Death by a thousand curb-cuts: Evidence on the effect of minimum parking requirements on the choice to drive; (2012) 20 ETRANP C 93-102

March 2012

Section: Pgs. 93-102 Vol. 20 No. C ISSN: 0967-070X

Length: 7960 words

Author: Rachel Weinberger rrw@design.upenn.edu

Department of City and Regional Planning, 127 Meyerson Hall University of Pennsylvania 210 S, 34th Street Philadelphia, PA 19104, USA

Body

ABSTRACT

Little research has been done to understand the effect of guaranteed parking at home—in a driveway or garage—on mode choice. The research presented here systematically examines neighborhoods in the three New York City boroughs for which residential, off-street parking is possible but potentially scarce. The research is conducted in two stages. Stage one is based on a Google Earth© survey of over 2000 properties paired with the City's tax lot database. The survey and tax lot information serve as the basis to estimate on-site parking for New York City neighborhoods. With parking availability estimated, a generalized linear model using census tracts as the unit of analysis, is used to estimate the maximum likelihood parameters that predict the proportion of residents who drive to work in the Manhattan Core.

The research shows a clear relationship between guaranteed parking at home and a greater propensity to use the automobile for journey to work trips even between origin and destinations pairs that are reasonably well and very well served by transit. Because journey to work trips to the downtown are typically well served by transit, we infer from this finding that non-journey to work trips are also made disproportionately by car from these areas of high on-site parking.

► Innovative use of GoogleEarthTM for data collection. ► Private residential parking increases auto use for Manhattan bound commute trips. ► Minimum parking requirements encourage auto use.

FULL TEXT

1 Introduction

Transportation systems consist of rights-of-way, vehicles and terminals. Any one of these elements can represent an upper bound on system capacity, i.e. limited terminal space or limited rights-of-way will create a bound on the number of vehicles that can be accommodated; limited vehicles or rights-of-way will determine the extent to which terminals are utilized. Congestion on just one of these elements suggests a system out of balance. The imbalance can be addressed by increasing capacity of the congested element or by limiting the capacity of one of the other elements. A better balance implies greater efficiency in resource allocation, as no one part of the system is

excessively idle while other parts are constrained. In the context of the auto/highway system terminals are the parking spaces where passengers and drivers embark and disembark. Unlike with shipping ports, airports or railway stations, a peculiarity of the system, at least in the United States, is that decisions regarding the rights-of-way are typically made at a regional level and in a context set by federal, state level and regional transportation policy, decisions regarding terminal facilities—i.e. parking spaces—are made locally and proscribed in zoning or building codes. Vehicle ownership and use decisions—such as how frequently and how far to drive—are made by private citizens.

With three disparate decision makers, two of whom are public bodies making policy decisions that create a context in which private citizens act and express their preferences, it is nearly guaranteed that the system will be unbalanced. To further complicate the matter the two public bodies are rarely, if ever, coordinated in their goals and decision processes. The importance of understanding and planning for land use and transportation interactions has long been recognized, indeed for at least 100 years ([Brown et al., 2009], p. 162). Yet these two spheres are seldom coordinated. Nowhere is the disconnection between land use and transportation policy more pronounced than with respect to parking policy. A critical element of the transportation system is administered through zoning and building codes which make limited, if any, reference to the overall transportation system in setting their requirements. The title of this paper is an acknowledgement of this latter fact; zoning and building codes stipulate off-street parking but with no understanding of the travel demand response to the requirement.

Parking supply and management is increasingly recognized as an important factor in mode choice (cf. [Vaca and Richard Kuzmyak, 2005][Kuzmyak et al., 2003][Shoup, 1995][Ison and Rye, 2006]). Until now, the vast majority of this research has focused on central business district (CBD) and other “destination” parking. There has been extremely limited research on parking at the “origin” or residential end of a trip; exceptions include [Stubbs, 2002] who looked at urban design, but not travel, implications of residential parking requirements in Great Britain and [Weinberger et al., 2008a][Weinberger et al., 2008b][Weinberger et al., 2009] who find that increased probability of commuting to work in Manhattan by car is associated with greater incidence of on-site, off-street, residential parking in two neighborhoods of New York City.

[Brown et al., 2009] Brown et al., 2009. Jeffrey R. Brown, Eric A. Morris, Brian D. Taylor; Planning for cars in cities: planners, engineers, and freeways in the 20th century; Journal of the American Planning Association; Vol. 75, No. 2; (2009), pp. 161-177.

[Vaca and Richard Kuzmyak, 2005] Vaca and Richard Kuzmyak, 2005. Vaca, Erin, Richard Kuzmyak, J., 2005. Chapter 13—Parking Prices and Fees. TCRP Report 95 Traveler Response to Transportation System Changes, Transportation Cooperative Research Program. Transportation Research Board, Washington, DC.

[Kuzmyak et al., 2003] Kuzmyak et al., 2003. Kuzmyak, J. Richard, Weinberger, Rachel, Pratt, Richard, Herbert, Levinson, 2003. Chapter 18—Parking Managment and Supply. Transit Cooperative Research Program (TCRP) Report 95: Traveler Response to Transportation System Changes. Transportation Research Board, Washington, DC.

[Shoup, 1995] Shoup, 1995. Donald Shoup; An opportunity to reduce minimum parking requirements; Journal of the American Planning Association; Vol. 61, No. 1; (1995), pp. 14-28.

[Ison and Rye, 2006] Ison and Rye, 2006. Stephen Ison, Tom Rye; Parking: parking; Transport Policy; Vol. 13, No. 6; (2006), pp. 445-446.

[Stubbs, 2002] Stubbs, 2002. Michael Stubbs; Car parking and residential development: sustainability, design and planning policy, and public perceptions of parking provision; Journal of Urban Design; Vol. 7, No. 2; (2002), pp. 213-237.

[Weinberger et al., 2008a] Weinberger et al., 2008a. Rachel Weinberger, Mark Seaman, Carolyn Johnson; Suburbanizing the City: How New York City Parking Requirements Lead to More Driving; Transportation Alternatives, New York (2008), .

[Weinberger et al., 2008b] Weinberger et al., 2008b. Rachel Weinberger, Mark Seaman, Carolyn Johnson, John Kaehny; Guaranteed Parking—Guaranteed Driving: Comparing Jackson Heights, Queens and Park Slope, Brooklyn Shows that a Guaranteed Parking Spot at Home Leads to More Driving to Work; Transportation Alternatives, New York (2008), .

[Weinberger et al., 2009] Weinberger et al., 2009. Rachel Weinberger, Mark Seaman, Carolyn Johnson; Residential off-street parking impacts on car ownership, vehicle miles traveled, and related carbon emissions: New York City case study; Transportation Research Record; Vol. 2118, (2009), pp. 24-30.

The current paper extends and generalizes the findings of [Weinberger et al., 2008b] by studying New York City more broadly. The paper systematically examines all neighborhoods in the three New York City boroughs for which residential, off-street parking is possible but potentially scarce. The excluded boroughs are Manhattan where only 22% of households report having a vehicle available and Staten Island, which is extremely low density by NYC standards, where 80% of households report availability of one or more vehicles (US Census Bureau 2000) and residential parking availability is not scarce.

Satellite imagery from Google Earth ([Google, 2008a]), Google Maps ([Google, 2008b]) and Bing Maps ([Microsoft Corporation, 2008]) was used to survey the lots containing one-, two- and three-family houses in the Bronx, Queens and Brooklyn. From that data collection, a binary logit model was developed to predict the likelihood of a garage or driveway on the property. This data was paired with information contained in the City's Primary Land Use Tax lot Output (PLUTO) database which reports the square footage devoted to parking for residential buildings of four-families and greater ([New York City Department of City Planning, 2007]). Using this information, the amount of parking per dwelling unit was estimated for each census tract and regressed against journey to work mode split data as reported in the Census Transportation Planning Package.

Controlling for median tract income, age of housing stock, vehicle availability, tract level transit accessibility, transit served destination and other variables, we find that tracts with higher levels of on-site parking have higher levels of drive mode share to the transit rich Manhattan Core. Thus we conclude that guaranteed parking at home is a contributing factor to a worker's decision to drive to work. From this we infer that driving to other activities is also likely to be higher.

In the short term, a better understanding of travel behavior consequences of residential parking policy can lead to a better coordination of parking supply decisions on the part of land use planners and better network planning and management by transportation planners. In the long term, integration of these two functions is the better strategy for developing and maintaining a balanced urban transportation system.

The paper is divided into four primary sections: the first looks at previous research pertaining to parking; the next section discusses the methodology and data used for the analysis; section three discusses the research findings and policy implications; conclusions follow.

2 Previous research

The majority of previous research looking at parking and travel behavior is focused on sensitivity to parking price (cf. [Hess, 2001][Golias et al., 2002][Beunen et al., 2006][Newmark and Shiftan, 2007][Kelly and Clinch, 2006][Kelly and Peter Clinch, 2009]),

---

[Google, 2008a] Google, 2008a. Google, “Google Earth”. Web page. Available at 〈http://earth.google.com/〉 (accessed 2008a).

[Google, 2008b] Google, 2008b. Google, “Google Maps”. Web page. Available at 〈http://maps.google.com/〉 (accessed 2008b).

[Microsoft Corporation, 2008] Microsoft Corporation, 2008. Microsoft Corporation, Bing Maps. Web page. Available at 〈http://www.bing.com/maps/〉 (accessed 2008).

[New York City Department of City Planning, 2007] New York City Department of City Planning, 2007. New York City Department of City Planning; Primary Land Use Tax Lot Output (PLUTO); New York City Department of City Planning, New York City (2007), .

[Hess, 2001] Hess, 2001. D.B. Hess; Effect of free parking on commuter mode choice—evidence from travel diary data; Transportation Research Record; Vol. 1953, (2001), pp. 35-42.

[Golias et al., 2002] Golias et al., 2002. John Golias, George Yannis, Michel Harvatis; Off-street parking choice sensitivity; Transportation Planning & Technology; Vol. 25, No. 4; (2002), pp. 333-348.

[Beunen et al., 2006] Beunen et al., 2006. R. Beunen, C.F. Jaarsma, H.D. Regnerus; Evaluating the effects of parking policy measures in nature areas; Journal of Transport Geography; Vol. 14, No. 5; (2006), pp. 376-383.

comparisons between parking and road pricing as a method of travel demand management (cf. Gillen, 1978Baldassare et al., 1998; Shiftan and Golani, 2005; Albert and Mahalel, 2006) or the effect on travel behavior of employer paid parking at work (cf. Willson, 1997Aldridge et al., 2006Vovsha and Petersen, 2009). There are some consistencies in this research, e.g. parking cash-out options, in which employees are offered the cash equivalent of their parking perquisites and allowed to choose the cash value or the "free" parking, appear to be universal in their effect of decreasing solo driving (Willson, 1997Aldridge et al., 2006Vovsha and Petersen, 2009; Shoup, 2005; Watters et al., 2006), but research on parking pricing versus congestion pricing differ in the question of whether travelers are more sensitive to parking pricing (Baldassare et al., 1998), more sensitive to congestion charges (Albert and Mahalel, 2006) or rather insensitive, only changing their parking location (Gillen, 1978).

Among the studies of price sensitivity we identified only one, which considered neighborhood characteristics at the origin end of a drive trip to downtown. The analysis shows that in Portland, OR, two land use variables, one, which indicates proximity to a transit stop, and the other, indicating a measure of pedestrian friendliness, are insignificant in mode choice to downtown destinations (Hess, 2001).

Additional efforts have looked at parking and "downtown destruction or regeneration", i.e. where parking policy can be used as regenerative and/or where parking restraint may be damaging to local economies. Marsden, 2006 reviews the literature and concludes that there is little evidence to suggest that parking restraint in town centers is a major

---

Newmark and Shiftan, 2007 Newmark and Shiftan, 2007. G.L. Newmark, Y. Shiftan; Examining shoppers' stated willingness to pay for parking at suburban malls; Transportation Research Record; Vol. 2010, (2007), pp. 94-103.

Kelly and Clinch, 2006 Kelly and Clinch, 2006. J.A. Kelly, J.P. Clinch; Influence of varied parking tariffs on parking occupancy levels by trip purpose; Transport Policy; Vol. 13, No. 6; (2006), pp. 487-495.

Kelly and Peter Clinch, 2009 Kelly and Peter Clinch, 2009. J. Andrew Kelly, J. Peter Clinch; Temporal variance of revealed preference on-street parking price elasticity; Transport Policy; Vol. 16, No. 4; (2009), pp. 193-199.

Gillen, 1978 Gillen, 1978. D.W. Gillen; Parking policy, parking location decisions and distribution of congestion; Transportation; Vol. 7, No. 1; (1978), pp. 69-85.

Baldassare et al., 1998 Baldassare et al., 1998. M. Baldassare, S. Ryan, C. Katz; Suburban attitudes toward policies aimed at reducing solo driving; Transportation; Vol. 25, No. 1; (1998), pp. 99-117.

Shiftan and Golani, 2005 Shiftan and Golani, 2005. Y. Shiftan, A. Golani; Effect of Auto Restraint Policies on Travel Behavior; Vol. 1932, (2005), pp. 156-163.

Albert and Mahalel, 2006 Albert and Mahalel, 2006. Gila Albert, David Mahalel; Congestion tolls and parking fees: a comparison of the potential effect on travel behavior: parking; Transport Policy; Vol. 13, No. 6; (2006), pp. 496-502.

Willson, 1997 Willson, 1997. R.W. Willson; Parking pricing without tears: trip reduction programs; Transportation Quarterly; Vol. 51, No. 1; (1997), pp. 79-90.

Aldridge et al., 2006 Aldridge et al., 2006. K. Aldridge, M. Carreno, S. Ison, T. Rye, I. Straker; Car parking management at airports: a special case? Parking; Transport Policy; Vol. 13, No. 6; (2006), pp. 511-521.

Vovsha and Petersen, 2009 Vovsha and Petersen, 2009. P. Vovsha, E. Petersen; Model for person and household mobility attributes; Transportation Research Record; Vol. 2132, (2009), pp. 95-105.

Shoup, 2005 Shoup, 2005. Donald C. Shoup; The High Cost of Free Parking; American Planning Association, Chicago, III (2005), .

Watters et al., 2006 Watters et al., 2006. Paul Watters, Margaret O'Mahony, Brian Caulfield; Response to cash outs for work place parking and work place parking charges: parking; Transport Policy; Vol. 13, No. 6; (2006), pp. 503-510.

Marsden, 2006 Marsden, 2006. G. Marsden; The evidence base for parking policies—a review; Transport Policy; Vol. 13, No. 6; (2006), pp. 447-457.

contributor to economic decline, indeed other research shows that economic decline and CBD parking capacity increases may track very closely and consistently (Garrick and Christopher, 2009Nelson\Nygaard Consulting Associates, 2005).

In addition, parking search behavior, better known as “cruising” and the congestion added due to cruising have drawn some research attention. Arnott and Inci, 2006 develop a theoretical model of curbside parking and traffic congestion. Arnott and Rowse, 2009 extend that work to develop a theoretical equilibrium model of cruising to equalize price differentials between under-priced (per their argument) on-street and over priced off-street commercial parking. Other research shows that cruising may account for as much as 30% of traffic in urban centers (Shoup, 1995Shoup, 2006).

Many of these efforts use stated preference (Golias et al., 2002; Shiftan and Golani, 2005; Albert and Mahalel, 2006) or opinion surveys (Baldassare et al., 1998) some use cross-sectional data (Gillen, 1978Hess, 2001) and others use ex- and post-ante data (Albanese and DiBella, 2009Kelly and Peter Clinch, 2009).

There are many ways to divide the literature; one can sort thematically, methodologically, based on data sources and types, according to the type of destination—downtown, university, shopping center or nature recreational facility—but the fact remains that very little research exists that even acknowledges residential or origin parking as a factor in travel decisions or an area for review in transportation policy. Perhaps this disconnect is due to a view that residential parking is an issue for housing and/or land use policy. This view is supported in research that identifies parking as a component of housing and other development cost. Jia and Wachs, 1999, for example, looked at property sales in six neighborhoods of San Francisco, California, and found that the presence of an off-street parking spot increased the cost of a house by 11.8% and a condominium by 13%. Jung, Owen. 2009 tests the added value of structured parking on condominiums in Edmonton, Canada, using two different datasets. In one analysis he finds an implicit price on parking but notes that the market value for parking is less than the developer cost. In the analysis of his second dataset he finds no implicit price. In both cases his finding suggests that the developer cost of parking is not ultimately passed on to the consumer. Litman, 2010 argues along the same lines as Jia and Wachs, 1999 that minimum parking requirements increase construction cost and present an obstacle to provision of affordable housing. He estimates that requiring one on-site parking spot added 6% to the cost of construction, two parking spots added 16%, and three parking spots added 34%.

Garrick and Christopher, 2009 Garrick and Christopher, 2009. Garrick, Norman, Christopher, McCahill, 2009. Hartford: It's a Parking Place—Tripling Space for Cars hasn't Helped City Prosper—It's Only Devalued Downtown. Hartford Courant (sec. on-line version).

Nelson\Nygaard Consulting Associates, 2005 Nelson\Nygaard Consulting Associates, 2005. Nelson\Nygaard Consulting Associates, 2005. Center City Parking Evaluation Final Report. Philadelphia City Planning Commission, Philadelphia, PA.

Arnott and Inci, 2006 Arnott and Inci, 2006. Richard Arnott, Eren Inci; An integrated model of downtown parking and traffic congestion; Journal of Urban Economics; Vol. 60, No. 3; (2006), pp. 418-442.

Arnott and Rowse, 2009 Arnott and Rowse, 2009. Richard Arnott, John Rowse; Downtown parking in auto city; Regional Science and Urban Economics; Vol. 39, No. 1; (2009), pp. 1-14.

Shoup, 2006 Shoup, 2006. Donald C. Shoup; Cruising for parking: parking; Transport Policy; Vol. 13, No. 6; (2006), pp. 479-486.

Albanese and DiBella, 2009 Albanese and DiBella, 2009. Massimo Albanese, Enrico DiBella; Possible impacts of parking pricing policies: the case of blue lined area in Genoa; International Journal of Transport Economics; Vol. 36, No. 3; (2009), pp. 301-335.

Jia and Wachs, 1999 Jia and Wachs, 1999. Wenyu Jia, Martin Wachs; Parking requirements and housing affordability: a case study of San Francisco; Transportation Research Record; Vol. 1685, (1999), pp. 156-160.

Jung, Owen. 2009 Jung, Owen. 2009. Jung, Owen. (2009) Who is Really Paying for your Parking Space? Unpublished Thesis. University of Alberta. 〈https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=CEA2010&paper_id=378〉 (accessed 2008)

Litman, 2010 Litman, 2010. Todd Litman; Parking Requirment Impacts on Housing Affordability; Victoria Transport Policy Institute, Victoria, British Columbia (2010), .

In spite of evidence that shows cost of parking is not fully borne by the consumer, which in turn implies a market distortion in which greater car ownership and lower home-ownership result (Weinberger et al., 2008a), two papers on residential parking maintain that car ownership is independent of parking supply (Stubbs, 2002Balcombe and York, 1993).

There is a dearth of information looking at residential parking and travel behavior. Balcombe and York, 1993 indicate that some of their research subjects indicated that they would walk for certain errands rather than give up a "good" parking space. From this one must infer that never having to give up a good space, i.e. by having a private, protected garage or driveway, would lead to additional auto trip-making, even for trips that are apparently walkable. A study comparing two matched neighborhoods in New York City, suggests that residents in the neighborhood with more on-site parking were 45% more likely to drive to work in Manhattan. A simulation of expected mode choice based on income, home ownership and other [non-parking] factors associated with auto use suggested that the neighborhood with more on-site parking should have had fewer drivers, *ceteris paribus* (Weinberger et al., 2008bWeinberger et al., 2009).

In this study we add to the literature by examining the effect of private, on-site, residential parking on commute behavior of New York City residents.

3 Methodology and data

The study is divided into two parts. The first combines New York City tax estimation data with the aerial data collection described below, to estimate the probability that any given property has a private parking space. Spaces are then aggregated to the census tract level. In the second part, the number of parking spaces per dwelling unit in a given tract is examined as a predictor of auto commuting to destinations in the Manhattan Core.

3.1 Methodology

The study described here first uses a binary logit model to predict on-site parking and then a generalized linear model (GLM) with a logit link function to explain the factors that increase or decrease the percentage of people driving to transit accessible work destinations. The unit of analysis in the first part is dwelling units but ultimately the analysis is relevant at the level of census tracts. Ideally a disaggregate mode choice model would be used to estimate the probabilities of individual decision makers to drive with parking availability at the trip origin included as an explanatory factor; however, in spite of the potential importance of this factor in mode choice it has not been included in any household travel surveys and thus no data exist to estimate this factor. The aggregate mode choice model is a reasonable second best approach to begin studying this question. All statistical analysis is done using SPSS Version 17.0.0 (SPSS Inc, 2008).

3.2 Data

Three data sources, including data collected specifically for this study were employed in the analysis.

The City of New York maintains a robust database called the Primary Land Use Tax lot Output (PLUTO) file which contains 70 variables describing lot and building characteristics and identifying geographic/political divisions for each tax lot in the city (New York City Department of City Planning, 2008). PLUTO data are updated annually to reflect change in ownership, new construction and other changes that may have occurred. This analysis is based on the 2007c version of PLUTO. As noted in the introduction, PLUTO reports the amount of square footage on a given lot

---

Balcombe and York, 1993 Balcombe and York, 1993. Balcombe, R.J., York, I.O., 1993. The Future of Residential Parking. Project Report. Transport Research Laboratory, Crowthorne, Berkshire, UK (Cited in Marsden (2006)).

SPSS Inc, 2008 SPSS Inc, 2008. SPSS Inc., 2008. SPSS for Windows Release 12.0.0. Chicago, Il.

New York City Department of City Planning, 2008 New York City Department of City Planning, 2008. New York City Department of City Planning, 2008. Primary Land Use Tax lot Output (PLUTO) Data Dictionary. Ver. 2007c. New York City, New York City Department of City Planning.

that is devoted to garage area but only for buildings with a legal certificate of occupancy of four families or more (DCP, 2008).

To gather necessary data on smaller buildings a random sample consisting of 2,328 one-, two- and three-family buildings was selected from the PLUTO database. Using ArcGIS™, a keyhole markup language (KML) overlay was created, (see sample in Fig. 1) which was then imported to Google Earth to identify the selected lots (Figs. 2–4). Using Google Earth aerial and street views, supplemented with BING maps we were able to determine the presence of a garage or driveway on each lot. Initial efforts included an attempt to estimate the number of vehicles that could be accommodated but given the subjectivity of that determination we ultimately decided to count a driveway or garage of any size as just one space. We were able to make determinations for 99% of the sample. Approximately 69% of the sampled units had on-site parking spaces and 31% did not. Brooklyn properties, with the highest average building age, had the fewest on-site parking spaces (57%), the Bronx was next with (71%) and Queens properties were most likely to have on-site parking (79%).

The aerial photography data collection was validated by a field test. Sampling within the estimation dataset, one “pivot” property in each of the three study boroughs was randomly selected. All properties that had been selected in the original estimation set and fell within a three-quarter mile radius of the pivot property were checked in the field and compared against the aerial photography determination. In all, 117 field observations were made; in 87% of cases the field observation was consistent with the aerial determination. In some cases of conflict it was determined that the field observation was in error and the google view correct. For example, the google views showed a delineation of the property line whereas in the field it was sometimes difficult to determine whether the driveway belonged to the subject property or to an adjacent property.

The second part of the analysis uses the 2000 Census Transportation Planning Package (CTPP) part III. CTPP was used to determine the number of workers from each tract who made their journey to work by car and by any means to jobs in the Manhattan Core (MC). The Core is defined by the New York City Department of City Planning as the area of Manhattan south of 110th street on the west side of Central Park and south of 96th Street on the east side (NYC n.d.) For this analysis it has been modified as work sites south of 96th Street on both the east and west sides of Central Park and it includes only those census tracts that fall within one quarter mile of a New York City Subway station. The selected work destinations are indicated in Fig. 5.

3.3 Estimating parking per dwelling unit

Using the PLUTO and aerial data a binary logit[1] model was developed to estimate the probability that a given property had, or did not have, an on-site parking space. A parking space was defined as either a driveway or a garage. The probability of a parking space was best determined by the building age, the built floor area ratio, the number of buildings on the lot, the residential square footage, whether or not the building was in Brooklyn and a variety of zoning designations. Surprisingly, there is no relationship between parking and the presence or absence of a basement—in Queens, in particular, it is very common to have a garage in the basement of a building (see Fig. 6)—nor was there a statistical relationship between parking and distance to transit, building class, the ratio of a building’s frontage to the lot frontage or the gap between the lot frontage and the building frontage (either of these measures would, in theory, indicate a passageway for a vehicle onto the property). The variables used in the parking prediction model are shown in Table 1.

On the estimation data set the model correctly predicts the presence or absence of a parking space 81% of the time. It correctly predicts the presence of a space in 92% of cases and the lack of a space in 58% of cases. An additional sample of 300 properties was surveyed to test the effectiveness of the model. Of those, 99% were observable. The model correctly predicted just over 82% of cases.

[1] Logit model belongs to a class of models that usually predict discrete choices, occasionally they are used to predict proportions as used later in this paper. A binary logit predicts the probability of an event occurring or not occurring hence its applicability in predicting the presence or absence of a on-site, off-street parking on any given parcel.

For properties of four families and more the PLUTO database lists the square footage devoted to parking/garage. To estimate the number of spaces per building the parking square footage was divided by 250 square feet. These spaces were summed across the census tract and added to the estimated spaces for small buildings. Total parking per tract was divided by the number of housing units in the tract to determine parking per dwelling unit. Parking data are aggregated to the tract level so they can be consistently paired with Census Journey to Work data.

3.4 Modeling mode choice

A limitation of any ecological study is the inability to model individual behavior as a consequence of individual circumstances. In the present case we are interested in knowing whether or not access to a protected, private parking space contributes to the decision of whether or not to drive. Due to data limitations we model behavior aggregated to the level of census tracts. Until we can model individual behavior we infer individual behavior from the tract level findings. To compensate for the cases in which viable alternatives to driving are scarce at the destination end of the commute trip–such as an outer borough to suburb origin and destination pair–we seek to explain only the percentage of work trips from a given census tract to the Manhattan core (MC) that are made by automobile. We expect these to be a function of several control variables such as tract median income level, automobile ownership, distance to subway or commuter train and our study variable, the level of on-site parking per dwelling unit. We posit the general relationship:(1) $y = f(\boldsymbol{u}, \boldsymbol{v}, w, \alpha, \boldsymbol{\beta}, \gamma, \delta)$ where y is the percent of people in a given tract who drive to work in the Manhattan core (i.e. number of people who drive to work in the Manhattan core divided by number of residents who work in the Manhattan core), $\boldsymbol{u}$ is a vector of characteristics of the built environment (e.g. median building age, transit accessibility), $\boldsymbol{v}$ is a vector of socio-economic and demographic characteristics measured at the tract level, w is the study variable: on-site parking per dwelling unit, α, $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$, δ are the estimated parameters, **bold** indicates vectors.

Generally, a suitable transformation to allow use of ordinary least squares (OLS) regression to model percentages is an aggregate logit model (cf. Small 2007 and Sen and Srivastava 1990):(2) $\ln\left(\frac{y_i}{1-y_i}\right) = \alpha + \beta' u_i + \gamma' v_i + \delta w_i$ where y is the percentage of commuters to the MC as above and $\alpha, \beta, \gamma, \delta$ and u, v, w are also as above, $\ln(y_i / 1 - y_i)$ is the log of the odds ratio or logit and e a residual, or error term, that captures the difference between the left hand side (LHS) and what is systematically explained by the variables and estimated parameters.

The logit transformation yields a functional form in which the LHS is never less than zero, nor does it exceed one, regardless of the right hand side, thus mimicking the true nature of a measured percentage. Furthermore, the transformation normalizes the dependent, or response, variable as illustrated in Fig. 7 thus ensuring compliance with an important condition of linear model estimation.

However, because Eq. (2) is undefined at y=0 and y=1—i.e. the cases where all workers drive to work or when no workers drive, it is of limited value for this analysis. In 103 of the 1,717 tracts under study there are no residents driving to work in the MC.[2] A difference of means test comparing parking per dwelling unit in tracts that have no drivers to the MC relative to tracts with at least one driver to the MC shows that tracts with no drivers to the MC have, on average 0.13 parking spaces per dwelling unit while tracts with drivers to the MC have, on average, 0.26 parking spaces per dwelling unit. The finding that the 103 tracts with no drivers to the Manhattan core have a lower incidence of the study variable, suggests that their inclusion is critically important to the analysis.

To handle this problem we employ a generalized linear model (GLM) approach specifying logit as the link function with a binomial distribution. The generalized linear model uses a maximum likelihood estimation. We posit two specific models, in the first the study variable—on-site parking—is used in conjunction with auto ownership. This introduces a new problem as we also hypothesize that both mode choice—as we model here—and car ownership are functions of on-site parking availability and that car use and ownership may be jointly determined. Hence the

[2] There is one tract in eastern Queens for which no residents work in the Manhattan Core. This tract has been omitted from the analysis.

first model takes the form:(3) $y_i = g^{-1}(\alpha + \beta' u_i + \gamma' v_i + \delta w_i)$where g^{-1} is the inverse of the logit link function. The second model is of the form:(4) $y_i = g^{-1}(\alpha + \beta' u_i + \gamma' v_i + \delta w_i + h(w_i))$with *w* representing parking per dwelling unit (as before) and *h(w)* is car ownership as a function of *w.* Using a control function as a generalization of the instrumental variable approach (Guevara and Ben-Akiva, 2006) we estimate auto ownership as a function of parking and other explanatory variables including four instrumental variables, which are correlated with auto ownership but not mode choice. The four variables are: the percent of the population who have recently moved from another metropolitan statistical area, the percent who have moved from the central city of another metropolitan statistical area, population density and the employed percent of the adult population. The former two have been shown to be associated with auto ownership but not with mode choice (Weinberger and Goetzke, 2010; Goetzke and Rachel, 2011). The latter two are intuitively obvious and were selected on theoretical grounds. In addition to actual auto ownership levels, we include the residual of the first stage analysis as an explanatory variable in our second stage (Guevara and Ben-Akiva, 2006).

Finally, because of the large number of zero observations we test whether that concentration affects the model. The test is performed by including a dummy variable for no drivers to Manhattan. The dummy is insignificant and does not substantially affect the other estimated coefficients. Hence we conclude the model as specified is sufficient. Additional details of that test are omitted.

4 Model results

Several demographic variables were included in the initial modeling efforts. Ultimately, median income, median age, average household size and percent of population reporting Black alone as race were statistically significant in explaining tract level mode choice for trips to the Manhattan Core. Additional significant explanatory variables include median year built (describing the housing stock), and the percent of car owning households. Home ownership is not shown to be associated with auto commuting in this model. In the second model it is, insofar as it is associated with auto ownership—a detail discussed below.

We include the percent of tract residents who work for any level of government as previous research on New York City has indicated this is a predictor for driving (Schaller, 2006Weinberger et al., 2008b). Many government employees have a parking placard as part of their perquisite package; this allows them far less restricted parking at their destinations than most other drivers. Thus it is an incentive to drive. In this effort we confirm that finding: tracts with higher percentages of government employees have higher percentages of auto commuters.

There is a transit control variable in the model. It is an accessibility index measuring the level of job opportunities that can be reached by transit from each tract. The accessibility index, which relies on a straightforward gravity model construction, measures the number of job opportunities accessible from each zone mediated by a distance decay parameter. The measure was calculated and provided by the New York Metropolitan Transportation Council. As expected, likelihood of driving decreases as transit accessibility increases.

Somewhat surprisingly, higher income is associated with lower levels of auto commuting, perhaps because wealthier households in New York reside in some of the most transit rich neighborhoods—though this effect should be controlled for by the transit accessibility index. There are no other surprises in Model 1 and the study variable,

---

Guevara and Ben-Akiva, 2006 Guevara and Ben-Akiva, 2006. Christian Guevara, Moshe Ben-Akiva; Endogeneity in residential location choice models; Transportation Research Record; Vol. 1977, (2006), pp. 60-66.

Weinberger and Goetzke, 2010 Weinberger and Goetzke, 2010. Rachel Weinberger, Frank Goetzke; Unpacking preference: how previous experience affects auto ownership; Urban Studies; Vol. 47, No. 10; (2010), pp. 2111-2128.

Goetzke and Rachel, 2011 Goetzke and Rachel, 2011. Goetzke, Frank, Rachel, Weinberger, 2011. Separating contextual from endogenous effects in automobile ownership models. In: Presented at the Transportation Research Board Annual Meeting.

Schaller, 2006 Schaller, 2006. Bruce Schaller; Necessity or Choice? Why People Drive in Manhattan; Transportation Alternatives, New York (2006), .

off-street parking, shows up positive and statistically significant in explaining the proportion of commuters who travel by car to the Manhattan Core. Complete results are given in Table 2.

As indicated in Section 3.4, for the second model we first estimate auto ownership, using population density, percent of employed adults, percent of population who have moved from other MSAs and those who have moved from other central cities, since the prior census as instrumental variables. As shown in Table 3, the variables that are positively correlated with tract level auto ownership are income, age, household size, home ownership, white population and off-street parking per dwelling unit. Variables that depress auto ownership are transit accessibility, Black population and, curiously, government employees. This last observation potentially underscores the effect of placards on the choice to drive. As a population that is less likely to own cars, other things being equal, proves to be more likely to drive. The four instruments are significant with expected signs. Having moved to New York in the recent past increases likelihood of auto ownership but having moved from a different center city decreases likelihood of auto ownership. Higher population density is associated with lower car ownership, and higher percentage of employed adults, which could indicate greater disposable income and a greater need for automobility, is associated with higher car ownership.

The residual term in Model 2 is statistically significant indicating that the assumption of co-determination of auto-ownership and auto commuting is correct, i.e. there exists some correlation between the percent of households without cars and the error term of Model 1. The correlation implies some bias in the coefficients of Model 1 which is therefore corrected in Model 2.

Consistent with Model 1, factors in the second stage of Model 2 that depress auto commuting are income, median age, household size, transit accessibility and the percent of population reporting Black alone as their race. Increased levels of auto and home ownership, more government employees and higher levels of off-street parking contribute to higher levels auto-commuting even after the question of co-determined commute mode choice and auto ownership is addressed.

The development of these models demonstrates a clear relationship between increased access to guaranteed parking at home and a propensity to drive to work in the Manhattan Core. Off-street parking correlates to driving to work both indirectly by its contribution to car ownership and directly by easing car use.

5 Conclusion and policy implications

While a true behavioral study with disaggregate data is preferred, the ecological study performed here provides important insight regarding a little studied area of transportation infrastructure and travel behavior, namely origin parking effects on mode choice. The research shows a clear relationship between guaranteed parking at home and the greater propensity to use the automobile for journey to work trips even between origin and destinations pairs that are reasonably well and very well served by transit. Because journey to work trips to the downtown are typically well served by transit, we infer from this finding that trips for other purposes from these areas of higher on-site, off-street parking are also made disproportionately by car.

In cities where on-site parking is relatively scare there is likely competition for curb-space which implies search costs and additional effort to walk from the parking spot to the home or other destinations. With on-site, private parking, the search costs and additional effort are eliminated thus travelers who have on-site parking face a different utility constellation than commuters without access to such parking at home. The guaranteed spot makes use of the automobile a more attractive option.

City planning departments across the United States make decisions with respect to the amount of parking to supply in order to mitigate potential local spot shortages. The policy consideration does not take into account induced behaviors demonstrated in this research, such as potential increased auto ownership or increased driving that can result from the increased parking supply. In New York City, in particular, the policy is intended to appease existing

residents making them more accepting of additional development (Hornick, 2010). With the exception of most of Manhattan and a small part of Queens, where parking provision is highly restricted as part of the City's effort to maintain compliance with the Clean Air Act, minimum parking requirements are stipulated for all parcels (New York City Department of City Planning, 2009). The reasoning is that with the [false] security that parking demand associated with new development will not create additional shortages, existing residents will find new development less objectionable (Hornick, 2010). To the extent that additional driving is the product of increased parking supply these residents may be trading parking ease for traffic congestion and additional energy consumption. Furthermore, on-site parking requires curb access, which reduces existing parking supply (Weinberger et al., 2008b). Thus on-site parking requirements, which require ***thousands*** of ***curb-cuts***, far from protecting existing residents' enjoyment of the street system, compromise that enjoyment on two counts.

A potentially important technical question that has not been addressed in this research is that of location self-selection. While it is highly conceivable that people who prefer to drive will self-select into districts that provide a high level of service for auto use—including ample protected parking, the question is not actually very important for policy considerations. For precisely this reason one could conclude from the research that parking should be more restricted in transit rich zones. McDonnell et al., 2009 show, for example, that in the New York City case, more parking per square foot of development is required in the most transit rich neighborhoods. From a policy perspective, householders with a strong preference to drive should be discouraged from transit rich areas because they potentially "waste" the transit resource.

Cities have long had the intuition that reducing parking requirements, indeed implementing parking maximums, will have the effect of reducing auto use. This is the primary rationale behind implementing parking maximums as part of several cities' efforts to comply with Clean Air Act requirements. Until now, that intuition has not been verified. Armed with new knowledge that minimum parking requirements will lead to additional driving, cities, particularly those in non-attainment for air quality standards and those seeking to increase use of transport modes that are more energy and space efficient than private automobiles, should consider this information when crafting their residential parking policies.

Acknowledgement

Many heartfelt thanks to Sadamitsu Sakoguchi without whose able assistance and dedication to data collection this project would not have been possible. Thanks to Amy Pfeiffer for her assistance in field checking the aerial data collection. Thanks also to Drs. Tony Smith and Gretchen Ostheimer and to the anonymous reviewers for their very valuable input and comments on early drafts and, finally, to Penelope Weinberger for her careful proof-reading. All errors and omissions are mine alone.

TABLES

Table 1

	B	S. E.	Wald	Sig.	Exp(B)
Constant	−2.810	.557	25.407	.000	.060
Building age square	−.001	.000	89.131	.000	.999

Hornick, 2010 Hornick, 2010. Hornick, Samuel, 2010. Parking Reform and Land Use Planning. Rudin Center for Transportation and Policy Management: Thinking and Doing Breakfast Series.

New York City Department of City Planning, 2009 New York City Department of City Planning, 2009. New York City Department of City Planning; Zoning Handbook; New York City Department of City Planning, New York City (2009), .

McDonnell et al., 2009 McDonnell et al., 2009. McDonnell, Simon, Josiah, Madar, Vicki, Been, 2009. Minimum parking requirements and housing affordability in New York City. In: Presented at the Transportation Research Board Annual Meeting.

	B	S. E.	Wald	Sig.	Exp(B)
Building age	.058	.010	36.430	.000	1.060
Brooklyn (0,1)	−.244	.123	3.958	.047	.783
Residential sq. ft	.001	.000	27.918	.000	1.001
Built FAR	−1.137	.197	33.454	.000	.321
Number of buildings on lot	1.149	.160	51.282	.000	3.156
Zoning designation:					
DR6B	.844	.382	4.893	.027	2.326
DR6	.702	.306	5.256	.022	2.017
DR7_1	1.115	.358	9.705	.002	3.050
DR5B	1.364	.412	10.956	.001	3.910
DM1_1	1.791	.576	9.671	.002	5.995
DR3_1	.771	.383	4.048	.044	2.161
DR5	1.312	.292	20.195	.000	3.713
DR5A	1.177	.561	4.396	.036	3.243
DR4_1	.996	.363	7.548	.006	2.709
DR4A	1.166	.438	7.097	.008	3.209
DR2	.902	.356	6.408	.011	2.465
DR3_2	1.512	.332	20.778	.000	4.538
DR3A	1.444	.411	12.361	.000	4.239
DR4	1.704	.314	29.460	.000	5.496
DR4B	1.624	.564	8.280	.004	5.074
DR3X	1.917	.827	5.374	.020	6.803
DR2A	1.664	.621	7.175	.007	5.283
Land use code one and two family	1.441	.250	33.193	.000	4.226
Building class code three family	1.417	.263	28.938	.000	4.125

On-site Parking Predictors.

Table 2

Parameter	Estimate	Std. Error	Significance
(Intercept)	−9.3	0.8386	***
Median age (tract)	−0.013	0.0012	***
Median year built (tract housing stock)	0.004	0.0004	***
Average household size	−0.087	0.0131	***
Percent government employees	2.618	0.1722	***
Transit access index (000s)	−0.306	0.0071	***
Percent households with at least one vehicle	2.294	0.0439	***
Median income (000s)	−0.011	0.0004	***
Percent population reporting Black Alone	−0.227	0.016	***
Off-street parking per dwelling unit	0.725	0.0333	***

Parameter estimates Model 1.

Dependent: Percent drivers to Manhattan core.

Log likelihood −19136.256.

□□□Statistically significant at α 0.01.

Table 3

Parameter	First stage: auto ownership	Second stage: percent drive to work in Manhattan				
	Estimate	Std. Error	Significance	Estimate	Std. Error	Significance
Constant/Intercept	0.145	0.044	***	−1.161	0.1052	***
Average household size	0.036	0.008	***	−0.089	0.0161	***
Percent housing owner occupied	0.292	0.020	***	0.647	0.0610	***
Median age (tract)	0.002	0.001	***	−0.012	0.0013	***
Percent population reporting race “White Alone”	0.041	0.015	***	0.128	0.0317	***
Percent population reporting race “Black Alone”	−0.043	0.013	***	−0.188	0.0293	***
Transit accessibility in ***thousands***	−0.054	0.003	***	−0.365	0.0100	***
Income in ***thousands***	0.002	2.51E−04	***	−0.010	0.0006	***
Percent government employees	−0.125	0.073	□	2.317	0.1767	***
Off-street parking per dwelling unit	0.140	0.018	***	0.740	0.0417	***
Percent movers from different MSA	0.241	0.094	**			
Percent movers from different MSA center city	−0.952	0.175	***			
Percent employed adults	0.444	0.032	***			
Population density	−0.025	0.002	***			
Percent households with				1.267	0.1294	***

Parameter	First stage: auto ownership	Second stage: percent drive to work in Manhattan				
	Estimate	Std. Error	Significance	Estimate	Std. Error	Significance
at least one vehicle						
First stage residual				1.129	0.1420	***

Parameter estimates Model 2.

Log-likelihood −19813.561.

□Statistically significant at α 0.1.

□□Statistically significant at α 0.5.

□□□Statistically significant at α 0.01.

CONTACT: □ Tel.: +718 622 4371, +215 746 4263; fax: +215 898 5731.

References

Brown et al., 2009 Brown et al., 2009. Jeffrey R. Brown, Eric A. Morris, Brian D. Taylor; Planning for cars in cities: planners, engineers, and freeways in the 20th century; Journal of the American Planning Association; Vol. 75, No. 2; (2009), pp. 161-177.

Vaca and Richard Kuzmyak, 2005 Vaca and Richard Kuzmyak, 2005. Vaca, Erin, Richard Kuzmyak, J., 2005. Chapter 13—Parking Prices and Fees. TCRP Report 95 Traveler Response to Transportation System Changes, Transportation Cooperative Research Program. Transportation Research Board, Washington, DC.

Kuzmyak et al., 2003 Kuzmyak et al., 2003. Kuzmyak, J. Richard, Weinberger, Rachel, Pratt, Richard, Herbert, Levinson, 2003. Chapter 18—Parking Managment and Supply. Transit Cooperative Research Program (TCRP) Report 95: Traveler Response to Transportation System Changes. Transportation Research Board, Washington, DC.

Shoup, 1995 Shoup, 1995. Donald Shoup; An opportunity to reduce minimum parking requirements; Journal of the American Planning Association; Vol. 61, No. 1; (1995), pp. 14-28.

Ison and Rye, 2006 Ison and Rye, 2006. Stephen Ison, Tom Rye; Parking: parking; Transport Policy; Vol. 13, No. 6; (2006), pp. 445-446.

Stubbs, 2002 Stubbs, 2002. Michael Stubbs; Car parking and residential development: sustainability, design and planning policy, and public perceptions of parking provision; Journal of Urban Design; Vol. 7, No. 2; (2002), pp. 213-237.

Weinberger et al., 2008a Weinberger et al., 2008a. Rachel Weinberger, Mark Seaman, Carolyn Johnson; Suburbanizing the City: How New York City Parking Requirements Lead to More Driving; Transportation Alternatives, New York (2008), .

Weinberger et al., 2008b Weinberger et al., 2008b. Rachel Weinberger, Mark Seaman, Carolyn Johnson, John Kaehny; Guaranteed Parking—Guaranteed Driving: Comparing Jackson Heights, Queens and Park Slope,

Brooklyn Shows that a Guaranteed Parking Spot at Home Leads to More Driving to Work; Transportation Alternatives, New York (2008), .

Weinberger et al., 2009 Weinberger et al., 2009. Rachel Weinberger, Mark Seaman, Carolyn Johnson; Residential off-street parking impacts on car ownership, vehicle miles traveled, and related carbon emissions: New York City case study; Transportation Research Record; Vol. 2118, (2009), pp. 24-30.

Google, 2008a Google, 2008a. Google, “Google Earth”. Web page. Available at 〈*http://earth.google.com/*〉 (accessed 2008a).

Google, 2008b Google, 2008b. Google, “Google Maps”. Web page. Available at 〈*http://maps.google.com/*〉 (accessed 2008b).

Microsoft Corporation, 2008 Microsoft Corporation, 2008. Microsoft Corporation, Bing Maps. Web page. Available at 〈*http://www.bing.com/maps/*〉 *(accessed* 2008).

New York City Department of City Planning, 2007 New York City Department of City Planning, 2007. New York City Department of City Planning; Primary Land Use Tax Lot Output (PLUTO); New York City Department of City Planning, New York City (2007), .

Hess, 2001 Hess, 2001. D.B. Hess; Effect of free parking on commuter mode choice—evidence from travel diary data; Transportation Research Record; Vol. 1953, (2001), pp. 35-42.

Golias et al., 2002 Golias et al., 2002. John Golias, George Yannis, Michel Harvatis; Off-street parking choice sensitivity; Transportation Planning & Technology; Vol. 25, No. 4; (2002), pp. 333-348.

Beunen et al., 2006 Beunen et al., 2006. R. Beunen, C.F. Jaarsma, H.D. Regnerus; Evaluating the effects of parking policy measures in nature areas; Journal of Transport Geography; Vol. 14, No. 5; (2006), pp. 376-383.

Newmark and Shiftan, 2007 Newmark and Shiftan, 2007. G.L. Newmark, Y. Shiftan; Examining shoppers' stated willingness to pay for parking at suburban malls; Transportation Research Record; Vol. 2010, (2007), pp. 94-103.

Kelly and Clinch, 2006 Kelly and Clinch, 2006. J.A. Kelly, J.P. Clinch; Influence of varied parking tariffs on parking occupancy levels by trip purpose; Transport Policy; Vol. 13, No. 6; (2006), pp. 487-495.

Kelly and Peter Clinch, 2009 Kelly and Peter Clinch, 2009. J. Andrew Kelly, J. Peter Clinch; Temporal variance of revealed preference on-street parking price elasticity; Transport Policy; Vol. 16, No. 4; (2009), pp. 193-199.

Gillen, 1978 Gillen, 1978. D.W. Gillen; Parking policy, parking location decisions and distribution of congestion; Transportation; Vol. 7, No. 1; (1978), pp. 69-85.

Baldassare et al., 1998 Baldassare et al., 1998. M. Baldassare, S. Ryan, C. Katz; Suburban attitudes toward policies aimed at reducing solo driving; Transportation; Vol. 25, No. 1; (1998), pp. 99-117.

Shiftan and Golani, 2005 Shiftan and Golani, 2005. Y. Shiftan, A. Golani; Effect of Auto Restraint Policies on Travel Behavior; Vol. 1932, (2005), pp. 156-163.

Albert and Mahalel, 2006 Albert and Mahalel, 2006. Gila Albert, David Mahalel; Congestion tolls and parking fees: a comparison of the potential effect on travel behavior: parking; Transport Policy; Vol. 13, No. 6; (2006), pp. 496-502.

Willson, 1997 Willson, 1997. R.W. Willson; Parking pricing without tears: trip reduction programs; Transportation Quarterly; Vol. 51, No. 1; (1997), pp. 79-90.

Aldridge et al., 2006 Aldridge et al., 2006. K. Aldridge, M. Carreno, S. Ison, T. Rye, I. Straker; Car parking management at airports: a special case? Parking; Transport Policy; Vol. 13, No. 6; (2006), pp. 511-521.

Vovsha and Petersen, 2009 Vovsha and Petersen, 2009. P. Vovsha, E. Petersen; Model for person and household mobility attributes; Transportation Research Record; Vol. 2132, (2009), pp. 95-105.

Shoup, 2005 Shoup, 2005. Donald C. Shoup; The High Cost of Free Parking; American Planning Association, Chicago, III (2005), .

Watters et al., 2006 Watters et al., 2006. Paul Watters, Margaret O'Mahony, Brian Caulfield; Response to cash outs for work place parking and work place parking charges: parking; Transport Policy; Vol. 13, No. 6; (2006), pp. 503-510.

Marsden, 2006 Marsden, 2006. G. Marsden; The evidence base for parking policies—a review; Transport Policy; Vol. 13, No. 6; (2006), pp. 447-457.

Garrick and Christopher, 2009 Garrick and Christopher, 2009. Garrick, Norman, Christopher, McCahill, 2009. Hartford: It's a Parking Place—Tripling Space for Cars hasn't Helped City Prosper—It's Only Devalued Downtown. Hartford Courant (sec. on-line version).

Nelson\Nygaard Consulting Associates, 2005 Nelson\Nygaard Consulting Associates, 2005. Nelson\Nygaard Consulting Associates, 2005. Center City Parking Evaluation Final Report. Philadelphia City Planning Commission, Philadelphia, PA.

Arnott and Inci, 2006 Arnott and Inci, 2006. Richard Arnott, Eren Inci; An integrated model of downtown parking and traffic congestion; Journal of Urban Economics; Vol. 60, No. 3; (2006), pp. 418-442.

Arnott and Rowse, 2009 Arnott and Rowse, 2009. Richard Arnott, John Rowse; Downtown parking in auto city; Regional Science and Urban Economics; Vol. 39, No. 1; (2009), pp. 1-14.

Shoup, 2006 Shoup, 2006. Donald C. Shoup; Cruising for parking: parking; Transport Policy; Vol. 13, No. 6; (2006), pp. 479-486.

Albanese and DiBella, 2009 Albanese and DiBella, 2009. Massimo Albanese, Enrico DiBella; Possible impacts of parking pricing policies: the case of blue lined area in Genoa; International Journal of Transport Economics; Vol. 36, No. 3; (2009), pp. 301-335.

Jia and Wachs, 1999 Jia and Wachs, 1999. Wenyu Jia, Martin Wachs; Parking requirements and housing affordability: a case study of San Francisco; Transportation Research Record; Vol. 1685, (1999), pp. 156-160.

Jung, Owen. 2009 Jung, Owen. 2009. Jung, Owen. (2009) Who is Really Paying for your Parking Space?

Unpublished Thesis. University of Alberta. 〈https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=CEA2010&paper_id=378〉 (accessed 2008)

Litman, 2010 Litman, 2010. Todd Litman; Parking Requirment Impacts on Housing Affordability; Victoria Transport Policy Institute, Victoria, British Columbia (2010), .

Balcombe and York, 1993 Balcombe and York, 1993. Balcombe, R.J., York, I.O., 1993. The Future of Residential Parking. Project Report. Transport Research Laboratory, Crowthorne, Berkshire, UK (Cited in Marsden (2006)).

SPSS Inc, 2008 SPSS Inc, 2008. SPSS Inc., 2008. SPSS for Windows Release 12.0.0. Chicago, Il.

New York City Department of City Planning, 2008 New York City Department of City Planning, 2008. New York City Department of City Planning, 2008. Primary Land Use Tax lot Output (PLUTO) Data Dictionary. Ver. 2007c. New York City, New York City Department of City Planning.

Guevara and Ben-Akiva, 2006 Guevara and Ben-Akiva, 2006. Christian Guevara, Moshe Ben-Akiva; Endogeneity in residential location choice models; Transportation Research Record; Vol. 1977, (2006), pp. 60-66.

Weinberger and Goetzke, 2010 Weinberger and Goetzke, 2010. Rachel Weinberger, Frank Goetzke; Unpacking preference: how previous experience affects auto ownership; Urban Studies; Vol. 47, No. 10; (2010), pp. 2111-2128.

Goetzke and Rachel, 2011 Goetzke and Rachel, 2011. Goetzke, Frank, Rachel, Weinberger, 2011. Separating contextual from endogenous effects in automobile ownership models. In: Presented at the Transportation Research Board Annual Meeting.

Schaller, 2006 Schaller, 2006. Bruce Schaller; Necessity or Choice? Why People Drive in Manhattan; Transportation Alternatives, New York (2006), .

Hornick, 2010 Hornick, 2010. Hornick, Samuel, 2010. Parking Reform and Land Use Planning. Rudin Center for Transportation and Policy Management: Thinking and Doing Breakfast Series.

New York City Department of City Planning, 2009 New York City Department of City Planning, 2009. New York City Department of City Planning; Zoning Handbook; New York City Department of City Planning, New York City (2009), .

McDonnell et al., 2009 McDonnell et al., 2009. McDonnell, Simon, Josiah, Madar, Vicki, Been, 2009. Minimum parking requirements and housing affordability in New York City. In: Presented at the Transportation Research Board Annual Meeting.

Classification

Language: ENGLISH

Document Type: Full-length article

Publication Type: Other (Journal)

Journal Code: JTRP

Subject: BUILDING & HOUSING CODES (89%); ZONING (89%); LAND USE & DEVELOPMENT (88%); CONSTRUCTION LAW (87%); Parking; Residential parking; Travel behavior; Mode choice

Industry: BUILDING & HOUSING CODES (89%); PARKING SPACES & FACILITIES (89%); ZONING (89%); CONSTRUCTION (87%); CONSTRUCTION LAW (87%); (87%); VEHICLE TRAFFIC (78%); RAIL STATIONS & TERMINALS (73%); HIGHWAYS & STREETS (68%)

Geographic: UNITED STATES (92%)

Load-Date: March 28, 2012

Transport Policy
Copyright 2011 Elsevier Ltd All Rights Reserved

End of Document