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ARTICLE

The influence of accessory dwelling unit (ADU) policy on the contributing factors to ADU development: an assessment of the city of Los Angeles

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Abstract
Since the accessory dwelling unit (ADU) has emerged as a policy alternative to increase housing stock and provide affordable options for areas impacted by housing shortages, many local governments recently adopted ADU policies that promote the construction of ADUs. Taking the City of Los Angeles as the study area, this paper examines how the city's ADU ordinance impacts the relationship of the characteristics of the properties and neighborhoods with ADU development by constructing multilevel logistic regression models. The outputs of the models suggest that the ordinance contributes to diversifying the types and locations of the properties and neighborhoods where ADUs are built. The influence of the property characteristics associated with ADU development before the implementation of the ordinance significantly diminished after the ordinance. The outputs also indicate that the ordinance probably attracted ADU developments in the areas with higher accessibility to bus transit. These findings will help planners take appropriate actions and policies that support ADU developments.

Keywords Accessory Dwelling Unit (ADU) · ADU Ordinance · Property Characteristics · Neighborhood Characteristics · Multilevel Analysis

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1 Introduction

The shortage of housing inventory has become a significant urban issue in the United States. From 2000 to 2015, 23 states in the U.S. under-produced 7.3 million housing units in total, which is roughly equivalent to 5.4% of the total housing stock of the U.S (Baron et al., 2018). In some states like California, this problem becomes more serious. California's major metropolitan areas needed from 190,000 to 230,000 housing units per year between 1980 and 2010, but about 120,000 new units each year were added during this period (Taylor, 2015). Consequentially, for example, Southern California requires at least 1.3 million new homes within the next decade (CAHCD, 2020). The lack of housing supply disparately impacts renters and low-income families by impacting affordability and increasing average housing costs.

Accessory dwelling unit (ADU) has gained popularity as a policy alternative to provide affordable options and increase stock in the housing market. ADU refers to a completely independent living facility on a lot in addition to a primary residence. In the past, ADUs were also known as secondary units such as granny flats, in-law units, and backyard cottages (CAHCD, 2020). ADUs can be constructed in various ways including by converting portions of existing homes or existing stand-alone accessory structures, constructing additions to new or existing homes, or building new stand-alone structures. Many local governments expect ADUs to become an infill housing type that increases housing affordability by adding many more housing units to the housing market (Kim, et al., 2022). ADUs can also play an important role in diversifying housing options. For example, ADUs functioning as low-maintenance housing can help the elderly to stay near family as they age. ADUs can also facilitate better use of the existing housing fabric in established neighborhoods (CAHCD, 2020).

To promote the construction of ADUs, recent changes in California ADU law have incrementally removed barriers to ADU development. Provisions for local government adoption of ADUs, called second unit ordinances, were first adopted in 1982 in California. Since then, numerous state legislative bills have been enacted, especially between the years 2016–2020. As the state passed Assembly Bill 2299 in coordination with Senate Bill 1069, the state of California significantly eases restrictions on building ADUs (Bennett et al., 2019). In Government Code Sect. 65852.150, the California Legislature declared that ADUs are allowed in single-family, multifamily, or mixed-use zones. The latest changes to the State ADU law are effective January 1, 2021, and the purpose of the changes is to further address barriers, streamline approval processes, and expand the potential capacity for ADUs. Since local governments should not unduly constrain ADU development according to the state ADU law, the law is the statutory minimum requirement and local governments could only go beyond the minimum to provide more ADU development (CAHCD, 2020). Reflecting these changes, many local governments in California including the City of Los Angeles have adopted zoning regulations that permit ADUs in residential areas, especially low-density residential areas.

The City of Los Angeles adopted the new ADU ordinance on December 11, 2019, and the ordinance was effective on December 19, 2019. Incorporating various provisions of State law, the new ordinance sets standards to promote ADUs. The city allows all residential or mixed-use zones to build ADUs as long as local governments find them with adequate water and sewer service, less impact on public safety (e.g. fire hazard areas), and traffic flow. The city does not require a minimum lot size and minimum and maximum unit size, but still imposes a height limitation (16 feet) and side and rear yard setbacks (four feet). Parking is not a requirement anymore in neighborhoods near transit stops or car share programs, historic districts, or permit parking areas. Replacement of off-street parking spaces is also not a requirement although ADUs are created through the conversion of a parking structure including a garage, carport, or covered parking structure.

Taking the City of Los Angeles as the study area, this study aims to examine how a local government' ADU ordinance influenced ADU development using a case study. Since a city's ordinance primarily regulates the physical characteristics of properties in which an ADU is constructed, it is expected for the ordinance to intervene in the potential of ADU development. It is also reasonable to hypothesize that ADU development depends not only on the characteristics of a property but also on the built environment and socio-demographic characteristics of the neighborhood where the property is located. However, there is a lack of studies that fully address this topic. We construct two multilevel logistic regression models to test the aforementioned relationships. The models test the likelihood of ADU development in association with the physical characteristics of properties as well as the socio-economic and built environmental conditions of neighborhoods before and after the implementation of the ordinance. By providing the interconnection between the changes in ADU development patterns caused by the ordinance and the characteristics of properties and surrounding communities, this paper could help urban planners and policymakers understand the factors facilitating efficient ADU development and affordable housing policies.

2 Literature review

ADUs are expected to increase housing affordability and create a wider range of housing options in the areas, where lack of housing supply and affordable housing has become a serious social problem. However, there are many challenges to the full realization of ADU potential at the local level. Much research addressed institutional challenges and societal perceptions of ADU and NIMBYism (Not In My Backyard). Exclusionary land-use regulations play a major role in preventing potential ADU from development by imposing compliance costs and limiting the supply of land available for development (Brinig and Garnett, 2013). The most contentious issue preventing ADU development is that the development may increase permissible residential density. For this reason, ADU development is considered "upzoning" in single-family residential areas, which is the most difficult land use type to change (Gabbe, 2019). Many residents in the areas echo a fear of decreased property values led by increased density and decreased on-street parking spaces if ADUs become widespread in their communities. This is a major factor to oppose ADU development (Brinig and Garnett, 2013).

The pushback vocalized by residents could sway local officials to advocate for restrictions on ADUs (Mukhija et al., 2014). Thus, it is noticed that the local atmosphere and socio-demographic characteristics of residents affect local approaches to ADU policies. In the Los Angeles metropolitan area, cities with lower incomes, low housing values, higher proportions of population growth among Latinxs, and greater rates of poverty and multi-generational households tend to have the most restrictive regulations (Pfeiffer, 2019). In contrast, a logit regression model of Los Angeles County implied that the likelihood of ADU development is higher in areas with higher proportions of non-Latinx White populations, high overcrowding, smaller lots, and more recently purchased homes (Chapple et al., 2020a). Similarly, a study done in Seattle's King County indicated that ADU permits positively correlate with Hispanic and African American households (Maaoui, 2018). Therefore, accepting the regional variations of ADU development county by county, a study suggested a cautious conclusion that requires a more nuanced interpretation of which local governments have more or less restricted ADU policies (Chapple et al., 2020a).

Although there are variations in the level of strictness considering ADU ordinances in localities, however, the regulatory instruments that the ordinances employ to intervene in ADU development remain similar. ADUs have been discretionary rather than ministerial, which means local governments require ADUs to meet strict development requirements, such as costly off-street parking, minimum lot size requirements, design standards, setbacks, height limits, and maximum unit size of ADUs (Chapple et al., 2020b; Ramsey-Musolf 2018; Mukhija et al., 2014). Of the instruments, off-street parking requirements may particularly be an extensively restrictive regulation that prevents ADU development (Brinig and Garnett, 2013). Advocates for ADU development argued against off-street parking requirements. Eliminating the requirements and legalizing garage conversions will ease ADU implementation since parking requirement increases the odds of a household owning a car (Brown et al., 2020).

Implementation of ADU development has been further complicated by existing non-conforming ADUs. Without the acquirement of costly building permits, many homeowners have created ADUs. For example, more than 75% of houses in some neighborhoods of Los Angeles have non-conforming ADUs (Bennet et al., 2019). The non-permitted informal units commonly have qualities like small physical size, unofficial utility connections, and incorporation of reclaimed materials that are incrementally applied by homeowners. This often allows them to provide a level of affordability to their occupants (Wegmann and Mawhorter, 2017). Legalizing the non-conforming units will be a monumental task to tackle. Targeting non-conforming units to bring them up to code may result in unintended consequences that may displace thousands of people residing in them who need affordable housing.

Speaking of affordability, although ADUs are expected to increase housing affordability due to the nature of their smaller size and lower building costs, whether ADU is a feasible solution to the affordable housing crisis or not is still controversial. A study found that ADU and rental markets are largely composed of low-income people, the elderly, and the disabled (Chapple et al., 2017a). The majority of ADUs in Vancouver, Seattle, and Portland rented for below-market rates (Chapple et al., 2017b). However, other studies reported that the rental costs of ADUs are similar to comparable apartments in multifamily developments (Ramsey-Musolf, 2018) and that the number of ADU applications was not associated with changes in the proportions of renters paying more than 50% of their income on housing (Pfeiffer, 2019).

3 Methodology

Since ADU ordinances are the primary instrument that regulates local ADU development, the changes in an ADU ordinance can significantly shift the framework of local ADU development. Thus, this study examines how the recently adopted ADU ordinance of the City of Los Angeles influenced ADU development in the city. The city is one of the cities that produced the largest number of ADUs in the State of California. To measure the impacts of the city's ADU ordinance adoption on ADU development in the city, we constructed two multilevel logistic regression (MLR) models that explore ADU development before and after the new ordinance; one for ADU development before the new ordinance (Before model) and one for ADU development after the new ordinance (After model). MLR was employed due to the hierarchical structure of the data. While some of the contributing factors represent the unique characteristics of each parcel, some are the conditions of the neighborhood in which a property is located. Thus, the relationships between neighborhood and property are likely a nested relationship since multiple properties in the same neighborhood share the same neighborhood conditions. Because of the nested data structure, a standard regression such as ordinary least squares (OLS) violates the independence assumption and underestimates the standard errors of regression coefficients. MLR models can partition variance between the neighborhood level and the property level and uses level-specific variables to explain the variance at each level.

3.1 Dependent variable

The unit of analysis of the models is the property parcel. The dependent variable of the models is a dummy variable coded with 0 (a property without ADU development) or 1 (a property with ADU development). We utilized the city's building permit data to identify the properties that construct an ADU. ADU building permits that issued a certificate of occupancy (CofO) from January 1, 2018, to December 11, 2020, were selected. With this process, 11,869 ADU applications total were identified, This includes 8,695 and 3,174 applications that a CofO was issued before and after the effective date of the new ordinance, respectively. The former was included in the Before model and the latter became the samples in the After model.

Therefore, the Before model tests the relationship between the property and neighborhood contributing factors and the likelihood of ADUs constructed from January 1, 2018, to December 18, 2019. The After model examines the factors' relationship with ADUs constructed from December 19, 2019, to December 15, 2020. Due to the recent adoption of the ordinance, the period that the After Model covers is shorter than the Before Model's period. However, the large enough sample size of the 'After' model allows the construction of a stable statistical model. Additionally, the approach of the Before and After models can address the lagged impacts of phenomena that occurred before the new ADU ordinance but influence the After model. The lagged impacts play a role in diluting the differences between the two models. Therefore, the contrasts between the two models found under the diluted circumstance emphasize the significant changes that occurred with the new ordinance.

Using the geographic information systems software, ArcGIS 10.6, we identified the locations of the corresponding properties to the 11,869 applications by geocoding them based

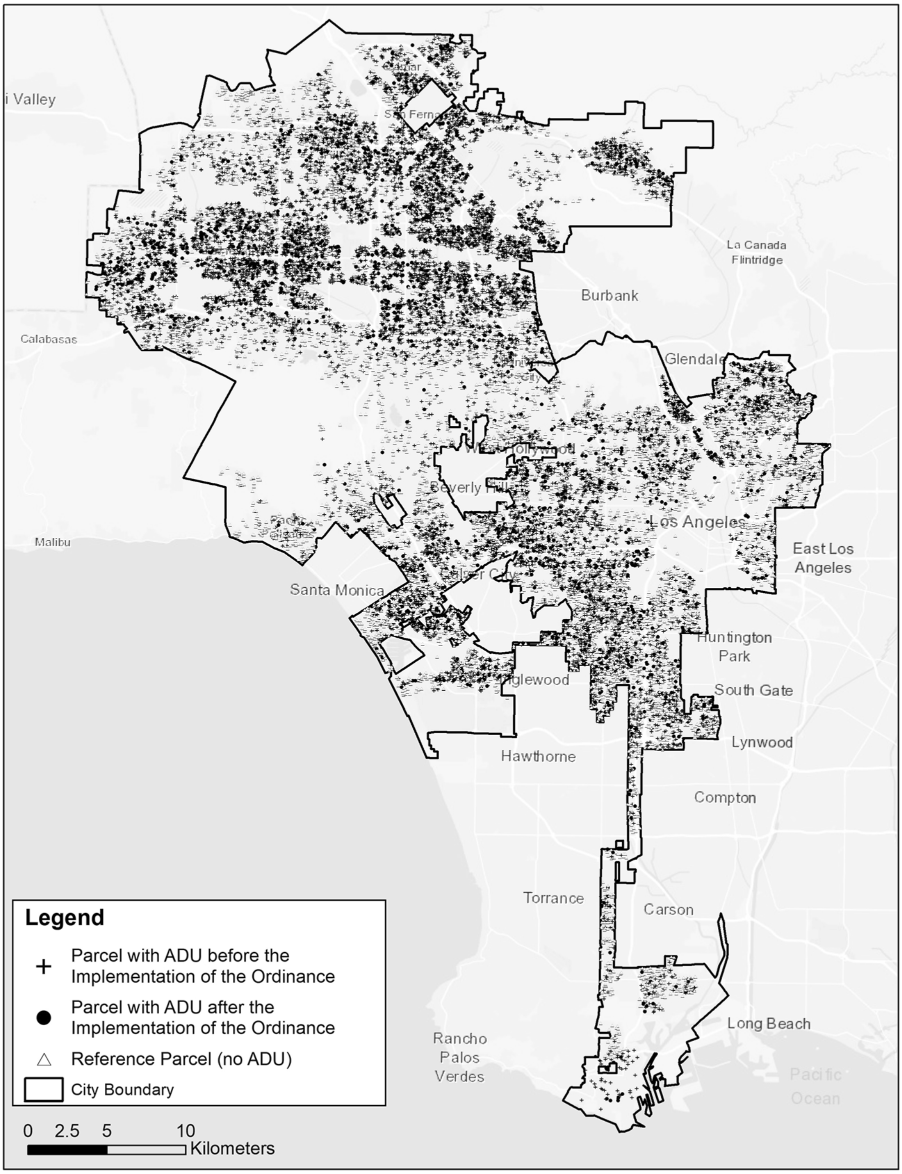

Fig. 1 The location of ADU and reference parcels

on the address in the data. Additionally, 12,421 parcels that did not experience ADU development were randomly selected considering the samples' spatial even distribution (Fig. 1).

It is noteworthy that the period of the After model coincidently overlaps with the period of the Coronavirus Disease 2019 (COVID-19) pandemic. The State of California declared a state of emergency due to the pandemic on March 4, 2020, about two and half months after the implementation of the new ADU ordinance. It is reasonable to hypothesize that

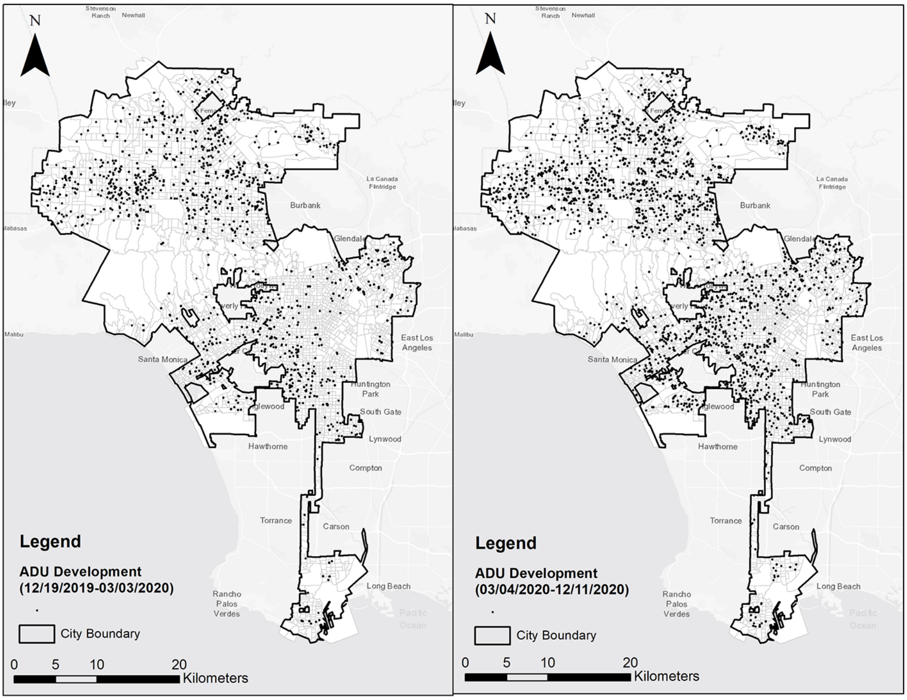

Fig. 2 ADU developments before and during the pandemic

the pandemic and the policies responding to the pandemic such as a state-at-home order directly or indirectly influence ADU development. For example, the number of daily ADU permissions dropped from 12.2 before the pandemic to 8.2 after the pandemic. However, we did not consider the impacts of the pandemic. Although the overall number of ADU permissions was reduced, the sample size (3,174) of the After model is large enough to construct a reliable statistical model. More importantly, it looks like the pandemic did not significantly influence the spatial patterns of ADU developments (Fig. 2). Since the implementation of the ADU ordinance, the overall spatial patterns of the ADU developments remain consistent regardless of the pandemic. For these reasons, the impacts of the pandemic were not included in the models. This does not mean that the impacts of the pandemic on ADU development are ignorable. Future studies need to consider investigating this topic.

3.2 Independent variable

Using the 24,290 parcel samples, we computed independent variables. Independent variables are regarded as potential factors influencing ADU development. In general, the literature suggests variables on the physical features, geographical location, and transportation accessibility of parcels as well as the socio-demographic characteristics and built environmental conditions of the neighborhood (Chapple et al., 2020a, b; Maaoui, 2018). There are no time-sensitive independent variables selected. In other words, the variables do not represent conditions or phenomena that significantly swing before and after the implementation

Table 1 The Description of Independent Variables

Level	Category	Name	Description
Neighborhood Level (Level 1)	Socio-demographic Characteristics	Pop_Den	Population density (persons per acre)
		Med_Inc	Median household income ($)
		Med_Rent	Median gross rent ($)
		Med_Val	Median owner-occupied home value ($)
		Ethcty	The proportion of non-Latino White (%)
	Housing and Land Use	Vac_Rate	Housing vacancy rate (%)
		Rent_Per	The proportion of renter-occupied housing units (%)
		Land_Dvrs	Land use diversity (Land use entropy index)
Property Level (Level 2)	Characteristics of Property	Area	Lot Size (acre)
		Yr_Built	Year built (year)
		Bldg_Area	The area of (an) existing building(s) (square foot)
		Far	Floor area ratio (FAR) of a parcel (ratio)
		A_Val	Appraisal value of the property ($)
		Elev	Elevation from the sea level (feet)
		Slope	The average slope of a parcel (degree)
	Transportation Accessibility	Hwy_Acc	Highway accessibility (distance to the nearest highway ramp) (feet)
		Bus_Trnst	Bus transit accessibility measured with the number of bus stops within 0.25 miles (count)
		Rail_Trnst	Rail transit accessibility (Dummy, if a rail transit exists within 0.5 miles, 1. Otherwise, 0)
	Accessibility to Amenities	Shop_Acc	Distances to the nearest shopping center (feet)
		Park_Acc	Distance to the nearest urban park (feet)
		Cbd_Acc	Distance to the central business district (CBD) of Los Angeles (feet)
		Sub_Cnt	Distance to the nearest sub-centers (feet)

of the new ordinance. Therefore, the aforementioned lagged impacts on the model outputs are controlled by the independent variables.

According to the literature, we selected 22 independent variables (Table 1) including eight neighborhood level and sixteen property level variables. The neighborhood level (Level 1) variables represent sociodemographic characteristics and housing/land use conditions. Thus, properties in the same neighborhood share the same value of the variables. The neighborhoods were defined with census block groups. The data for the variables were extracted from U.S. Census American Community Survey 2018 (5 years-estimated), except for land use diversity (Land-Dvrs). The variable, Land-Dvrs, is a land-use entropy measure that reflects the degree of uniformity of land use mixtures. Aggregating the land use codes into eight categories (residential, office, commercial and services, industrial, mixed-use, facilities and education, open space and recreation, and others), the variable is computed as suggested in the following equation:

$$Land\_Dvrs = \sum \frac{P_j \times LN\left(P_j\right)}{LN\left(j\right)}$$

where Pj = proportion of land-use category j within the buffer,

j = number of land-use categories, and
LN = the natural logarithm of a number

The property level (Level 2) variables are categorized by Characteristics of Property, Transportation Accessibility, and Accessibility to Amenities. All the variables other than elevation and slope under the Characteristics of Property category were retrieved from Los Angeles County Appraisal Office's property parcel data. Overlaying the parcel data over the digital elevation model data from the U.S. Geological Survey (USGS), the elevation and slope of each property parcel were acquired. Three types of geospatial analyses quantified the variables under the Transportation Accessibility and Accessibility to Amenities categories. They are distance analysis, density analysis, and others. Distance analysis refers to the measurement between a property and a variety of urban amenities or facilities. The analysis measures a Euclidian distance between a property and the closest amenity/facility. The density analysis returns the number of facilities within a 0.25-mile buffer as a pedestrian catchment.

4 Results

Before conducting the multilevel logistic models, we summarize the descriptive statistics for the independent variables by the type of the samples (Table 2). Of the independent variables, the standard deviations of the variables representing dollar value such as median household income, median gross rent, median owner-occupied home value, and appraisal value of property were relatively large as expected. Otherwise, the small standard deviations suggest the consistent patterns of the variables in the study area. The descriptive statistics of the types are also comparable.

Using IBM's SPSS (version 27), the MLR models were constructed. Overall, the models generated reasonably reliable results. In comparison to the null models, the MLR models' log-likelihood values increase. Especially, the larger change of the log-likelihood value of the After model presents a stronger model fit than the Before model (Table 3). This indicates that the explanatory power of the independent variables in the models increases with the city's new ADU ordinance. According to the Before model, 13 out of 22 independent variables present a correlation with the dependent variable at a statistically significant level.

Table 2 Descriptive Statistics of the Independent Variable by Sample Type

Level	Category	Variable	ADU Properties Before the New Ordinance (n = 8,695)				ADU Properties After the New Ordinance (n = 3,174)				Reference Properties (n = 12,421)			
			Mean	St.D.	Min.	Max.	Mean	St.D.	Min.	Max.	Mean	St.D.	Min.	Max.
Level 1	Socio-demographic Characteristics	Pop_Den	17.6	10.3	0.13	127.7	17.8	14.3	0.7	133.6	19.0	14.9	0.01	181.9
		Med_Inc	≈ 78 K	≈ 37 K	≈ 10 K	≈ 250 K	≈ 88 K	≈ 48 K	≈ 0.8 K	≈ 250 K	≈ 85 K	48 K	≈ 0.8 K	≈ 250 K
		Med_Rent	1522.5	756.6	0	3501	1605.9	858.1	0	3501	1543.2	831.7	0	3501
		Med_Val	≈ 64 K	≈ 340 K	≈ 92 K	≈ 2 M	≈ 760 K	≈ 445 K	≈ 92 K	≈ 2 M	≈ 744 K	438 K	≈ 92 K	≈ 2 M
		Ethcty	35.1	26.6	0	100	40.1	30.2	0	97.4	37.6	29.8	0	100
	Housing and Land Use	Vac_Rate	5.2	5.3	0	46.7	6.1	6.0	0	46.8	6.1	6.0	0	46.8
		Rent_Per	40.4	22.2	0	100	39.2	24.9	0	95.4	41.9	25.2	0	100
		Land_Dvrs	0.27	0.18	0	0.84	0.28	0.18	0	0.85	0.29	0.18	0	0.85
Level 2	Characteristics of Property	Area	0.19	0.18	0.01	9.66	0.18	0.15	0.03	3.59	0.21	0.28	0.01	9.39
		Yr_Bult	1945	17.2	1883	2018	1947.2	18.18	1885	2017	1949.4	22.0	1880	2017
		Bldg_Area	1600.4	1199.3	360	86,236	2213.3	4245.0	504	65,895	2588.3	5575.4	192	231,545
		Far	0.21	0.09	0.01	1.99	0.26	0.23	0.03	2.85	0.3	0.28	0.003	10.53
		A_Val	≈ 528 K	≈ 644 K	187	≈ 1.8 M	≈ 584 K	≈ 116 K	22	≈ 18 M	≈ 642 K	≈ 1.7 M	4947	≈ 93 M
		Elev	640.8	380.8	8.7	2099.5	613.2	366.4	10.4	2009.8	573.8	401.2	6.3	2354.2
		Slope	1.41	2.0	0	21.0	1.3	1.8	0	13.8	2.2	2.9	0	21.7
	Transportation Accessibility	Hwy_Acc	1558.7	1210.8	19.1	7082.4	1605.3	1272.7	14.3	5583.7	1553.4	1224.9	12.2	9062.7
		Bus_Trnst	17.8	19.2	1	179	19.5	21.1	1	177	20.4	24.7	1	591
		Rail_Trnst	0.05	0.21	0	1	0.05	0.22	0	1	0.07	0.26	0	1
	Accessibility to Amenities	Shop_Acc	692.7	504.8	18.3	5842.3	672.9	490.6	21.3	4456.9	843.1	682.4	16.0	6066.7
		Park_Acc	955.1	496.3	17.0	3261.	950.2	485.5	54.6	3153.6	933.7	527.9	6.5	3678.4
		Cbd_Acc	21909.7	9822.6	1394.7	41484.3	21762.1	10629.48	1610.4	40711.8	19541.8	10687.9	492.5	41,955
		Sub_Cnt	5901.2	2450.6	20.1	13,940	5515.5	2346.2	216.2	12773.2	5808.5	2503.5	27.45	14536.6

Overall, the variables representing the features of a property significantly influence ADU development. All the variables in the category of property characteristics present a statistically significant correlation with the dependent variable.

Additionally, three variables, bus transit accessibility (Bus_Trnst), distance to the nearest shopping center (Shp_Acc), and distance to CBD (Cbd_Acc), present a correlation with the dependent variable. The impacts of the variables at the neighborhood level are less significant than the ones at the property level. Three variables, population density (Pop_Den), median household income (Med_Inc), and land-use diversity (Land_Dvrs), present a statistically significant correlation with the dependent variable. According to the Before model, in general, the likelihood of ADU development tends to increase in parcels that are smaller in size with a smaller, older main dwelling unit. The Before model also indicates that ADU development tended to occur in areas where population density is low and the land uses are less diverse (likely dominantly single-family residential neighborhoods).

On the other hand, the outputs of the After model indicate that four out of 22 independent variables correlate with the dependent variable at a 95% significance level. A noteworthy finding is that fewer independent variables were found to have a significant coefficient with the dependent variable in the After model compared to the Before model. Especially, the variables in the category of property characteristics significantly lose their correlation with the dependent variable in the After model. Only two out of the seven variables, Area and Slope, present a statistically significant correlation with the dependent variable.

5 Discussion

This paper examines the impacts of the city's ADU ordinance on ADU development. Overall, the ordinance positively influenced the likelihood of a property building an ADU. The number of the independent variables that present a correlation with the dependent variables at a statistically significant level reduced from 13 in the Before model to four in the After model. ADU development had a strong correlation with many features at property and neighborhood levels prior to the new ordinance. This indicates that ADU development before the new ADU ordinance in the city tended to occur in properties and neighborhoods that meet certain conditions. On the contrary, this correlation was weakened after the implementation of the ordinance. This probably suggests that ADU development is no longer limited to properties and neighborhoods with specific conditions. As the ordinance was supposed to facilitate and promote ADU development, the properties with an ADU are now dispersed into a wide range of homeowners and locations throughout the city of Los Angeles.

We also found that property characteristics are stronger predictors of ADU development compared to neighborhood-level characteristics. According to the Before model, ten out of 14 variables at level 2 (property level) present a statistically significant correlation with the dependent variables, while three out of eight variables at level 1 (neighborhood level) do. The number of the independent variables that show the correlation in the After model was reduced to three and one at levels 2 and 1, respectively. Therefore, it is reasonable to say that the features of the individual property are more influential on the likelihood of an ADU development on the property than the characteristics of the neighborhood where the property is located at. This pattern remains consistent before and after the implementation of the ordinance.

Table 3 The Outputs of the Multilevel Logistic Regression Models

Level	Category	Variable	Before Model Before the New Ordinance (n=21,116)			After Model After the New Ordinance (n=15,595)		
			Coef.	Sig.	Exp (Coef.)	Coef.	Sig.	Exp (Coef.)
		Intercept	26.9308	***0.000	5E+11	12.3929	0.051	2E+5
Level 1	Socio-demographic Characteristics	Pop_Den	-0.0114	***0.000	0.989	-0.0203	**0.003	0.980
		Med_Inc	-3.901E-06	***0.000	1.000	-2.54E-06	0.359	1.000
		Med_Rent	-3.068E-05	0.243	1.000	5.234E-06	0.948	1.000
		Med_Val	-2.867E-08	0.757	1.000	-2.21E-07	0.391	1.000
		Ethcty	0.1108	0.333	1.117	0.0683	0.838	1.071
	Housing and Land Use	Vac_Rate	-0.2956	0.425	0.744	-0.5342	0.637	0.586
		Rent_Per	0.1017	0.470	1.107	0.1659	0.686	1.180
		Land_Dvrs	-0.4288	***0.000	0.651	-0.5837	0.099	0.558
Level 2	Characteristics of Property	Area	-1.0109	***0.000	0.364	-0.8760	*0.046	0.416
		Yr_Bult	-0.0130	***0.000	0.987	-0.0059	0.076	0.994
		Bldg_Area	-0.0001	***0.000	1.000	3.494E-05	0.090	1.000
		Far	-3.8234	***0.000	0.022	-0.6324	0.076	0.531
		A_Val	4.613E-07	***0.000	1.000	3.146E-08	0.330	1.000
		Elev	0.0005	***0.000	1.000	0.0003	0.207	1.000
		Slope	-0.1100	***0.000	0.896	-0.1166	***0.000	0.890
	Transportation Accessibility	Hwy_Acc	-1.412E-05	0.407	1.000	4.204E-05	0.406	1.000
		Bus_Trnst	-0.0021	*0.039	0.998	0.0012	0.688	1.001
		Rail_Trnst (Reference=0)	-0.0873	0.272	0.916	-0.2535	0.288	0.776
	Accessibility to Amenities	Shop_Acc	-0.0003	***0.000	1.000	-0.0003	*0.013	1.000
		Park_Acc	-2.147E-05	0.581	1.000	0.0001	0.377	1.000
		Cbd_Acc	9.131E-06	**0.007	1.000	7.079E-06	0.478	1.000
		Sub_Cnt	2.667E-06	0.748	1.000	-1.83E-05	0.470	1.000
-2LL Change			3508.72			6368.44		

Note: *, **, *** Correlations are significant at the 0.05, 0.01, and 0.001 levels, respectively (2 tails)

The reference category is properties with no ADU development

-2LL Change = -2 log-likelihood change in relation to the null model

Particularly, the changes in the significance of variables under the Characteristics of Property category are significant. All seven variables present a statistically significant correlation with the dependent in the Before model, but only two variables, Area and Slope, remain significant in the After model. Speaking of property characteristics, they used to be the primary factors in ADU development before the ordinance. All the variables under the category present a correlation with the dependent variables at a statistically significant level before the new policy. The physical characteristics of a property such as the size of the main dwelling unit, property value, lot size, year built, and available lot area for an ADU unit are important factors for ADU development. They seem to be the factors that directly relate to the profitability of ADU. Generally, ADUs tended to be built on smaller, older, and less expensive properties before the ordinance. This perhaps suggests that property owners in lower-income neighborhoods were motivated to build ADU as a secondary income source.

This finding aligns with the previous study reporting that ADUs have more likely been built in areas with high overcrowding, smaller lots, and more recently purchased homes. (Chapple et al., 2020b). However, the finding contrasts with a pre-conceived notion that anticipates households with ADUs to be white, older, middle-class homeowners with a good knowledge of the regulatory tools available to them. This preconceived notion has even shaped the local conversation about the pros and cons of ADU development (Maaoui, 2018). The notion becomes a barrier for property owners interested in ADU development, especially for low-income, underrepresented property owners. As the After model suggests, the property characteristics also become a less dominant factor in ADU development. Thus, it will be important for local governments to prevent public opinion about ADU development from being swayed by this unjustified notion.

Considering the study area which is well-known for flourished automobile dependency and car culture, highway accessibility in the Transportation Accessibility category was expected to be a significant factor in the likelihood of ADU development, but highway accessibility does not present a correlation with the likelihood in both the Before and After models. The bus transit accessibility variable (Bus_Trnst) is the only variable correlated with the likelihood of ADU development in the category. Interestingly, ADU development was more likely to occur in the areas with fewer bus stops before the ordinance. This probably implies that the ADUs tended to be constructed in predominantly single-family zoned and low-density areas with limited access to bus transit. However, the correlation between bus transit accessibility and the likelihood of ADU development is not found after the implementation of the ordinance.

Off-street parking requirements are considered one of the most restrictive regulations that prevent property owners from building an ADU (Brinig and Garnett, 2013). The ordinance waives the parking requirements from the properties within 0.5 miles of a transit stop including a bus stop. The parking requirement exemption seems to contribute to attracting ADU developments in the areas with high accessibility to bus stops. Although the direction of the correlation did not change from negative to positive, the disappearance of the negative correlation can be counted as a substantial change considering the short period being observed since the adoption. Thus, it would be important to take into account of ADUs in bus route planning. The provision of bus transit plays a role in lessening barriers not only for property owners looking for building an ADU but also for renters without personal vehicles (Kim et al., 2018).

In the same vein, the likelihood of ADU development negatively correlated with population density and land-use diversity indicates that ADUs are more likely to be built within single-family residential areas before the ordinance. The positive correlation between distance to CBD and the likelihood of ADU development of the Before model also implies that ADU development is more likely to occur in the periphery of the city rather than the urban core areas before the ordinance. Ironically, the urban core areas are the places that could most benefit from affordable housing and housing that accommodates extended families (Kim et al., 2016; Pfeiffer, 2019). Additionally, ADUs in areas with dense, diverse land uses could be preferred by renters who look for affordable housing and do not own personal vehicles (Kim et al., 2022). In this respect, it is plausible to say that the ordinance equipoises the negative correlations by playing a positive role in bringing ADUs to the areas with high demands for affordable housing since the negative correlations are not significant according to the outputs of the After model. One of contributing factors to this change is probably the new ordinance that allows the construction of ADUs in multifamily residential and mixed-use areas.

6 Conclusion

This paper presents a systemic approach that explores how the intervention of a city's ADU ordinance influences the relationship between ADU development and the characteristics of properties and neighborhoods. Despite its findings, we acknowledge the limitation of socio-demographic variables employed in this paper. In addition to the socio-demographic features of neighborhoods, it is reasonable to assume that property owners' socio-demographic backgrounds are influential factors in ADU development on a property. They may include their ethnicity, age, income, and employment status. While this paper employs a couple of proxy variables for that, such as the value of the property and the size of the parcel, it looks like they do not fully reflect property owners' characteristics. Thus, future studies need to investigate the influence of property owners' socio-demographics on ADU development.

Nonetheless, this paper sheds light on the impacts of policy intervention on ADU development. The ADU ordinance of the City of Los Angeles contributes to promoting ADU development. The multilevel logistic regression models suggest that the ordinance contributes to diversifying the types of properties and the locations of the neighborhoods in which ADUs are developed. Especially, the characteristics of the properties associated with ADU development before the implementation of the ordinance diminished after the implementation.

In general, this paper confirms that local governments' ADU ordinances can contribute to expanding the accessibility to ADU in broad geographical contexts. Therefore, ADUs could help increase housing stock and offer a wider range of housing options within communities. However, since there are regional variations in terms of how ADUs have been built as previous research pointed out (Chapple et al., 2020a), it may not be appropriate to generalize all the findings of this paper to other larger areas. Since the period that the After Model covers is short, the findings of this paper can be also adjusted as the dynamics between local policies and ADU development evolves in the future. Thus, future studies need to keep investigating the roles of local policies in ADU development in other geographical contexts. Many planning professionals and scholars expect that ADU can be a viable alternative to the affordable housing crisis in California, but the roles of local governments' ADU ordinances in promoting ADU as an affordable housing option also remain unclear and needs to be further studied.

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