing ADU Construction

Proposition 1. *Consider the regulation equilibrium. Let $p_r^*(a)$ denote the equilibrium price of rental housing if the homeowner chooses a as the collective level of ADU production. If the magnitude of the marginal disutility from overcrowding and the nuisance effect is strictly greater than the magnitude of marginal profits from increased ADU production:*

$$\forall a > 0,\ \|\frac{d}{da}(D)\| > \|p_r^*(a) - \sigma_a a\|.$$

Then, the homeowner sets $a = 0$.

The assumption in this proposition relates the marginal impact of ADU construction on utility from housing to the profit of an ADU. This assumption is akin to a community deciding that the average profits from an ADU do not outweigh the disutility they would experience from an ADU next door. Prior to 2016, this was the decision often made by many local communities in California.

In the next proposition, I have the homeowner choose a for only their own level of ADU production, disregarding the spillover impact on their neighbors.

Proposition 2. *Consider the deregulation equilibrium. If the homeowner optimizes over their individual a, the supply curve of total rental housing is given by*

$$p_r\left(\frac{\lambda_r}{\sigma_r} + \frac{\lambda_s}{\sigma_a}\right).$$

This proposition characterizes supply from developers $p_r\frac{\lambda_r}{\sigma_r}$ and supply from ADUs $p_r\frac{\lambda_s}{\sigma_a}$. Note that each form of supply is increasing in the land allocated to it and decreasing in its construction costs. A natural question is where we will see more supply from ADUs in the rental market. The next proposition answers what conditions will drive ADU production.

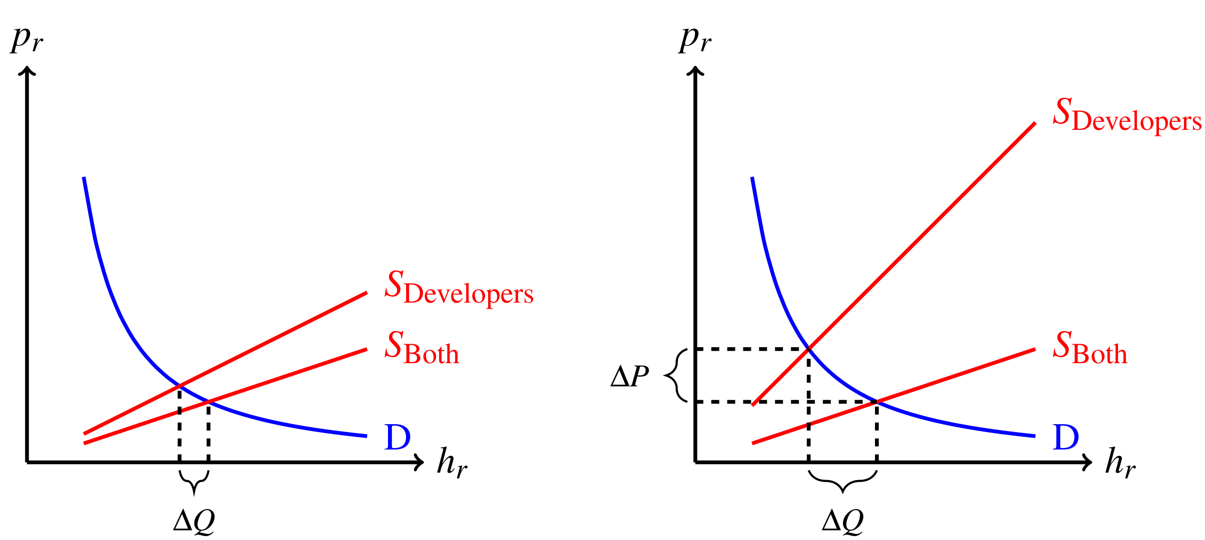
Proposition 3. *In the individual equilibrium, areas with rental supply constraints will see more ADU production. Formally, the ratio of rental housing in individual equilibrium to rental housing* *in collective equilibrium is given by*

$$\left(1+\frac{\lambda_s\sigma_r}{\lambda_r\sigma_a}\right)^{\frac{1}{1-\eta}}.$$

Because η is negative, the above value is increasing in λ_s, σ_r and decreasing in λ_r, σ_a. This aligns with intuition: more land for rental housing or higher costs for ADUs lowers ADU production, and higher cost for rental housing and more land for single-family housing increases ADU production. This is magnified when $|\eta|$ is small, which again lines up with intuition because η is the inverse price elasticity of demand.

The main qualitative prediction of this proposition is that if developers are "efficient enough" at building housing, then fewer ADUs will appear in the market. In Figure 2, I plot two hypothetical scenarios, one with a low σ_r developer (relative to a high σ_a) and one with a high σ_r developer (relative to a low σ_a), holding all other parameters constant. I plot the supply curves in the regulation equilibrium (where just developers supply rental housing) and in deregulation equilibrium (where both developers and homeowners supply rental housing). In the first scenario, homeowners produce few ADUs. In the second, homeowners produce many ADUs.

Figure 2: Supply Constraints on Developers and ADU Production



(a) $\sigma_r = \frac{1}{2}$, $\sigma_a = 1$, Few ADUs Built

(b) $\sigma_r = 1$, $\sigma_a = \frac{1}{2}$, Many ADUs Built

Notes: This figure plots supply curves from developers and from both developers and homeowners. I hold $\lambda_r = \lambda_s = 1$, and set $\eta = -.75$. I vary the values of σ_r, σ_a between the two panels. This is a toy example of the results in Propositions 2, 3, and 4.

4.2.2 Estimating the Supply Effect and the Nuisance Effect

Next, I derive two propositions to estimate the supply effect and the nuisance effect of ADUs.

Proposition 4. *Let p_r^* be the equilibrium price between renters and developers, i.e., when the supply curve is $\lambda_r \frac{p_r}{\sigma}$ in regulation equilibrium. Let h_r^* be the equilibrium quantity of rental housing. Let $p_r'^*$ be the equilibrium price when homeowners may produce ADUs, i.e., when the supply curve is given by Proposition 2. Let $h_r'^*$ be the equilibrium quantity of rental housing in deregulation equilibrium. Then,*

$$\log(p_r'^*) - \log(p_r^*) = \eta \left(\log(h_r'^*) - \log(h_r^*)\right). \tag{1}$$

Intuitively, Equation 1 says that the percent change in housing price is proportional to the percent change in housing supply.[26] Economically, a supply shift's effect on the price can be recovered by tracing out the demand curve, which is illustrated in Panel (b) of Figure 2.

Proposition 5. *The nuisance effect of ADUs on property values can be estimated by comparing properties within the same market c with different distances from neighboring ADUs. Formally, the equilibrium price of single-family housing in deregulation equilibrium can be written as*

$$p_s^* = \frac{1}{2}\left(\frac{p_r^{*2}}{2\sigma_a} - O(\bar{a}^*) - \sum_{j \neq i}(1-\delta_j)N(a_j^*)\right) + \sqrt{\frac{\sigma_s}{\lambda_s} + \frac{1}{4}\left(\frac{p_r^{*2}}{2\sigma_a} - D^*\right)^2}, \tag{2}$$

where p_r^*, a^* and D^* are the equilibrium rental price, ADU production, and homeowner disutility.

Equation 2 lines up with expectations. We have home prices increasing in construction costs σ_s, decreasing in availability of land λ_s, decreasing in disutility from renters D, and increasing in ones own ADU yielding rental income $\frac{p_r^{*2}}{2\sigma_a}$ in equilibrium. Proposition 5 shows that differences in distance to an additional density from ADUs can yield estimates of the nuisance effect. In particular, between two properties in the same market c, the overall overcrowding effect they experience $O(\bar{a})$ is the same. However, the distance weights on the nuisance effect will differ. Furthermore, I assume the cost of constructing single-family housing σ_s subsumes all additional differences in property characteristics (year built, square footage, etc.). Then, the equation derived in this proposition motivates my empirical strategy to estimate $N(\cdot)$ in section 7 because I compare property values very near to ADUs to those slightly further away.[27]

[26] The logarithm here approximates percent changes because $\frac{Q'-Q}{Q} = \frac{Q'}{Q} - 1 \approx \log\left(\frac{Q'}{Q} - 1 + 1\right) = \log(Q') - \log(Q)$ using the fact that $\log(x+1) \approx x$ for small x.

[27] Of course, there is a D^* inside the square root term, so the model does not directly justify simply differencing prices across varying distances to an ADU. However, the model certainly provides motivation for the distance comparison I will use.

5 The Effect of Deregulation

This section estimates the causal effect of zoning deregulation on ADU construction using a difference-in-difference design. I then test a prediction of my model, that the presence of supply constraints predicts ADU construction. Finally, I review some evidence of continuing regulatory barriers through investigating bunching in ADU floor areas.

5.1 Upzoning's Effect on ADUs Constructed

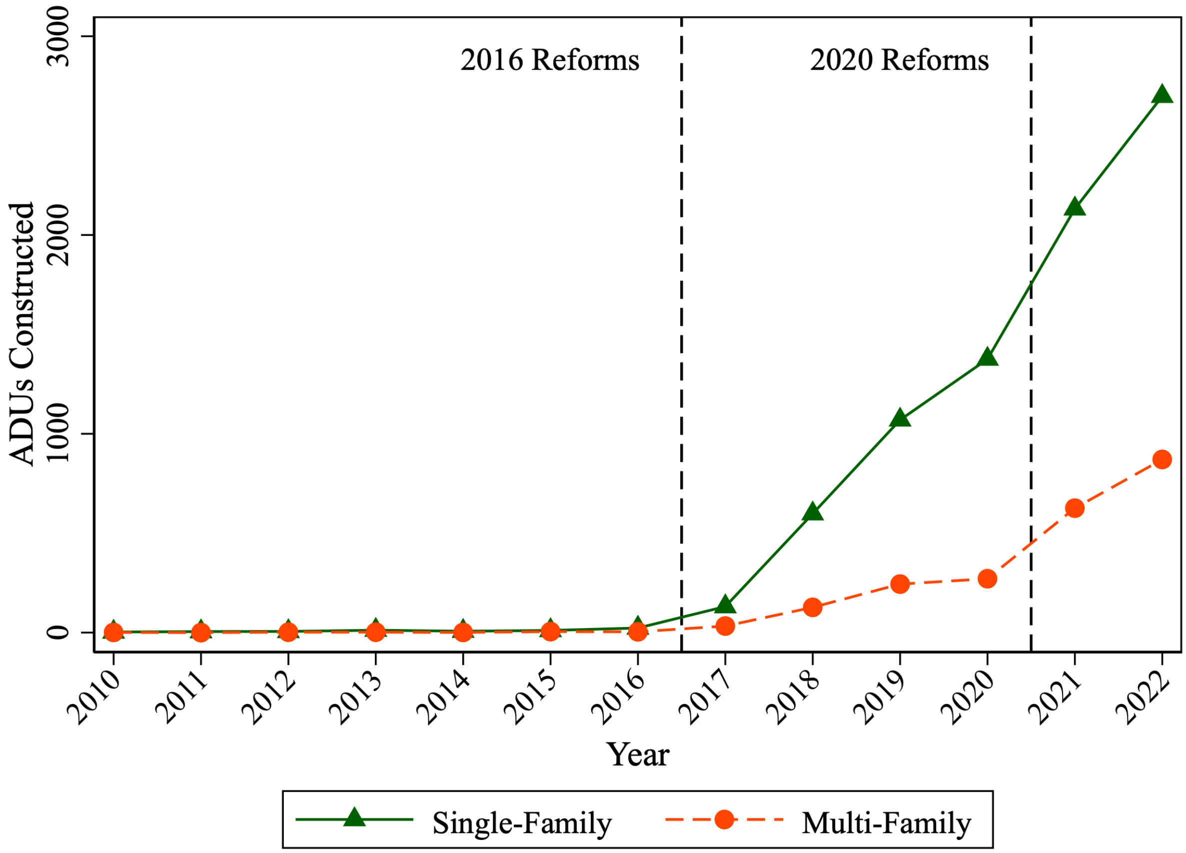
Comparing single-family zones to multi-family zones is a natural way to study the causal effect of removing permitting restrictions on ADU construction, while adjusting for the effect of other pro-ADU legislation, such as subsidies, and confounding demand shocks. While (1) overall demand for ADUs increased equally across the two zone types and (2) the process of building an ADU became subsidized on multi-family zones through California's legislative changes, these zones didn't experience the same *by-right permitting* that single-family zones experienced. Hence, these two groups can be used to study the effect of upzoning on ADU construction. In Figure 3, I plot ADUs constructed from 2010 through 2022 by the zone type.

This figure provides motivation for comparing single- and multi-family zones to isolate the causal effect of permit deregulation. First, single-family zones experienced a higher number of ADUs constructed after 2016. The green line moves much farther up. Second, only the 2016 legislative changes upzoned single-family zones differently from multi-family zones. The 2020 legislative changes did not. Hence, if single- and multi-family zones are comparable, the green line should see a greater increase in slope after the 2016 reforms, but not after the 2020 reforms. This is precisely what we see in the figure: the 2016 changes drive a sharper increase in ADU permitting in single-family zones, but the slope of the upward line caused by the 2020 reforms looks roughly similar between the two types of zones.

Methodology

The outcome of interest is the number of ADUs constructed in a Census tract. Ideally, I would compare outcomes in tracts that are entirely single-family zoned to tracts that are multi-family zoned. However, zoning status varies at different levels throughout cities. An entire neighborhood may be zoned a particular way, or zoning status might differ between parcels adjacent to each other. To aggregate this variation to the Census Tract level, I create a tract-level measure of treatment exposure. For a Census Tract c, I spatially merge c with the residential zones contained within it from the zoning dataset. Then, I calculate how much of the area of the tract is single- or multi-family zoned. I then define a proportion "in-sample" variable as the area of the tract that is single-

Figure 3: ADUs Constructed Over Time by Zone Type



Notes: This figure plots the number of ADUs constructed in Anaheim, Los Angeles, San Diego, and San Francisco each year since 2010, by the zone type in which the ADU was constructed. I restrict to ADUs issued within zones in my sample, single- or multi-family residential zones. The green, triangle-marked line plots the number of ADUs constructed on single-family zoned parcels. The orange, circle-marked line plots the number constructed on multi-family zoned parcels.

or multi-family zoned divided by the total area of the tract.[28] I exclude tracts with lower than fifty percent "in-sample," only keeping tracts that are sufficiently residential. I then define the proportion single-family zoned Z_c as

$$Z_c := \frac{\text{area in tract } c \text{ that is single-family zoned}}{\text{area in tract } c \text{ that is single or multi-family zoned}}$$

In Appendix Figure B.3, I plot the density of the "in-sample" measure and the density of Z_c given "in-sample" greater than .5. The distribution of the "in-sample" justifies the choice of .5 as a cutoff for inclusion in a residential sample, because there is a mass of tracts above .5, which are primarily residential. The distribution of Z_c within the sample justifies my use of it as a measure of exposure:

[28]The area is unitless and calculated from the spatial polygon itself. Given that I am simply interested in the relative measure of area that is zoned a particular way, it is not necessary to use a particular unit.

the distribution is bimodal, with peaks at zero and one. This indicates Z_c well approximates a binary treatment indicator of being single- versus multi-family zoned. In Appendix Figure B.4, I map which parts of each city in my sample are in sample. In Appendix Figure B.5, I map Z_c for each city. These figures show which areas of each city are being compared in my analysis.

Let t denote time and define $\mathbb{1}\{\text{Post 2016}\}_t$ as an indicator of whether t is greater than 2016. As an initial specification, I estimate the following

$$\underbrace{Y_{c,t}}_{\text{ADUs Built}} = \beta_0 + \beta_1 \mathbb{1}\{\text{Post 2016}\}_t + \underbrace{\beta_2 Z_c \times \mathbb{1}\{\text{Post 2016}\}_t}_{\text{diff-in-diff term}} + \underbrace{x_{c,t}^T \vec{\eta}}_{\text{covariates}} + \underbrace{\psi_c}_{\text{Tract FE}} + \underbrace{\varepsilon_{c,t}}_{\text{centered error}} \tag{3}$$

where β_2 is the coefficient of interest. I add time-varying covariates that relate to housing construction, which I acquire at the census tract level from ACS data. For each tract c at time t, I control for median income and population. Because these characteristics typically influence decisions on whether to build additional housing, I attempt to isolate the effect of the treatment that is unrelated to these covariates.

I also estimate a dynamic version of the model for two reasons. First, the treatment effect could grow over time, as more people find out about the option of adding more units to their property and decide whether it is economically viable. Second, given that there were two broad rounds of deregulation, one in 2016 and one in 2020, it is useful to study time-dependent coefficients. Therefore, I estimate

$$\underbrace{Y_{c,t}}_{\text{ADUs Built}} = \beta_0 + \underbrace{\sum_{j=2010, j\neq 2016}^{2022} \beta_j Z_c \times \mathbb{1}\{t=j\}_t}_{\text{dynamic diff-in-diff}} + \underbrace{x_{c,t}^T \vec{\eta}}_{\text{covariates}} + \underbrace{\psi_c}_{\text{Tract FE}} + \underbrace{\gamma_t}_{\text{Time FE}} + \underbrace{\varepsilon_{c,t}}_{\text{centered error}} \tag{4}$$

Here, the policy has potentially different effects in each year, where β_j represents the effect in year j and the covariates are the same as in the first specification.

Results

My analysis suggests that zoning deregulation has a causal effect on ADU construction that is consistent in sign and magnitude across a range of specifications. I estimate upzoned tracts experienced one more ADU constructed per year. In Table 2, I report the pooled specification defined in Equation 3. Column (1) reports the outcome of the regression without covariates. The coefficient of interest is positive and significant. Note that the coefficient on Post-2016 is also positive, significant, and of the same magnitude as the coefficient of interest. This reflects that interest in ADUs and zone-independent pro-ADU policies grew over time. Column (2) adds controls for median household income and population that could also explain the rise in ADU permits. These do not change the sign or magnitude of the treatment effect, while modestly increasing the R^2. In fact, changes in median income and population reduce the coefficient on Post 2016, which emphasizes why isolating the effect of deregulation through the comparison between single- and multi-family zones is necessary.

Table 2: Difference-in-Difference on ADUs Constructed

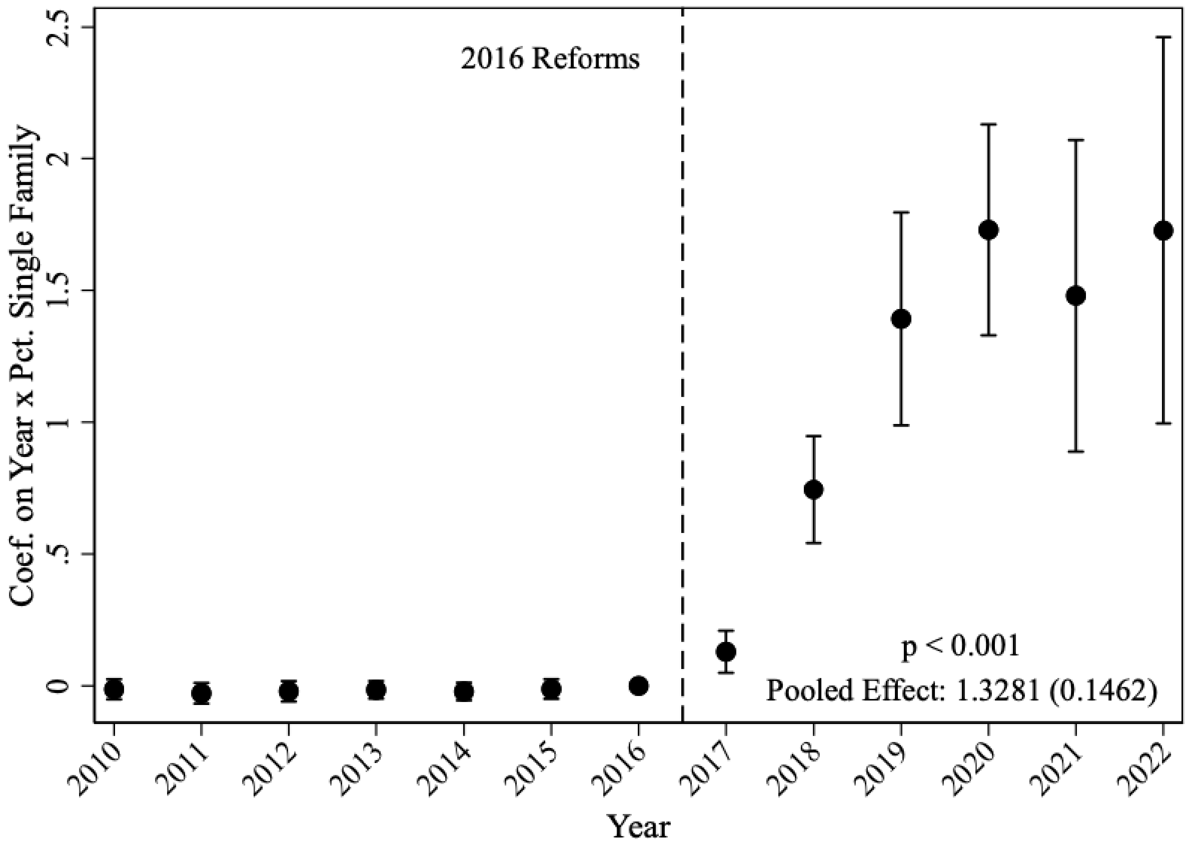
	(1) ADUs Built	(2) ADUs Built
Post 2016	0.904	0.553
	(0.0771)	(0.0761)
Post 2016 × Z_c	1.197	1.328
	(0.146)	(0.146)
Median Income ($1000)		0.0215
		(0.00255)
Population (1000)		-0.266
		(0.0792)
Constant	0.0113	-0.535
	(0.0273)	(0.393)
FEs	Tract	Tract
SEs	Clustered at Tract	Clustered at Tract
N	10829	10807
r2	0.277	0.295

Notes: This table presents results from Equation 3. The regression is run without covariates in column (1) and with controls for median income and population in column (2). There is a unit (tract-level) fixed effect and standard errors are cluster robust at the unit level.

In Figure 4, I plot the β_j from Equation 4 and report the results in the Appendix Table B.5. The estimates remain of similar size and magnitude to the pooled specification. Both the size and the magnitude of the coefficient of interest are robust to adding controls. A test of the hypothesis that all coefficients are equal has a p-value less than 0.001.

In 2017 and onwards, the effect begins to take shape, and we see significant and positive coefficients. The size of the coefficients is largest after 2020, which could be because ADUs took time to become popular amongst homeowners. Given that an ADU is a significant change to one's single-family home, it is reasonable that many homeowners waited until other homeowners had seen success with their ADUs. California also engaged in significant information campaigns regarding ADUs, so the growth in the effect could be explained by increased awareness. A test of

Figure 4: Event Study Coefficients on ADUs Constructed



Notes: This figure plots the coefficients from a linear panel event study of ADUs constructed on $Z_c \times$ Year from Equation 4. The confidence intervals are at the 95 percent level. The p-value on the right-hand side is the result of a joint test of whether all the coefficients are equal. The pooled effect is obtained by regressing the number of ADUs constructed on $Z_c \times \mathbb{1}\{\text{Post 2016}\}_t$ as outlined in Equation 3.

the hypothesis that all post-treatment coefficients are equal has a p-value less than 0.001, which suggests that the dynamic effects model is valuable.

However, it is not precise to attribute the magnitude of the coefficients to reflect the effect of solely the reform their time period corresponds to. The reforms in 2016 could have a cumulative effect over time, so what we are seeing in the later years is the cumulative effect of both rounds of reforms.

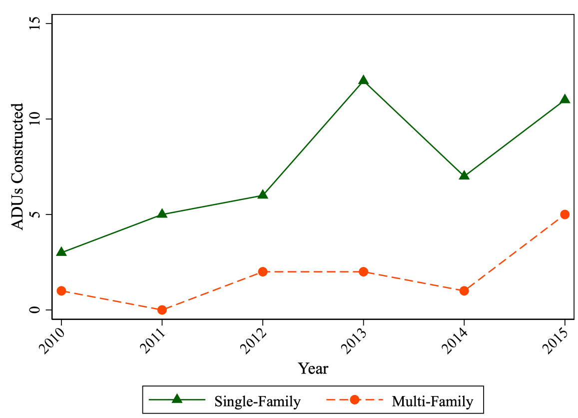
The effect, while statistically significant, is economically modest. The average tract in my sample in 2016 has 910 rental housing units in the ACS data, so an increase of one ADU in each post-2016 year is approximately a 0.33 percent increase in the rental housing stock, using the survey estimate that 51 percent of ADUs are rented out from Chapple et al. (2021).

Assessing the Parallel Trends Assumption

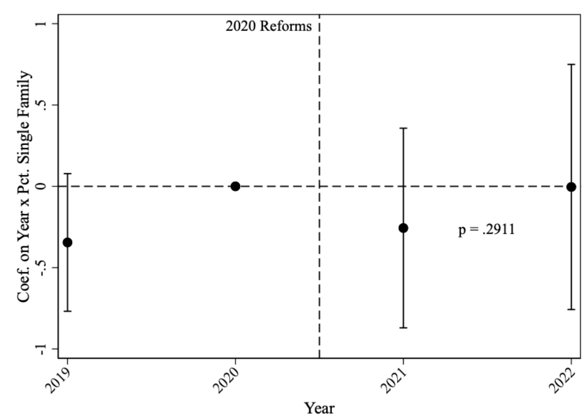
My goal is to investigate whether permit deregulation had a causal effect on the number of ADUs constructed. I want to disentangle this effect from other regulatory improvements or increases in ADU popularity and thus compare two neighborhoods that were treated differently by the 2016 ADU reforms. To do so, my empirical strategy rests on an assumption akin to the "parallel trends" assumption in the binary treatment two-period difference-in-difference framework. I assume that, absent the policy change in 2016, ADUs constructed in tracts that are primarily single-family zoned would have trended like tracts that are multi-family zoned.

However, if there were other policies that affected the groups differently, or perhaps changing characteristics that make single-family zoned tracts more conducive to ADUs, this would threaten my analysis. I take three approaches to validating my assumption: (1) a classic pre-trends test, (2) a placebo test using the 2020 policy change, and (3) assessing whether a related outcome exhibits parallel pre-trends. I present the first two tests to validate my empirical strategy in Figure 5.

Figure 5: Assessing Parallel Trends Assumption



(a) Pre-Trends



(b) Placebo Using 2020 Reform

Notes: Panel (a) plots the number of ADUs constructed over time from 2010–2015 by the zoning of the parcel in which they were built. It is a zoomed-in version of Figure 3 because the magnitude of the lines grows sharply after the 2016 reforms. For Panel (b), the unit of analysis is the Census tract. Panel (b) plots the coefficients from a regression of ADUs constructed on $Z_c \times$ Year as defined in Figure 4 and Equation 4, but restricted to 2019–2022. The p-value is from a joint test of whether all coefficients are equal.

A classic trends for pre-trends would involve examining the pre-2016 coefficients in the dynamic specification. These are, of course, very close to zero due to the small number of ADUs constructed prior to 2016. However, there were some ADUs and it could be useful to examine the raw data visually. In Panel (a), I plot ADUs constructed prior to the policy. This is the 2010 – 2016 portion of Figure 3, in which the scale of ADUs constructed post-policy dwarfed pre-policy ADUs. While the lines move roughly in parallel, the number of permits is so small and the policy is such a large shock that this test cannot be that informative.

In Panel (b), I conduct a "post-trends" placebo test. I use the wave of reforms in 2020 that did not affect single-family zoned areas differently. This test is motivated by both Figure 3 and the fact that the coefficients in Figure 4 level out around 2019. In this placebo test, I treat 2020 as the treatment year and estimate my dynamic specification. I plot the coefficients in Panel (b). A test of whether all coefficients are equal fails to reject the null at $p = .2911$. Hence, this placebo provides further evidence that my specification captures the causal effect of permit deregulation and not some other confounding trend.

My final test replaces the left-hand side variable of Equation 4 with the number of grandparents living with their own grandchildren.[29] I choose this variable because ADUs are often made to house the elderly. Therefore, this variable could capture confounding changes in demand between single- and multi-family zones. In Appendix Figure B.6, I plot the coefficients from this regression. A test of whether all pre-treatment coefficients are equal fails to reject the null at $p = 0.8588$. The coefficients drop after 2020, raising the concern that there are different changes in demand between the two zone types due to the Covid-19 pandemic. This is more of a concern for my subsequent analysis on rent, which I address in Section 6.2 and 6.3.

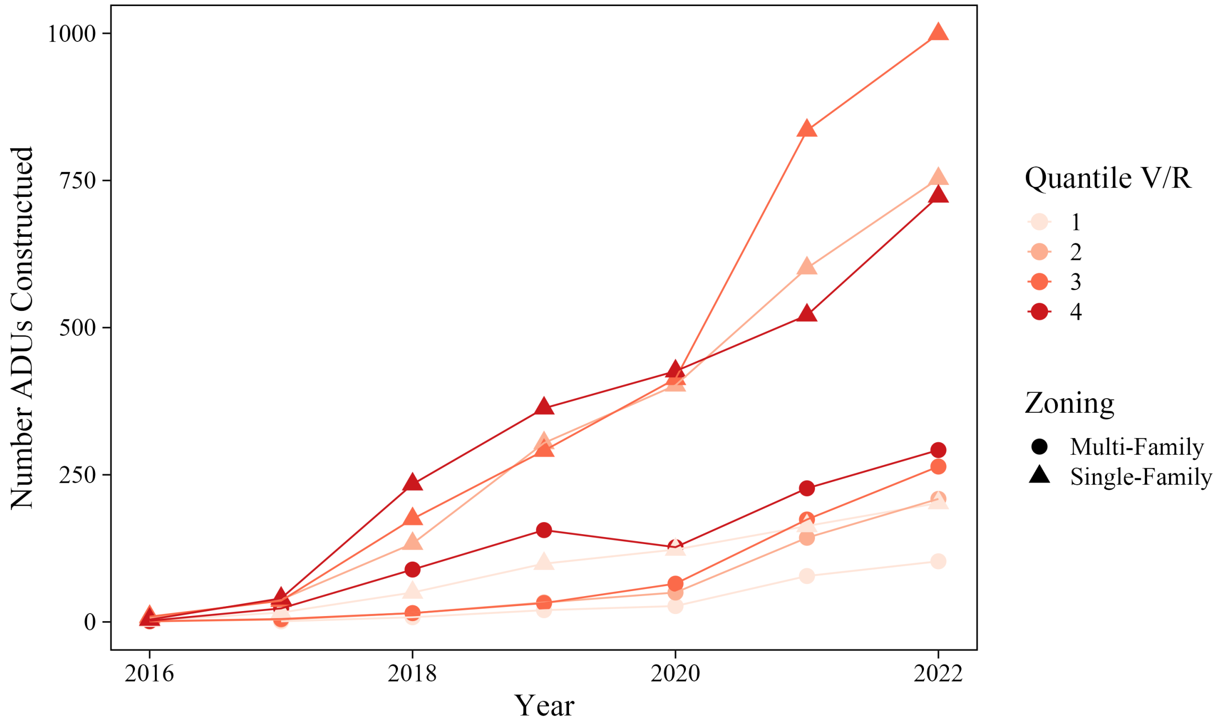
5.2 Do Supply Constraints Predict ADU Construction?

Next, I test Proposition 3, which predicts that supply constraints on housing predict ADU construction. To proxy for supply constraints, I follow Glaeser and Gyourko (2018), who use the ratio of home values to construction costs as a measure of the presence of binding regulatory supply constraints. I use a similar measure at the zip code level: the ratio of home values to replacement costs (henceforth, V/R). The intuition is the same: in efficient markets, a home's value should be equal to the cost of replacing it. If Proposition 3 is correct, then areas with a high V/R will see high levels of ADU construction. In Figure 6, I plot the ADUs permitted in single- and multi-family zones by their quartile value of the value to replacement ratio.

As shown, while ADUs are constructed primarily in single-family zones, the V/R value explains differing quantities of ADU construction. The ratio is generally positively associated with increasing ADU construction, as the vast majority of ADUs constructed are coming from the second, third, and fourth quantiles of the value to replacement ratio. For single-family zones, the third and second quantile of the V/R ratio produce more than the fourth. This is likely because the most supply constrained areas like the ones in the fourth quantile are also places where there is already significant wealth and aversion to renters. Simply put, no one is renting out a backyard unit in Beverly Hills. In multi-family zones, the increase in ADUs is driven by higher values of the V/R

[29] This variable is acquired from the ACS data.

Figure 6: ADUs Permitted by Zone and Value to Replacement Ratio



Notes: This figure must be in color to be interpretable. This figure plots the number of ADUs constructed in each year since 2010, by the zone type in which the ADU was constructed and the quantile of the value-to-replacement ratio (V/R) in the zip code in which the ADU was constructed.

ratio. The second, third, and fourth quantiles groups of multi-family zones produce more ADUs than the first quantile of single-family zones. This validates the predictions of my model, that σ_r must be high for regulatory changes to spur ADU construction.

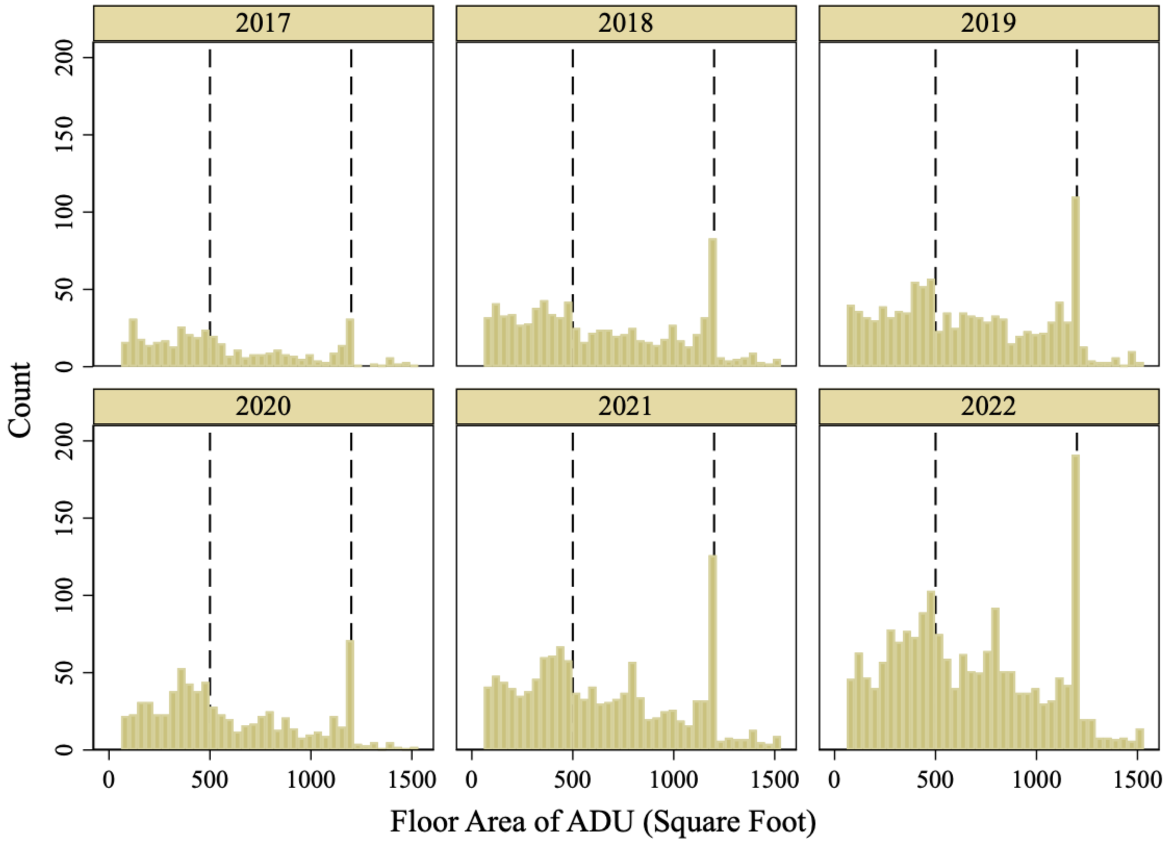
5.3 Evidence of Continuing Regulatory Barriers

Bunching in Floor Area Limits

I investigate whether there is bunching at the floor size limits under which state preemption applies. A JADU (a "junior" ADU, smaller and with fewer requirements) that is subject to the state guidelines may be at most 500 square feet, and an ADU may be at most 1,200 square feet. Local jurisdictions have discretion on ADUs that surpass these size limits. In Figure 7, I plot a histogram of the floor size of permitted ADUs.[30] There is clear visual evidence of bunching at the limits described above, suggesting that ADU owners are keen to be subject to state regulations, as opposed to local discretionary authority.

[30] Only the Los Angeles permits contained a floor size variable. For other cities, I use the text of the permit description and search for numbers immediately preceding variations of "sqft."

Figure 7: Histogram of Floor Area by Year



Notes: This figure plots a histogram of the floor area of each ADU permitted in the sample, by year. Los Angeles is the only city of where floor area data was available for each permit as a separate variable. For the other cities, I obtain floor area from the text of the permit description, searching for numbers that precede variations of "sqft." The vertical lines are at 500, and 1,200 square feet, which are the state-set floor area limits for a JADU and ADU respectively such that the state legislation protects a permit from local regulations.

Two alternative explanations are available. First, a local jurisdiction can be permissive, but homeowners may simply prefer the certainty of the state ADU ordinance. Second, the state ordinances automatically apply if local ordinances are not up to scratch. Therefore, local jurisdictions may have simply opted to not modify their codes in accordance with the state legislation. However, it is clear that homeowners desire to build larger ADUs.

Potential Circumvention of Permitting Time Regulations

In 2020, California required ADU permits to be approved within 60 days. Anecdotal evidence suggests that this order was not followed. Appendix Figure B.7 plots a histogram of the days between when a permit was approved and when it was submitted. Clearly, the 60-day limit was not entirely binding.

My conversations with David Hamilton, a subject-matter expert in contracting and residential development at the Harvard Graduate School of Design, indicated that these excessive waiting times could be occurring completely legally. Local permitting authorities could, after the passage of 59 or so days, ask the petitioner to make some update to their permit or to correct some error. Under this explanation, most permits would be approved in multiples of 60 days. In the figure, I add vertical lines at multiples of 60. It is unclear whether this phenomenon is present in ADU permitting. While there are some potential spikes, the evidence is not visually clear.[31]

There could be numerous regulatory barriers still at play and specific laws that must be preempted. However, in our conversation, State Senator Wieckowski suggested that the current legislative language is enough and now the state must follow up in voiding local regulations in court.[32]

6 The Effect on Rent Prices

This section estimates the effect of ADU construction on rents, exploiting the variation in ADU construction between single and two/three-family zones. I apply the same empirical strategy as the previous section. I then benchmark my empirical results against the predictions from my model.

6.1 Empirical Strategy

Following the previous section, I estimate a pooled specification given by Equation 5 and a dynamic specification given by Equation 6. The ideal experiment would be to take two independent housing markets, assign one to be single-family density and the other to be multi-family density, and measure the impact of increased density on rents. Given that these gentle density reforms transformed single-family areas to more resemble two- or three-family areas, already existing multi-family areas serve as a natural comparison group because they were, in a sense, "always treated" with gentle density. Of course, these areas differ in many other characteristics, which is why I use a difference-in-difference strategy that makes the assumption that those differences are constant over time. I address the assumption that the areas are independent at the end of Section 6.3.

$$\underbrace{R_{c,t}}_{\text{Log(Rent)}} = \beta_0 + \beta_1 \mathbb{1}\{\text{Post 2016}\}_t + \underbrace{\beta_2 Z_c \times \mathbb{1}\{\text{Post 2016}\}_t}_{\text{diff-in-diff term}} + \underbrace{x_{c,t}^T \vec{\eta}}_{\text{covariates}} + \underbrace{\psi_c}_{\text{Tract FE}} + \underbrace{\varepsilon_{c,t}}_{\text{centered error}} \quad (5)$$

[31] I attempted statistical tests at detecting bunching, but there is not enough data between each multiple of 60 to accurately deal with several bunching points.

[32] Indeed, the California Attorney General filed a lawsuit in early March 2023 against Huntington Beach for illegal barriers to ADU and duplex production.

$$\underbrace{R_{c,t}}_{\text{Log(Rent)}} = \beta_0 + \underbrace{\sum_{j=2015, j\neq 2016}^{2022} \beta_j Z_c \times \mathbb{1}\{t=j\}_t}_{\text{dynamic diff-in-diff}} + \underbrace{x_{c,t}^T \vec{\eta}}_{\text{covariates}} + \underbrace{\psi_c}_{\text{Tract FE}} + \underbrace{\gamma_t}_{\text{Time FE}} + \underbrace{\varepsilon_{c,t}}_{\text{centered error}} \tag{6}$$

Rent prices are inflation adjusted to 2022. The ACS changed the top-coding of the variable in 2015 from \$2,001 to \$3,501. Top-coding the later years to match the previous years would remove too much of the distribution of rents. I am unable to use rents before 2015, so I estimate these specifications from 2015 to 2022.

6.2 Results

In Table 3, I report the estimates from Equation 5. In Column (1), I report the simple regression without covariates. In (2), I add covariates of median income and population. In this preferred specification, I find that there is no statistically detectable effect of ADU construction on rent prices. I rule out estimates greater than a 2.2 percent reduction in rents.

In Figure 8, I plot the coefficients of interest from the dynamic specification in Equation 6. The full coefficients are available in Appendix Table B.6. A test of whether all the coefficients are jointly equal to zero fails to reject the null at $p = 0.1578$. However, the shape of the coefficients trends downward, and the coefficients are directionally consistent with my economic model, which implies a negative effect of increased ADU supply on rents.

One potential threat to identification, suggested by the noticeably lower point estimates in 2020 and onward, is that the pandemic changed both supply and demand differently for single- and multi-family zoned tracts. Of course, the lower point estimates could be a cumulative effect of California's ADU policies changing supply in single-family areas. However, the pandemic explanation is also plausible given substantial shifts in work-from-home dynamics and location preferences. As an initial robustness check, I estimate my pooled specification on my sample restricted to 2015–2019 and get a coefficient of -0.0017 (.0068). This excludes reductions in rent more negative than 1.5 percent. To more substantially deal with both the noise in my estimates and the threat to identification from other trends in housing markets, I turn to my economic model.

6.3 Benchmarking Using Theory

Drawing from the economic theory developed in Section 4, I use the result of Proposition 4 to estimate a plausible range for β_j in Equation 6. I start with the true amount of housing stock and the median rent price in each census tract in my sample in 2015. For each subsequent year, I use

Table 3: Difference-in-Difference on Rent

	(1) Log(Rent)	(2) Log(Rent)
Post 2016	0.106	0.0678
	(0.00507)	(0.00552)
Post 2016 × Z_c	-0.0144	-0.00519
	(0.00855)	(0.00865)
Median Income ($1000)		0.00256
		(0.000205)
Population (1000)		-0.0111
		(0.00372)
Constant	7.437	7.281
	(0.00249)	(0.0232)
FEs	Tract	Tract
SEs	Clustered at Tract	Clustered at Tract
N	6635	6628
r2	0.911	0.920

Notes: This table presents results from Equation 5. The regression is run without covariates in column (1) and with controls for median income and population in column (2). There is a unit (tract-level) fixed effect and standard errors are cluster robust at the unit level.

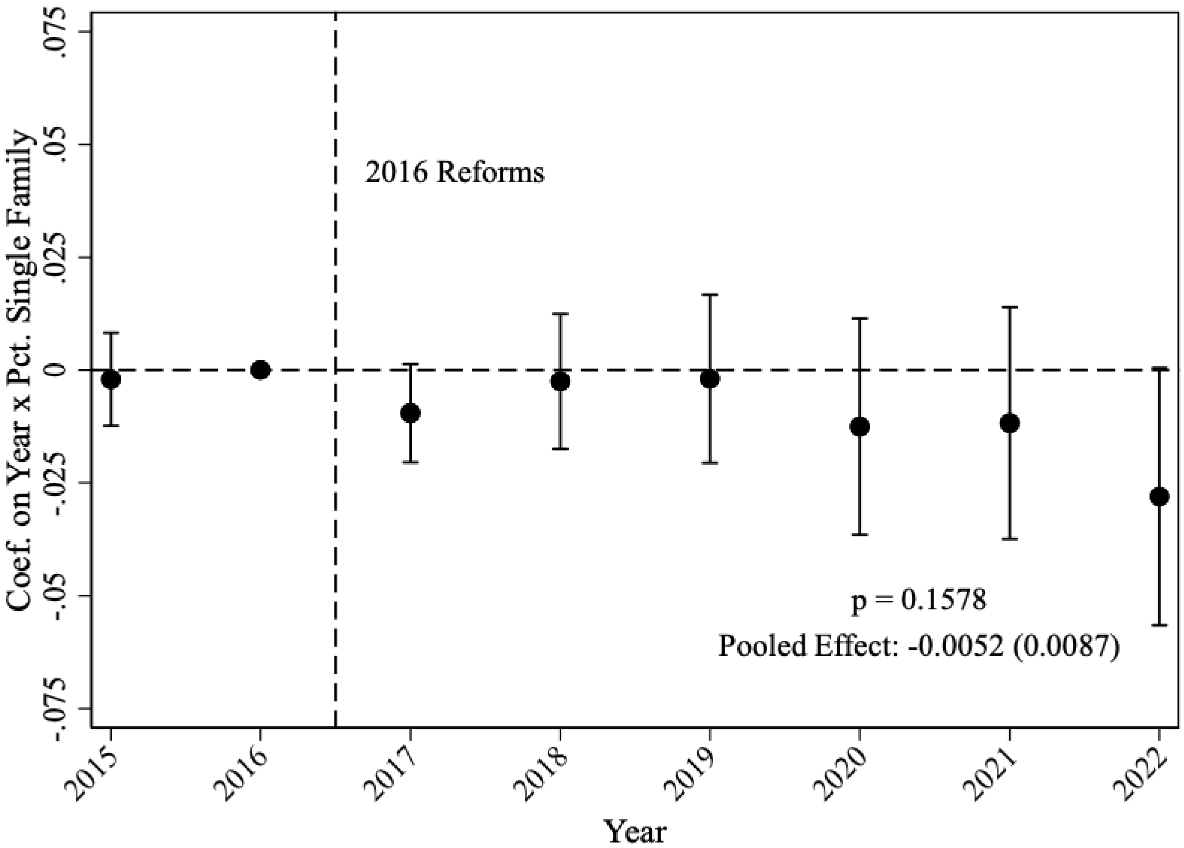
(i) an estimate of the price elasticity of demand of rental housing from the economic literature and (ii) the true number of ADUs constructed, adjusting for how many are rented out, to estimate rent prices in the next period. I repeat this process forward to build rent price trajectories that contain variation solely from the supply effects of ADUs. I then fit Equation 6 on this dataset to yield plausible estimates for β_j.

Denote the number of ADUs constructed in tract c at time t as $A_{c,t}$. Denote the simulated number of rental units as $Q_{c,t}$ and the simulated rental price $P_{c,t}$. Finally, denote the price elasticity of demand for rental housing as $\frac{1}{\eta}$. Recall from Proposition 4, the log change in rents is equal to η times the log change in supply. Therefore, I can estimate the change in log rent price from a supply shock as:

$$\ln(P_{c,t}) - \ln(P_{c,t-1}) = \eta \left[\ln(Q_{c,t}) - \ln(Q_{c,t-1})\right] \tag{7}$$

The assumption that allows the use of the proposition is that $Q_{c,t}$ and $P_{c,t}$ are equilibrium price and quantity, and the change from $Q_{c,t-1}$ to $Q_{c,t}$ comes from the shift in the supply curve due to

Figure 8: Event Study Coefficients on Rent



Notes: This figure plots the coefficients from a linear panel event study of log rent on $Z_c \times$ Year from Equation 6. The confidence intervals are at the 95 percent level. The p-value on the right-hand side is the result of a joint test of whether all the coefficients are equal. The pooled effect is obtained from Equation 5.

ADUs. Under these assumptions, I take $Q_{c,t}$ to be equal to $Q_{c,t-1} + .51 \cdot A_{c,t-1}$. That is, quantity in a tract evolves only with respect to constructed ADUs. Note that I adjust ADU quantity downward by the proportion of ADUs rented out (.51). I set $Q_{c,2015}$ and $P_{c,2015}$ equal to the true number of rental units and rent price respectively. Then, I estimate this model forward for $t \in \{2016, 2017, 2018, 2019, 2020, 2021, 2022\}$. At each step, I compute $Q_{c,t+1}$ and use Equation 7 to estimate the change in log rent price. I then update $P_{c,t+1}$ with this change. In this simulation, each tract's rent price trajectory is constructed as it would be if the *only change* was the construction of ADUs.

My estimates for the price elasticity of rental housing demand $\frac{1}{\eta}$ come from Mayo (1981), which comprehensively reviews estimations of housing demand in the economics literature. Table 1 in that paper reviews prominent estimations of the price elasticity of demand in log-linear models, collecting the estimates from 16 papers. I estimate my synthetic dataset across $\frac{1}{\eta} \in \{-1.28, -.71, -.56, -.17\}$. This set covers the smallest and largest estimates of elasticity in the paper and two less extreme estimates.[33]

I estimate Equation 6 on the simulated data. Therefore, to the extent that my treatment variable Z_c picks up the effect of ADU deregulation, which is the assumption that my empirical strategy itself requires, the coefficients in the synthetic price regression should accurately reflect what the coefficient would be in the regression with true data. Formally, I estimate

$$\underbrace{P^S_{c,t}}_{\text{Log(Simulated Price)}} = \beta^S_0 + \underbrace{\sum_{j=2015, j\neq 2016}^{2022} \beta^S_j Z_c \times \mathbb{1}\{t=j\}_t}_{\text{dynamic diff-in-diff}} + \underbrace{x^T_{c,t}\vec{\eta}}_{\text{covariates}} + \underbrace{\psi_c}_{\text{Tract FE}} + \underbrace{\gamma_t}_{\text{Time FE}} + \underbrace{\varepsilon_{c,t}}_{\text{centered error}} \tag{8}$$

where the β^S_j are the coefficients of interest. In Figure 9, I plot the coefficients across each elasticity specification overlaid on the empirical estimates from the previous section.

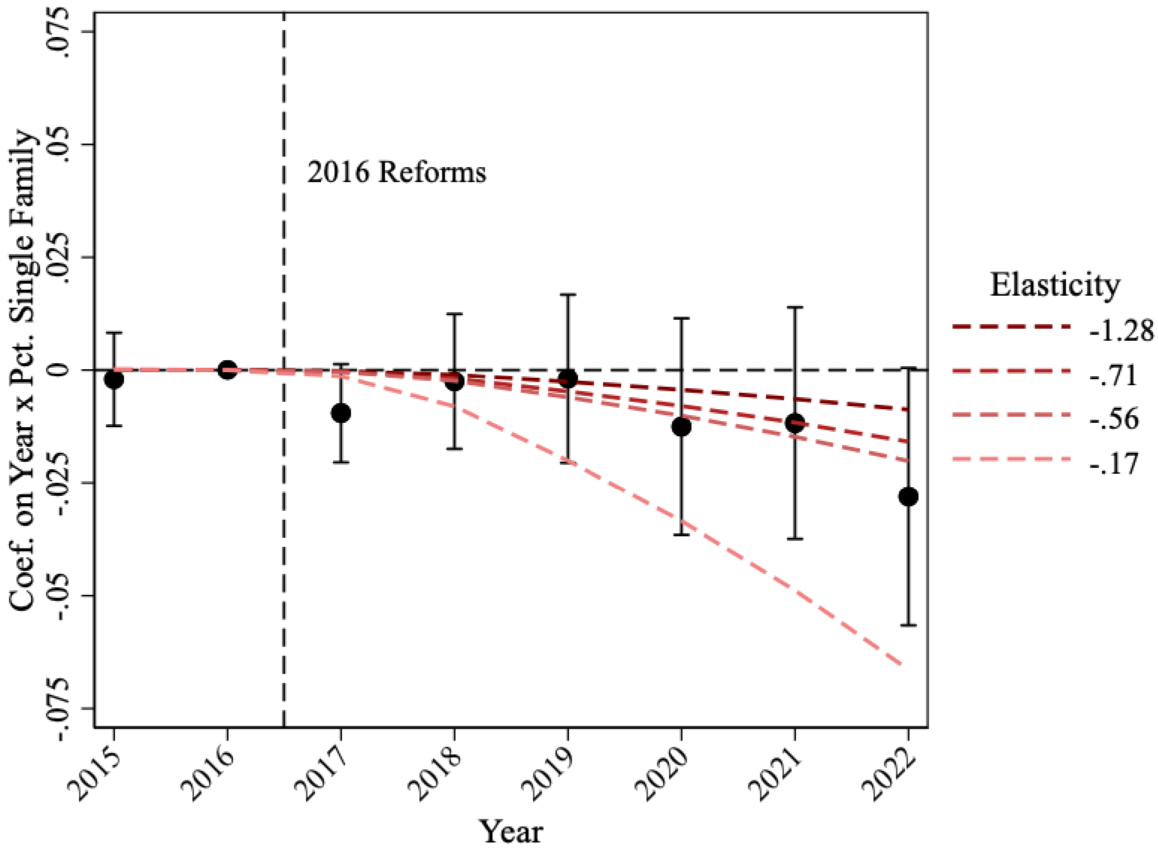
The confidence intervals from my empirical specification contain most of the estimates from the elasticity-based estimation. The elasticity estimates for $-.56$ line up with the point estimates. The simulated effects for $-.17$ are quite extreme relative to my coefficients. Regardless, the range that the simulated coefficients suggest coupled with my confidence intervals are more important. Because California is likely more inelastic than other places, I find the range of estimates for $\frac{1}{\eta} = -.56$ and $-.71$ most plausible. A back-of-the-envelope calculation suggests that the implied elasticity from my preferred pooled estimate $-.00519$ is $-.64$.[34] This is almost exactly between $-.71$ and $-.56$.

Some dynamic point estimates are quite negative relative to the forecast of moderate elasticity values. This gives some credence to the idea that the pandemic or other trends are driving some of my results. A more charitable explanation could be that my estimation solely picks up on the supply effect, but the true impact of ADUs on rent stems from a supply effect plus a nuisance effect on other renters, where ADUs lower the quality of the single-family neighborhood. This is plausible, given that members of a single-family neighborhood clearly pay for lower density and their own privacy and space. However, as Section 7 will demonstrate, the nuisance effect is quite small. Therefore, it is unlikely that my coefficients are more negative than the simulated ones due to a nuisance effect.

[33] Although these estimates are old, it is reasonable to assume the true elasticity lies somewhere in this range.

[34] Suppose one ADU is built per year post-treatment and 51 percent of ADUs are rented out. In 2015, the average tract had 901 rental units – an increase in three rental units is an increase of .33 percent. Dividing by the estimated log change in prices $-.00519$ yields an implied elasticity of $-.64$.

Figure 9: Event Study Coefficients on Rent Compared to Model Prediction



Notes: This figure must be in color to be interpretable. This figure plots the coefficients from Equation 8 on synthetic datasets constructed across four specifications of the price elasticity of rental housing demand. I also include the coefficients from Equation 6 plotted in Figure 8.

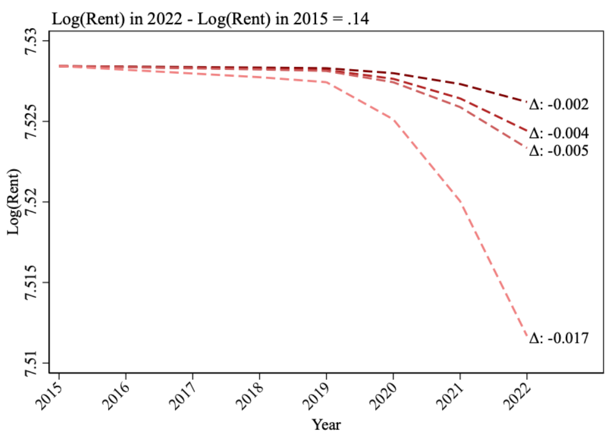
Definition of a Housing Market

In this analysis, I take a housing market c to be a Census tract. It is not clear this is the right definition of a housing market. If I have misspecified the area in which a supply effect from new housing is constant, this could bias my estimates. On one hand, there is evidence that supply effects are also quite local and decay with distance rapidly (Asquith et al., 2023). In this case, one would need granular rent data to study rents very close to new ADUs – I lack such data. On the other hand, a market c could be some much larger geographic area, perhaps at the level of the four cities in my sample. If people move across tracts within cities in response to new housing, then rent effects are properly estimated of at the city level. However, at the city level, there is very little room to isolate variation in ADU construction. Instead, to address this case, I repeat my simulation exercise in each of the four cities.

In each city in my sample, I take the sum of housing units across tracts and take a population weighted mean of median rents. Then I simulate prices forward using Equation 7. In Figure 10, I plot these simulated prices and report the change between 2015 and 2022 next to each line. These estimates are very close to the estimates in my tract-level empirical analysis – half a percent to one percent. I also report the actual change in log rent between 2015 and 2022 in a note on the plots. The growth in rents is about 14 to 18 percent – an order of magnitude larger than the supply effect predictions for the moderate values of the elasticity parameter. Therefore, I conclude that ADU deregulation is not driving any meaningful reduction in rent prices. A combination of theory and empirical estimation suggests the effect is about a half to one percent decline in rents, although I am not able to statistically distinguish that from zero.

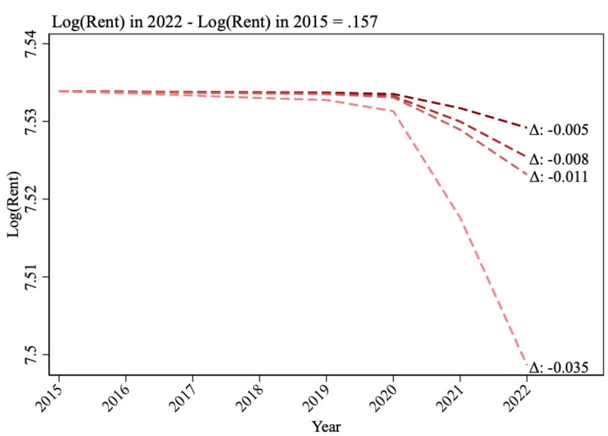
Figure 10: Model Predictions of the Supply Effect at City Level

(a) Anaheim

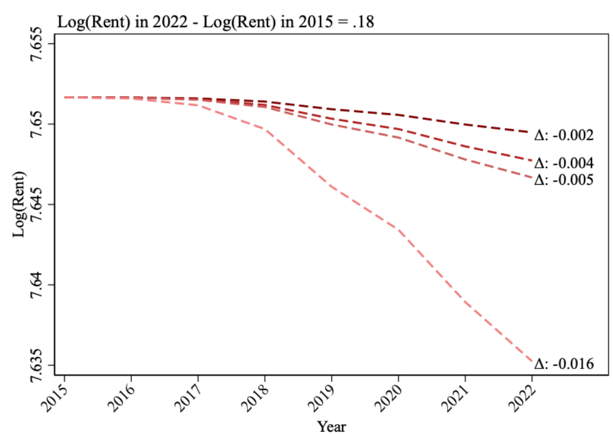


(b) Los Angeles

(c) San Diego



(d) San Francisco



Notes: This figure plots simulated rent trajectories for each city in the sample. I start with rent prices and housing stock in 2015. For the elasticity values enumerated in Figure 9, I use constructed ADUs to predict subsequent changes in rents using Equation 7. I report the change between 2022 and 2015 next to each line. I also report the true change in rent in a footnote on each plot.

7 The Nuisance Effect on Neighbors

This section estimates a nuisance effect from ADUs.

7.1 Empirical Strategy

The challenge to estimating the nuisance effect is that location of ADU construction is non-random. ADUs might be built in areas with less valuable single-family homes or areas about to experience increased presence of renters. The first could be measured, but the second is impossible. Indeed, if the channel by which ADUs impose a nuisance is through the presence of renters, then this second problem poses a serious roadblock to cross-sectional estimation of the nuisance effect. To overcome this, I compare the property values close to the ADU over time to property values just slightly farther way over time. My strategy to use variation in distance from an event site to overcome the non-random placement of events draws from Linden and Rockoff (2008) and Diamond and McQuade (2019).

This strategy also draws on the economic theory shown in Proposition 5. Under the assumptions of my model, a home being slightly closer or slightly further away from an ADU only affects its property value through the nuisance effect. Taking this to the context of ADUs, I limit my analysis to property sales with a certain distance d of a constructed ADU. For property i and time t, let ADU(i) denote the ADU that property i is less than d away from.[35] I estimate

$$\begin{aligned}\overbrace{\log(P_{i,t})}^{\text{Log(Sale Price)}} = \beta_0 + \beta_1 \mathbb{1}\{\text{After ADU(i) Constructed}\}_{i,t} + \underbrace{\gamma_t}_{\text{time FE}} + \underbrace{\psi_i}_{ADU(i)\text{ FE}} + \underbrace{x_{i,t}^T \vec{\eta}}_{\text{covariates}} + \underbrace{\varepsilon_{i,t}}_{\text{centered error}} \\ + \underbrace{\beta_2 \mathbb{1}\{\text{Within } d/2 \text{ of ADU(i)}\}_i \times \mathbb{1}\{\text{After ADU(i) Constructed}\}_{i,t}}_{\text{Interaction Term}} \quad (9)\end{aligned}$$

where β_2 is the coefficient of interest. In my analysis, I take d to be 1000 feet. Therefore, my treatment group is properties sold within 500 feet of a new ADU. I use the “ring method” of Linden and Rockoff (2008), where I consider a unit to be treated if it is within $d/2$ of the constructed ADU and as not treated otherwise. The intuition behind this strategy is that units closer to the ADU should experience a higher nuisance effect. However, Diamond and McQuade (2019) use a non-parametric strategy, where they allow for property values in an area around an event of interest to

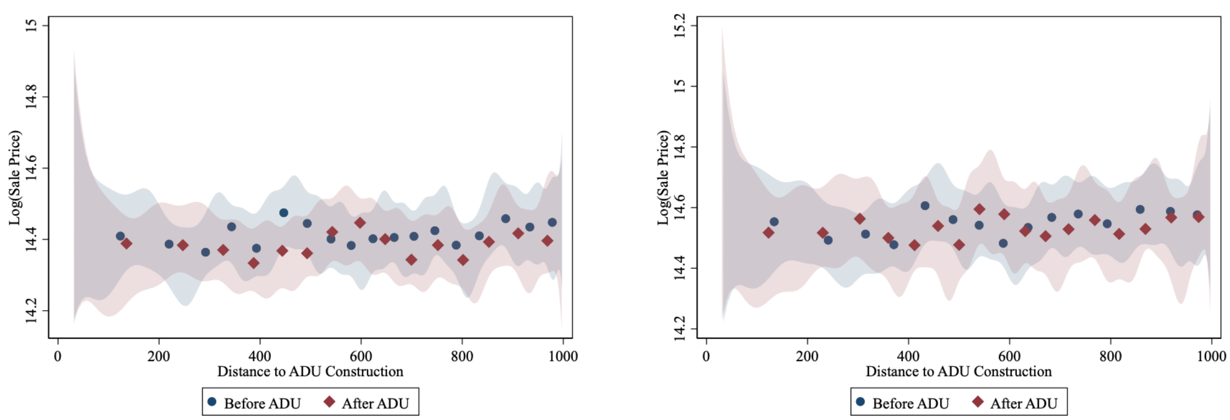
[35] I remove transactions of the property containing the ADU. I only keep a sale price if it is within a year on either side of its corresponding ADU construction. I match i to the closest constructed ADU but ensure there are no other ADUs within 1000 feet in my sample. I remove prices above the 99th and below the 1st percentile. I remove transactions where the floor area is above the 95th and below the 5th percentile. I finally balance the sample, keeping observations such that ADU(i) has one transaction in each treated/untreated group in each before/after period.

be some function of distance from that event. They are able to estimate the empirical derivatives of this function, and thus make fewer assumptions on how distance affects property values. However, due to sample size constraints, I am unable to use the "empirical derivatives" method and use the "ring method" instead.

7.2 Visual Evidence

Due to the parametric nature of my specification, I first review some visual (lack of) evidence for the nuisance effect. Figure 11 plots a binned scatter plot of the distance from the construction site and log sale price before and after the ADU was constructed. Panel (a) uses the entire sample and (b) restricts to sales near ADUs built in above median income Census tracts. Results are similar between (a) and (b). In the presence of a nuisance affect, the after line should gain a clear upward slope compared to the before line, as being further away from the event site increases property values. However, the relationship remains nearly identical before and after the construction. Indeed, the uniform confidence bands in the figure basically lie on top of each other. This is strong visual evidence that there is no economically significant nuisance effect. An advantage of this analysis is that it does not rely on my parametric assumptions. Hence, even if the effect was not linear as I assume or if the specification of d in the "ring" analysis was incorrect, the figure would still show a potential nuisance effect.

Figure 11: Property Values by Distance to ADU, Before and After



(a) Pooled

(b) High Income Neighborhoods

Notes: This figure plots a binned scatterplot of the log of sale prices for properties sold within 1000 feet of an ADU on their distance to said ADU. The plot is split by whether the sale occurred in the year before or after the ADU was built. Panel (a) reports results for the full sample, while Panel (b) restricts to ADUs built in above median income Census Tracts. 95 percent uniform confidence bands, estimated with a cubic B-spline, are shown. Bins are selected through IMSE-optimal direct plug-in rule.

Appendix Figure B.8 plots a time series of sale prices by whether they are within 500 feet or further away from a constructed ADU. I compute the average sale price in each month relative to when ADU(i) was constructed. Both lines follow a very similar pattern. If there was a large nuisance effect, then the red line should dip sharply after zero. There is no such movement. Panel (b) subsets to properties sold near ADUs built in above median income neighborhoods. There is also no strong visual evidence of a nuisance effect and the confidence intervals lie mostly on top of each other.

7.3 Results

In Table 4, I report the results of estimating Equation 9. Column (1) reports a bare-bones regression, with no covariates or fixed effects. Column (2) adds fixed effects for ADU(i) and (3) adds controls. Across all specifications, the coefficient is directionally consistent with a negative nuisance effect but not statistically nor economically significant. Point estimates suggest a one to two percent decline in property values and my preferred specification rules out estimates more negative than 3.6 percent. The estimate is fairly stable across all specifications, while the R^2 increases substantially.

In Appendix Table B.7, I report the results of estimating Equation 9 on a sample of property sales where ADU(i) is in an above median income neighborhood.[36] The columns report the same specifications as the previous table. Across all specifications, the coefficient is directionally consistent and larger. The point estimates give a nuisance effect of two to four percent. This suggests that higher income neighborhoods may indeed experience more nuisance from ADUs, but I am still unable to distinguish this effect from zero. My preferred specification rules out estimates more negative than 5.7 percent. This is evidence that nuisance effects from ADUs are likely overstated, even in high income neighborhoods.

One note of caution is that I lack as many observations with 50 or so feet of the ADU, where the nuisance effect would be the strongest. If a nuisance effect were to exist, it is plausible that it ought to only affect the units directly next to an ADU. Notice that the confidence bands in Figure 11 become much larger near values very close to zero. To allay this concern, I compute the nuisance effect and vary the distance d that's used to define treatment. Appendix Figure B.9 plots estimates of the nuisance effect for various definitions of the treatment ring, always comparing them to a control ring of properties sold 500 to 1000 feet away. The point estimates are quite consistent. There is no clear downward pattern in the point estimates as the treatment rings get tighter, although the confidence intervals of course become larger. This is suggestive evidence that my estimates are accurate, but studying the potential decay of a nuisance effect with respect to

[36] I use the median income variable from the ACS. I map ADU(i) to its Census tract and use the 2022 value of median income. I do this separately by Los Angles and San Francisco, so this sub-sample consists of above median income neighborhoods in both cities.

Table 4: Nuisance Effect Estimates

	(1) Log(Price)	(2) Log(Price)	(3) Log(Price)
Near ADU	-0.00134	0.0110	0.000479
	(0.0148)	(0.0120)	(0.00831)
After ADU Built	-0.0212	-0.0112	0.00139
	(0.0152)	(0.0108)	(0.00787)
Near ADU $\times$ After ADU Built	-0.0246	-0.0191	-0.0132
	(0.0219)	(0.0156)	(0.0116)
Floor Area			0.000314
			(0.00000793)
Year Built			-0.000405
			(0.000154)
Num. Beds			0.0222
			(0.00293)
Constant	14.41	14.40	14.57
	(0.0164)	(0.00611)	(0.297)
FEs	None	ADU(i)	ADU(i)
SEs	Cluster, ADU(i)	Cluster, ADU(i)	Cluster, ADU(i)
N	8828	8828	8799
r2	0.00129	0.470	0.720

Notes: This table reports estimates of Equation 9. Column (1) reports the regression with covariates or fixed effects. Column (2) adds ADU(i) fixed effects and (3) adds covariates. Floor area is in square footage units.

distance is a promising direction for future work.

Furthermore, it could be the case that some other confounder also changes with distance, nullifying the assumption that property values close to vs further away would have moved similarly if not for the construction of the ADU. I report several balancing tests in Appendix Figure B.10, which show that relevant property characteristics are not changing by distance to the ADU over time. In particular, I plot the relationship of distance to number of beds, year property is built, and square footage of a house by whether the property was sold before or after the ADU was built. This shows that the assumptions of my strategy are plausible. Appendix Figure B.11 conducts the same balance tests for the high income neighborhood sub-sample.

This section provides guidance for future research into the spillover effects of density. My theoretical model predicts that homeowners will coordinate to prevent new construction if the marginal disutility of increased density is greater than the potential profits. The estimation in this section shows that the distance-dependent nuisance effect is likely small in the context of ADUs, which suggests that homeowners are primarily worried about the overall increase congestion in their neighborhood. This finding is reflected in the content of many of the regulations that the state lifted: requirements for parking, impact fees, and requirements for setbacks. Hence, future research on single-family zones can focus on measuring disutility from the congestion effect, which is not in the scope of this paper.

8 Conclusion

This paper studies a land use regulation reform focused on accessory dwelling units. I find that permit deregulation increases housing supply, which is in line with this paper's theoretical prediction that local homeowner-driven control will result in strong limits on local construction and that lifting that control will increase the production of ADUs. Exploiting variation between single- and multi-family zones, I find a tract exposed to permit deregulation experienced one more ADU constructed than a non-exposed tract. I then assess whether ADUs can ease rent prices. I first characterize the supply effect of ADUs using economic theory and then estimate the effect of ADUs in a linear panel model. The effect is statistically indistinguishable from zero, and my estimates and model in conjunction suggest that a plausible effect could be no larger than a one to two percent reduction in rent prices. Finally, I find that ADUs do not impose a nuisance effect on neighbors. My confidence interval excludes effects more negative than a 3.6 percent reduction in home values.

These findings contribute to the growing body of literature suggesting that land use regulations are a major barrier to housing construction. California's policy relied on individual homeowners adding units, and upzoning still caused an increase in housing supply. Furthermore, my findings on the nuisance effect contribute to the literature on the effects of new construction by studying these issues in the context of "gently" upzoned single-family neighborhoods.

Policymakers should note California's successful state-level preemption of local regulations. By establishing a right to construction, California was largely successful in removing local barriers, in whatever form they appeared. However, if policymakers want address housing shortages, they should be skeptical of ADUs as housing supply. Housing infill on single-family zones through ADUs is an inadequate strategy to ease rising house and rent prices, and perhaps stronger upzoning measures should be considered.

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A Proofs

Proof of Proposition 1

Proof. Recall that the coordinating homeowner takes positive housing consumption as given under the regulation equilibrium because only incumbents may coordinate on regulations. Substituting the budget constraint into the objective function, we get:

$$\max_a \left[\log(h_s) - h_s D(a) + w_h + a h_s p_r^*(a) - \sigma_a \frac{a^2}{2} h_s - p_s h_s\right]$$

Differentiating, we have

$$\frac{d}{da} = -h_s \frac{d}{da} D + h_s p_r^*(a) + a h_s \frac{d}{da} p_r^*(a) - \sigma_a a h_s$$
$$= h_s \left(\underbrace{p_r(a) - \sigma_a a - \frac{d}{da} D}_{(A)} + \underbrace{a \frac{d}{da} p_r^*(a)}_{(B)} \right)$$

where proving that (A) and (B) are negative concludes the proof. From A1, we have that (A) is negative. For (B), we must characterize $p_r^*(a)$. Demand for rental housing is given by the first order condition of the renter's problem: $h_r^{\eta} - p_r = 0$. The second order condition is met because $\eta h_r^{\eta-1} < 0$ because $\eta < 0$. Therefore, the demand for rental housing at p_r is $p_r^{\frac{1}{\eta}}$. The first order condition of the developer's problem is given by $p_r \lambda_r - d_r \sigma_r \lambda_r = 0$, which implies $d_r^* = \frac{p_r}{\sigma_r}$. The second order condition is met because $-\sigma_r \lambda_r$ is negative. The supply of apartments is $\lambda_r \frac{p_r}{\sigma_r}$. Hence, the overall supply of rental housing is given by $a\lambda_s + \frac{p_r}{\sigma_r}\lambda_r$ and the demand for rental housing is $p_r^{1/\eta}$. Because markets clear, we have

$$a\lambda_s + \frac{p_r}{\sigma_r}\lambda_r = p_r^{1/\eta}$$

A closed form expression for p_r is not feasible, but because $p_r^*(a)$ is the solution to the above expression, we have that:

$$p_r^*(a)^{\frac{1}{\eta}} - \frac{\lambda_r}{\sigma_r} p_r^*(a) - a\lambda_s = 0$$

From the implicit function theorem, it follows that

$$\frac{1}{\eta} p_r^*(a)^{\frac{1}{\eta}-1} \frac{dp_r^*(a)}{da} - \frac{\lambda_r}{\sigma_r} \frac{dp_r^*(a)}{da} - \lambda_s = 0 \implies \frac{dp_r^*(a)}{da} = \lambda_s \left(\frac{1}{\eta} p_r^*(a)^{\frac{1}{\eta}-1} - \frac{\lambda_s}{\sigma_r} \right)^{-1}$$

Note that η is negative, $p_r^*(a)$ is non-negative, and λ_s, σ_r are positive. Hence, we have that $\frac{dp_r^*(a)}{da}$ is negative. □

Proof of Proposition 2

Proof. We have from the proof of Proposition 1 that the supply from developers of rental apartments is $p_r \frac{\lambda_r}{\sigma_r}$. In the individual equilibrium, the homeowner solves:

$$\max_{h_s, a} \left[\log(h_s) - h_s D(a) + w_h + a h_s p_r - \sigma_a \frac{a^2}{2} h_s - p_s h_s \right]$$

Differentiating with respect to a:

$$\frac{d}{da} = h_s p_r - \sigma_a a h_s \implies a^* = \frac{p_r}{\sigma_a}$$
$$\frac{d}{da^2} = -\sigma h_s < 0$$

The cross-partial is zero:

$$p_r - \sigma_a a^* = p_r - \sigma_a \frac{p_r}{\sigma_a} = 0$$

We will show the second derivative with respect to housing is negative in the proof for Proposition 5. Hence, the overall supply of rental housing is

$$p_r \left(\frac{\lambda_r}{\sigma_r} + \frac{\lambda_s}{\sigma_a} \right)$$

as desired. □

Proof of Proposition 3

Proof. We have from the proof of Proposition 1 that rental demand is $p_r^{\frac{1}{\eta}}$. In regulation equilibrium, $a = 0$, so rental supply is $p_r \frac{\lambda_r}{\sigma_r}$. Setting supply equal to demand, we have $p_r^* = \left(\frac{\lambda_r}{\sigma_r}\right)^{\frac{\eta}{1-\eta}}$. Plugging back into rental housing demand, we have regulation equilibrium rental housing:

$$\left(\frac{\lambda_r}{\sigma_r} \right)^{\frac{1}{1-\eta}}$$

Following the same argument, but using the supply curve from Proposition 2, we have deregulation equilibrium rental housing

$$\left(\frac{\lambda_r}{\sigma_r} + \frac{\lambda_s}{\sigma_a} \right)^{\frac{1}{1-\eta}}$$

The ratio of these two is as desired. □

Proof of Proposition 4

Proof. From the proof of Proposition 3, we have price in each equilibrium as $\left(\frac{\lambda_r}{\sigma_r}\right)^{\frac{\eta}{1-\eta}}$ and $\left(\frac{\lambda_r}{\sigma_r}+\frac{\lambda_s}{\sigma_a}\right)^{\frac{\eta}{1-\eta}}$. Then, it follows that

$$\begin{aligned}
\log(p_r'^*) - \log(p_r^*) &= \log\left(\frac{\lambda_r}{\sigma_r}+\frac{\lambda_s}{\sigma_a}\right)^{\frac{\eta}{1-\eta}} - \log\left(\frac{\lambda_r}{\sigma_r}\right)^{\frac{\eta}{1-\eta}} \\
&= \eta\left[\log\left(\frac{\lambda_r}{\sigma_r}+\frac{\lambda_s}{\sigma_a}\right)^{\frac{1}{1-\eta}} - \log\left(\frac{\lambda_r}{\sigma_r}\right)^{\frac{1}{1-\eta}}\right] \\
&= \eta\left[\log(h_r'^*) - \log(h_r^*)\right]
\end{aligned}$$

where the last line follows from expressions for $h_r'^*$ and h_r^* from the proof for Proposition 3. □

Proof of Proposition 5

Proof. From the proof of Proposition 2, we have that $a^* = \frac{p_r}{\sigma_a}$. Substituting the budget constraint into the objective function, differentiating with respect to housing, and verifying the second derivative is negative:

$$\begin{aligned}
&\max_{h_s,a}\left[\log(h_s) - h_sD + w_h + ah_sp_r - \sigma_a\frac{a^2}{2}h_s - p_sh_s\right] \\
&\frac{d}{dh_s} = \frac{1}{h_s} - D + ap_r - \sigma_a\frac{a^2}{2} - p_s = 0 \\
&\frac{1}{h_s} = D - (ap_r - \sigma_a\frac{a^2}{2}) + p_s \\
&h_s^* = \frac{1}{D-(ap_r-\sigma_a\frac{a^2}{2})+p_s} \\
&\frac{d}{dh_s^2} = \frac{-1}{h_s^2} < 0
\end{aligned}$$

Then, setting housing demand equal to housing supply:

$$\begin{aligned}
\frac{p_s\lambda_s}{\sigma_s} &= \frac{1}{p_s + D - \frac{p_r^2}{2\sigma_a}} \\
p_s\left(p_s + D - \frac{p_r^2}{2\sigma_a}\right) &= \frac{\sigma_s}{\lambda_s} \\
p_s^2 + p_s\left(D - \frac{p_r^2}{2\sigma_a}\right) - \frac{\sigma_s}{\lambda_s} &= 0
\end{aligned}$$

Completing the square, we get

$$0 = \left(p_s + \frac{D - \frac{p_r^2}{2\sigma_a}}{2}\right)^2 - \frac{\sigma_s}{\lambda_s} - \frac{\left(D - \frac{p_r^2}{2\sigma_a}\right)^2}{4}$$

$$\frac{\sigma_s}{\lambda_s} + \left(\frac{D - \frac{p_r^2}{2\sigma_a}}{2}\right)^2 = \left(p_s + \frac{D - \frac{p_r^2}{2\sigma_a}}{2}\right)^2$$

$$p_s^* = \frac{p_r^2}{4\sigma_a} - \frac{D}{2} + \sqrt{\frac{\sigma_s}{\lambda_s} + \left(\frac{p_r^2}{4\sigma_a} - \frac{D}{2}\right)^2}$$

Then, substituting the definition of D yields the result. □

B Additional Figures and Tables

Table B.1: Benchmarking Permits to APR by City

City	Permits in 2021	APR in 2021	Permits in 2022	APR in 2022
Anaheim	142	70	173	149
Los Angeles	3227	3174	4657	3448
San Diego	1227	402	1736	1467
San Francisco	213	78	243	37

Notes: This table compares permit counts in this paper's permit data against APR data. For both datasets, I constrain to permits I can geocode. I report the permits in this paper's data against permits either marked "issued" or "completed" in the APR data. I split out the counts by year and by city.

Table B.2: Benchmarking Permits to APR by City, Including APR's Pending Permits

City	Permits in 2021	APR in 2021	Permits in 2022	APR in 2022
Anaheim	142	70	173	149
Los Angeles	3227	6506	4657	6746
San Diego	1227	873	1736	1471
San Francisco	213	239	243	112

Notes: This table compares permit counts in this paper's permit data against APR data. For both datasets, I constrain to permits I can geocode. I report the permits in this paper's data against permits either marked "issued", "completed", or "pending" in the APR data. I split out the counts by year and by city.

Table B.3: Summary Statistics – ADUs and Rental Stock

	Mean	p25	p50	p75	SD	Min	Max	N
2015								
ADUs Built	0.01	0	0	0	0.12	0	2	833
ADU Permits Issued	0.02	0	0	0	0.16	0	3	833
Num. Rental Units	901.30	521	816	1193	535.00	8	3911	833
2016								
ADUs Built	0.03	0	0	0	0.19	0	3	833
ADU Permits Issued	0.07	0	0	0	0.40	0	5	833
Num. Rental Units	910.15	515	833	1200	541.22	4	3886	833
2017								
ADUs Built	0.15	0	0	0	0.45	0	3	833
ADU Permits Issued	1.07	0	0	1	1.88	0	16	833
Num. Rental Units	910.60	520	830	1201	541.25	4	3879	833
2018								
ADUs Built	0.67	0	0	1	1.27	0	9	833
ADU Permits Issued	2.03	0	0	3	3.23	0	22	833
Num. Rental Units	912.37	524	828	1209	543.35	4	3988	833
2019								
ADUs Built	1.26	0	0	2	2.27	0	18	833
ADU Permits Issued	2.34	0	1	4	3.48	0	22	833
Num. Rental Units	915.94	532	831	1221	546.24	4	4015	833
2020								
ADUs Built	1.51	0	0	2	2.45	0	20	833
ADU Permits Issued	1.82	0	1	3	2.46	0	14	833
Num. Rental Units	829.18	493	775	1120	468.16	0	3946	833
2021								
ADUs Built	2.63	0	1	4	3.70	0	59	833
ADU Permits Issued	3.52	0	2	5	4.19	0	59	833
Num. Rental Units	819.50	469	764	1124	465.80	0	3895	833
2022								
ADUs Built	3.33	0	2	5	4.65	0	68	833
ADU Permits Issued	4.98	1	3	8	5.54	0	69	833
Num. Rental Units	821.71	475	754	1127	472.30	0	3914	833

Notes: This table reports summary statistics for tracts in my sample, separately across 2015 to 2022. The two variables concerning ADUs are computed from the building permit data. The rental units variable is from the ACS.

Table B.4: Summary Statistics – Rent and Covariates

	Mean	p25	p50	p75	SD	Min	Max	N
2015								
Rent	1758.40	1361.92	1649.62	2060.78	534.63	329.68	4322.83	829
Median Income ($1000)	79.22	51.19	72.55	100.03	37.02	16.03	230.57	832
Population (1000)	4.47	3.37	4.23	5.29	1.69	0.08	20.66	833
2016								
Rent	1787.34	1375.44	1676.62	2089.98	540.76	336.54	4268.98	831
Median Income ($1000)	81.35	51.41	73.17	102.62	38.46	17.66	226.46	832
Population (1000)	4.50	3.36	4.29	5.32	1.71	0.09	20.85	833
2017								
Rent	1824.66	1405.25	1714.48	2137.13	550.56	346.24	4179.94	830
Median Income ($1000)	84.31	53.45	76.17	106.49	39.30	19.12	233.26	832
Population (1000)	4.54	3.41	4.31	5.39	1.74	0.08	21.93	833
2018								
Rent	1876.24	1430.02	1745.86	2209.71	563.52	329.83	4080.27	831
Median Income ($1000)	87.24	55.59	78.03	109.50	41.20	19.59	242.64	830
Population (1000)	4.55	3.40	4.30	5.40	1.78	0.07	23.40	833
2019								
Rent	1932.22	1486.98	1842.99	2250.51	575.20	320.52	4007.65	830
Median Income ($1000)	91.10	57.79	81.27	112.66	43.12	14.13	268.46	831
Population (1000)	4.56	3.39	4.30	5.41	1.80	0.06	25.35	833
2020								
Rent	2003.37	1550.28	1901.95	2329.38	606.44	313.22	3958.81	827
Median Income ($1000)	95.67	61.61	85.22	118.14	44.55	12.67	265.89	829
Population (1000)	4.22	3.19	4.00	5.07	1.44	0.03	10.23	833
2021								
Rent	2045.63	1592.50	1927.31	2373.36	613.75	298.09	3781.18	828
Median Income ($1000)	97.78	65.48	87.08	120.13	45.10	12.22	266.80	831
Population (1000)	4.14	3.10	3.98	4.96	1.41	0.03	9.84	833
2022								
Rent	2051.21	1606.00	1916.00	2380.00	598.86	301.00	3501.00	829
Median Income ($1000)	98.61	66.02	87.91	120.31	45.54	12.17	250.00	827
Population (1000)	4.09	3.10	3.95	4.91	1.39	0.04	9.54	833

Notes: This table reports summary statistics for tracts in my sample, separately across 2015 to 2022. All three variables are from the ACS. Rent and median income are in 2022 dollars. Median income and population are in units of 1000. All statistics reported to two decimal points.

Table B.5: Event Study on ADUs Constructed

	(1) ADUs Built		(2) ADUs Built	
2010	-0.0249	(0.00914)	-0.0199	(0.0185)
2011	-0.0140	(0.0110)	-0.00483	(0.0184)
2012	-0.0153	(0.0107)	-0.00133	(0.0179)
2013	-0.0133	(0.0103)	0.000708	(0.0159)
2014	-0.00927	(0.0116)	0.00514	(0.0163)
2015	-0.00908	(0.0129)	-0.000709	(0.0145)
2017	0.0514	(0.0235)	0.0389	(0.0249)
2018	0.228	(0.0501)	0.203	(0.0517)
2019	0.453	(0.123)	0.413	(0.121)
2020	0.515	(0.103)	0.460	(0.112)
2021	1.780	(0.186)	1.715	(0.194)
2022	2.322	(0.227)	2.287	(0.240)
2010 $\times Z_c$	0.00153	(0.0145)	-0.0130	(0.0194)
2011 $\times Z_c$	-0.0134	(0.0154)	-0.0280	(0.0199)
2012 $\times Z_c$	-0.00689	(0.0163)	-0.0205	(0.0197)
2013 $\times Z_c$	-0.00619	(0.0154)	-0.0150	(0.0170)
2014 $\times Z_c$	-0.0155	(0.0165)	-0.0213	(0.0171)
2015 $\times Z_c$	-0.00942	(0.0189)	-0.0119	(0.0190)
2017 $\times Z_c$	0.124	(0.0407)	0.129	(0.0406)
2018 $\times Z_c$	0.734	(0.104)	0.744	(0.104)
2019 $\times Z_c$	1.375	(0.207)	1.392	(0.206)
2020 $\times Z_c$	1.712	(0.204)	1.730	(0.204)
2021 $\times Z_c$	1.457	(0.306)	1.480	(0.302)
2022 $\times Z_c$	1.738	(0.375)	1.728	(0.374)
Median Income ($1000)			0.00336	(0.00289)
Population (1000)			-0.00501	(0.0698)
Constant	0.0276	(0.0274)	-0.223	(0.318)
FEs	Tract		Tract	
SEs	Clustered at Tract		Clustered at Tract	
N	10829		10807	
r2	0.395		0.396	

Notes: This table presents results from estimating Equation 4. The regression is run without controls in column (1) and with controls for median income and population in column (2). There is a unit (tract-level) fixed effect and standard errors are cluster robust at the unit level.

Table B.6: Event Study on Rent

	(1)		(2)	
	Log(Rent)		Log(Rent)	
2015	-0.0167	(0.00278)	-0.0133	(0.00277)
2017	0.0278	(0.00325)	0.0229	(0.00331)
2018	0.0514	(0.00451)	0.0414	(0.00466)
2019	0.0818	(0.00571)	0.0660	(0.00610)
2020	0.123	(0.00747)	0.101	(0.00847)
2021	0.143	(0.00777)	0.120	(0.00910)
2022	0.157	(0.00827)	0.133	(0.00963)
2015 × Z_c	-0.000994	(0.00531)	-0.00209	(0.00528)
2017 × Z_c	-0.0114	(0.00563)	-0.00958	(0.00556)
2018 × Z_c	-0.00626	(0.00767)	-0.00256	(0.00762)
2019 × Z_c	-0.00725	(0.00953)	-0.00197	(0.00949)
2020 × Z_c	-0.0170	(0.0123)	-0.0126	(0.0122)
2021 × Z_c	-0.0161	(0.0130)	-0.0118	(0.0131)
2022 × Z_c	-0.0309	(0.0145)	-0.0281	(0.0146)
Median Income ($1000)			0.00131	(0.000215)
Population (1000)			0.000413	(0.00326)
Constant	7.446	(0.00254)	7.338	(0.0198)
FEs	Tract		Tract	
SEs	Clustered at Tract		Clustered at Tract	
N	6635		6628	
r2	0.927		0.929	

Notes: This table presents results from estimating Equation 6. The regression is run without controls in column (1) and with controls for median income and population in column (2). The specification is only run from 2015 on due a variable measurement change in the ACS before 2015 for rents. There is a unit (tract-level) fixed effect and standard errors are cluster robust at the unit level.

Table B.7: Nuisance Effect Estimates for Above Median Income Neighborhoods

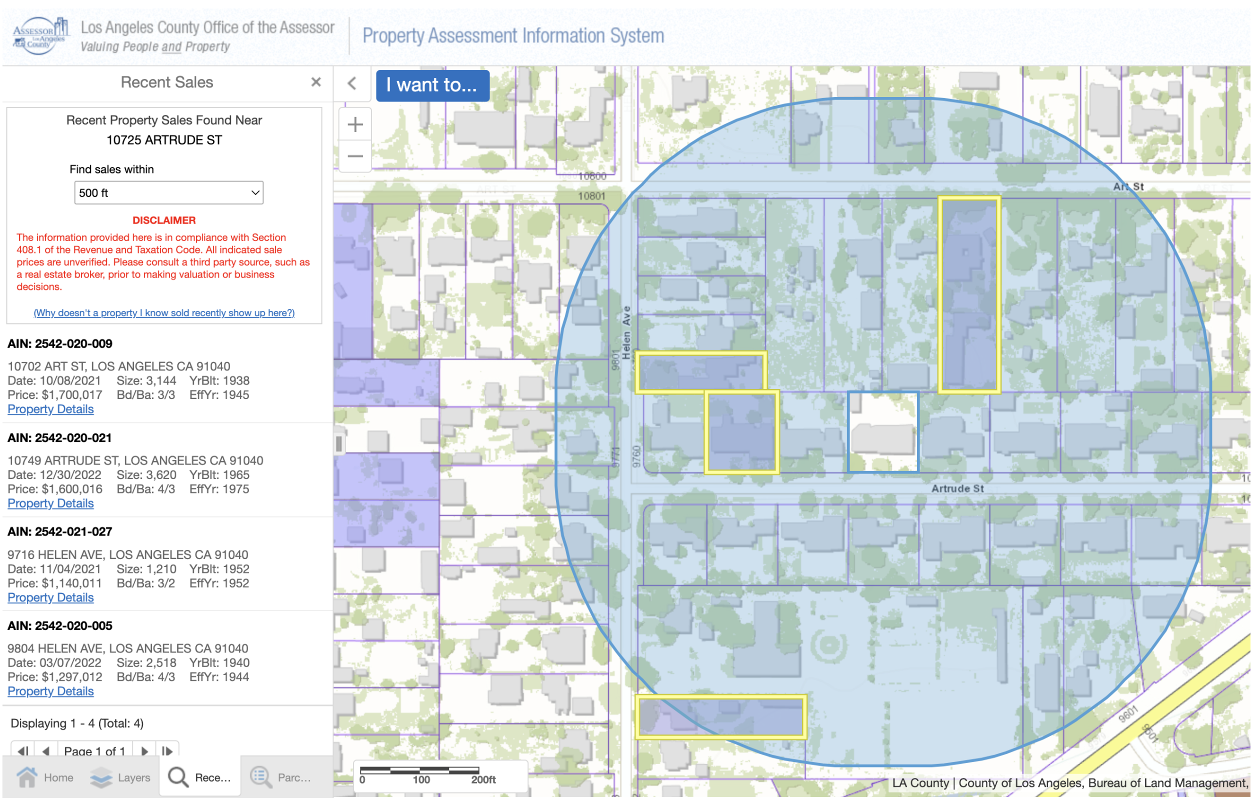
	(1) Log(Price)	(2) Log(Price)	(3) Log(Price)
Near ADU	-0.0170	0.0123	0.00377
	(0.0213)	(0.0189)	(0.0117)
After ADU Built	-0.00802	-0.00200	-0.00116
	(0.0210)	(0.0163)	(0.0108)
Near ADU × After ADU Built	-0.0174	-0.0381	-0.0232
	(0.0312)	(0.0238)	(0.0171)
Floor Area			0.000323
			(0.0000105)
Year Built			-0.000535
			(0.000226)
Num. Beds			0.0281
			(0.00430)
Constant	14.55	14.54	14.89
	(0.0210)	(0.00950)	(0.435)
FEs	None	ADU(i)	ADU(i)
SEs	Cluster, ADU(i)	Cluster, ADU(i)	Cluster, ADU(i)
N	4524	4524	4509
r2	0.00100	0.356	0.689

Notes: This table reports estimates of Equation 9 for properties sold near ADUs in above median income Census Tracts. Column (1) reports the regression with covariates or fixed effects. Column (2) adds ADU(i) fixed effects and (3) adds covariates. Floor area is in square footage units.

Figure B.1: Example ADUs in California

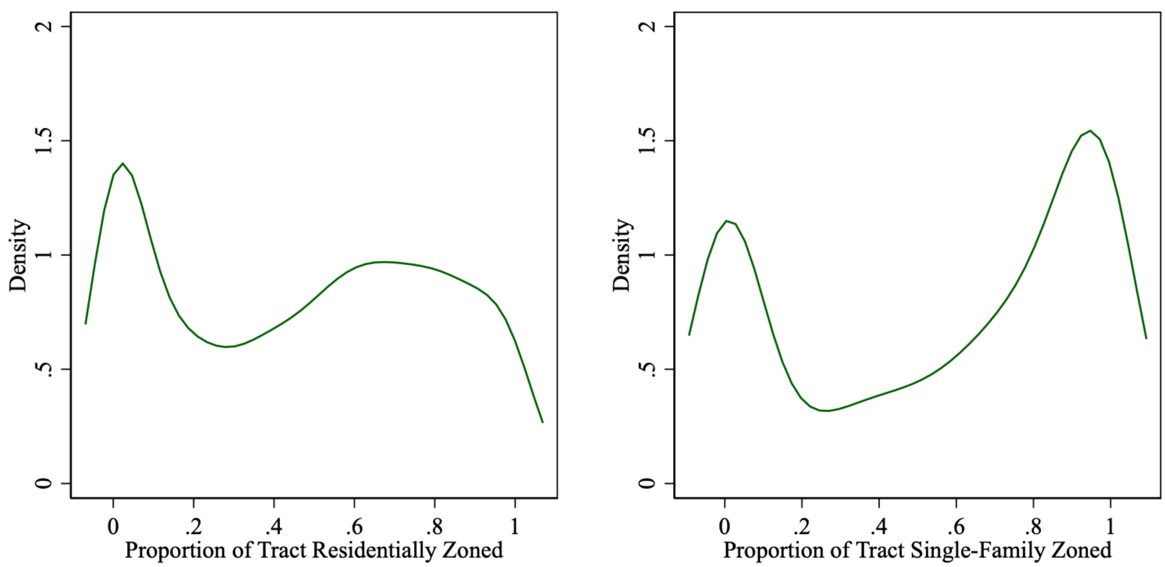
Notes: This figure shows example detached ADUs built in backyards. The photograph is from California Department of Housing and Community Development (2022).

Figure B.2: Los Angeles Property Information Map



Notes: This figure shows an example search for a house that has had added an ADU and the nearby property transactions on the Los Angeles Property Information Map.

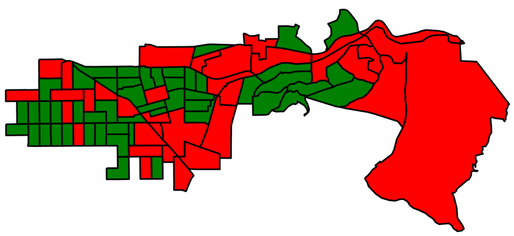
Figure B.3: Distribution of Tract Area in Sample and Single-Family Zoned



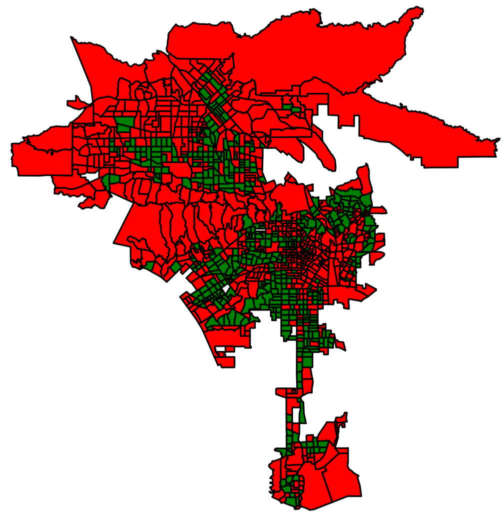
Notes: Panel (a) plots kernel density estimates of the distribution of the "in-sample" variable over Census Tracts. This variable is defined the proportion of the tract that is residentially (single- or multi-family) zoned. Panel (b) plots the distribution of the proportion of the residential area in the tract that is single-family zoned (Z_c) given that the tract is at least 50 percent residential. Estimation is done with a Gaussian kernel and nrd0 bandwidth selection.

Figure B.4: Sample Restrictions by City

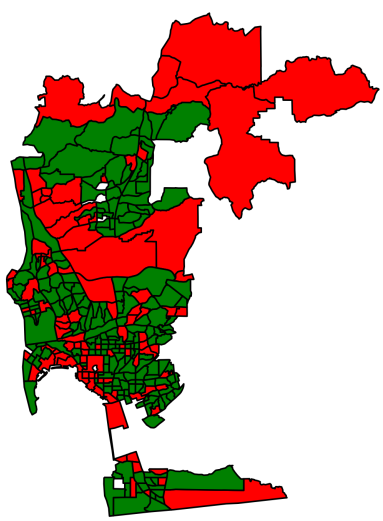
(a) Anaheim



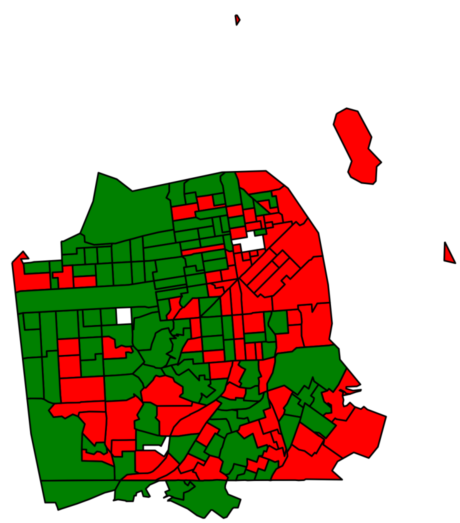
(b) Los Angeles



(c) San Diego

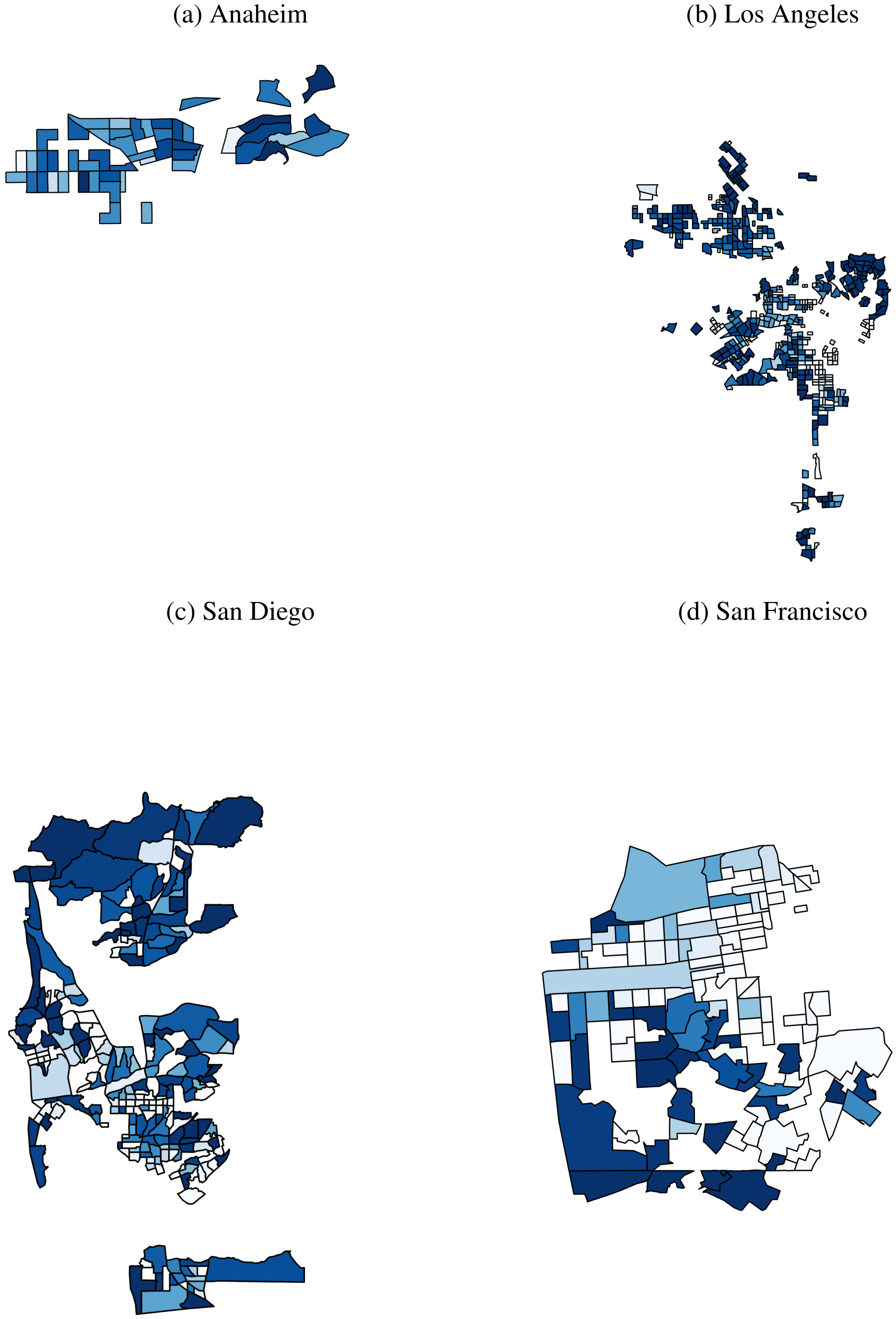


(d) San Francisco



Notes: This figure maps an indicator for whether the Census Tracts in my sample are at least 50 percent residentially zoned. Green indicates sample inclusion, red exclusion.

Figure B.5: Treatment Variable (Z_c) by City



(a) Anaheim

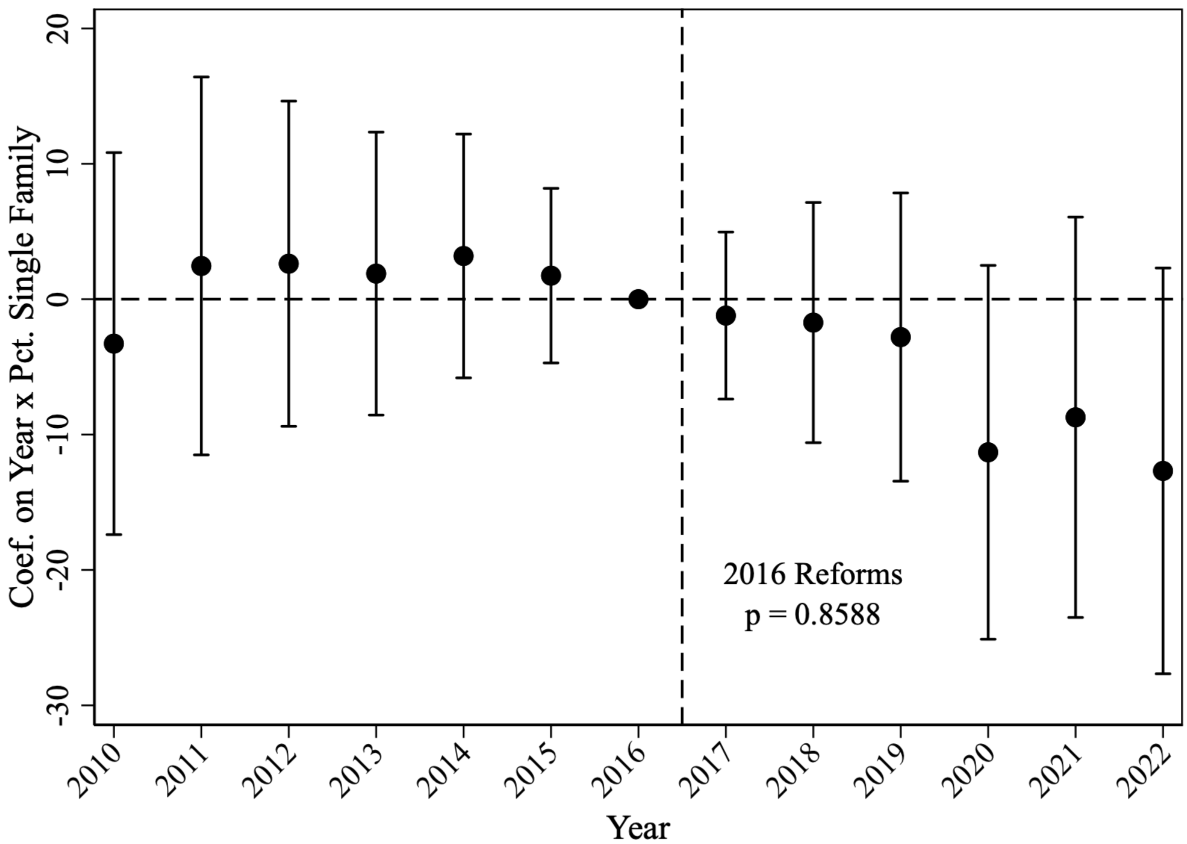
(b) Los Angeles

(c) San Diego

(d) San Francisco

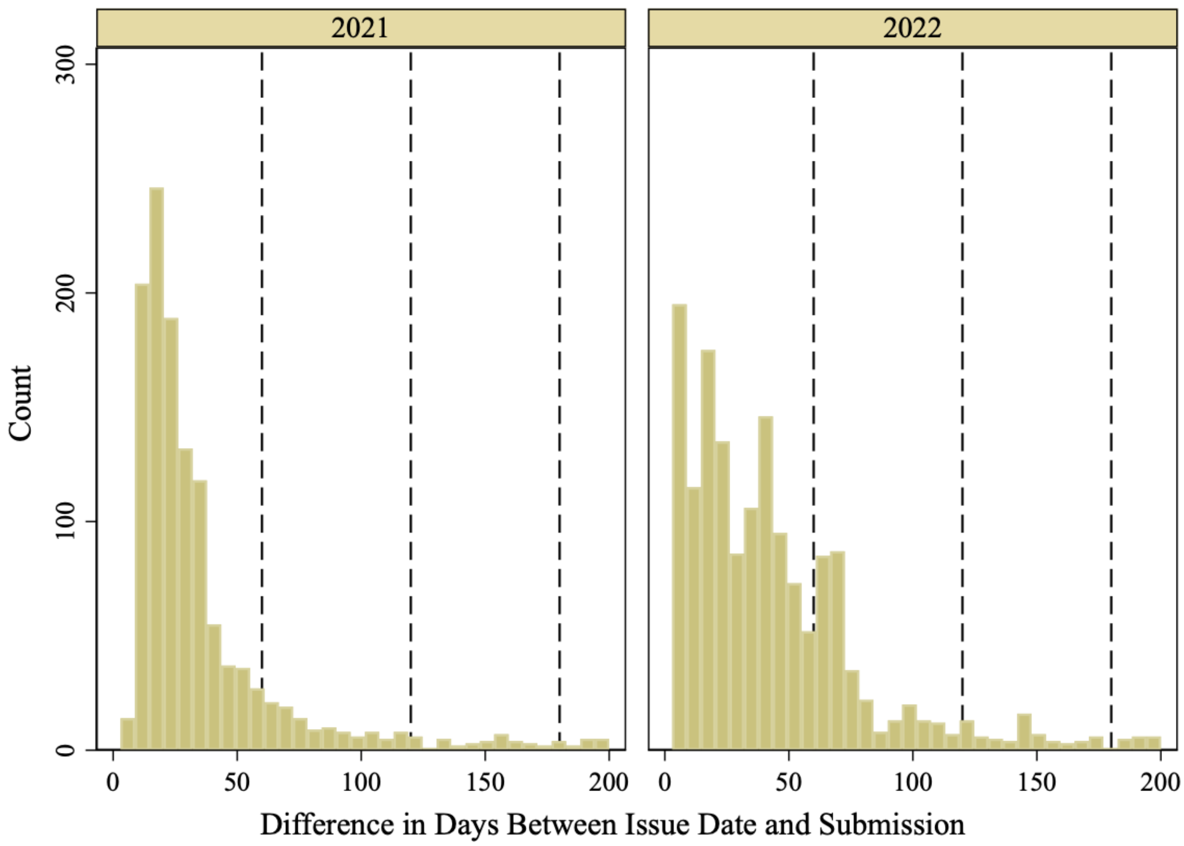
Notes: This figure plots a map of Z_c (proportion of tract that is single-family zoned) for tracts included in my sample. Darker blue values indicate higher values of Z_c.

Figure B.6: Event Study Coefficients on Grandparents Living with Grandchildren



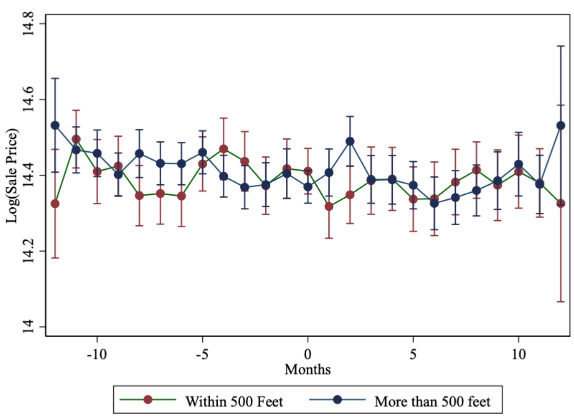
Notes: This figure plots the coefficients from a linear panel event study of grandparents living with grandchildren on $Z_c \times$ Year from Equation 4. The confidence intervals are at the 95 percent level. The p-value on the right-hand side is the result of a joint test of whether the pre-treatment coefficients are equal.

Figure B.7: Histogram of Wait Times by Year

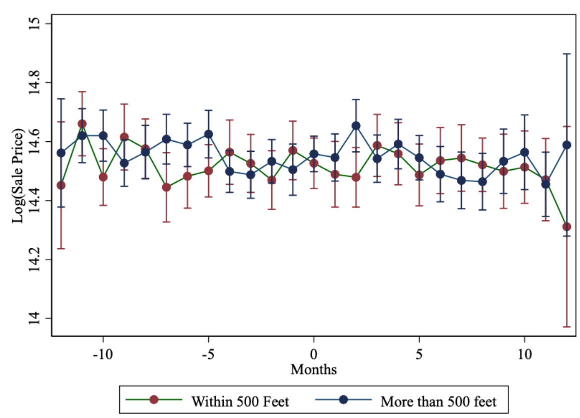


Notes: This figure plots a histogram of the wait time for an ADU permit (defined as the difference between the date the permit is submitted versus approved in days) by year of issuance. Vertical lines are added at 60-day intervals.

Figure B.8: Property Values Time Series, by Distance to ADU



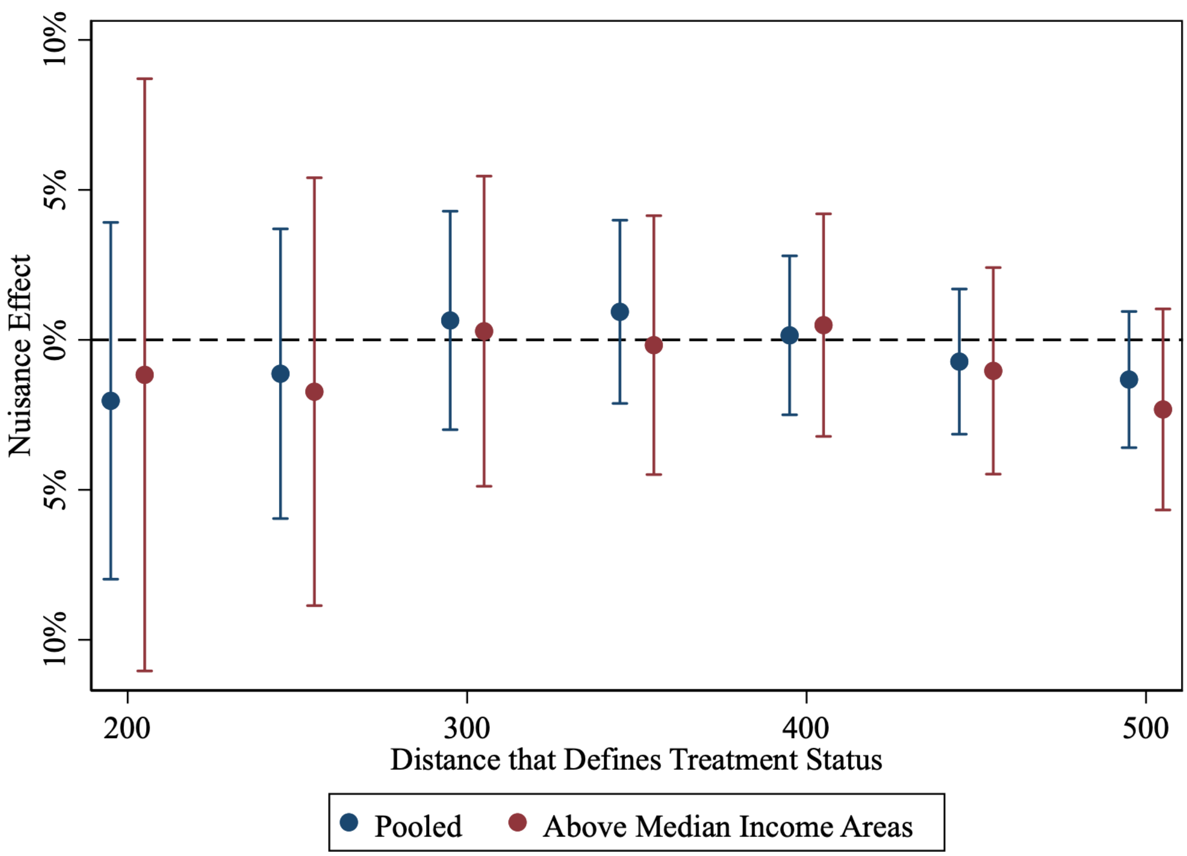
(a) Pooled



(b) High Income Neighborhoods

Notes: This figure plots a time series of sale prices for properties sold within 1000 feet of an ADU. I focus on properties sold one year before or after the ADU was built. I split the series by whether the property was within 500 feet of the ADU. I plot 95 percent confidence intervals. Panel (a) shows the full sample and (b) restricts to properties sold near ADUs in above median income tracts.

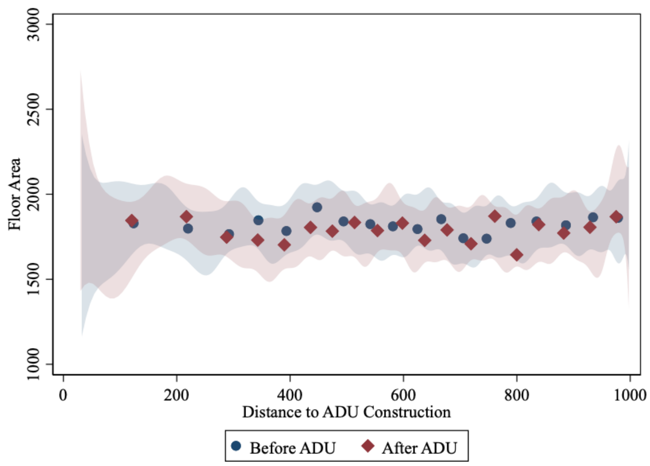
Figure B.9: Nuisance Effects for Different Definitions of the Treatment Ring



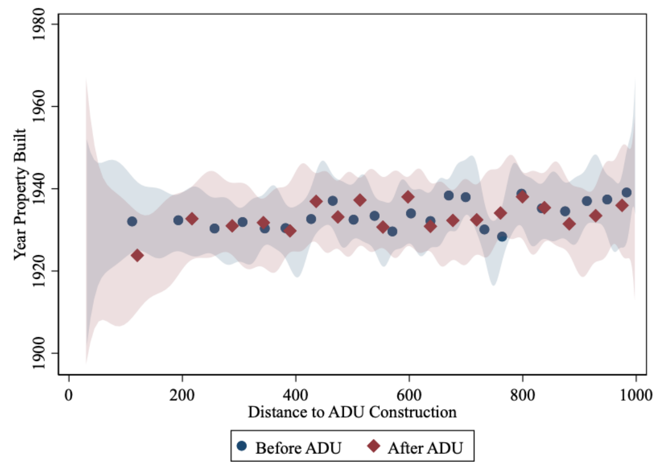
Notes: This figure plots estimates and 95% confidence intervals of the nuisance effect for various definitions of the treatment ring. For each value on the x-axis, I define the treatment "ring" as properties sold within that distance of a constructed ADU. I am always comparing those treated properties to properties sold 500-1000 feet away from the ADU. My specification is analogous to Column (3) of Table 4, using the same fixed effects, controls, and standard errors. A dashed line is plotted at zero.

Figure B.10: Nuisance Effect Balance Tests

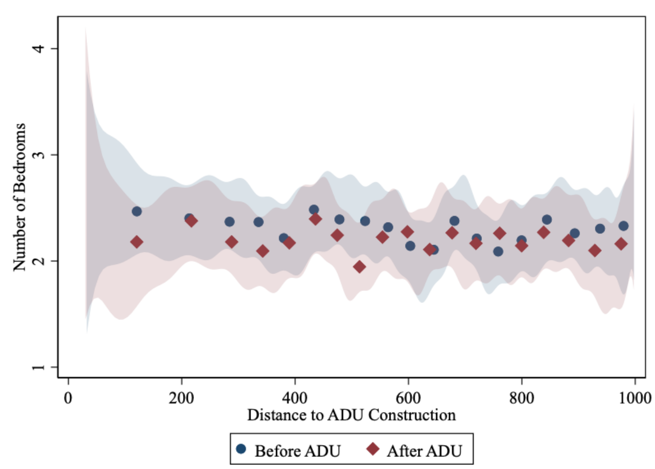
(a) Floor Area



(b) Year Property Built



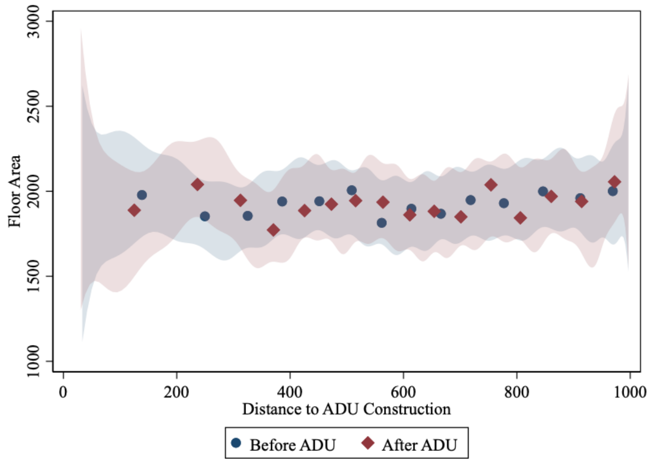
(c) Beds



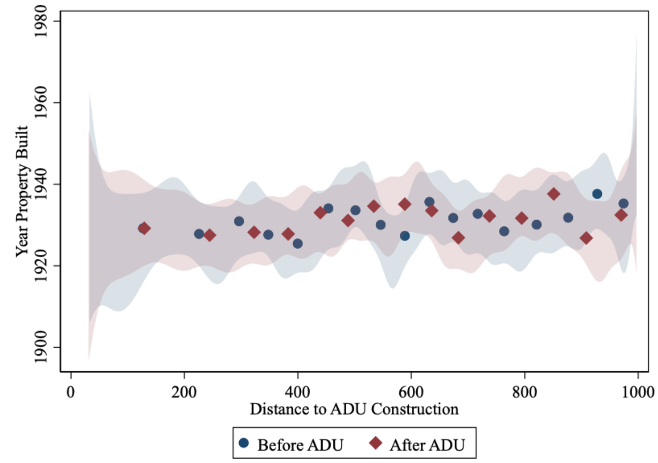
Notes: This figure plots a binned scatterplot of three property characteristics for properties sold within 1000 feet of an ADU on their distance to said ADU. The plot is split by whether the sale occurred in the year before or after the ADU was built. Panel (a) has floor area in square feet as the outcome, (b) has the year the property was built, and (c) has the number of beds. 95 percent uniform confidence bands, estimated with a cubic B-spline, are shown. Bins are selected through IMSE-optimal direct plug-in rule.

Figure B.11: Nuisance Effect Balance Tests for Above Median Income Neighborhoods

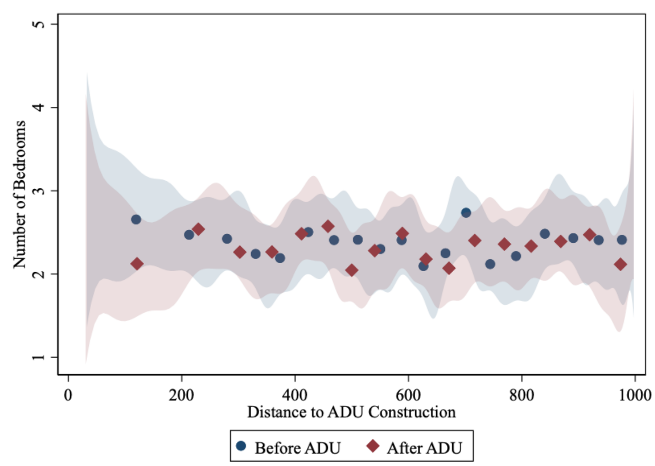
(a) Floor Area



(b) Year Property Built



(c) Beds



Notes: This figure plots a binned scatterplot of three property characteristics for properties sold within 1000 feet of an ADU on their distance to said ADU. This figure restricts to properties near ADUs built in above median income census tracts. The plot is split by whether the sale occurred in the year before or after the ADU was built. Panel (a) has floor area in square feet as the outcome, (b) has the year the property was built, and (c) has the number of beds. 95 percent uniform confidence bands, estimated with a cubic B-spline, are shown. Bins are selected through IMSE-optimal direct plug-in rule.