Bundled parking and residential rents in the metropolitan United States

UCLA Ziman Center Working Paper
November 11, 2015

C.J. Gabbe, Gregory Pierce, and Randall Crane
Department of Urban Planning
University of California, Los Angeles
Contact: cgabbe@ucla.edu

Abstract
Minimum parking requirements in municipal zoning codes drive up the price of housing. The relationship between bundled parking and housing prices, however, remains poorly understood. We use national American Housing Survey data and hedonic regression techniques to investigate this relationship. We find that the cost of garage parking to housing renters is approximately $1,700 per year, or an additional 17% to a housing unit's rent. The lack of rental housing without bundled parking imposes a steep cost on carless renters – commonly the lowest income households – who are paying for parking that in most cases they do not need or want. We estimate the direct deadweight loss for carless renters to be $440 million annually. We conclude by advising cities not only to reduce or eliminate minimum parking requirements, but also to allow and encourage landlords to unbundle parking costs from housing costs.

Keywords
housing affordability, housing prices, parking regulation, minimum parking requirements, American Housing Survey

Acknowledgments
We thank the UCLA Ziman Center for Real Estate Howard and Irene Levine Program in Housing and Social Responsibility for generously funding this research. We also thank Donald Shoup, Michael Manville, and attendees of the 2015 Association of Collegiate Schools of Planning conference for their insightful comments on previous versions of this study.

Introduction

Minimum parking requirements are a central tool of local land use regulation in the United States. Given the documented inefficiencies of many cities' parking policies, however, urban policymakers have taken an interest in reforming them. Bundled parking refers to parking spaces that are rented or sold in conjunction with a housing unit (McDonnell, Madar, & Been, 2011). In most cities today, developers are required by municipal regulation to provide on-site parking. A major justification for reducing or eliminating minimum parking requirements is that they unnecessarily drive up the price of housing. To date, there are no national estimates of the impact of bundled parking on housing prices. We focus on urban renters because these households are experiencing the worst – and worsening – housing cost burdens (Joint Center for Housing Studies, 2015). Thus, we ask: what are the effects of parking provision on residential rents in America's cities?

To answer this question, we utilize a nationally representative sample of rental housing units from the 2011 American Housing Survey (AHS). We first outline the existing state of research and the policy rationale for reducing parking regulation, including the case for unbundling parking costs from rental housing costs. We then focus our analysis on garage parking, the costliest form of off-street parking (Shoup, 2014). We describe the prevalence of bundled and garage parking across different types of households, housing units, and metropolitan areas. We subsequently build hedonic regression models to estimate the effect of garage parking on residential rents in American metropolitan areas. We find that the cost of garage parking for renters is approximately $1,700 per year, and the bundling of a garage space adds about 17% to a unit's rent. There are about 708,000 households without a car who have a garage parking space. This excess parking supply that is due to municipal regulations, not consumer demand, represents a direct deadweight loss to society estimated to be approximately $440 million per year. We argue, however, that this figure represents the tip of the iceberg when considering the indirect cost of minimum requirements. We conclude by recommending two types of local land use regulatory changes to reduce the cost burden of parking: (1) cities should reduce or eliminate minimum parking requirements, and (2) cities should allow or encourage landlords to offer unbundled parking options.

Literature review

The spread of municipal parking regulation in the aftermath of World War II has been well-documented (see Shoup, 2005). Today, minimum parking requirements are practically ubiquitous in the United States. Reforming these standards is of great interest to planners, policymakers and developers for several reasons. First, high parking requirements reinforce auto-oriented development patterns, hindering cities' sustainability goals (Manville, Beata, & Shoup, 2013). Second, the supply of parking space necessitated by minimum standards exceeds the demand for parking in many areas, resulting in inefficient land use (Shoup, 2005). Third, parking standards impose unnecessary costs on renters and buyers, particularly in expensive housing markets (Manville et al., 2013). Ideally, consumers should have a choice as to whether they buy or rent a parking space connected with a housing unit (Manville, 2013). Parking spaces are not necessary housing unit attributes, regulated for health or safety reasons, as are connections to water or sewage service, for example (Shoup, 2005). Rather, parking spaces should be treated as

residential amenities, similar to on-site storage space, a dishwasher or air-conditioning. Parking provision should be market-driven; developers should have flexibility in how much parking they provide, and housing consumers should have a choice in how much parking they rent or buy.

There is a limited supply of housing units without dedicated parking. Housing units built before the 1930s, before off-street parking requirements were adopted as a municipal response to on-street parking shortages, often have no on-site parking (Shoup, 2005). For new housing developments, some cities – including New York, San Francisco, Portland, and now Los Angeles — have reduced or eliminated minimum parking requirements in downtowns or other neighborhoods (Los Angeles Department of City Planning, 2013; Millard-Ball, 2002). San Francisco has banned the bundling of parking into the monthly rent or sales price of a new housing unit (City of San Francisco, 2013). Fewer parking spaces may also be allowed through discretionary processes. For example, planning officials may also approve zoning variances for development with less parking than required, but getting these variances approved is easier in certain cities than others (Manville et al., 2013). Given these limited scenarios, the prevalence of housing without parking is generally low and varies considerably by city and metropolitan area. For example, about 95% of metropolitan Los Angeles housing units include at least one parking space, while only 63% of those in metropolitan New York City include one or more parking spaces (Manville et al., 2013). Comparing the two central cities reveals an even larger disparity: 90% of central Los Angeles units have parking but only 31% of central New York City units.

Minimum parking requirements are a binding constraint on new development in some areas. That is, if requirements were lowered or eliminated, real estate developers may reduce the amount of parking they provide (Manville, 2013). A small body of empirical research shows that parking requirements act as a binding constraint, in the context of non-residential properties in metropolitan Los Angeles (Cutter & Franco, 2012), adaptive reuse of commercial properties in downtown Los Angeles (Manville, 2013), new housing developments in London (Li & Guo, 2014), and mega-developments in New York City (McDonnell et al., 2011). Along with the direct effects of parking requirements, parking regulations also engender several indirect adverse impacts. Studying New York City, Manville et al. (2013) found that a ten percent increase in minimum parking requirements was associated with a five percent increase in vehicle density, a five percent increase in vehicles per capita, six percent reductions in population and housing densities, and a two percent reduction in transit commute share.

Several city-specific studies provide empirical estimates of the effect of parking provision on housing costs (Manville, 2013). These scholars have used multivariate techniques to isolate the value of a parking space within the context of a larger bundle of housing attributes. Jia and Wachs (1999) collected data on a sample of 232 property sales in San Francisco to test the relationship between off-street parking and housing prices. They used a hedonic regression model and found that the average single-family unit with off-street parking sold for 12% higher and the average condo unit with off-street parking sold for 13% higher than the price of units without parking. Manville (2013) studied a sample of buildings in downtown Los Angeles that had been converted to housing after the city passed its Adaptive Reuse Ordinance, which reduced parking requirements for these types of projects in and near downtown L.A. The author regressed the natural log of price on bundled parking, bathroom, year of construction, and other housing attributes. He found that an "apartment with bundled parking is associated with $200

more in asking rent, and bundled parking with a condo is associated with a $43,000 increase in asking price" (Manville, 2013, p. 12). These articles provide some preliminary evidence regarding the effect of bundled parking on housing prices, but are limited to selected neighborhoods within single cities. Building on these studies, we draw on a national sample of housing units and a more robust set of control variables to assess this relationship.

Data

Data for this study are primarily derived from the 2011 American Housing Survey (AHS), a biennial survey sponsored by the U.S. Department of Housing and Urban Development (HUD) and conducted by the U.S. Census Bureau. The AHS is unique because each survey contains both a nationally representative sample of housing units, which are surveyed consistently over time, and an over-sample of housing units from a rotating set of metropolitan areas. The AHS provides weights to ensure that the total sample is representative of the national housing stock, as well as replicate weights to account for variance in single survey estimates. In all calculations reported in this analysis, we follow the guidance of the AHS codebook and employ 160 replicate survey weights using the balanced repeated replicate (BRR) weights command in Stata 13.

The AHS includes questions on topics including household socioeconomic characteristics, physical housing quality attributes, housing costs and tenancy arrangements, relocation behavior, neighborhood characteristics, and intra- and inter-metropolitan locations (AHS, 2014). We restrict our sample to urban areas of U.S. Census Bureau defined metropolitan statistical areas (MSAs) because there is sufficient demand for land in these areas to make the space needed for parking very costly (Willson, 1995). In the 2011 AHS, more than 7% of all housing units in urban areas do not have bundled parking, compared with less than 2% of all housing units outside urban areas. Similarly, parking is rarely unbundled for homeowners (less than 3%) and is much more prevalent for rental units (nearly 13%). Moreover, we further restrict our sample to renters in urban areas because these households are experiencing the worst – and worsening – housing cost burdens (Joint Center for Housing Studies, 2015). Using the 2011 AHS micro-data, we can analyze such 38,662 rental units, which are statistically representative of the national urban, rental housing stock.

Our primary outcome of interest in this analysis is annual household rent. We measure this using the variable RENT, which denotes how much is paid by the household at a given time, and FRENT, which denotes the frequency of the rent payment (e.g. weekly, monthly etc.). As described above, our analysis focuses on the relationship between parking and rent. We focus specifically on garage parking because it is the most expensive type of parking to construct, and the prevalent form of parking in central, transit-oriented neighborhoods.[1] Nationally, the construction cost of an above-ground parking space averages $24,000 and an underground space averages $34,000 (Shoup, 2014). In the AHS, the variable GARAGE indicates if space in a garage or carport is included with the unit. Garage parking spaces may be located underground or above ground (Econometrica, Inc., 2013).

[1] Surface parking, on the other hand, is generally provided in areas where the opportunity cost of not building housing is lower.

Methods

Our approach to modeling parking provision and residential rents is based on the conception of a housing unit as a heterogeneous bundle of attributes (Kain & Quigley, 1975). The price of a unit is a function of the components of this bundle, including a housing unit's size, attribute quality and locational characteristics (DiPasquale & Wheaton, 1996). Hedonic regression models are commonly to isolate the underlying equilibrium price for each housing attribute (Allen, Springer, & Waller, 1995; Sirmans, Macpherson, & Zietz, 2005; Witte, Sumka, & Erekson, 1979). The availability of on-site garage parking is one such factor in a household's housing purchase or rental decision, and it is the primary explanatory variable of interest in this paper. Economic theory does not specify the housing characteristics which should be incorporated in a hedonic regression model (Edmonds, 1984; Sirmans et al., 2005). As such, there is considerable variation in the independent variables other scholars have included in their models. Categories of characteristics generally include structural quality, internal attributes, external features, natural environmental features, neighborhood and location, public services, selling factors and financing issues (Sirmans et al., 2005). We selected variables based on a combination of theory (Sirmans et al., 2005) and other hedonic model specifications using AHS data (Downes & Zabel, 2002; Glaeser & Gyourko, 2003; Kiel & Zabel, 1997; Thibodeau, 1995).

In addition to the garage parking variable described above, we include unit characteristic variables related to size and indoor amenities. A bedrooms variable reflects the number of full bedrooms in a housing unit, and a bathrooms variable captures the number of full bathrooms in the unit. These are two of the most commonly used variables in hedonic models (Sirmans et al., 2005). We expect each additional bedroom and bathroom to add to the rental price. We use four indicator variables representing common apartment amenities that presumably represent unit quality: central air-conditioning, a dishwasher, in-unit laundry, and a fireplace. We also include a variable representing building age, measured by the number of years since the building was constructed. We expect units in newer buildings to be more expensive. Because the relationship between building age and price is generally non-linear due to depreciation and vintage effects (Goodman & Thibodeau, 1995), we also include building age squared in our models.

A drawback of recent changes in the AHS public use file is the lack of variables with which to measure neighborhood characteristics (Kiel & Zabel, 1997). Ideally we would include a measure of neighborhood housing density, but since that is unavailable in the public use file, we use the height of the building as a proxy for neighborhood density. That is, we expect that a unit in a 20-story building is more likely to be in a denser neighborhood than a unit in a 2-story building, and we expect higher rents in more dense areas due to the cost of land. For neighborhood quality, we follow Thibodeau (1995) and use respondents' self-reported neighborhood opinion rating. Like Glaeser and Gyourko (2003), we add an indicator variable reflecting Central City location to reflect relative location within a given metropolitan area. Lastly, since we are using a national sample and there is great inter-metropolitan variation in the built environment and economic conditions, we control for metropolitan population density and median income in 2010.[2] We expect rents to be higher in denser and higher-income metropolitan areas.

[2] We aggregate county-level data from the 2010 American Community Survey to the 1980 standard metropolitan statistical areas (SMSA) definitions used in the 2011 American Housing Survey.

We specify two hedonic regression models to isolate the relationship between garage parking and rent, *ceteris paribus*. Again, we focus on the role of garage spaces because they are more expensive to construct and are more likely to be built in urban areas with relatively high land costs. Our hedonic regression models are shown in equations 1 and 2 below.

Equation 1

$$\text{Rent}=a+b_1\text{Garage Parking}_i+b_2\text{Controls}_i+e_i$$

Equation 2

$$\ln(\text{Rent})=a+b_1\text{Garage Parking}_i+b_2\text{Controls}_i+e_i$$

where the dependent variable is a household's annual rent (Equation 1) or the natural log of annual rent (Equation 2); *garage parking* is an indicator variable with a value of one if a housing unit has at least one garage parking space on-site included in the cost of rent; the *controls* are a vector of neighborhood and metropolitan variables, and an error term expresses the residual of each equation. As a robustness test to ensure that our results were not driven by metropolitan level factors, we also ran the models with standard errors clustered by Standard Metropolitan Statistical Area (SMSA), of which there were 147 in the sample.

We use equations 1 and 2 to model the entire urban rental sample, a sub-sample of recent movers, and a sub-sample of carless renters. We use the entire urban rental sample to estimate the overall effects of garage parking across all rental units. We use the sub-sample of recent movers as a robustness check because additional neighborhood quality variables are available for housing units occupied by recent movers in the AHS.[3] Lastly, we estimate the spending on garage parking by carless renters. We use this last value to estimate the direct deadweight loss borne by renters who do not have an automobile, but are nevertheless paying for a garage parking space. We calculate deadweight loss by multiplying the coefficient for garage parking from the carless renter sub-sample by the number of carless renters living in units with a garage by the sample weight to make the estimate nationally representative.

Results

We first characterize bundled parking and vehicle ownership. We then report descriptive statistics and bivariate correlations between annual rent and each individual unit characteristic, neighborhood attribute, and metropolitan independent variable. Finally, we present the results of the hedonic regression models.

Bundled parking and renters without vehicles

A large majority (83%) of the units in the sample included some kind of parking on-site. About 38% of rental units had garage parking while 45% of the units had surface or other non-garage parking spaces. About 17% of the urban rental units in the survey did not have a parking space, and this ranged dramatically by metropolitan area. The New York City area had the highest prevalence of units without parking (73%), contrasting sharply with Orange County, California

[3] Specifically, the survey asks new movers whether they moved to their current residence because of the quality of neighborhood factors including schools, public services, transit, and general appearance. Data on these additional neighborhood variables is available for a limited set of urban rental households (n= 13,677). We include these variables in the same model as above with a more limited sample.

at the other extreme (1% of units). Across metros, there were approximately 3.5 million rental units without parking. These units tended to be smaller, older and with fewer in-unit amenities than units with bundled parking.

Most American households have at least one automobile; nationwide only about 7.1% of rental households do not have a car (United States Census Bureau, 2011). As with bundled parking, there is considerable inter-metropolitan variation in the share of households without a vehicle, from 26% in metropolitan New York City to 1.5% in the St. George (Utah) metropolitan area. Across the entire 2011 AHS sample – which includes renter and owner-occupied units – more than 29% of households without a car do not live in a housing unit with a bundled parking space, as opposed to less than 4% of households with a vehicle. Within our final sample of renter-occupied units, these percentages are 27% and 7% respectively. Quantifying the relationship between vehicle ownership and parking is important because carless households are paying for something that they most likely do not need or want. For instance, studies find evidence of substantial under- utilization of garage spaces in multi-family residential buildings across multiple West Coast metropolitan areas (Willson, 2015). While resale or valuable repurposing of spaces undoubtedly occurs, most if not nearly all of these spaces are wasted.

The American rental housing stock

The average yearly rent in the sample was approximately $10,951, or $913/month, with a standard deviation of $478.[4] Turning to the independent variables, the amenities of air-conditioning, laundry and dishwashers were each present in about half of the rental housing in the sample. Fireplaces were a feature of only 15% of the rental units. The mean rental unit had about 2 bedrooms and more than 1 bathroom. The average unit was constructed nearly fifty years ago, well into the post-war period with ubiquitous parking requirements (Shoup, 2005). The average rental unit in the sample was situated in a 3-story building, reflecting a mix of single-family, low-rise apartments and high-rise apartment building types. About 59% of rental units were in the central city of their respective metropolitan areas; the rest were in core urban areas outside the central city or in smaller suburban jurisdictions. The average renter in the survey assessed their neighbourhood quality as an 8 on a 10 point scale, with 10 being the most favourable assessment.

Bivariate results

The bivariate correlations between each of the independent variables and annual rent mostly show expected relationships (Table 1). Our primary variable of interest, garage parking, is positively associated with unit rent. The variables for unit size and quality are all positively associated with rent, with the exception of central air-conditioning, which has a very small negative coefficient. Newer units are generally more expensive than older ones. Units in higher-rise buildings tend to be less expensive, which may be capturing the difference between single-family and multi-family rental housing. Units in neighborhoods that are more highly rated by residents are associated with higher rents. Lastly, units in denser and higher income metropolitan areas tend to be more expensive, as expected.

[4] All in 2011$. The AHS topcodes rental values at the 99.5th percentile, so we would expect these averages to be marginally higher in the absence of topcoding. However, this does not represent a concern for the integrity of the analysis, as we are most interested in parking's effect on low- and moderate-cost rental housing, rather than the high end of the rental market.

Table 1: Descriptive Statistics and Bivariate Correlations

Variable	Average	Correlation to yearly rent
Outcome of interest		
Annual rent	$10,951	NA
Parking characteristics		
Garage parking space(s)	38%	0.37***
Other unit and building characteristics		
Number of bedrooms	1.95	0.27***
Number of full bathrooms	1.25	0.37***
Central air-conditioning	50%	-0.01*
Fireplace	15%	0.29***
Dishwasher	50%	0.30***
Laundry	47%	0.17***
Age of building (years)	49	0.09***
Neighborhood characteristics		
Number of floors in building	3.0	-0.04***
Self-assessed neighbourhood rating (1-10, 10 being highest)	7.56	0.12***
Location in central city of metropolitan area	59%	-0.06***
Metropolitan area characteristics		
Population density (persons/square mile	1,907	0.22***
Median income	$58,079	0.43***

* p-value <.10, ** p-value <.05, *** p-value <.01

Hedonic regression results

Again, we use hedonic regression techniques to examine the relationship between garage parking and housing rents while holding other unit, neighborhood, and metropolitan factors constant. We

report coefficients and robust standard errors for each of two model specifications (Table 2). Model 1 coefficients can be interpreted in terms of the dollar value they compose of rent. A one-unit change in Model 2 coefficients is associated with a 100 times the coefficient percentage change in rent. In both models, the distribution of the dependent variable approximates the normal curve.

Table 2: Hedonic regression results on annual rent

Variable Name	Model 1: Coefficient (robust standard error)	Model 2: Coefficient (robust standard error)
Parking characteristics		
Garage parking	$1699*** (95)	.17*** (.01)
Other unit and building characteristics		
Number of bedrooms	739*** (87)	.06*** (.01)
Number of bathrooms	1811*** (290)	.14*** (.02)
Central air-conditioning	-156 (111)	-.02 (.01)
Fireplace	950*** (150)	.07*** (.01)
Dishwasher	2097*** (118)	.24*** (.01)
Laundry	-76 (106)	-.01 (.01)
Building age	-50*** (8.39)	-.005*** (.001)
Building age squared	.56*** (.08)	.000*** (.000)
Neighborhood characteristics		
Number of floors in building	41 (26)	-.01** (.002)
Self-assessed neighbourhood rating (1-10, 10 being highest)	227*** (21)	.02*** (.002)
Location in central city of metropolitan area	80 (88)	-.01 (.01)
Metropolitan area characteristics		
Population density (persons/sq km)	643*** (30)	.06*** (.002)
Median income (000)	168*** (5.1)	.02*** (.000)
Constant	-6589 (512)	7.69 (.05)
Model statistics	N=38,662 Prob>F= 0.000	N=38,662 Prob>F= 0.000

	Adjusted R-Squared=0.34	Adjusted R-Squared=0.28

As shown in Table 2, the substantive results of the two specifications are quite comparable. The statistical significance and the direction of the relationship between the independent variables and garage parking is identical across models, except for building height. The two models, however, provide different information regarding the value of garage parking as a factor in rental price. Model 1 shows that a parking garage spot costs about $1,700 per year, or $142/month. Model 2 suggests that the addition of a parking space increases the price of rent by around 17%. Both models show that the cost of a garage space represents a substantial share of a household's rent payment.[5]

In terms of importance in the model, metro effects of density and income have the greatest impacts on prevailing rent prices, and building age is the most influential building characteristic or unit characteristic. Building height – our proxy for density – is not significantly associated with rent levels, but residents' self-assessment of neighbourhood quality is associated with higher monthly rent. Unit size – measured in terms of the number of bedrooms and bathrooms – is positively associated with rents, as expected. With respect to unit amenities, fireplaces and dishwashers are associated with higher rents, while the laundry and central air-conditioning variables have no significant relationship with renters' housing cost.

In the hedonic regressions on the sub-sample of units occupied by carless renters (results not shown), we find that garage parking costs an average of $621 a year or a 13% premium on their rental price. We calculate the deadweight loss to society stemming from garage parking provided by landlords to 708,000 housing units with residents who do not own a car. At a national level, this deadweight loss amounts to $440 million paid for garage parking spaces unused by residents annually. This is just the direct cost of parking requirements on low-income renters, and does not account for the many indirect costs of parking provision (Shoup, 2005).[6]

Discussion

Our results support the economic logic that an apartment with garage parking, *ceteris paribus*, will be more expensive than one with surface parking or no parking. Garages spaces are a valuable amenity. Garage parking offers cover from the elements, which reduces external wear to a vehicle, and guarantees convenience and time saved for the consumer. Garage parking is particularly valuable in higher-density urban neighborhoods where on-street parking is metered or difficult to procure. Garage parking, however, is expensive to build and its provision often represents a substantial opportunity cost for a real estate developer. Above-ground parking also represents an opportunity cost in that land area is devoted to parking rather than leasable residential or commercial space. We show that these direct and indirect costs are passed on to consumers in the form of higher rents. Again, garage parking is associated with higher rents of

[5] The substantive result of our modelling was unchanged by employing a clustered standard error approach. Although coefficients are reduced and confidence intervals are increased in this specification, the statistical significance and sign of the relationships between individual attributes and rental value are consistent, including the value of garage parking. This gives us further confidence that metropolitan level effects, although important, are not driving the model results.

[6] We lack data on the prevalence of renters sub-leasing their parking spaces, but even if a small share of renters do rent out their garage parking, the amount of wasted resources is substantial.

about $142 per month or a 17% premium for urban residents. Our findings are the first that are national in scope to quantify the relationship between parking and housing costs.

While the ubiquity of parking provision can be attributed to a combination of misguided regulation and household demand, the provision of parking supply without associated demand can only be characterized as wasteful. We are concerned about the social equity dimensions of parking provisions, and we quantify the extent of this loss nationally for urban renters. We find that there is a large deadweight loss associated with renters paying for garage parking that they do not want or need, which we estimate to be about $440 million dollars per year. Given that the carless population in the U.S. is generally lower-income than the car-owning population, many of the households involuntarily paying for garage parking are the ones that can least afford to do so. In fact, we find that the households which have a garage space but no car have only a little more than half of the income ($24,000) of other households ($44,000). In the absence of paying for an unused parking space, these rent outlays could be applied to renting a larger or better-located unit, other consumer spending, or saving for a home purchase. The deadweight loss associated with carless households has not been well quantified previously in the literature, and future research should also quantify the indirect costs of bundled parking provision on households and society more broadly.

Our findings support arguments for easing or eliminating minimum parking requirements in urban areas. This is a timely recommendation because even if parking requirements were relaxed today, as is being implemented in some cities, the housing stock is fairly durable and suppliers take years to adjust to demand for new bundles of housing attributes (DiPasquale & Wheaton, 1996). It would conceivably take a decade or two before consumers could choose from a wider selection of housing options with unbundled parking. Reducing or eliminating minimum parking requirements would have the biggest benefits to renters in higher-density, centrally-located neighborhoods where garage parking is prevalent. We also recommend that cities consider policies requiring developers to unbundle parking from new housing, as has been the approach of San Francisco (City of San Francisco, 2013). The combination of these regulatory changes would allow real estate developers to better respond to demand from consumers who are currently or prospectively carless.

There are two potential limitations to our analysis. First, some of the price premium associated with garage parking may be attributable to unobservable characteristics associated with garage parking which are not captured in our model; this is an inherent limitation of a hedonic modeling approach. To ensure that our estimate of parking cost was not overly sensitive to our final model specification, we tested the inclusion of other collinear independent variables. We did not find that the inclusion of these variables substantially lowered our estimate of garage space price in the main model. Second, there are a limited number of exogenous neighborhood attribute variables available for the entire sample due to limitations in reporting in the AHS dataset. Consequently, in our main models, we use several proxies and self-reported variables to represent neighborhood characteristics. In our smaller sub-sample of recent movers, we find that only school quality is a significant factor in rental value and that the inclusion of these variables does not substantially alter our estimates from our more expansive sample. Particularly, the estimated impact of garage parking on rental value is virtually identical to the full sample. This

gives us confidence that the inclusion of neighborhood amenities would not substantially change our findings.

Conclusion

In this study, we examine the effects of parking provision on metropolitan residential rents. We focus specifically on renters in urban areas because these households are experiencing the worst housing cost burdens. Our findings provide the first nationally representative evidence that urban garage parking provision is very costly to renters. We provide further evidence that minimum parking requirements are burdensome to renters and lead to societal waste. Carless households, including many lower-income households, in neighborhoods where garage parking is the norm are disproportionately affected. Eliminating minimum parking requirements in these locations would allow the market to gradually meet the apparent demand for housing options with unbundled parking, would reduce the annual $440 million deadweight loss directly experienced by urban renters without cars, and would partially remedy the addiction to driving and sprawling urban form that these requirements have induced over the past seventy-five years.

References

Allen, M. T., Springer, T. M., & Waller, N. G. (1995). Implicit pricing across residential rental submarkets. *The Journal of Real Estate Finance and Economics*, *11*(2), 137–151. http://doi.org/10.1007/BF01098658

City of San Francisco. (2013, September 6). San Francisco Planning Code. City of San Francisco. Retrieved from http://www.amlegal.com/nxt/gateway.dll?f=templates&fn=default.htm&vid=amlegal:sanfrancisco_ca

Cutter, W. B., & Franco, S. F. (2012). Do parking requirements significantly increase the area dedicated to parking? A test of the effect of parking requirements values in Los Angeles County. *Transportation Research Part A: Policy and Practice*, *46*(6), 901–925. http://doi.org/10.1016/j.tra.2012.02.012

DiPasquale, D., & Wheaton, W. C. (1996). *Urban economics and real estate markets*. Englewood Cliffs, N.J: Prentice Hall.

Downes, T. A., & Zabel, J. E. (2002). The impact of school characteristics on house prices: Chicago 1987–1991. *Journal of Urban Economics*, *52*(1), 1–25.

Econometrica, Inc. (2013). *Codebook for the American Housing Survey, Public Use File, 1997-2011*. Washington, DC: U.S. Department of Housing & Urban Development, Office of Policy Development. Retrieved from http://www.huduser.org/datasets/ahs/AHS_Codebook.pdf

Edmonds, R. G. (1984). A theoretical basis for hedonic regression: A research primer. *Real Estate Economics*, *12*(1), 72–85.

Glaeser, E. L., & Gyourko, J. (2003). *The Impact of Building Restrictions on Housing Affordability*. New York, N.Y: FRBNY Economic Policy Review. Retrieved from http://app.ny.frb.org/research/epr/03v09n2/0306glae.pdf

Goodman, A. C., & Thibodeau, T. G. (1995). Age-related heteroskedasticity in hedonic house price equations. *Journal of Housing Research*, *6*(1), 25–42.

Jia, W., & Wachs, M. (1999). Parking Requirements and Housing Affordability: Case Study of San Francisco. *Transportation Research Record: Journal of the Transportation Research Board*, *1685*(-1), 156–160. http://doi.org/10.3141/1685-20

Joint Center for Housing Studies. (2015). *The State of the Nation's Housing 2015*. Cambridge, MA: Harvard University. Retrieved from http://www.jchs.harvard.edu/research/state_nations_housing

Kain, J. F., & Quigley, J. M. (1975). Housing Markets and Racial Discrimination: A Microeconomic Analysis. *NBER*. Retrieved from http://www.nber.org/books/kain75-1

Kiel, K. A., & Zabel, J. E. (1997). Evaluating the usefulness of the American housing survey for creating house price indices. *The Journal of Real Estate Finance and Economics*, *14*(1-2), 189–202.

Li, F., & Guo, Z. (2014). Do parking standards matter? Evaluating the London parking reform with a matched-pair approach. *Transportation Research Part A: Policy and Practice*, *67*, 352–365. http://doi.org/10.1016/j.tra.2014.08.001

Los Angeles Department of City Planning. (2013). Cornfield Arroyo Seco Specific Plan.

Manville, M. (2013). Parking Requirements and Housing Development. *Journal of the American Planning Association*, *79*(1), 49–66. http://doi.org/10.1080/01944363.2013.785346

Manville, M., Beata, A., & Shoup, D. (2013). Turning Housing Into Driving: Parking Requirements and Density in Los Angeles and New York. *Housing Policy Debate*, *23*(2), 350–375. http://doi.org/10.1080/10511482.2013.767851

McDonnell, S., Madar, J., & Been, V. (2011). Minimum parking requirements and housing affordability in New York City. *Housing Policy Debate*, *21*(1), 45–68. http://doi.org/10.1080/10511482.2011.534386

Millard-Ball, A. (2002). Putting on their parking caps. *Planning. April*, *2002*, 16–21.

Shoup, D. (2005). *The High Cost of Free Parking*. Chicago, IL: Planners Press, American Planning Association.

Shoup, D. (2014). The High Cost of Minimum Parking Requirements. In C. Mulley & S. Ison (Eds.), *Parking: Issues and Policies* (pp. 87–113). Emerald Group Publishing.

Sirmans, S., Macpherson, D., & Zietz, E. (2005). The Composition of Hedonic Pricing Models. *Journal of Real Estate Literature*, *13*(1), 1–44. http://doi.org/10.5555/reli.13.1.j03673877172w0w2

Thibodeau, T. G. (1995). House price indices from the 1984-1992 MSA American housing surveys. *Journal of Housing Research*, *6*, 439–482.

United States Census Bureau. (2011). 2011 American Community Survey 1-year Estimates.

Willson, R. W. (1995). Suburban parking requirements: a tacit policy for automobile use and sprawl. *Journal of the American Planning Association*, 61(1), 29-42.

Willson, R.W. (2015). *Parking Management for Smart Growth*. Washington DC: Island Press.

Witte, A. D., Sumka, H. J., & Erekson, H. (1979). An estimate of a structural hedonic price model of the housing market: an application of Rosen's theory of implicit markets. *Econometrica: Journal of the Econometric Society*, 1151–1173.