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Seeking the Effects of Land Use on Modal Shift of Automobile Commuters in Response to TDM Policies: Case Study of Tehran

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ABSTRACT

To reduce the number of private cars and respectively to decrease the side effects of congestion in central business districts (CBD) of metropolitans is one of the main purposes of implementing transportation demand management policies. This study uses a set of stated preference data to investigate the relationship between land use characteristics, five TDM strategies and modal shift from private car. The target group of the study includes commuters who often drive to CBD for work or study during the morning peak hours. Results reveal the effectiveness of some of the tested variables on the choice to give up driving.

Keywords:

Binary Logit, Central Business District (CBD), Land Use, Modal Shift, Transportation Demand Management (TDM).

1. Introduction

Transportation demand management strategies emerged to reduce the use of private cars and increase the efficiency of the available road network facilities. This strategies aiming to decrease car use try to achieve the goal by either making driving more expensive or sometimes prohibited or motivating other options like transit, walking, etc. However, studies reveal that the expected results of the implementation of the strategies are not always accomplished. The main reason of the gap between prediction and real reaction to the strategies might be the incomplete capturing of the effective elements of the neighborhood, and some socioeconomic characteristics on one's mode choice. O'Fallon et al. [1], accepting the idea, suggested that the differences between expected and real effects of policies are according to the presence of some constraints influencing commuter mode choice [1]. Some studies mention that the more accurate the effective factors on people reaction to TDM policies are, the more precise would the forecast of people's behavior in response to these strategies be (e.g. [2], [3]). So, some studies focused on different policies and showed the

effectiveness of them in changing commuters' travel behavior and some others also paid attention to other kinds of probable impressive variables. Among the TDM policies some researchers solely investigated the restrictive strategies. Parking management as one of this kind which appears in many studies has a close relationship with land use. Although, it is believed that using parking management as a restrictive policy in CBDs is not an accepted strategy according to its negative impacts on business and economy of the central part of the city [4]. Albert and Mahalel show that between two policies of congestion toll and parking fee, the latter is more accepted and the former makes more changes in travel behavior [5]. Although, it seems that the amount of the cost imposed to the costumers has direct impact on the degree of the effectiveness of the raising parking fees' policy [6]. Some other studies focused on incentive policies and suggested that by improving the public facilities and active modes' situations other modes will be competitive with personal cars [7]. Nurrden et al. [8] showed that the main factors to motivate transit use are decreased travel time, improved access to transit stations, and subsidized tickets [8]. Alpizar and Carlsson's study on improved transit travel time suggested that reaching the goals of a plan to reduce congestion and air pollution needs both raised cost of personal transport and a faster and more reliable transit service [9]. A study done by Giuliano and Small showed that different policies had diverse impacts on congestion. According to this study, restrictive strategies affect highway peak hour users more than incentive ones do [10].

Washbrook who investigated the effects of road charging and parking policy on single occupancy vehicle commuters and also improved transit choices, suggested that an increase in the cost of using private car is more effective than improving the travel time and the travel cost of transit [11], [12]. Erikson et al. [13] showed that a combination of restrictive and incentive strategies causes more decrease in personal car use than each single policy and the reduction is a result of chaining the trips and changing the mode from personal car [13]. O'Fallon et al. [1] used a bundle of 11 strategies – five car restrictive, five transit incentive and one bicycle incentive- and used a package of 10 chosen policies for each of the three urban study areas in New Zealand to investigate the effects of a package of strategies on commuter mode choice. Their study, using both multinomial and nested logit models revealed that restrictive strategies are more effective that incentive ones. The study also showed that rather than the strategies, the structure of the city, i.e. the density of the jobs in central part of the city and the situation of the actual transit are effective on people's mode choice. They also mentioned that some socioeconomic characteristics of the commuters have influence on choosing mode [1]. The relation between land use and travel behavior has been investigated in many researches during the past two decades and there are some comprehensive reviews of the literature available (e.g. [14] and [15]). Much of the studies investigates the impact of land use attributes on mode choice and many found that mode choice decision is affected by land use characteristics (e.g. [16] and [17]). A research done by Zhang investigated the role of land use in travel mode choice using two data sets from Boston and Hong Kong revealed that "land use still matters for travel mode choice when the effects of travel time, cost, and socioeconomic factors are taken into account." His study's results showed that in both work and non-work trips while controlling for price variables, land use explains additional variations in mode choice. It also suggests that in Boston land use characteristics of the destination mattered more [18]. Despite all these evidences, it might be interesting to know that not all the studies reported the significance of land use attributes on mode choice (for more details see [19]).

According to what mentioned above, seeking the effects of land use characteristics on mode choice is a well-known research area in transportation behavior studies and the land use attributes were found significantly effective on modes' utilities in some studies. On the other hand, it is important to reveal the impressive factors on changing mode after facing TDM strategies to have a clearer image of the upcoming results of the policy implementation. This study tries to find the role and the place of land use attributes in utility of the changing mode decision. The paper continues with a description of the data and survey. Then it describes the modal change modeling approach, including descriptive variables used in the model. This paper then presents the results of the models and concludes with a summary and discussion.

2. Data and survey

This study is based on a stated preference experimental data gathered in May 2010 in Tehran, the capital of Iran, to explore the effects of a bundle of five policy measures on commuters' driving to work or school in Tehran's automobile restricted central business district (CBD) between 6 a.m. to 10 a.m. Tehran is a 1,600 km^2 city with a CBD of nearly 32 km^2. Its population was 7.9 million with an average household size of 3.46 on 2006 [20] and the average monthly household income was $946 in the urban part [21]. Beside the SP part, the survey questionnaire also gathered information on socioeconomic characteristics, and the home and work area of each respondent, which was completed with the land use data of the city to specify each person's home and work areas' land use aspects. Socioeconomic attributes included age, gender, education, employment status of the respondents and some traits of the household such as the number of the owned cars and motorcycles, household number, number of employed members, etc. Also respondents mentioned their current home to work and work to home travel time (for more detail on dada see [22]). The SP part of the questionnaire was based on five different policies, three aiming to discourage car use and two to encourage use of public transit. Each of the policies has different levels and people were asked to state whether they would give up driving to work or school in a hypothetical situation of a particular composition of those five policies. In case they preferred not to drive any more, they were asked to define a new mode for their commute trip. The first group of policies contained CBD entrance toll with three levels of $5/day, $10/day, or $15/day, parking charge of $1.2/day, $2/day, or $3/day, and fuel price of $0.4/L or $0.8/L. The other group of policies contains transit access time and transit travel time. As the questionnaire first asked about the respondent's access time to nearest transit station the scenarios were based on two level for transit access time, one was the actual time and the other was a 33% decreased access time. For transit travel time no change, 20% decrease or 33% decrease were used in scenarios. A full factorial design of the experiment would make 108 possible combinations of these policies but the study was based on a fractional factorial with main effects and two-way interaction independent and orthogonal and a set of 36 scenarios was chosen. These scenarios were randomly divided to six groups which ended in versions of questionnaire and each respondents answered six scenarios.

A number of CBD schools and workplaces were selected and commuters driving to work or school during the morning peak hour who desired to answer the questionnaire were interviewed. Table 1 summarizes some characteristics of the respondents. As its shown respondents with age 30 or below were the main group of respondents and there were less than 10 percent aged over 51. Number of the men was twice as women and almost 60 percent of the respondents were married.

Almost half of the respondents' education was bachelor's degree and more than half of them were full-time employees.

Table 1: Key characteristics of the sample.

N=577 by Age (years)				
Characteristics	≤30 (%)	31-50 (%)	≥51 (%)	Overall (%)
Overall	46.6	45.1	8.1	99.8
Gender				
Male	56.5	74.2	83.0	66.7
Female	43.5	25.8	17.0	33.3
Marital Status				
Single	78.4	9.6	2.1	41.1
Married	21.6	90.4	97.9	58.9
Education				
High school or Less	1.1	4.2	0.0	2.4
High school graduate	9.3	19.2	19.1	14.6
Some college	6.7	8.8	12.8	8.2
Bachelor's degree	53.7	43.5	46.8	48.5
Master's degree	13.8	13.1	10.6	13.2
PhD or MD	15.3	11.2	10.6	13.0
Employment Status				
Self-employed	7.8	15.0	29.8	12.8
Full-time employee	29.7	77.7	68.1	54.5
Part-time Employee	7.4	4.2	2.1	5.6
Student	55.0	3.1	0.0	27.1

Note: The interior of the table is based analyzed by column, where, for example, the first column of numbers represents the distribution across categories for respondents age 30 or younger.

3. Modal shift modelling

As mentioned earlier the main purpose of this study was to investigate the effect of land use attributes on the choice of changing the commute mode from car to any other mode of transport in situation of the existence of a bundle of TDM strategies. In other words, this paper tries to test the hypothesis of the effectiveness of different land use characteristics of home and work area of the commuters on their modal shift choice when facing car use discouraging and transit use encouraging policies. To do so, a bunch of land use measures including the population density based on individuals and families, percentage of residential, commercial, service, etc. in each study zone, and access to regular buses, bus rapid transit and heavy rail transit (metro) of both residential and work zone were examined. Among those some attributes of work zone and home zone showed to be effective on modal shift. Two models containing a base model and an extended model were estimated. The base model has significant variables among those typically used in mode choice modeling (i.e. traveler's socioeconomic characteristics) and the five TDM strategies. In the extended model land use variables where added to the list of independent variables.

Table 2 gives the description of the final model's variables. It can be seen that besides the socioeconomic variables of the person and the household, five land use characteristics and three policy variables emerged in the final extended model.

Table 2: Description of variables.

No.	Var.	Description	Type of Values
socioeconomic— Person related			
1	entCBD	Has pre-purchased permission to enter CBD	Dummy--- 1 if yes
2	adfuel	Additional fuel needed beyond coupons	Ordinal variable 0 to 4
3	gen	Gender	Dummy—1 if male
4	HWdist	Home-to-work distance	km
5	#cars	No. of cars in household	na
6	#cycls	No. of cycles in household	na
7	wortm	Work trip time	min
8	cprs	Uses car because of personal issues	Dummy—1 if yes
Policy			
9	entoll	Cordon Entrance toll	$5,$10,$15 per day
10	prkfee	Parking fee	$1.20, $2,$3 per day
11	tacctm	Transit access time	Actual time, 33% decrease in actual time
Land use			
12	Wpd	Population density of work area	na
13	HsrvLU	Percentage of service land use of Home area	na
14	HbsnLU	Percentage of business land use of Home area	na
15	HtrLU	Percentage of transportation related land use of Home area	na
16	HmLU	Percentage of mixed land use of Home area	na
Socioeconomic—Family related			
17	cpnoch	Couple with no child	Dummy—1 if yes
18	cpyngch	Couple with eldest child above 18 years old	Dummy—1 if yes
19	sngl	Single person	Dummy—1 if yes

Note: No. = number, na = not applicable.

Table 3 shows the base and extended model's variables and coefficients. It also shows the result of the statistical test used to confirm the significance of the improvement of the extended model. As the table shows, in both base and extended models signs and level of significance of the common variables are the same; which means that adding land use variables to model did not change the signs and the degree of the significance of other variables. In general, the results suggests that land use has an independent influence on mode choice. This finding is consistent with previous studies (e.g. [18], [23], and [24]).

Table 3: Variables of the binary model.

Variable	Base Model Coef.	Expanded Model Coef.
Constant	2.065[a]	2.157[a]
entCBD	-1.141[a]	-1.015[a]
sdfuel	-0.404[a]	-0.397[a]
gen	0.365[a]	0.367[a]
HWdist	0.028[a]	0.025[a]
wortm	-0.010[a]	-0.011[a]
#cars	-0.425[a]	-0.373[a]
#cycls	1.564[a]	1.505[a]
cprs	-1.238[a]	-1.418[a]
entoll	0.114[a]	0.115[a]
prkfee	0.148[b]	0.149[b]
tacctm	-0.534[b]	-0.536[b]
Wpd	--	0.003[a]
HsrvLU	--	-0.032[a]
HbsnLU	--	-0.057[a]
HtrLU	--	0.068[a]
HmLU	--	0.194[a]
cpnoch	-0.308[b]	-0.358[b]
cpyngch	0.343[a]	0.373[a]
sngl	-0.926[a]	-0.870[a]
N	577*6 scenarios each= 3462	
log likelihood at zero [L(0)]	-2399.68	-2399.68
log likelihood at constant [L(c)]	-1912.57	-1912.57
log likelihood at zero [L(β)]	-1592.64	-1613.29
ρ^2	0.336	0.328
ρ_c^2	0.167	0.156
ρ^2 (adjusted)	0.328	0.321
Number of parameters	20	15
χ^2	639.866	598.565
Model improvement test (-2[L(β)(base model)- L(β)(expanded model)])	χ^2=41.30 d.f.=5, ρ≤0.001	

[a] Significant at 1% level.

[b] Significant at 5% level.

3.1. Impact of the land use variables

Among different attributes of land use tested in this research five were found effective on decisions of usually driving commuters to give up using their car in the hypothesis situation of facing a bundle of TDM strategies. Of all the work zone's land use characteristics only the population density seems to be effective, while four land use attributes of the home zone's design are significant. In a glance it might be surprising that the work place land use characteristics seems indifferent in utility function, but it seems reasonable when paying attention to the fact that all the trips studied here ends in CBD. This means that most land use attributes of the 32 km^2 CBD of Tehran are not much effective on the utility function of using personal car. On the other hand, home zones of the commuters have key role in their mode choice decision. The significance of transit access time in final model somehow approves this idea. The negative sign of the percentage of service and business in the home zones reveals that people living in zones with higher degree of services and businesses are more unlikely to give up driving under the suggested TDM policies.

This might be according to the fact that using personal cars gives the driver a higher chance of chaining his commute trip with other trips like shopping, using services, etc. and giving up driving omits this opportunity. On the other hand, the percentage of land which is related to transportation facilities in a home zone seems to have a positive effect on people's using other modes rather than personal cars.

3.2. Impact of the policy variables

As it is shown, among five policy variables which the study tested, two of the car discouraging and one of the transit encouraging variables remained in the final model. As mentioned in the literature and as would be expected, policies discouraging car use should have positive impact on choice of giving up car. Final model shows that both the CBD entrance toll and parking fee have positive signs as expected. The negative sign of the encouraging transit use policy of "transit access time" is also reasonable revealing the fact that transit access time is one of the main reasons people would prefer to use their cars for commute trips. A study seeking the mode choice of commuters when TDM policies are enforced done by Habibian and Kermanshah for a Tehran's commuters dataset reveals that among the same five policies which the present paper checked, entrance toll, parking fee, and transit access time have significant effects on commuters' mode choice [25]. According to a study done by Shahangian et al. [22] on gender differences in response to policies targeting commute to automobile restricted CBD, with a same dataset as the dataset of the present study, in both men's and women's models entrance toll is significant and transit access time only remained in final model of men's mode choice [22].

3.3. Impact of the socioeconomic variables

As it is shown in table 3, having a pre-purchased yearly permission to enter CBD makes the utility of giving up the car less. Although, the respondents were briefed that under the circumstance of the new policy implementation the yearly permission would not be available and if they want to enter the CBD they should daily buy a permit with any of the three levels of $5/day, $10/day, or $15/day, being in this group of people makes the utility of changing their mode less. That could be because of their habit and compatibility with paying the entrance toll in advance. The same negative sign appeared for the coefficient of the variable which reveals the amount of the fuel the respondents usually use additional to the monthly coupons any car has in Tehran (a coupon of 100L/month for each car). People who use more fuel, which is sold in a higher amount, $0.4/L instead of the coupon fuel price of $0.1/L, are less likely to give up driving while facing the policy bundle. Significance of this variable in the final model also suggests that when people are used to pay more to use their car it is harder to make them give up driving with increasing the cost of driving. The positive sign of the dummy variable of genders shows that men are more likely to decide not to use their car when facing a bundle of TDM strategies. Home to work distance variable suggests that the farther the home from the work place the more is the utility of changing mode from private car to commute. But, on the other hand, people with more work to home trip (commute return trip) time are less likely to give up driving. As the work to home distance and time variables are not much correlated according to different pattern of congestion in different parts of Tehran presence of these two variables together in the model is not surprising. According to the results, it could be seen that, in general, people who live farther from their work place would prefer to give

up driving in the hypothetical situation of TDM policies' implementation, while people who face more jam on their return trip to home prefer to keep driving even in higher costs. The negative sign of the household's cars number and the positive sign of number of the motor cycles in the utility function of changing mode from car is as expected. The final model also shows that people who use their car because of their personal and family issues prefer not to change their mode even if some TDM strategies make their trip more expensive. The last group of variables, which relates to the life cycle status of the respondents' family reveals that single persons and adults who live with a partner and no child, would not give up driving, while being in a family with the eldest child above 18 years old make the utility of changing commute mode more.

4. Conclusion

Using a SP dataset of regular commuter drivers to Tehran's CBD, this paper investigated the effects of land use attributes on decision of commuters to change trip mode from car in the presence of a package of TDM policies. The hypothetical TDM package includes three automobile restrictive and two transit incentive policies each with different levels. The study reveals that using the land use characteristics makes the model more informative without making any difference in other variables' signs and level of significance. Among the land use attributes of home and work zone tested in this study, five remained significant in the final model. Results show that the population density of the work zone is the only land use attribute related to the destination, while the trip's origin has four effective measures related to the land use mix of the zone. The findings suggest paying more attention to land use management of home zones rather than the CBD. Although, further studies are recommended before policy implementation. Also, according to the importance of the home zones' land use attributes in changing the decision to drive to work, it seems meaningful to investigate the relation between residential choice and mode choice under the TDM policies application in future studies. Among five TDM strategies tested in this study, two seems to be not effective on persuading drivers to choose another mode of transport rather than their cars. These two are increased fuel fee and decreased transit travel time. So, results suggest to either relinquish the implementation of these policies as main tools for reducing car use or test different and considerable higher levels of the price for the fuel fee. This study was based on commute trips and showed that land use attributes can affect people's decision of not driving after facing a TDM policy package, but to reach a comprehensive understanding of the relation between trips, TDM policies, and land use characteristics complementary studies should pay attention to other trip purposes as well. The final model also shows that men, people who own motorcycle, individuals who live farther from their work place, and members of families with eldest child older than 18 years are more likely to give up driving when facing the TDM packages. People who pay more than others for driving in current situation, either through purchasing yearly entrance permit of CBD, or using more fuel than the coupon and so pay higher prices for the additional fuel, unwilling more to change their modes. Also, it seems the more is the car ownership and return trip time, the less is the utility to quit driving. Likewise, being single or living in a family consists only of a couple makes the personal car more desirable. It should be noted that as this study tried to investigate the role of some TDM policies and land use attributes on decision to give up driving, definitely the same role could be checked in mode choice decision in future studies. Therefore, by

recognition of the effective land use characteristics on each replacing mode's utility, making a better decision for policy implementation would be easier.

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6. References

[1]- Fallon, C., O., Sullivan, C., and Hensher, D. A., 2004, **Constraints Affecting Mode Choices by Morning Car Commuters**, Transport Policy, 11 (1), 17-29.
[2]- Cao, X. and Mokhtarian, P. L., 2003, **Modeling the Individual Consideration of Travel-related Strategies**, Research Report UCD-ITS-RR-03-03, Institute of Transportation Studies, University of California, Davis.
[3]- Choo, S. and Mokhtarian, P. L., 2004, **Modeling the Individual Consideration of Travel-related Strategy Bundles**", Research Report UCD-ITS-RR-04-07. Institute of Transportation Studies, University of California, Davis.
[4]- Marsden, G., 2006, **The Evidence Base for Parking Policies- A Review**, Transport Policy, 13, 447-457.
[5]- Albert, G. and Mahalel, D., 2006, **Congestion Tolls and Parking Fees: A Comparison of the Potential Effect on Travel Behavior**, Transport Policy, 13, 496-502.
[6]- Hensher, D., and King, J., 2001, **Parking Demand and Responsiveness to Supply, Pricing and Location in the Sydney Central Business District**, Transportation Research Part A, 35, 177-196.
[7]- Poudenx, P., 2008, **The Effect of Transportation Policies on Energy Consumption and Greenhouse Gas Emission from Urban Passenger Transportation**, Transportation Research Part A, 42, 901-909.
[8]- Nurdden, A. Rahmat, R. A., and Ismail, A., 2007, **Effect of Transportation Policies on Modal Shift from Private Car to Public Transport in Malaysia**, Journal of Applied Sciences, 7, 1014-1018.
[9]- Alpizar, F. and Carlsson, F., 2001, **Policy Implications and Analysis of the Determinants of Travel Mode Choice: An Application of Choice Experiments to Metropolitan Costa Rica**, Working Papers in Economics, 56, Department of Economics Gotenborg University.
[10]- Giuliano, G. and Small, K. A., 1995, **Alternative Strategies for Coping with Traffic Congestion**, The University of California Transportation Center, Berkeley, 1994. In H. Giersch (Ed.), Urban Agglomeration and Economic Growth, Berlin, Springer-Verlag, 199–226.
[11]- Washbrook, K., 2002, **Assessing the Potential for Road and Parking Charges to Reduce Demand for Single Occupancy Vehicle Commuting in the Greater Vancouver Region**, Research Project, School of Resource and Environmental Management, Simon Fraser University.
[12]- Washbrook, K., Haider, W. and Jaccard, M., 2006, **Estimating Commuter Mode Choice: A Discrete Choice Analysis of the Impact of Road Pricing and Parking Charges**, Transportation, 33, 621-639.

[13]- Eriksson, L., Nordlund, A. M., and Garvill, J., 2010, **Expected Car Use Reduction in Response to Structural Travel Demand Management Measures**, Transportation Research Part F, 13, 329-342.
[14]- Handy, S., Cao, X. and Mokhtarian, P., 2005, **Correlation or Causality between the Built Environment and Travel Behavior? Evidence from Northern California**, Transportation Research Part D: Transport and Environment, 10 (6), 427-444.
[15]- Cao, X., Mokhtarian, P. and Handy, S., 2008, **Examining the Impacts of Residential Self-selection on Travel Behavior: Methodologies and Empirical Findings**, Research Report UCD_ITS_RR-08-25, Institute of Transportation Studies, University of California, Davis.
[16]- Alqhatani, M., Bajwa, S. and Setunge, S., 2013, **Modeling the Influence of Socioeconomic and Land Use Factors on Mode Choice: A Comparison of Riyadh, Saudi Arabia, and Melbourne, Australia**, International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering, 7 (2), 2013.
[17]- McKibbin, M., 2011, **The Influence of the Built Environment on Mode Choice- Evidence from the Journey to Work in Sydney**, in Proc. Australasian Transport Research Forum.
[18]- Zhang, M., 2004, **The Role of Land Use in Travel Mode Choice: Evidence from Boston and Hong Kong**, Journal of American Planning Association, 70 (3), 344-360.
[19]- Zahabi, S. A., Miranda-Moreno, L. F., and Patterson, Z., 2012, **Evaluating the Effect of Land Use and Strategies for Parking and Transit Supply on Mode Choice of Downtown Commuters**, The Journal of Transport and Land use, 5 (2), 103-119.
[20]-Tehran Governor's Website. **An Introduction to Tehran,** http://www.ostan-th.ir/images/pdf/e.pdf. Accessed Nov. 13, 2011.
[21]- Statistical Center of Iran. **Summary Results of the Urban and Rural Household Income and Expenditure Survey**. http://www.amar.org.ir/Upload/Modules/Contents/asset0/english /summary_results-final_1388_2009_.docx.pdf. Accessed Nov. 13, 2011.
[22]-R. Shahangian, M. Kermanshah, and Mokhtarian, P., (2012), "Gender Differences in Response to Policies Targeting Commute to Automobile Restricted Central Business District-Stated Preference Study of Mode Choice in Tehran, Iran", Journal of Transportation Research Record, **2320**, Transportation Research Board of The National Academies, Washington, D.C., pp. 80-89.
[23]- Cervero, R., 2003, **Built Environment and Mode Choice: Toward a Normative Famework**, Transportation Research Part D, 7, 265-284.
[24]- Cervero, R. and Kockelman, K., 1997, **Travel Demand and the Three D's: Density, Diversity and Design**, Transportation Research Part D, 2, 199-219.
[25]- Habibian, H. and Kermanshah, M., 2011, **Exploring the Role of Transportation Demand Management Policies' Interactions**, Scientia Iranica Transaction A: Civil Engineering, 18 (5), 1037-1044.