Investigating ADUs: Determinants of Location and Effects on Property Values

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Abstract

Cities across the United States are facing a housing shortage. Accessory dwelling units (ADUs) offer a unique development strategy to fill low-density residential zones. However, remarkably little is known about the topic. This paper examines ADUs in Los Angeles to discover what housing and location factors contribute to homeowners' decision to construct an ADU. The analysis finds that larger homes on lots with higher land value – though not necessarily larger lots – tend to encourage more ADU construction. The paper then investigates the effect of an ADU on property value. An instrumental variable approach is used by exploiting a Califorinia law that removed several barriers to ADU permits. Results suggest that addition of an ADU increases the property value of a parcel between 40 and 60 percent.

*I am grateful to Jan Brueckner for his guidance throughout the project. I am solely responsible for any errors or omissions.

1 Introduction

California has been experiencing a housing shortage for several decades. The median cost of a home in California is currently over $575,000 – more than twice the national average.[1] Homelessness is also disproportionately high. California contributes only 12% of the national population but almost one fourth of its homeless population. Attempts to mitigate the housing shortage and its ill effects, such as large-scale construction projects and rent controls, have either faced too much opposition, only provided temporary relief, or in the case of rent control, made the problem worse.

Recently, another strategy has entered the spotlight as a potential relief to these housing shortages: accessory dwelling units (ADUs). ADUs are small housing structures constructed by homeowners on the same lot as a larger primary dwelling. Historically, they have been known as "granny flats" or "in-law suites" since many have been built to house aging family members. However, as the national demographics change, so do housing demands.[2] These units now present a unique opportunity to create an additional supply of housing since, by their nature, they overcome two considerable difficulties in the creation of affordable housing: limited room for expansion and high costs to reorganizing existing infrastructure. In the US, single-family homes make up 62% of the housing stock.[3] If enough homeowners are incentivised to construct an ADU, then there could be a meaningful increase in the housing supply without additional sprawl, and at no great cost to local governments. In 2016, two bills were signed into law in California that made construction of ADUs notably

[1]According to Zillow, the median home value in the US is $248,857. The median home value in California is $578,267.

[2]See Myers and Pitkin (2009) for a an overview of demographic shifts since the 1950s and the effects on housing demands.

[3]For more information on single-family rentals, see Terner Center (2018).

easier, and in 2017 there was a sudden surge of ADU building permits. Los Angeles County saw almost twenty times the number of permits in 2017 than it did in 2016.

Studies have evaluated the use and benefits of ADUs for the elderly.[4] However, despite their growing popularity, ADUs still remain under-researched in the economics literature.[5] Krass (2013) investigated neighborhood factors that contributed to ADU density in Washington, finding that the main factor is the percentage of families with a relative other than minors or a spouse living in a household. Results also indicated no relationship between ADU density and residential lot size or residential unit density. Brueckner, Rabe, and Selod (2018) explored a more informal version of ADUs in South Africa called backyarding, where homeowners rent portions of their backyard to individuals who then construct a dwelling or shack. They find that homeowners in locations with better job access have a greater extent of backyarding on their lot.

If the US plans to invest in ADUs to ease the severity of the housing shortage, then more research is required to understand the demographic groups to which ADUs appeal as well as to assess the positive and negative consequences of widespread adoption. This paper begins by investigating housing characteristics and location factors that contribute to ADU development. With this information, planners might eventually be able to identify and target neighborhoods in which ADU development could be successfully encouraged. Using both a linear probability model and a logit model, the probability of a resident constructing an ADU is related to the neighborhood demographics, main house characteristics and proximity to local amenities. The results confirm Krass (2018) and Brueckner, Rabe, and

[4] Chapman and Howe (2001) investigate the use of ADUs as a place for the elderly to age in place. Liebig, Koenig, and Pynoos (2006) provide an overview of ADU regulation and their use for multigenerational housing.

[5] Wegmann and Nemirow (2011) provides a literature review of secondary units and urban infill.

Selod (2018) results and additionally suggest that ADUs are more likely to be constructed in homes with larger square footage, though not necessarily a large lot size, located near public transportation.

Another question of interest is how addition of an ADU will affect property values. The construction costs of ADUs can be quite large, but familiarity with the financial benefits of ADU development could encourage homeowners to make the initial investment. However, the value-enhancement question is difficult to answer because several factors that contribute to property value will also influence whether or not a homeowner chooses to build an ADU. Exploiting a change in California law regarding ADU construction, and the sudden surge of ADU permits that followed, this study uses an instrumental variable approach and finds that the addition of an ADU increases the value of a property by about 50% on average.

Section 2 of this paper gives a brief introduction to ADUs, and Section 3 describes the data used in the analysis. Section 4 discusses the factors contributing to the location of ADU development, while Section 5 looks at the effect of ADUs on property values. Section 6 concludes.

2 Background

An accessory dwelling unit, or ADU, is a small secondary housing structure located on the building lot of a larger primary dwelling. Although they can be known by other names such as granny flat, carriage house, backyard cottage, among others, ADUs are distinguished from other types of accessory units in that they must have a separate kitchen, living space, and entrance from the main house. The diagram below depicts examples of different ADUs.[6] They can be detached structures, such as backyard cottages, depicted by building (C) in Figure 1, or part of the primary dwelling can be converted into an attached ADU, depicted in buildings (A) and (B) as in a basement, attic, or add-on apartment.

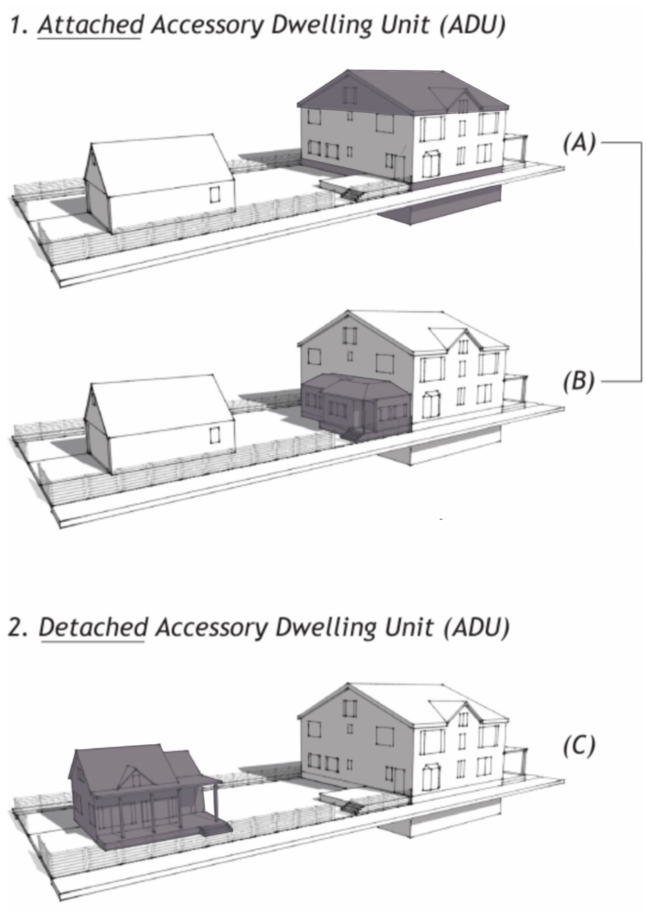

Figure 1

Historically, ADUs were common in the early 1900's, but fell out of favor after World War II when the popularity of suburbs began to rise. The demand for low-density housing prompted local governments to regulate or prohibit the construction of ADUs.[7] In the

[6]Diagram from Boulder Housing Programs and Initiatives (bouldercolorado.gov/housing/adu).

[7]For more information on the history of ADUs, see US Department of Housing and Urban Development

decades to come, a combination of environmental concerns and community-level involvement in land-use decisions began to change the expansion of housing within cities. Environmental regulations prevented cities from sprawling, on the belief that additional transportation usage has negative effects on the environment. Additionally, any new construction projects were required to be in accordance with the California Environmental Quality Act by providing a full report outlining a variety of environmental impacts that the project would impose. In contrast, home-owners prevented plans that increased urban density with protests and political pressures. In fact, a 1950s provision in the state constitution requires community approval before any low-income housing projects can be developed.

Objections to development projects coming from both sides delayed and blocked housing projects to the point that California found itself in an affordable housing crisis. California's population grew, but housing development slowed, creating a shortage. Building significantly fewer houses than was necessary to match its population growth pushed prices to exorbitant levels, and many homeowners began building ADUs illegally to supplement their income. Mixed reactions to ADUs resulted in tenuous responses from policy-makers. However, the increasing severity of housing shortages eventually spurred some organizations and researchers to advocate for their development, and encouraged some jurisdictions to embrace the structures as a convenient means to increase the housing stock.[8] California took a step in favor ADUs by mandating that every local jurisdiction adopt provisions to permit the units.[9] However, the local provisions often included extremely burdensome permit processes, and

(2008).

[8] Gellen (1985) estimated the total amount if excess space in American homes and advocated for the conversion of this space into ADUs.

[9] See Brinig and Garnett (2013) for a legal analysis of ADU regulations.

California did not see a meaningful response.[10]

In September 2016 two California bills were signed into law making ADU development much easier for California residents.[11] Going into effect on January 1^{st}, 2017, the wide-ranging changes removed significant barriers that kept homeowners from investing in ADUs, such as difficulty in obtaining building permits and off-street parking requirements. Under this new law, building permits must be approved or denied within 120 days and are considered non-discretionary permits, meaning that they are automatically granted after meeting objective requirements rather than requiring committee review and approval. The law also eliminates off-street parking requirements for homes within half a mile of public transit, homes in historical districts, or for ADUs attached to an existing unit.

The response to the reform was dramatic. In 2016, 117 permits were issued for ADU development in Los Angeles County. In 2017, that number was 2,316 – more than ten times the previous year's amount. Figure 2 below depicts the yearly permits issued in LA county from 2013 to 2019.

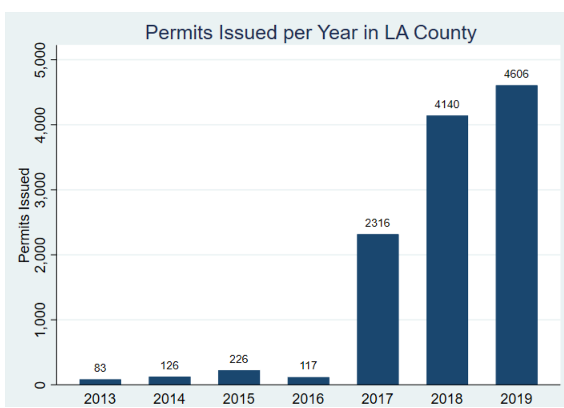

Figure 2

[10]Ramsey-Musolf (2018) investigates outcomes of legislation allowing ADUs to be considered low-income housing. Additionally, attempts to expand the use of ADUs through legislation in Florida faced a similarly disappointing outcome. See (Gottlieb 2017) for an overview of the legislation and outcomes.

[11]Summaries of the two bills, SB No. 1069 and AB No. 2299, are provided in the Appendix.

The first year after ADU permits became accessible, more ADU permits were issued than had been in the previous four years combined.

3 Data

3.1 Parcel Data

An observation in this study is a tax parcel in a residential zone in Los Angeles City. Parcel data from 2013 to 2019 are gathered from the Los Angeles Open Data Catalog. Each of the observations includes housing and lot characteristics as determined by the Los Angeles County Office of the Assessor including house and lot square footage, the year of construction of the main house, the number of bedrooms and bathrooms, land value, and total property value. Table A1 in the Appendix reports the descriptive statistics for home and lot characteristics.

The median property values over time are plotted for the 2013 to 2019 sample period in Figures 3 and 4. The left pane shows the growth of the median property value of all residential parcels in Los Angeles, while the right pane depicts the growth of the median property value of all parcels that construct an ADU within the sample period. The city-wide median value grows in a fairly linear fashion while the median value of parcels that eventually construct ADUs grows at a faster rate, accelerating in 2017 after California passes its ADU laws, and eventually surpasses the city-wide median.

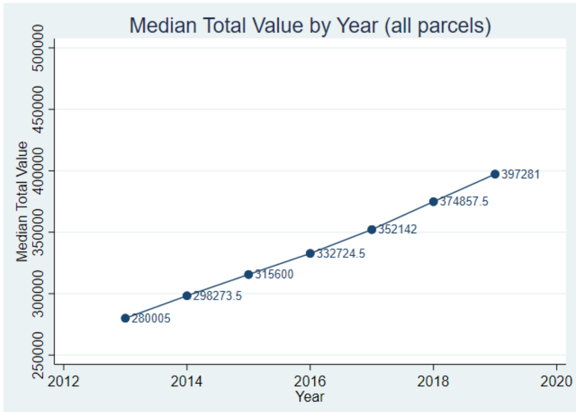

Figure 3

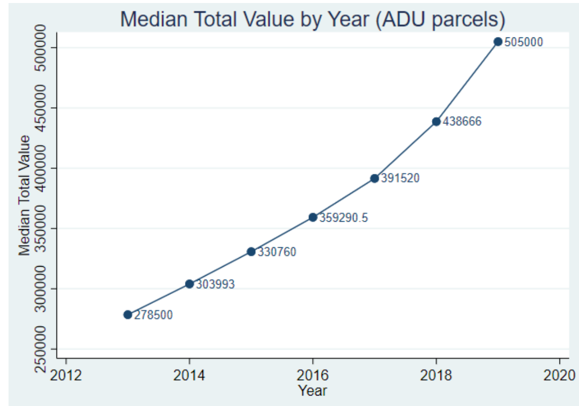

Figure 4

3.2 Building Permit Data

Permit data are collected from Los Angeles City Planning. The dataset is comprised of 10,030 building permit records for ADU construction including the permit number, issue date, homeowner address, and project description. In order to link the permit record with the tax parcels, the assessor id number for each permit is scraped from the Los Angeles Department of Building and Safety. To see where in Los Angles ADUs are constructed, each address from the building permit records is plotted on a map using GIS software. The map in Figure 5, presented in the Results section, shows this distribution of ADUs across Los Angeles.

3.3 Census Data

Census tract demographics are also included in this study. Data on population density, racial mix, and household makeup are collected from the census. The specific variables and the summary statistics are listed in table A2. The data are converted into GIS (geographic information system) format by the GIS software company ESRI. GIS software then assigns the respective census tract demographics to all parcels located within the boundary of a given tract.

3.4 GIS Data

Another factor of interest is the proximity of parcels to local amenities such as beaches and schools. The locations of universities, public transportation stops, and beaches located in Los Angeles are also supplied by ESRI. Figures A1 and A2 in the appendix show the locations of public transportation stops and colleges or universities in Los Angeles. GIS software then calculates the distance in miles between each tax parcel and the nearest of each of the above amenities as well as the distance to the CBD, LAX, and the nearest commercial zone. Summary statistics of these distances are provided in Table A3 in the appendix.

3.5 Combining Datasets

The original assessor data contained $5,411,135$ observations across the seven-year period. The sample is then limited to only residential zones. Outliers are eliminated by trimming the top and bottom 1 % of observed square footage and total values, and then observations with missing data are dropped. The final dataset has 4,787,450 observations and just under 700,000 parcels each year.

4 Locations of ADUs

The first question addressed in this paper concerns which factors are associated with a homeowner's decision to construct an ADU.

4.1 Estimating Equations

Figure 5 shows the density of parcels that acquired a building permit for an ADU between 2013 and 2019 in the city of Los Angeles. The following analysis identifies which housing and location characteristics likely influenced homeowners to develop these ADUs.

Density of ADUs in Los Angeles City

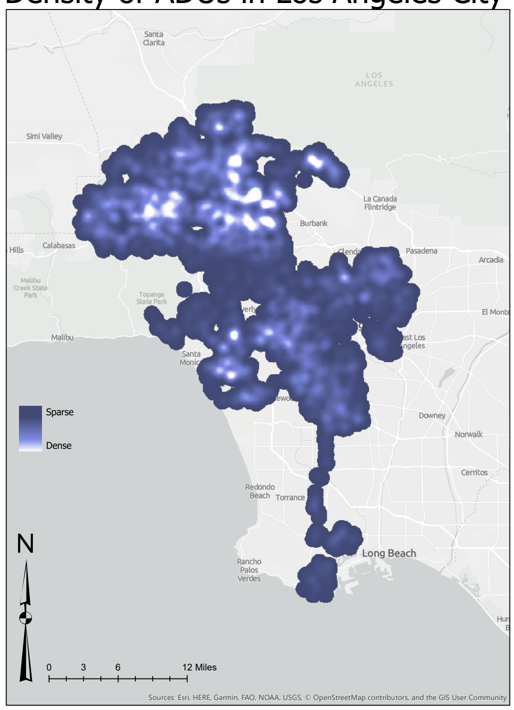

Figure 5

The outcome of interest is an indicator variable, $hasADU$, which is equal to 1 when a parcel has been issued an ADU permit, and is equal to 0 otherwise. Since the dependent variable measures the number of issued permits for ADUs and not construction of ADUs, the variable is likely to be an overestimate of the true adoption rate. Nevertheless, conversion rates in Portland stand at about 85%, suggesting that, with some degree of error, the $hasADU$ variable is a reasonable proxy for constructed ADUs. Due to the binary nature of this variable, a discrete choice model is used for each estimation. The first specification uses a logit regression to measure the relationship between probability of ADU construction and various characteristics of parcel i at time t. The estimation equation is

$$hasADU_{it} = F(\beta_0 + \beta_1 X_{it} + \beta_2 C_{it} + \beta_3 W_{it}) + \epsilon_{it}, \tag{1}$$

where F is a logistic cdf, X is a vector of main house characteristics, including square footage and number of bedrooms, C is a vector of census tract attributes such as median household income and racial mix, and W is a vector of distances to local amenities like universities and the Los Angeles CBD. The signs and levels of significance of all resulting coefficients are of interest to determine which factors are positively and negatively associated with ADU construction.

The purpose of this exercise is to see which factors have significant effects in the positive or negative direction; the magnitude of these effects is of secondary importance. To that end, the linear probability coefficients are also included to permit the comparison of relative magnitudes. The coefficients of the estimators are likely to be small in magnitude since, of the 680,526 parcels in the dataset, 9,725 have ADUs, meaning that only about 1.5% of parcels constructed ADUs in the 7 years that are observed. The second estimating equation is

$$hasADU_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 C_{it} + \beta_3 W_{it} + \gamma_i + \epsilon_{it}, \tag{2}$$

where X, C, and W are defined as in equation (1) and γ are census block fixed effects. Standard errors in both equations (1) and (2) are clustered at the census block level, since errors may be correlated within neighborhoods. Table 1 below displays the results from equations (1) and (2).

4.2 Results

Table 1 Factors Associated with ADU Construction Results

	LOGIT		LPM	
Dependent Variable: hasADU	(1)	(2)	(3)	(4)
House and Lot Characteristics				
Main House sqft (hundreds)	0.0004***	0.0003***	0.0000***	0.0000***
	(0.000)	(0.000)	(0.000)	(0.000)
Main House Bedrooms	0.0671***	0.0586***	0.0001***	0.0001***
	(0.011)	(0.012)	(0.000)	(0.000)
Main House Bathrooms	-0.0359*	-0.0362*	-0.0001***	-0.0001***
	(0.019)	(0.019)	(0.000)	(0.000)
Land Value		0.0004***		0.0000***
		(0.000)		(0.000)
Total Value	0.0003***		0.0000***	
	(0.000)		(0.000)	
Lot Area (thousands)	-0.0000***	-0.0000***	-0.0000**	-0.0000**
	(0.000)	(0.000)	(0.000)	(0.000)
Year Built	-0.0004***	-0.0003***	-0.0000***	-0.0000***
	(0.000)	(0.000)	(0.000)	(0.000)
Proximity to Local Amenities				
Miles to LAX	0.0177*	0.0172*	0.0002	0.0002*
	(0.010)	(0.010)	(0.001)	(0.001)
Miles to Universities	-0.0664*	-0.0669*	-0.0001*	-0.0001*
	(0.037)	(0.037)	(0.000)	(0.000)
Miles to CBD	0.0407***	0.0408***	0.0002***	0.0002***
	(0.007)	(0.007)	(0.000)	(0.000)
Miles to Commercial Zone	-0.5354***	-0.5302***	-0.0012***	-0.0012***
	(0.120)	(0.121)	(0.000)	(0.000)
Miles to Public Transportation	-0.0449***	-0.0439***	-0.0002***	-0.0002***
	(0.014)	(0.014)	(0.000)	(0.000)
< 2 miles to Beach	-0.5937***	-0.5981***	-0.0018***	-0.0018***
	(0.198)	(0.198)	(0.000)	(0.000)
Census Demographics				
Percent White	0.0285**	0.0285**	0.0001***	0.0001***
	(0.012)	(0.012)	(0.000)	(0.000)
Percent Black	0.0060	0.0059	0.0000	0.0000
	(0.004)	(0.004)	(0.000)	(0.000)
Percent Latino	0.0167***	0.0169***	0.0001***	0.0001***
	(0.004)	(0.004)	(0.000)	(0.000)
Percent Under 19	-0.0109*	-0.0110*	-0.0001***	-0.0001***
	(0.006)	(0.006)	(0.000)	(0.000)
Population Density (Pop per square mile)	-0.0000***	-0.0000***	-0.0000***	-0.0000***
	(0.000)	(0.000)	(0.000)	(0.000)
Parent Living in Household	0.0033**	0.0033**	-0.0000	-0.0000
	(0.002)	(0.002)	(0.000)	(0.000)
Median Household Income	-0.0000***	-0.0000***	-0.0000***	-0.0000***
	(0.000)	(0.000)	(0.000)	(0.000)
Time Trend	Y	Y	Y	Y
Neighborhood Fixed Effects	Y	Y	Y	Y
R^2			0.006	0.006
Observations	4,787,450	4,787,450	4,787,450	4,787,450

Note: Standard errors are clustered by neighborhood (census tract).
* indicates significance at 10% level
** indicates significance at 5% level
*** indicates significance at 1% level

The housing and lot characteristics of interest are square footage of both the house and lot, the number of bedrooms and bathrooms, the construction year of the main house, and the total property value. In addition, the relationship between land value and ADU construction is also of interest, but because land value and total value have a such a high correlation coefficient (greater than 0.9), they are not included in the same regression. Columns (1) and (3) show the results of estimates including $TotalValue$ and column (2) and (4) are results when using $LandValue$. Estimates remain very similar between the two.

$SquareFeet$, $Bedrooms$, $LandValue$ and $TotalValue$ all have positive and strongly significant coefficients in all four columns. Thus, ADUs are more commonly found in homes with larger square footage, more bedrooms, and with higher land and property values. These results are all intuitive. A larger square footage could mean that the family has more ability to comfortably convert part of their home, such as an attic or basement, into an attached ADU. At a higher land value and total value, there is a greater opportunity cost to using the yard or home for their own consumption rather than building an ADU and renting it out. The $Bathrooms$ coefficient is negative and significant for all four estimate. Finally, $YearBuilt$ and $LotArea$ both have negative and significant coefficients in all columns. A negative coefficient on $YearBuilt$ implies that ADUs are constructed less often in newer, more modern houses. The negative coefficient on $LotArea$ seems counterintuitive; it would make sense to have ADUs in parcels with a larger area to house them. However, the coefficient on $LotSize$ is the smallest in magnitude of all variables. Increasing the lot size by 1000 square feet will decrease the probability of constructing an ADU by less than $1/1000^{th}$ of a percent. So though it is a statitically significant estimate, it is not an economically significant magnitude. Similarly, Krass(2018) results suggested that $LotArea$ had no significant relationship with ADU density.

Proximity to local amenities may also influence a homeowner's decision to construct an ADU. The distance variables capture the distance between the center of each parcel and LAX, LA's CBD, the nearest commercial zone, the nearest stop for public transportation, and the nearest college or university. Additionally, there is a binary variable, *Beach* that indicates whether the parcel is within two miles of a beach. The coefficient on $MilestoCBD$ is positive and significant in all cases, and the coefficient on $MilestoLAX$ is positive and significant in all but column (3). These results suggest that the greater distance between a parcel and LAX or the CBD, the more ADUs are found. Thus, proximity to LAX or the CBD does not encourage ADU development. Conversely, the coefficients on $MilestoUniversities$, $MilestoCommercialZones$, and $MilestoPublicTransportation$ are significant and negative. The negative coefficient implies that proximity to universities, commercial zones, and public transportation encourage ADU construction. These coefficients suggest that there could exist a market for university students or professionals working in commercial zones who are interested in renting smaller housing and who would take public transportation to school or work. The coefficient on the *Beach* variable is significant and negative, indicating that ADUs tend to exist farther from the beach rather than near it. The map in Figure 5 supports this result; the vast majority of ADUs are further inland and the density of ADUs is very sparse near the beaches.

The census variables, collected at the tract level, are population density per square mile, frequency of households that have parents of the homeowners residing with the family, percentage of population under 19 years of age, median household income, and the racial mix variables $PercentWhite$, $PercentBlack$, and $PercentLatino$. $PopulationDensity$ has a significant negative coefficient across all estimations, implying that areas with less density will see more ADUs compared to more populated areas. The coefficient on $ParentLivingInHousehold$ is strongly significantly positive in both logit model estimates, confirming results from Krass (2018) that say homeowners are more likely to construct an ADU if the homeowner's parent is living in the same household. In contrast, neighborhoods with more children are less likely to see ADUs, as suggested by the significantly negative coefficient on $PercentUnder19$. $MedianHouseholdIncome$ is also strongly negative across all four equations implying that ADUs will be less likely to be built in the wealthier neighborhoods of Los Angeles. Finally, the coefficients on $PercentWhite$ and $PercentLatino$ are both positive and significant, while the coefficient on $PercentBlack$ is positive but insignificant. Thus, ADUs are more common in census tracts with a higher white or latino population than tracts with a higher black population.

5 Property Value Results

The second aim of this paper is to estimate the average effect that the addition of an ADU has on property value. In the seven-year sample used in this analysis, parcels that constructed an ADU had a large increase in their property values – much larger than their non-ADU counterparts. Table 2 compares the property values of parcels with ADUs to all LA parcels in the beginning and at the end of the sample. The left column contains the median property values of all parcels in the dataset, and the right hand column displays the median property values for only parcels that got ADUs throughout the sample period. The first row compares those two values in 2013, before most parcels got their ADUs, and the second row compares the two values in 2019 after ADU permits had been issued. In 2013, the median value of parcels that get ADUs was $278,500 – about equal to the median value of all LA parcels. However, by 2019, after most ADUs had been constructed, the parcels that got ADUs had a median property value more than $100,000 greater than the median value of general LA parcels. By this measure, constructing an ADU clearly has a dramatic effect on property value, but simply comparing medians could be misleading; a more rigorous estimation is required for identification.

Table 2 Property Value Growth of Tax Parcels

	All LA Parcels	ADU Parcels
2013	280,005	278,500
2019	397,281	505,000

5.1 *Identification Strategy*

The sample is a longitudinal dataset comprised of yearly tax parcel observations from 2013 to 2019. The variable of interest is the log of property value for parcel i in year t. The baseline equation is

$$log(totalValue_{it}) = \beta_0 + \beta_1 hasADU_{it} + \beta_2 X_{it} +_3 C_{it} + \beta_4 W_{it} + \gamma_i + \epsilon_{it}, \tag{3}$$

where $hasADU$, X, C, and W are defined the same as in the previous equations, and γ denotes census block fixed effects. However, there is reason to suspect that estimates of β_1 in equation (3) will be biased, since several factors that determine property value likely also influence a homeowner's decision to construct an ADU.

The possible omitted variable bias present in the first specification can be solved using an instrumental variable approach by exploiting the change in California law between 2016 and 2017. There is good reason to believe this instrument is valid since factors affecting property values may have inspired the law change, but the implementation of the law does not directly affect those values. Conversely, the change in the law directly affected the probability of constructing an ADU. Between 2016 and 2017, the number of ADU permits issued increased beyond ten-fold and continued to grow in 2018 and 2019. The instrumental variable $afterLaw$ is a binary variable indicating whether or not the laws easing ADU construction had passed. For observations between 2013 and 2016, $afterLaw$ is equal to 0; from 2017 to 2019, $afterLaw$ is equal to 1.

The preferred method for this analysis is a two stage least squares estimation. The first stage estimates the probability of an ADU construction for a given parcel using a linear probability model almost identical to equation 2 in the ADU location analysis. The first stage equation is

$$hasADU_{it} = \pi_0 + \pi_1 afterLaw_i + \pi_2 X_{it} + \pi_3 C_{it} + \pi_4 W_{it} + \gamma_i + \nu_i, \tag{4}$$

where X, C, and W, have all been defined previously. The second stage is then similar to equation (3), replacing $hasADU$ with the fitted values $\widehat{hasADU}$ from the first stage. The estimation equation is thus

$$log(totalValue_{it}) = \delta_0 + \delta_1 \widehat{hasADU}_{it} + \delta_2 X_{it} + \delta_3 C_{it} + \delta_4 W_{it} + \gamma_i + \nu_{it}, \tag{5}$$

Standard errors are again clustered by census block. The results of estimating equations

(4) and (5) are displayed in Table 3. Column 1 shows the OLS results from equation (3), and column 2 displays the IV results from equation (5).

5.2 Results

Table 3 Property Value Estimation

Dependent Variable: log(total value)	OLS	IV
has ADU	0.3715***	0.4606*
	(0.007)	(0.271)
House and Lot Characteristics		
Main House Bathrooms	0.0396***	0.0396***
	(0.005)	(0.005)
Main House Bedrooms	-0.0306***	-0.0306***
	(0.002)	(0.002)
Main House sqft (hundreds)	0.0002***	0.0002***
	(0.000)	(0.000)
Lot Area (thousands)	-0.0000	-0.0000
	(0.000)	(0.000)
Year Built	0.0002***	0.0002***
	(0.000)	(0.000)
Proximity to local amenities		
Miles to LAX	-0.0208***	-0.0207***
	(0.003)	(0.003)
Miles to Universities	-0.0400***	-0.0400 ***
	(0.012)	(0.012)
Miles to CBD	-0.0045**	-0.0045**
	(0.002)	(0.002)
Miles to Public Transportation	0.0208***	0.0208***
	(0.004)	(0.004)
< 2 miles to Beach	0.0411	0.0411
	(0.042)	(0.042)
Census Demographics		
Percent Black	-0.0094***	-0.0094***
	(0.001)	(0.001)
Percent Latino	-0.0043***	-0.0043***
	(0.001)	(0.001)
Percent White	0.0037***	0.0037***
	(0.001)	(0.001)
Population Density (pop per square mile)	-0.0000***	-0.0000***
	(0.000)	(0.000)
Neighborhood Fixed Effects	Y	Y
Time Trend	Y	Y
R^2	0.372	0.372
Observations	4,787,450	4,787,450

First Stage Results

Dependent Variable: hasADU	
afterLaw	0.0038***
	(0.0002)
R^2	0.006
F Statistic	489.27***

Note: Standard errors are clustered by neighborhood (census tract).
* indicates significance at 10% level
** indicates significance at 5% level
*** indicates significance at 1% level

The first stage results for the instrument are reported at the bottom of Table 3. Other variables included in the first stage and their coefficients are similar to those in Table (1), and are not included in this table. The first stage F statistic is 489.27 and the instrument $afterLaw$ is significant at the 1% level, indicating that $afterLaw$ is a strong instrument.

The variable of interest in the second stage is $hasADU$, located in the first row of Table 3. The OLS regression yields the coefficient 0.3715. This magnitude suggests that the addition of an ADU to a parcel increases the property value by about 37%. The IV coefficient in column two is 0.4606, suggesting that the OLS is underestimating the effect and an ADU will increase the property value of a parcel by about 46% on average. The coefficient is only significant at the 10% level, an outcome that may be due to the poor fit of the first-stage equation, which has an R^2 of only 0.006 despite the strength of the instrument. In other words, with the fitted hasADU values diverging more from the actual 0-1 values than would be true in a better fitting first stage, precisely gauging the impact of hasADU on property values is more difficult. Nevertheless, the order of magnitude of the second-stage coefficient is similar that of the OLS estimate, which suggests that some credence can be placed in the measured property-value effect.

Normally the coefficient on an indicator variable with a log-transformed dependent variable is interpreted as an approximation, where 100 times the coefficient is roughly equal to the percent change in the dependent variable as a result of a change in the indicator variable from 0 to 1. In this case, however, the coefficient is quite large, which makes the approximation less reliable. Thus, it is beneficial to find a more exact estimate than the approximation given by the coefficient β. Using the more precise estimate, calculated by $e^{(\beta)} - 1$, the OLS equation in column (1) estimates a 45% increase in property values as a result of ADU construction.[12] The IV estimate suggests that the increase is closer to 58%.

The property-value impact from the presence of an ADU is thus around 50%, which may seem to be an implausibly large value. It is possible that home buyers may be overestimating the gain from the rental income generated by an ADU in bidding for houses, but data on ADU rents would be needed to investigate this possibility. Regardless, this ADU premium is one implied by the data, even after treatment of the potential endogeneity problem, and it must be viewed as accurate, at least for Los Angeles housing market.

In addition, the IV estimate is unusually larger than the OLS estimate. One possible explanation for this outcome is that an omitted variable could be negatively correlated with the property value while being positively correlated with hasADU, or vice versa. For example, if an individual is quite frugal and interested in passive income streams, he or she is much more likely to be interested in constructing an ADU, but is also less likely to own an expensive home. This trait would not be captured by any variables currently in the regression.

The $SquareFoot$, $Bathroom$, and $YearBuilt$ variables all have positive coefficients. Thus, additional bathrooms, square footage, and more recent constructions are all expected to increase property values. *Bedrooms* and *LotArea* have negative coefficients, though the coefficient on *LotArea* is insignificant. The negative coefficient on *Bedrooms* suggests that, holding square footage constant, using the given space for additional bedrooms decreases the value of the house.

$MilestoLAX$, $MilestoCBD$, and $MilestoUniversities$ all have negative coefficients in both the OLS and IV estimates. Thus, proximity to these locations increases property value.

[12] A derivation of this equation can be found in the Appendix.

A positive coefficient on the $MilestoPublicTransportation$ variable implies that houses with lower property values tend to be located nearer to public transportation. The $Beach$ variable also has a positive coefficient. Thus, houses closer to the beach tend to have higher property values.

Lastly, the $PopulationDensity$ variable results in a negative and significant coefficient. The result suggests that, for a given square footage and lot size, a more crowded neighborhood decreases the property value. Both black and latino racial variables have negative coefficients, demonstrating that census tracts with a higher percentage of black and latino residents have lower property values. In contrast, the white racial variable is positive and significant, indicating that census tracts with a higher percentage of white residents have higher property values

6 Conclusion

This paper explores both determinants and the property-value effects of ADU construction.. The analysis uses data from Los Angeles to determine what factors are associated with the location of ADUs, and and to gauge the effect of their construction on property values. In the location analysis, the factors contributing to ADU construction fell under three main categories: house and lot characteristics, proximity to local amenities, and neighborhood demographics. The results show that ADUs are constructed in parcels with high land value and larger main houses that are near public transportation, universities, and commercial zones. Additionally, ADUs are more likely to appear in neighborhoods with a lower population density and a greater percentage of white or latino residents.

The second analysis addresses the effect of ADU construction on property value, using value data from the Los Angeles Office of the Assessor. A potential for bias exists because several factors that determine property value are also likely to influence a homeowner's decision to construct an ADU. In order to resolve this estimation issue, an instrumental variables approach is employed. Changes to California law in 2017 made access to ADU permits much easier for homeowners, and the number of issued ADU permits increased by a factor of 20 between 2016 and 2017. Using the law change as an instrument, the analysis concludes that addition of an ADU will increase property values upwards of 58% in Los Angeles.

The purpose of this paper is to offer information to organizations hoping to encourage ADU construction by identifying neighborhoods in which ADU development could be successfully encouraged. Additionally, providing information of the financial benefits of ADU construction could encourage homeowners to make the initial investment. While ADUs present a promising opportunity to ease the housing shortages faced in cities across the country, much research is still required in order to implement appropriate policies. Homeowners are justifiably concerned that increased presence of ADUs in their neighborhood could have several negative effects including increased neighborhood density, introduction of unwanted demographics due to the much more affordable housing, a decrease of their own property value, or decreased availability of street parking. Additionally, local governments are interested in other effects of ADUs such as their potential to ease overcrowding and homelessness or their relatively positive effect the environment compared to other housing projects. As ADUs become more popular across the US, these questions will become easier to answer with the additional availability of data.

7 References

Brinig, M. F. and Garnett, N., (2013). 'A room of one's own: Accessory dwelling unit reforms and local parochialism.' Urban Lawyer, 45(3), 519-570.

Brueckner, J., Rabe, C., and Selod, H., 2019. 'Backyarding: Theory and evidence for South Africa'. Regional Science and Urban Economics, 79, p.103486.

Gellen, M., (1985). 'Accessory Aprartments in Single-Family Housing.' New Brunswick, New Jersey, USA: The Center for Urban Policy Research.

Gottlieb S.A., 2017. 'Florida's Accessory Dwelling Unit Laws: Mitigating Florida's Housing Woes through State-Encouraged Expansion of ADU Permitting,' Stetson Law Review 46, no. 3 (Spring 2017): 627-658

Krass, C., 2013. 'Factors Associated With Accessory Dwelling Unit Density. Master of Urban Planning'. University of Washington.

Liebig P., Koenig T., and Pynoos J. (2006). 'Zoning, Accessory Dwelling Units, and Family Caregiving,' Journal of Aging Social Policy, 18:3-4, 155-172,

Myers, D.and Pitkin, J., (2009). 'Demographic Forces and Turning Points in the American City 1950-2040'. The ANNALS of the American Academy of Political and Social Science, 626(1), 91–111.

Ramsey-Musolf, D. (2018). 'Accessory Dwelling Units as Low-Income Housing: California's Faustian Bargain.' Urban Sci., 2, 89.

Terner Center, 2018. 'The Rise Of Single-Family Renals After The Foreclosure Crisis'. Berkeley, California.

Wegmann, J. and Nemirow, A., (2011). 'Secondary units and urban infill: A literature review'. Working Paper, No. 2011-02, University of California, Institute of Urban and Regional Development (IURD), Berkeley, CA

8 Appendix

8.1 *Summary Statistics*

Table A1 House and Lot Summary Statistics

	Mean	Std. Dev.	Min	Max	N
SQFT	2,189.64	2,516.30	600.00	40,632.00	4,787,450
Bedrooms	3.67	3.92	0.00	99.00	4,787,450
Bathrooms	2.87	3.89	0.00	99.00	4,787,450
Year Built	1,945.42	130.62	0.00	2,019.00	4,787,450
Total Value (Thousands)	512.01	806.69	5.12	71,824.68	4,787,450
Land Value (Thousands)	306.77	543.17	0.004	64,430.97	4,787,450
has ADU	0.01	0.12	0.00	1.00	4,787,450

Table A2 Census Variables Summary Statistics

	Mean	Std. Dev.	Min	Max	N
Percent White	40.10	30.31	0.00	100.00	4,787,450
Percent Black	8.25	15.13	0.00	93.44	4,787,450
Percent Latino	39.16	28.80	0.00	100.00	4,787,450
Percent Under 19	22.63	7.20	0.00	61.00	4,787,450
2010 Population Density (Pop per Square Mile) (U.S. Census)	12,781.44	10,012.96	0.00	19,2290.50	4,787,450
2010 Population in Households (U.S. Census)	1691.22	809.15	0.00	6470.00	4,787,450
2010 Parent Living in Family Households (U.S. Census)	29.92	20.22	0.00	122.00	4,787,450
Median Household Income	71,689.46	37,285.02	0.00	250,000.00	4,787,450

All variables are per census tract.

Table A3 GIS Variables Summary Statistics

	Mean	Std. Dev.	Min	Max	N
Miles to LAX	14.15	6.26	0.92	26.77	4,787,450
Miles to University	1.35	0.88	0.01	5.51	4,787,450
Miles to CBD	11.18	6.72	0.00	24.86	4,787,450
Miles to Commercial Zone	0.21	0.26	0.00	2.46	4,787,450
Miles to Transit	2.55	2.06	0.01	10.39	4,787,450
Beach	0.08	0.28	0.00	1.00	4,787,450

Metro and Transit System Stops in Los Angeles Area

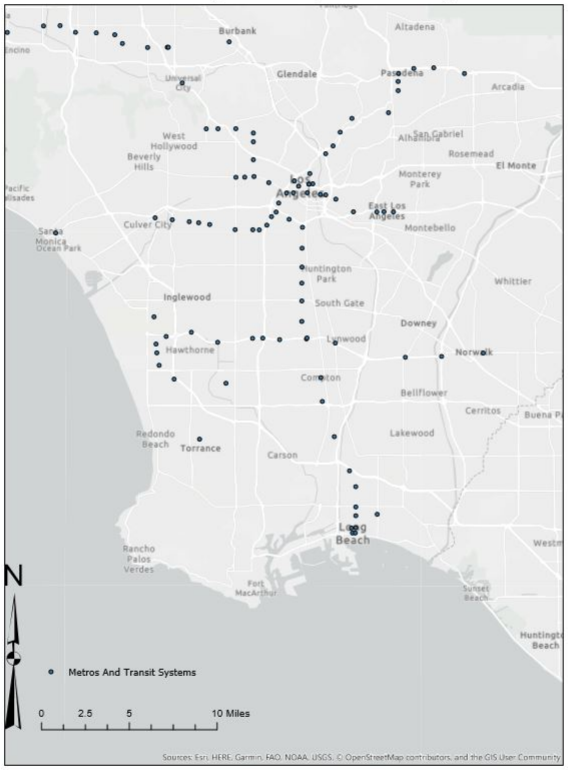

Figure A1

Colleges and Universities in Los Angeles Area

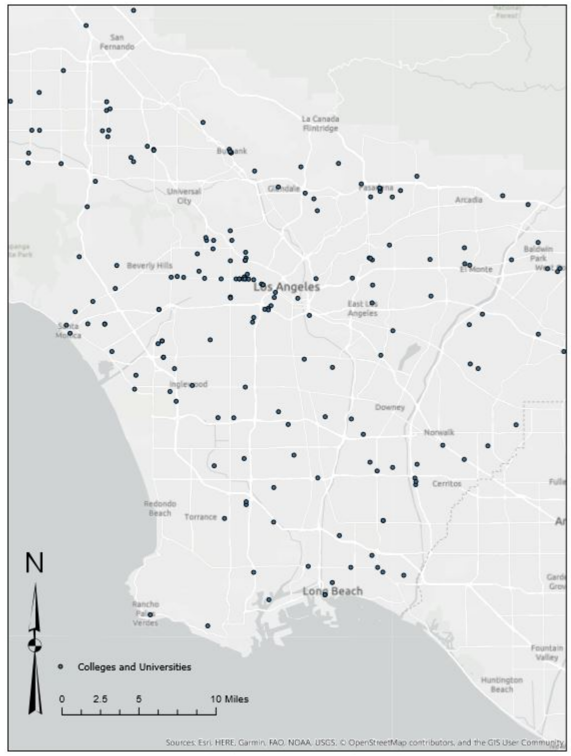

Figure A2

Summary of Senate Bill No. 1069 and Assembly Bill No. 2299

Senate Bill No. 1069 and Assembly Bill No. 2299 were both signed by Governor Jerry Brown on September 27th, 2016 to be implemented January 1st, 2017. The following amendments were detailed in these bills to relieve barriers to ADU construction.

- No local ordinance can be the basis for denial of an ADU building permit.
- ADU permits must be considered ministerial, nondiscretionary permits, and must be approved or denied within 120 days of application.
- No passageway may be required with new ADU construction.
- No setback may be required for a garage that is converted to an ADU.
- A setback of maximum five feet from side and rear lot lines may be required for an ADU constructed above a garage.
- A local agency may establish minimum and maximum unit size requirements for ADUs so long as it allows an efficiency unit to be constructed.
- ADUs may not be required to provide fire sprinklers if they are not required for the primary residence.
- A local agency may reduce or eliminate parking requirements for ADUs.
- Local law may not impose parking standards for ADUs that are
    1. located within one half-mile of public transit. located with in historic district.
    2. part of the existing primary residence or existing accessory structure
    3. When a car-share vehicle lot is located within one block of the ADU.
- ADUs shall not be considered new residential uses for the purposes of calculating local agency connection fees or charges for utilities.
- Detached ADUs have a cap of floorspace at 1,200 square feet. Attached ADUs that are an addition to the main house have a cap of floorspace at 1,200 or 50% of main house square footage, whichever is less. ADUs built entirely inside the main house has no size limit.

Derivation of Exact Coefficient Interpretation

For a logged dependent variable and a binary independent variable, the percentage difference between the predicted values of $TotalValue$ when $hasADU = 1$ and $hasADU = 0$ is written as

$$\%\Delta totalValue = \frac{TotalValue_{hasADU=1}}{TotalValue_{hasADU=0}} - 1,$$

and the log-specified notation gives

$$ln(TotalValue_{hasADU=1}) - ln(TotalValue_{hasADU=0}) = \beta.$$

Taking the anti-log gives

$$\frac{TotalValue_{hasADU=1}}{TotalValue_{hasADU=0}} = e^{\beta},$$

which can be plugged into the first equation to get

$$\Delta\% totalValue = e^{\beta} - 1.$$

Thus the exact interpretation of a coefficient on a binary independent variable for a log-transformed dependent variable is $e^{\beta} - 1$