Factors Associate with Students' Parking-Pass Decisions: Evidence from an American University

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Sultana, S. Factors Associate with Students' Parking-Pass Decisions: Evidence from an American University. *Transport Policy*, 44 (Nov. 2015), 65-75.

Made available courtesy of Elsevier: https://doi.org/10.1016/j.tranpol.2015.07.002

Abstract:

The primary objective of this research is to provide an in-depth understanding about factors affecting university students' parking-pass purchase decisions by integrating concepts and variables developed in various disciplines. A sample of 2253 undergraduate students at the University of North Carolina at Greensboro (UNCG) collected through a web-based survey is used for this study. Results from cross-tabulation analysis and logistic regression indicate that parking-pass purchase decisions are largely determined by students' car ownership, daily car-use habits, and faster mobility needs despite viable alternatives. Conversely purchase decisions have little relation to gender, race/ethnicity, income, and environmental concerns. Holding a parking pass fulfilled students' aspirations seeking safety, reliability, flexibility, spontaneity, and mobility. Most importantly, socio-economic status and psychological motives of car use have the greatest magnitude of predicting parking-permit purchases, while the built environment where students live has a minor influence.

Keywords: Car use habits | Parking pass | Built-environment | Environmental beliefs | University students commuting | Gender | UNCG

Article:

1. Introduction

Concerns over climate change have brought consensus on reducing greenhouse gas (GHG) emissions on American college and university campuses (American Colleges and Universities President's Climate Commitment (ACUPCC), 2007). Acknowledging this responsibility, the University of North Carolina (UNC) system is mandated to be carbon neutral by AD 2050 (McDonald, 2013). Since transportation-related GHG emissions are currently the second largest contributor of a university's carbon footprint (Bonham and Koth, 2010), substantial measures have been adopted including alternative transportation to campus and no additional parking capacity for reducing the domination of auto-commuting. The expectation is that these measures

will encourage students to switch their travel-mode choices away from single-passenger car drivers. However, these passive-approach policies have had limited success in changing university students' commuting behaviors (Miralles-Guasch and Domene, 2010), suggesting intervention is required to make significant changes in transportation mode choices.

Previous studies (e.g., Balsas, 2003; Shannon et al., 2006; Delmelle and Delmelle, 2012) suggest parking permit possession is a critical factor for university students' travel-mode choice decisions. Hence, parking space reduction intervention strategy seems to be the most effective to reduce car use as it is the case in Europe, yet there has been limited implementation of this strategy in the U.S. From a transportation-equity perspective, reducing parking space capacity is an ineffective strategy, unless adequate alternatives are provided. Raising parking prices has also been proposed to change travel-mode choices from cars. However, the effectiveness of this program is low (Shiftan and Golani, 2005, Watters et al., 2006) and even may have negative consequences (Shiftan and Burd-Eden, 2001) as higher parking prices may be a factor in students' decisions on which university to attend. Therefore, if parking scarcity was among the challenging issues that many university campuses across the U.S. faced in the last quarter of 20th century (Shoup, 2005), a challenging task in the 21st century at American universities will be reducing on-campus parking spaces.

An in-depth understanding about the factors influencing students' parking-pass purchase decisions is necessary to implement successful measures for reducing campus parking space. Ignoring this issue is worrisome since successful implementation of modal switch seems to be influenced by the availability of campus parking spaces (Shoup, 2005). Thus, the primary objective of this research is to evaluate factors that increase the odds of parking-pass purchase decisions among university students by integrating concepts and variables developed for explaining car-use behaviors in multiple disciplines. While numbers of previous research have investigated the effect of availability of parking spaces and prices on car use (e.g., Shiftan and Burd-Eden, 2001; Shiftan and Golani, 2005), this research evaluates how parking-permit purchase decisions are impacted by a suite of factors including socio-economic and demographic, built environment, psychological (e.g., perceived mobility necessity needs, instrumental or symbolic–affective motives), habitual, and environmental beliefs based on data collected at the University of North Carolina at Greensboro (UNCG).

2. Literature review

There is a paucity of research for understanding university students' parking-pass purchase decisions. Though various disciplines including geography, transport and urban studies, social psychology, environmental science, and economics have tried to isolate the motive(s) of car use based on disciplinary perspective, the existing literature does not indicate whether car use and parking-pass purchase decisions are determined by the same factor(s). Thus, it is essential to discuss a complex combination of factors for reliance on cars for developing an appropriate conceptual framework of this research.

2.1. Urban form, parking policies and car use

There is consensus in the literature that low-density built environments with differing land uses and absent of sidewalks and bike lanes are the primary reasons for car use (Sultana and Weber, 2007, Ewing and Cervero, 2010). Many university campuses have developed transportation-network facilities conducive to alternative-mode choices (Balsas, 2003), but a lack of similar off-campus facilities also may affect university students' commute-mode choices (Miralles-Guasch and Domene, 2010). Studies that identified obstacles for cycling on university campuses (e.g., Shannon et al., 2006; Bonham and Koth, 2010) confirm that distance between homes to campus accounts for increased car use. As a result, distance is a crucial urban built environment factor for understanding, describing and predicting students' commuting mode choice.

Parking policies have traditionally been treated as exogenous variables regarding travel behavior research and only recently have been considered as critical factors related to travel-mode choice analysis (Van Exel and Rietveld, 2009). However, this topic has been gaining attention for managing car ownership and car use in Western Europe and to a lesser degree in the U.S.A. Using case studies of eight employers in Los Angeles, Shoup (2005) investigated how employer-provided parking affects employees' mode choices and found that free and low-priced parking increases workers' car use. Economic incentive programs such as “parking cash out” – where workers were paid the amount that their company subsidized for parking, if they chose not to drive to work – were successful and more effective than providing free-transit. Yet, this program was criticized for being long-term financially unfeasible and generally unappealing to higher income groups (Shiftan and Golani, 2005, Watters et al., 2006).

A number of studies also identified that parking space availability and cost partially affect car ownerships and housing locations, and mode choices in household activities (Habib et al., 2012, Guo, 2013). Free and available on street-parking encourages private car ownerships and car uses among households' found in a study based on New York City (Guo, 2013). Parking choice is a key factor nested within households' activity scheduling process in Montreal, Canada (Habib et al., 2012). University campuses with the highest number of parking spaces had the lowest percentages of non-motorized transportation; thus, reducing the availability of parking spaces and/or increasing prices leads to decreases in automobile use in favor of switching to other more sustainable-mode choices (Balsas, 2003). A recent case study based on an American university revealed that holding a parking permit is the greatest predictor of the university students' commuting behavior (Delmelle and Delmelle, 2012). Some studies also identified that if parking prices become an affordability issue, students will consider switching transportation mode from cars (Toor and Havlick, 2004, Delmelle and Delmelle, 2012). The case studies based on developed countries around the word reveal the same results: reducing availability of parking spaces and/or increasing prices leads to decreases in automobile use in favor of switching to other more sustainable-mode choices (Shiftan et al., 2003, Van Exel and Rietveld, 2009, Kodransky and Hermann, 2011).

2.2. Psychological and environmental values/attitudes and car use

Research from behavioral social psychology has identified psychological factors associated with car dependency including perceived mobility needs, instrumental-reasoned motives, and symbolic–affective motives (Steg, 2005, Lois and Lopez-Saez, 2009). The instrumental-reasoned motives related to car use are speed, shorter travel times, flexibility, and convenience. Symbolic–

affective motives are not explicitly studied as people are unlikely to admit that symbolic and affective aspects make car use more attractive. Symbolic values refer to the identity of a person such as social position, status, power, or expressing of one's self-identity (Steg, 2005). In contrast, affective motives refer to emotions evoked by driving a car such as feeling control of one's life and sense of freedom (Steg, 2005).

Individuals valuing cars as a higher mobility necessity use cars more often because they perceive alternative transportation modes as insufficient to meet their needs for flexibility and spontaneity. Thus, perceived mobility necessity can be more influential than actual mobility needs (Haustein and Hunecke, 2007). Steg (2005)examined the relative importance of symbolic affective as opposed to instrumental motives of car use by collecting data through a questionnaire survey in two cities in the Netherlands and concluded that car use fulfilled both the instrumental functions and symbolic and affective motives. Lois and Lopez-Saez (2009)concluded that neither mobility needs nor symbolic motivations have a direct effect on car use in Spain except when meditated by affective motivations. Thus, if a person scores high on car issues such as either speed and freedom or power and status, they are more inclined to use a car for daily travel if such appraisal caused positive affective experiences.

Daily transportation-mode choices are habitual and not always from the deliberation of alternative choices (Bamberg and Schmidt, 2003, Gardner and Abraham, 2007, Haustein et al., 2009). Based on a longitudinal study at the University of Giessen in Germany where prepaid bus tickets were given to the students as an intervention method, Bamberg and Schmidt (2003) found increased positive attitudes towards bus use and concluded that habitual mode-choice decision can be significantly altered by targeting one or more interventions. A meta-analysis that synthesized the findings of 23 studies also identified the strong effect of habit on car-use behavior (Gardner and Abraham, 2007). Researchers concluded that prior travel-mode choice contributes future travel behavior if circumstances remain stable (Haustein et al., 2009, Van Exel and Rietveld, 2009).

Additional transportation research has included environmental attitudes to predict car use revealing that environmental value orientation is correlated with pro-environmental behavior and people's willingness to reduce car use (Anable, 2005). Other findings argued that despite environmentalists' positive attitudes towards the environment and favorable opinions towards alternative-transportation modes, these individuals do not necessarily engage in environmentally favorable mode choices (Haustein et al., 2009). Likewise, Haustein and Hunecke (2007) concluded based on study in three large German cities that mobility-related attitudes and perceptions are better predictors of car use than environmental beliefs. Clearly, travel-mode choice associated with environmental values research is inconclusive.

2.3. Socio economic-demographic and household characteristics and car use

Theoretical and empirical research (e.g., Weber and Sultana, 2008; Schwanen and Karen, 2011) provides evidence that socio-economic and demographic characteristics of workers' such age, race, gender, income, home and car ownership have a larger influence than urban form on commuter mode choice. Car ownership is one of the strongest predictors for daily car use among adults in U.S (Matas and Raymond, 2008) and among university students in Thailand (Limanond

et al., 2011). The effect of social status on travel behavior and commuting research also shows that income influences the ability of individuals to own a car to overcome the distance constraints (Shiftan and Golani, 2005, Matas and Raymond, 2008). Young adults' (e.g., early 20s) motivation for car use is principally based on mobility needs as they are less willing than older adults to use cars for commuting and more willing to use public transit and non-motorized modes (Shiftan and Golani, 2005, Kuhnimhof et al., 2012, Schwartz, 2013).

There is evidence that gender differences in journey-to-work trips exist, as women tend to have shorter travel distances (Madden, 1981) and commuting times than men (Sultana, 2005), yet gender discussion is lacking in studies that involve factors associated with car use (Polk, 2004; Kuhnimhof et al., 2012). Studies based on German cities show women are more likely than men to exhibit pro-environmental behavior and hence use cars less often for trips (Matthies et al., 2002). However, gender differences in car travel were not observed in a study in Germany among young adults (Kuhnimhof et al., 2012). Lower car use among women may be an artifact of lower income and once economic factors are inoperative, women may be more emancipated from the potency of the car use as a symbol of freedom, privacy and safety (Polk, 2004, Matas and Raymond, 2008). Consistent with later argument, one study based on an American university students reported that females, especially those with children, are more likely to drive than male students (Delmelle and Delmelle, 2012) because of their higher perceived necessity for mobility and for trip chaining (i.e., one trip is linked together with the next trip).

In summary, each discipline has made distinct contributions for understanding the complexity of car use, yet there is paucity of integrative approaches (Schwanen and Karen, 2011). In addition, research is limited regarding American university students' transportation- mode choice and especially regarding parking-pass purchase decisions. Thus, the conceptual framework of this research is based on combination of concepts and variables developed in various disciplines to evaluate how parking-permit purchase decisions are impacted by those factors in a university setting. Specifically, I address these limitations by solely focusing on factors associated with university-issued parking permit purchase decisions instead of the effect(s) of parking policy on mode choice. I then use an incorporation of an additional synthesis of variables developed in various disciplines to identify a comprehensive view of the key motivation factors for universities seeking to reduce parking space.

3. Research design: setting, survey design and implementation

3.1. Setting

This study assumes students' parking-pass purchases are predetermined by their selective commute-mode choices and uses data collected at UNCG as case study. UNCG is a 215-acre campus located in an urban setting approximately one-mile SW of downtown Greensboro, NC (Fig. 1) and has the third-largest student body (18,647 in 2014–15 academic year) in the UNC System (Office of Institutional Research, 2015). There are approximately 7500 parking spaces at UNCG for students and faculty/staff that require parking permits. Of these parking spaces, 27% are dedicated as on-campus resident student parking, 34% are on-campus parking decks, 22% are commuter/surface parking, 13% are classified as park and ride, and about 4% are constituted as meter parking (POCAM, 2015). There are also approximately 800 free-parking spaces on

campus that do not require UNCG parking permits including no time-limit on-street parking, two-hour on-street parking, and off-campus on-street neighborhood parking near to campus. In addition, a parking permit is not required for parking decks with hourly charges. These pose some limitation on parking-pass purchase data as these free parking spaces are not captured in the data set.

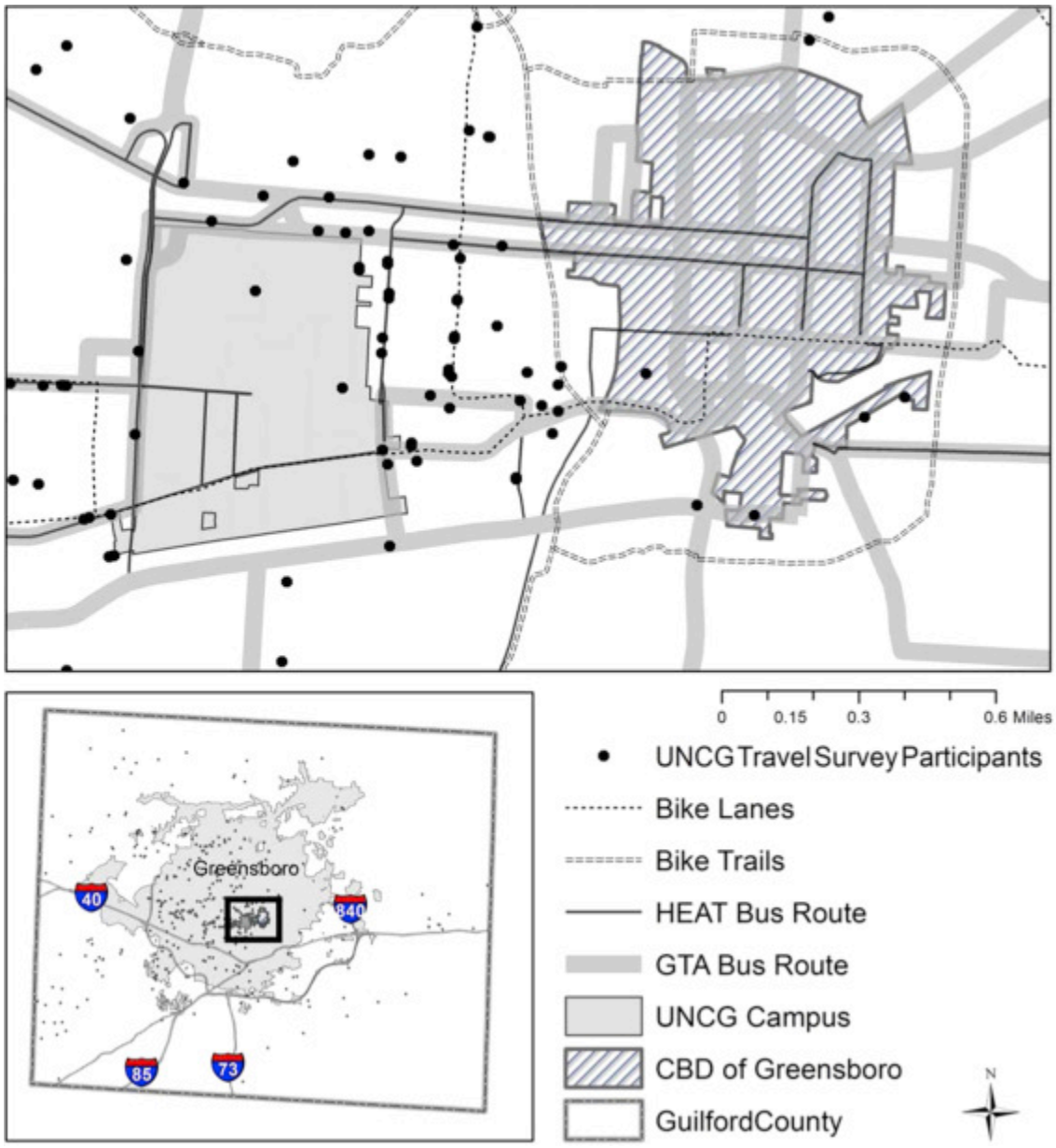

Fig. 1. Study area with participanting students' residential locations.

Various parking options are available to UNCG students with annual prices ranging from as $31 to $458 annually. Parking permit prices are based on convenience such as proximity to buildings and ease of finding a parking space at any time. In that sense, the campus parking decks offer the most convenient parking option and hence the most expensive parking permits to purchase at UNCG. Commuter/surface parking lots adjacent to the classroom buildings with an annual cost

of $311 offer ease of entry and exit for early morning classes, but may be difficult to find a space after 9 AM. The lowest cost parking purchase option are the Park and Ride lots located on the campus periphery, which are serviced by university shuttle every 20 min. Approximately, 6000 parking permits are issued each academic year (POCAM, 2015). During the peak demand, 86% parking spaces are utilized.

Transportation was identified the second largest contributor (30%) of GHG emissions with student commuting representing the largest (77%) transportation-related carbon footprint at UNCG (McDonald, 2013). In addition to no additional parking capacity since 2008, the campus has invested much effort building bicycle and walking networks, and has made campus accessible by a number of fare-free public transit systems including the Greensboro Transit Authority (GTA) and campus shuttle services. PART Express, the regional bus system connected with surrounding major cities and outlying counties also routes through UNCG. Emergency ride-home programs exist for encouraging carpooling and ride-sharing. There is also parking space reserved for low-emission vehicles. UNCG received recognition for a bike-friendly infrastructure and best workplace for commuter campus in the USA. Despite these efforts and successes, GHG emissions from student commuting remain a concern (McDonald, 2013) as UNCG strives for a more carbon-neutral campus. Yet, with insufficient information on what affects students' parking-pass purchase decisions, it is difficult to implement an effective strategy to promote changes in commuting behavior.

3.2. Survey design and data implementation

The target population was comprised from a sample of undergraduate students at UNCG enrolled during academic year 2009–10 and a volunteer web-based survey invitation was emailed to all undergraduate students in spring 2010. At that time, the total student enrollment was 17,540 and represented by 14,315 undergraduates of which 69% were female, 26% were minorities, and about 15% of the student population was classified as non-traditional (age 25+) students (Office of Institutional Research, 2015). To insure that research involving people followed federal regulations, human-subject approval for this proposal was obtained from the office of the Institutional Review Board (IRB) at UNCG. Students were asked to supply their university ID number as well as their current residential address, age, income, parental income, race/ethnicity, education, employment status, transportation mode, car availability in household, and housing information (rented or owned either by student or family). Household was defined as student living with people in a dwelling at that time survey was conducted. Additionally, a series of questions were asked regarding individual perceptions and attitudes about transit facilities, cycling and walking, and environmental beliefs using a five points Likert scale. Many of these data were collected as categorical variables and then were coded as dummy variables.

A total of 2274 students participated in the web survey. This dataset was then integrated with a Parking Operations and Campus Access Management dataset to distinguish which students bought parking permits by matching university ID numbers in both datasets. Twenty-one IDs provided by the respondents did not match with the university student ID in Campus Access Management dataset and were excluded from the study. The subsequent dataset of 2253 participants used for analysis represented approximately 16% of the undergraduate students at

UNCG. However, not all questions were answered by the participants or answered correctly, so records with missing values were excluded wherever it was appropriate for the analysis.

The home addresses of the survey respondents were geocoded to capture the built-environment of students' residential locations. Unfortunately, only 700 addresses were geocoded correctly and 506 of which were within Greensboro city limits, where UNCG is located (Fig. 1). Therefore, built-environment variables such as population density, sidewalk ratio, bicycle lane ratio, proximity to bus stops, as well as network distance to campus at students' home locations were interpolated at a raster grid (with 100×100 m^2 cells) only within Greensboro. All these calculations were performed using ArcGIS 9.3 Network Analyst. The resulting values were then assigned to each student. The expectation was that students who live in high-density areas with more sidewalks and bike lanes and in close proximity to bus stops are willing to use cars less often and hence, less willing to hold parking permits.

This research was geared towards identifying relative-odds ratio associated with having a parking permit between two groups of students (e.g., traditional vs. non-traditional, low-income vs. high-income students, etc). Thus, the collected variables were coded dichotomously. Mantel–Haenszel estimates of common-odds ratios were used from cross-tabulation analysis to interpret the results and assumed that both groups have equal odds ratios equal to 1. Odds ratios>1 suggest people are more likely purchase parking passes than those without that factors, while odds ratios<1 indicate people are less likely to purchase parking passes. Multivariate logistic regression was then used to further identify the most important variables that increased the odds of students' parking-pass purchase decisions while considering simultaneous effect of independent variables.

4. Results and discussion

4.1. Socio-demographic and mode of transportation characteristics of participating undergraduate students

The geographic distribution of residential location of 2253 participating students was represented by 86.9% reporting living off campus and 13.1% living on campus (Table 1). Female-student participation rates are disproportionately higher (77.6%) compared to the actual female undergraduate student-body population (69%) at UNCG. Full-time (90.4%) and traditional (69.4%) students were also major participants in this web-based survey. The participants' ethnic backgrounds were identified as non-Hispanic white (68.1%), African American (15.7%), Asian (4.8%), Native American and Pacific Islander (4.5%), multiracial (4.3%), and Hispanic (2.6%).

Students (1782) who reported their transportation mode to campus, 62.7% identified single-passenger vehicle as their predominant transportation mode followed by 5.7% carpooled, but only 37.4% of these auto-commuters held parking permits. This survey revealed that despite a large proportion of regular auto-commuters from all distance parameters, approximately half of these students did not have a parking pass (Fig. 2). While 22.3% survey participants reported they walked regularly to campus, 3.7% reported biked to campus. Another 5.7% students used transit regularly (Table 1). The majority parking permit holders had either commuter/surface (28.4%) or park-and-ride (28.0%) passes. A significant percentage of students also held campus

parking deck (21.9%), or resident (20.4%) parking permits. These numbers clearly suggest majority UNCG students chose parking perking permits based on ease of finding a parking space and convenience instead of cost savings.

Table 1. Descriptive analysis on participating students' basic demographic characteristics.

Basic characteristics of students		**Respondents (*n*)**	**Percent valid respondents**	**Total valid sample (*N*)**	**Missing**
Purchased parking pass	Yes	842	37.4	2253(100%)	0
	No	1411	62.6		
Car ownership	Yes	1572	88.2	1782(79.1%)	471(20.9%)
	No	210	11.1		
Types of parking pass	Resident	172	20.4		
	On campus parking deck	184	21.9		
	Commuter/surface parking	239	28.4	842(37%)	1411(72.6%)
	Park and ride	236	28.0		
	Evening	11	1.3		
Mode of transportation to campus	Walk	379	22.3		
	Bike	66	3.7		
	Transit or other	101	5.7	1782(79.1%)	471(20.9%)
	Carpool	101	5.7		
	Drove alone	1117	62.7		
Living choice	On-campus	258	13.1	1975(87.7%)	278(12.3%)
	Off-campus	1717	86.9		
Gender	Male	455	22.4	2035(90.3%)	218(9.7%)
	Female	1580	77.6		
Age	Traditional students (<=25 years old)	1419	69.4	2046(90.8%)	207(9.2%)
	Non-traditional (=>25 years old)	627	30.6		
Race	White	1376	68.1		
	Black/African American	317	15.7		
	Asian	97	4.8	2021(89.7%)	232(10.3%)
	Hispanic	55	2.7		
	Multicultural	86	4.3		
	Native Am, Pacific Island & other	90	4.5		
Student status	Full-time	1739	90.4	1923(85.4%)	330(14.6%)
	Part-time	184	9.6		

4.2. Cross-tabulation analysis: relative odds factors that increase parking pass purchase

4.2.1. Influence of socio-demographics and living choices

The basic demographics of the group that have higher probability to possess a parking pass are students who enroll full-time, own a car, live in a home either owned by themselves or their parents, female, non-Hispanic whites, and parents earning more than $50,000 annually (Table 2). Car ownership increases mobility and hence increases the highest odd of parking permits purchase among students reflected by the fact that UNCG Students are 800% more likely to have a parking permit if they own a car (Table 2). The odds of purchasing a parking pass increase (57%) if students residing homes are owned either by themselves or by their parents (Table 2). In this scenario, savings on housing costs may exceed the costs of parking permits or these students may have less flexibility to live nearby campus.

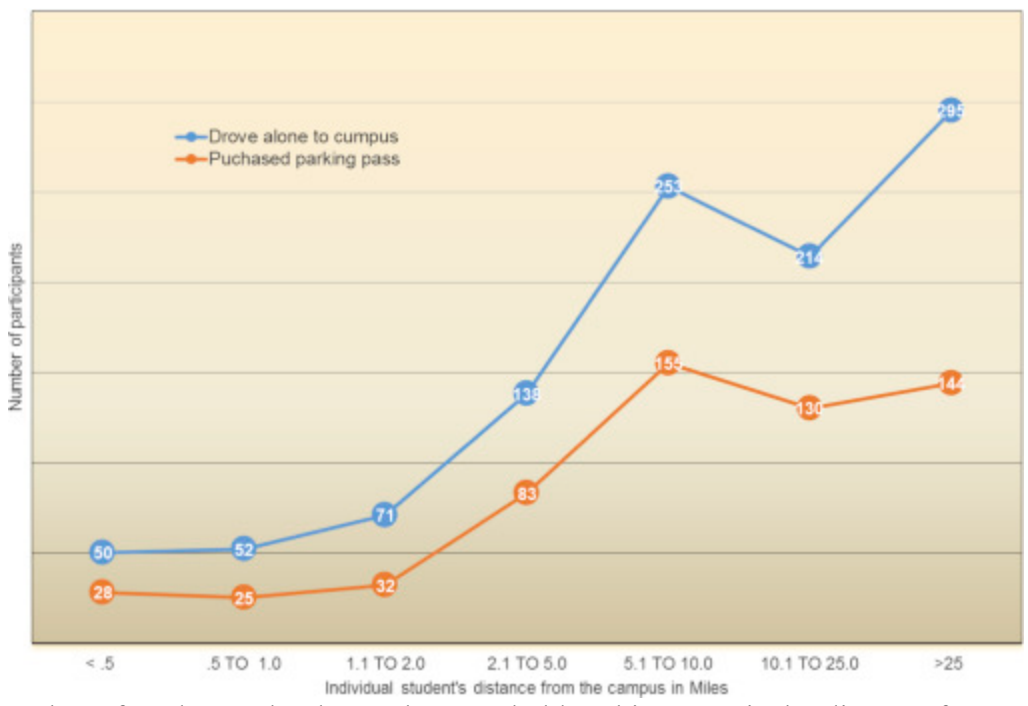

Fig. 2. Number of students who drove alone vs. held parking permits by distance from campus.

Table 2. Cross-tabulation analysis[a].

Variable	Dichotomous	Bought parking pass		Chi-square test	Mantel–Haenszel odds ratio estimate		
		Yes	No		Estimate	Lower bound	Upper bound
Socio-economic-demographic and living choice/built-enviroment variables							
Full-time vs. part-time students	Part-time=0	29.9% (*n*=55)	70.1% (*n*=129)	8.73	1.64	1.18	2.27
	Full-time=1	41.1% (*n*=715)	58.9% (*n*=1024)				
Gender	Male=0	34.7% (*n*=158)	65.3% (*n*=297)	3.48	1.23	.99	1.52
	Female=1	39.6% (*n*=625)	60.4% (*n*=955)				
Race	Black/African American=0	30.6% (*n*=97)	69.4 (*n*=220)	12.48	1.60	1.23	2.07
	White=1	41.4% (*n*=569)	58.6% (*n*=807)				
	All minority=0	32.6% (*n*=210)	67.4% (*n*=435)	14.33	1.46	1.20	1.78
Parents' income	<=50,000=0	37.3% (*n*=190)	62.7% (*n*=320)	4.52	1.33	1.02	1.72
	=>50,001=1	44.1% (*n*=190)	55.9% (*n*=241)				
Own a car	No=0	9.0% (*n*=19)	91.0% (*n*=191)	95.09	7.95	4.91	12.86
	Yes=1	44.1% (*n*=694)	55.9% (*n*=878)				
Current residence	On-campus=0	49.2% (*n*=127)	50.8% (*n*=131)	13.21	.616	.744	.801
	Off-campus=1	37.4% (*n*=642)	62.6% (*n*=1075)				
Distance from campus (off-campus students)	<5 miles=0	25.1% (*n*=168)	74.9% (*n*=502)	92.92	2.89	2.32	3.60
	>5 miles=1	49.2% (*n*=429)	50.5% (*n*=443)				
Had sidewalk at students' home location	No=0	41.1% (*n*=509)	58.9% (*n*=729)	4.475	.81	.661	.984
	Yes=1	36.0% (*n*=223)	64.0% (*n*=396)				
Home ownership	Rent=0	33.9% (*n*=334)	66.1% (*n*=652)	20.91	1.57	1.29	1.90
	Own=1	44.6% (*n*=342)	55.4% (*n*=425)				
Most important reason for current home location	Convenient to campus=0	32.4% (*n*=160)	67.6% (*n*=334)	5.41	1.35	1.04	1.74
	Cost/price of home=1	39.3% (*n*=220)	60.7% (*n*=340)				
	Other =1	44.1% (*n*=161)	55.9% (*n*=204)	12.32	1.64	1.24	2.17
Travel destination after campus activities	Home=0	33/0% (*n*=248)	67.0% (*n*=906)	9.49	1.35	1.11	1.60
	Other places=1	39.6% (*n*=596)	60.4% (*n*=904)				
Psychological variables: habitude, attitudes, and perceptions about cars							
The most dominant mode of transportation to campus	Other=0	21.7% (*n*=144)	78.3% (*n*=521)	148.95	3.76	3.02	4.68
	Car=1	50.9% (*n*=569)	49.1% (*n*=548)				
The most important reason to travel by a car	Other=0	31.8% (*n*=210)	68.2% (*n*=450)	29.32	1.74	1.42	2.13
	Faster=1	44.8 (*n*=503)	55.2% (*n*=619)				
Main mode of transport in HS	Other=0	34.8% (*n*=285)	65.2% (*n*=533)	12.83	1.41	1.17	1.71
	Car=1	43.0% (*n*=447)	57.0% (*n*=592)				
Environmental believes and attitudes							
Consider an environmentalist	Strongly disagree=0	44.1% (*n*=219)	55.9% (*n*=278)	7.77	.71	.56	.91
	Strongly agree=1	35.9% (*n*=231)	64.1% (*n*=278)				
Need to stop global warming even if it means raising gasoline price and taxes	Strongly disagree=0	44.5% (*n*=211)	55% (*n*=263)	4.83	.77	.60	.97
	Strongly agree=1	38.0% (*n*=256)	62.0% (*n*=263)				
America is more danger from global warming than from terrorists	Strongly disagree=0	45.7% (*n*=175)	54.3% (*n*=208)	5.87	.74	.58	.94
	Strongly agree=1	38.3% (*n*=321)	61.6% (*n*=516)				
Consider an environmentalist in practice	Strongly disagree=0	41.5% (*n*=94)	58.5% (*n*=134)	.585	.99	.67	1.20
	Strongly agree=1	38.7% (*n*=375)	61.3% (*n*=593)				
Consider moving close to campus to reduce GHG emission from transportation	Yes=0	32.9% (*n*=160)	67.1% (*n*=327)	5.82	1.34	1.06	1.70
	No=1	39.6% (*n*=303)	60.4% (*n*=462)				
Consider moving close to campus to save commute time and cost	Yes=0	32.8% (*n*=206)	67.2% (*n*=423)	9.35	1.42	1.13	1.78
	No=1	40.9% (*n*=279)	59.1% (*n*=403)				

[a]Table only contains those variables which are statically significant at *p Value=<.05.

Living choice variables that significantly influence on parking purchase decisions are: home location – off-campus vs. on-campus, distance from campus, sidewalk at home locations, and convenience is the most important reason for current home location (Table 2). Surprisingly, off-campus students were 39% less likely to purchase a parking pass than on-campus residents. This is most likely because a parking permit is required for on-campus students to have their own cars on campus. This survey data reveals that the possession of students' parking permit starts increasing two miles distance from campus and significantly increases after five miles distance from campus (Fig. 2). Based on the survey data, the average distance that UNCG students travel to campus is five miles and thus, the distance variable is coded dichotomously based on the average distance parameter. Students living more than five miles from the campus have 189% greater odds of purchasing a parking pass than students who live less than five miles range from the campus. Sidewalks at students' home locations make a slight (19% less likely) difference on parking-pass purchase decisions. Related, survey participants were asked to give the most important reason for choosing their current home location and the majority participants reported that their choice was based on cost followed by convenience to the UNCG campus. That said it is expected that students were less likely to buy parking passes when home location choice was based on campus convenience rather than cost savings or other reasons (Table 2).

Students were asked to provide their travel destinations after completing on-campus classes to identify whether parking purchase decisions can be complicated by activities at the end of class. The majority (67%) of students reported they travel home, followed by other places (24%), work (8%), and daycare (1%). The participants were advised to be specific if they choose “other places” as many conduct trip-chains either to pick-up children from afterschool program (not daycare) or to complete errands. Students going to other destinations are more likely use cars to travel to campus because of higher perceived necessity to be mobile for trip chaining. Therefore, destinations after leaving campus variables were recoded into dichotomous variables, home=0; All other places=1. Students traveling to destinations other than directly to home are more likely buy parking passes, and this result is consistent with prior studies that argued that car use increases with higher perceived necessity to be mobile for trip chaining (Schwanen and Karen, 2011).

4.2.2. Influence of psychological variables and perceptions/attitudes about cars and transit

A set of psychological variables such as car use habits, perceived mobility necessity needs, instrumental or symbolic–affective motives may increase the odds of having a parking permit among the students. Habitual car users are referred to those students that use a car as their most dominant commute mode to campus. The odds-ratio value suggests that habitual car users were 400% more likely to hold a parking permit (Table 2). Of these habitual drivers, faster mobility need was identified as the most important reason for driving to campus and these drivers are 74% more likely to buy parking passes (Table 2 and Fig. 3). Similarly, a history of car use in high school increases the odds (41%) of purchasing a parking permit compared to those who used other modes of transportation in high school (Table 2). These findings are consistent with existing literature (Haustein et al., 2009) that also determined prior car-use habits affect current commute mode choices.

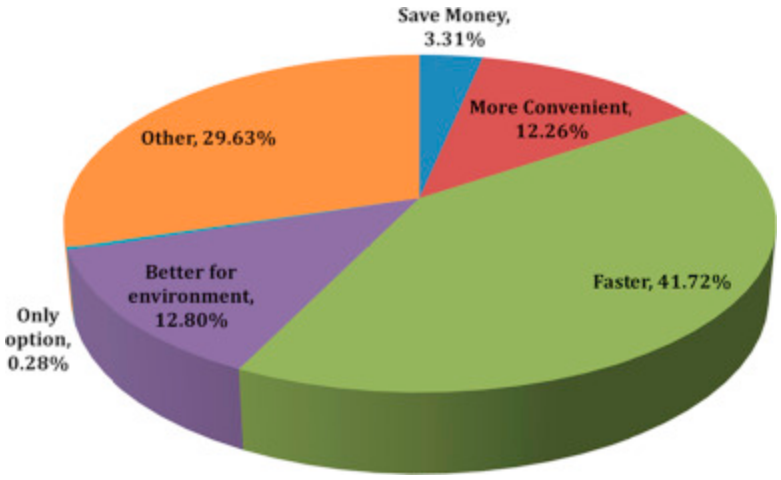

Fig. 3. The most important reason for driving to UNCG campus.

Students' affective motives of safety, availability and reliability of transit may also affect their decision to purchase a parking permit (Bamberg and Schmidt, 2003). Therefore, survey participants were asked to provide specific answers if "other" was chosen as reason for driving to campus (Fig. 3). Unavailability, unreliability, and safety concerns about transit were the "other" most widely cited reasons (30%). A significant number (about 99% of all "other" respondents) of students reported, "Public transportation is not dependable and I am busy and can't wait for bus. PART Bus [local bus] does not run late enough for evening classes" or similar words to that effect. Students also had safety concerns about public transit such as "I work late nights on campus and I didn't feel safe waiting around for public transportation to pick me up." Another student reported "I drive to my night class because I do not like to walk back to my apartment in the dark, not enough street lights and it doesn't feel as safe as it does in the day time." None mentioned they drive to campus for symbol of power and status. Therefore, young adults' (e.g., early 20s) motivation for car use is principally based on mobility needs, not from the motivation of power and status (Kuhnimhof et al., 2012).

4.2.3. Influence of environmental perspectives

A series of environmental beliefs and practice questions were asked in the survey. Pro-environmental statements have significant impacts on a student's parking-pass purchase decisions. The odds of purchasing a parking permit are reduced 29% if students hold pro-environmental perspectives (Table 2). Concurrently, this study demonstrates that environmentalists in practice do not always follow environmentally friendly behavior in life as no significant difference on parking-pass purchase decisions were linked to environmentalist in practice statement (Table 2). Students were asked to provide reasons if they would consider moving closer to campus. Of these students who responded to the question, 26% wished to move closer to campus to reduce GHG emission; whereas, 34% wished to move closer to campus for time and transportation-cost savings (Fig. 4). Clearly, economic and time benefits had higher relative odds of reducing parking purchase decision compared to environmental beliefs (Table 2). The likelihood of a parking-pass purchase would be reduced by 42% if students consider moving closer to campus to save time and cost from transportation. In contrast, students who consider moving close to campus for reducing GHG emission were 34% less likely to buy the parking pass (Table 2). This is consistent with the other research that argued that people are more

concerned with their own well-being than environmentally relevant behavior (Haustein and Hunecke, 2007).

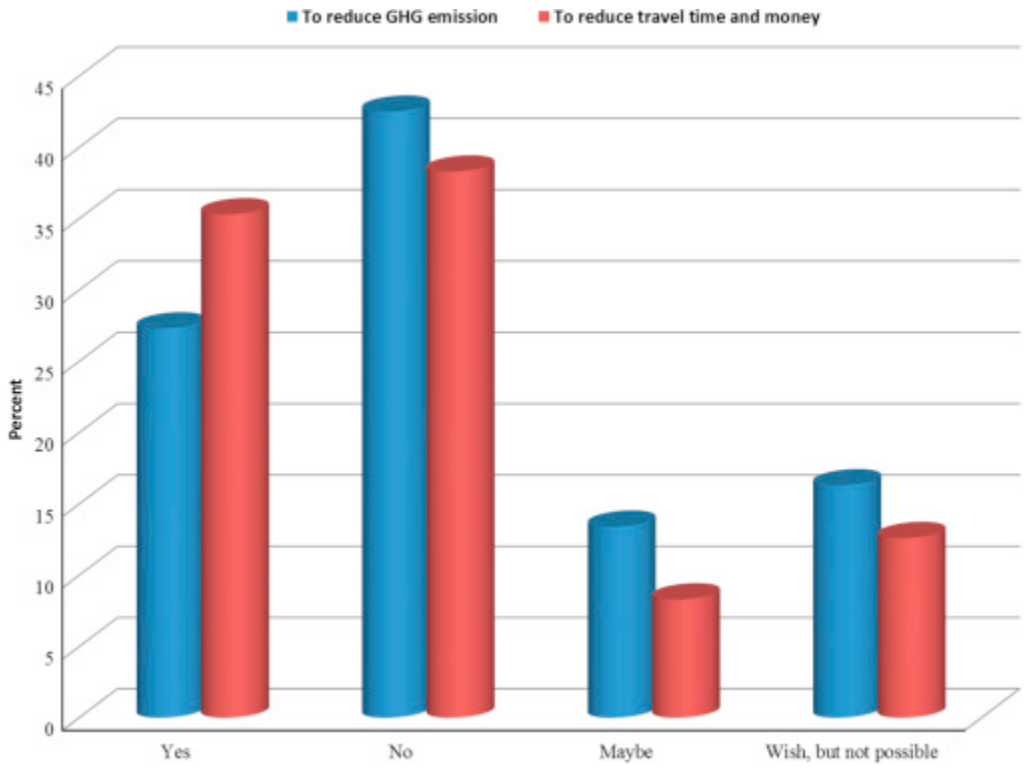

Fig. 4. The primary reasons for considering moving closer to campus.

4.3. Logistic regression analysis: predictive models

Since Mantel–Haenszel estimate of common-odds ratios analysis does not take into consideration the simultaneous effect of independent variables, a multivariate logistic regression is the next stage of analysis to estimate multiple factors with an effect on parking-pass purchase decisions (y/n). Two models are constructed by using the same set of data to compare the effect of variables on parking-pass decision between two models. On-campus students are excluded from the both models since a parking permit is required for these students for keeping their cars on campus. Model 1 included the entire sample of off-campus students and Model 2 included only sample of students who live within the Greensboro city limit to determine whether the magnitude of these variables differs spatially in parking-pass purchase decisions.

4.3.1. Predictive Model 1 for entire off-campus students

The first logistic model (Model 1) represents the best model (Table 3) for the entire off-campus student population (1717 students=87% of the sample size), which explains 28% of the variation in the analysis. Model 1 indicates that except environmental perceptions, students' parking-permit purchase decisions are influenced by a suite of socio-demographic, physiological, and living choice variables. Among socio-demographic groups of variables, three variables have strong influenced on students' parking-pass purchase decisions. Either being a full-time student or car owner increased the odds of purchasing a parking pass approximately three-fold (Table 3).

A significant association exists between students' age and parking permit purchase decisions (Table 3). This result, in general, is an indication what the most recent literature suggesting that younger adults are less willing to use cars for commuting (Kuhnimhof et al., 2012, Schwartz, 2013).

Table 3. Logistic Regression models of parking pass purchase (Yes/No).

Variables	Model 1: Off-campus students (*N*=1717)			Model 2: Off-campus students within city of Greensboro (*N*=506)		
	B	SE	OR	B	SE	OR
Socio-demographic						
Age	−.028	.012	.973**	−.014	.017	.989
Race: Black=0 vs. White=1	.310	.231	1.36	−.277	.363	.76
Gender: Male=0 vs. Female=1	.264	.193	1.30	.089	.295	1.09
Fulltime: Fulltime=1 vs. part-time=0	1.102	.292	3.01***	.940	.452	2.56**
Total income	−.030	.049	.971	.083	.076	1.09
Car ownership: No=0 vs. Yes=1	.996	.458	2.71**	1.796	.808	6.03**
Home ownership: Rent=0 vs. Own=1	.141	.211	1.15	−.129	.329	.88
Living choices and built environment at students' home locations						
Convenience to campus is the primary reason for home location: No=0 vs. Yes=1	−1.221	.581	.295**	−.531	.491	.59
Distance from campus	.173	.055	1.19***	.402	.170	1.50**
Side walk at home location: No=0; Yes=1	.012	.178	1.01			
Sidewalk ratio	NA	NA	NA	−.001	.003	.999
Bike lane ratio	NA	NA	NA	.009	.009	1.01
Population density	NA	NA	NA	−.006	.015	.994
Bus stop distance from home	NA	NA	NA	.010	.041	1.01
Psychological variables						
Habitual driver (drive to campus everyday): No=0 vs. Yes=1	1.848	.282	6.34***	1.344	.419	3.84***
Dominant travel mode in HS: alternative=0 vs. car=1	−.141	.235	.869	−.209	.337	.811
Faster is the most important reason for driving to campus: No=0 vs. Yes=1	.332	.176	1.39**	.154	.583	1.17
Environmental believes and attitudes						
Will move close to campus for reducing GHG emission: No=0 vs. Yes=1	−.069	.242	.93	.146	.326	1.16
Will move close to campus for reducing travel time and cost: No=0 vs. Yes=1	−.050	.240	.95	−.045	.351	.96
Nagelkerke *R* square value	.279			.291		

**Significant at *P*=.05.
***Significant at *P*=.001.

Although other socio-demographic variables significant in Mantel–Haenszel estimate of common-odds ratios are not statistically significant in Model 1, their directions of OR are expected. It appears that being female, white and high-income have some effect on increasing the odds of holding a parking pass. Yet, these differences may become insignificant among young adults since more than 70% respondents are female and below the age of 25. Similarly, since 88% of the respondents own at least one car, it is no surprising that parking-pass purchase decisions are insignificantly linked to income and race when all the variables are controlled in the analysis.

Intensity of density, diversity of land uses, and availability of public transportation and non-motorize infrastructure generally decrease as distance from downtown increase in cities within America. Thus, controlling for living choices and built environment variables, distance from campus served as a proxy of built environment in this model. Other built environment variables such as presence of bicycle routes, bus stops etc. were not possible to calculate due to the lack of such data for areas outside Greensboro. As expected, the effect of distance and living choices on parking pass purchase are observed in Model 1 (Table 3). Each percentage of distance from UNCG campus to students' residence increased the odds of buying parking passes by 19%. Conversely, each additional percentage of students choosing their residential location based on convenience to campus decreases the odds of holding a parking permit by 70%. The former finding is consistent with research that has demonstrated car-use behavior to overcome distance constraints (Limanond et al., 2011), while the later finding is consistent with the residential self-selection hypothesis where individuals choose neighborhoods based on their expected travel patterns (Ewing and Cervero, 2010).

The psychological values of car use are strongly associated with the great odds of increasing student parking-pass purchase decisions (Table 3). Of all the psychological variables, habitual car use is the most influential factor for explaining students' parking pass purchase decisions, which alone increases the odds by 6.3 times. Model 1 clearly suggests that a parking-pass purchase decision is driven primarily by car-use habits that also explained the auto-commuting choice at universities (e.g., Gardner and Abraham, 2007; Haustein et al., 2009). Faster mobility need is another psychological contributing factor for increasing the odds of purchasing a parking permit 1.4 times. These students may perceive having a parking permit as a necessity for higher mobility needs and use cars more often for speed, reduced travel time, flexibility, and convenience when alternative transportation modes are perceived as insufficient to meet those needs as survey participants indicated.

Although none of the environmental values are statistically significant in Model 1, they deserve explanation. The OR values indicate that environmental values somewhat likely decrease the odds of parking-pass purchase decisions, but their significances may disappear when other mobility needs become more important (Table 3). Concurrently, these results are consistent with literature that demonstrated self-identified environmentalists do not always follow environmentally friendly behavior (Haustein et al., 2009).

4.3.2. Predictive Model 2 for off-campus students who live in Greensboro

A second logistic model (Model 2) was intended to examine more extensively the factors associated with parking-pass purchase decisions for those students, who live in Greensboro where other transportation opportunities are available. Model 2 was developed for those off campus students who met this criterion (sample size=506). In this model, additional built environment variables were added including network distance, population density, sidewalk ratio, bicycle lane ratio, bus stop distance at residential locations. Model 2 indicates various commonalities and differences in parking pass purchase decisions with Model 1. First, Model 2 explains 29% of the variance in purchase decisions, which has slightly more explanatory power than Model 1. Second, the parking purchase decision is again the effect of roughly the same sets

of variables such as car ownerships, habitual car users, full-time students, and distance from the campus (Table 3).

However, their magnitudes are different from Model 1. For example, parking pass purchase decision for students living in Greensboro (Model 2) has the stronger association with car ownership than among all the off campus students (Model 2); latter group has strongest relationship with physiological factors such as daily car use habits, and car ownership has the half of the effect of than that of Model 2. Additionally, full-time student status is more strongly associated with parking pass purchase decision for all off-campus students than students living in Greensboro. Distance from campus variable has more association (1.19 in Model 1 vs. 1.50 in Model 2) with the latter group for having a parking permit (Table 3). Presence of sidewalks, bike lanes, bus stops distance, and population density at students' home location seem to have some effects on less likelihood of parking passes, but these do not show statistically significant. These results are consistent with empirical research that provides evidence how socio-economic statuses make built-environments less significant for mode choice decision (Hess, 2001, Sultana and Weber, 2007).

5. Conclusions

Given the paucity of research in understanding students' decisions to purchase parking passes, this case study provides an in-depth understanding about the nature of factors that increase the odds by integrating extensive variables developed in multiple disciplines. The findings of this research support several key points. First, car use and parking-pass purchase decisions are determined by roughly the same factor(s) such as a suit of socio-demographic, built-environments, and psychological variables including age, full-time student status, distance from campus, living choices, car ownership, daily car-use habits, and perceived mobility necessity needs. Second, psychological motives of car use followed by socio-economic status have the greatest magnitude of predicting parking-permit purchases, while the built environment surroundings students' place of residence has a minor influence. Daily car-use habits and car ownership are the major factors for the increasing odds of parking-pass purchases, but the magnitude of these variables differs spatially. Parking-pass purchase decision is heavily influenced by car ownership among students living in Greensboro while daily car-use habits have a higher association among students living outside the city. Third, consistent with earlier mode-choice research, this study provided evidence that distance from campus is the most important built-environment variable for explaining parking-pass purchase decisions. Fourth, this research supports the self-selection hypothesis where individuals may locate closer to campus to opt out the parking permits.

Fifth, this research confirmed why debate exists in the literature concerning the role of built environment and environmental values on car use. This case study indicated younger drivers are less likely to hold a parking permit; nonetheless, the built environment variables that are conducive to alternatives mode choices such as presence of sidewalks, bike lanes, bus stops, and population density have no significant impact on parking-pass purchase decision regardless of location. Perhaps the most striking aspect of this research finding is that the environmental beliefs are a minor consideration regarding parking-pass purchase decisions regardless of living choices. These students' motivation of holding a parking permit may reflect that the pragmatics

of mobility needs such as safety, speed, ease and reliability offered by cars has primacy over alternative choices and environmentally relevant values.

The results presented here have important implications for campuses and suggest that implementing policies to reduce on-campus parking must consider a suite of factors to be effective. For universities to adopt policies/measures that restrict car ownership, yet do not create an undue hardship for the students, requires suitable alternatives. For example, restricting parking spaces for on-campus students may be compensated by hourly rental use of Zipcars. It may also be useful to abolish on-campus free-parking policies, but it remains unclear if this policy implementation would reduce parking space demand. Similarly, would the provision of a variety of housing options within five miles of UNCG coupled with properly connected alternative transportation networks such as sidewalks, bike lanes, and transit within and surrounding major cities and counties reduce the demand for parking spaces among full-time students? Further, would regular car-use habits be changed by solely offering alternatives without interventions? All these questions and measures require examination with future research to determine their effectiveness as strategies for reducing parking spaces on university campuses.

Acknowledgment

This research was supported through Undergraduate Research, Scholarship and Creativity Office (URSCO) at University of North Carolina – Greensboro. I am thankful to my colleague, Mark Schulz and two undergraduate research assistants, Chandler Hagen and Marcie Dalrymple helping me out with this project. I wish to thank Paul A. Knapp, Preeta A. Shaikh and three anonymous reviewers for their valuable feedback that has substantially improved this paper. All shortcomings are nonetheless mine.

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