Investigating on the Effects of Congestion Pricing on Increasing Public Transit Share

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Abstract

Nowadays, traffic management policy in metropolitans is focused on increasing the share of public transit. The limitation of supply and slowing growth of road infrastructures have provided congestion for users who choose personal cars. Therefore, applying demand management policies which decrease the utility of personal cars and increase the tendency to public transit can be very important. Congestion pricing is a concept from market economics regarding the use of pricing mechanisms. One of the main questions is the effect of pricing strategy on mode choice behavior of users. This paper aims to investigate the effects of congestion pricing on choosing transit among people. Since direct observation of the pricing scenarios is impossible, stated preference approach has been used. Scenarios of pricing based on empirical design are provided and distributed among the respondents. The questionnaire included socio-economic and trip characteristics of the respondents. Based on the pricing scenarios, three choices including "personal car", "public transit", and "other modes" were included. More than 3500 questionnaire are gathered and coded. For modeling, the multinomial logit has been applied and calibrated for every choice. The results show that pricing can be used as an appropriate tool for demand management and encouraging users to choose public transit. Setting 30000 IRR[1] entrance toll causes 13 percent change in modal shift from personal car to public transit. Finally, the model results at various costs have been discussed.

Keywords: Mode choice, congestion pricing, stated preference survey.

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1. Introduction

Increasing the congestion of personal cars in urban areas, especially peak hours, has been lead to problems including delay, CO_2 distribution, sound pollution and other disorders in efficiency of urban transportation. Based on the European UNITE Project (EUP), prices of traffic congestion in England is 15 billion Euro per year which is 1.5 percent of gross domestic production (GDP). In France and Germany, this number is about 1.3 and 0.9 percent [Victoria Transport Policy, 2011].

Congestion pricing or congestion charging is a system of surcharging users of public goods that are subject to congestion through excess demand such as higher peak charges for use of personal cars and road pricg ing to reduce congestion. The objective of this policy is the use of a price mechanism to make users more aware of the costs that they impose upon one another when consuming during the peak demand, and that they should pay for the additional congestion they create. So, assigning tolls for traffic cordons (cordon pricing) is one way to reduce vehicles congestion and also use its revenues to develop public transit.

The current study aims to investigate the effect of congestion pricing on the switching mode choice behavior of users from private to public transit. In fact, this study seeks to evaluate the effect of pricing on changing users' tendency toward choosing public transit. Tehran even and odd restricted traffic area[2] has been chosen for this study. Stated preference approach is also used to gather the required data at various pricing scenarios. Finally, the mode choice behavior of users is modeled and results are reported.

2. Literature Review

Polak et al [Polak, 1992] studied the pricing of urban congested areas using stated preference method in Trundhim of Netherland. In this study, home based trips were analyzed and multinomial logit was applied for modelling. The results of the research showed that being late at work is more unpleasant than going early and respondents prefer waiting over delay. Chen (1993) used a multinomial and nested logit model to investigate the behavior of commuters in Singapore [Chen, 1993]. In his nested logit model, he divided three peak hours of morning into three separate hours. He also divided every hour into four fifteen minutes spans. Chen arrived with the conclusion that the anticipated delay, travel cost and time of travel are three important factors affecting participant's behavior. In this research, the socio-economic charistristics of users had not been considered in their choice utility.

In a study in Los Angles, Small et al showed that with pricing rate of 15 cents per car-mile, those people who carpools or uses public transit, gain more benefit than others [Small, 1992]. In this study, it was assumed that the pricing mechanism is per the distance travelled by the users. Also, a specific pricing range was determined for evaluating users mode choice. Frick et al investigated the effect of toll increasing on a bridge in San-Francisco. According to the results, if the amount of tolls increase from 1 to 3 dollars in peak hours, the entrance demand will decrease around 7 percent [Frick et al, 1996]. In this research, just a link had been considered for pricing.

Eliasson et al investigate the effectiveness of pricing in Stockholm [Eliasson et al, 1996]. The results showed that the number of public transit users increased about 10 percent comparing to last year.

Bureau and Glachant investigated the effects of different pricings scenarios in Paris urban network. The results showed that for 0.7 to 1 Euro per user, pricing can decrease the entrance of personal cars up to 20 percents [Bureau and Glachant, 2008].

Shunan Xu and Ben Akiva (2009) used nested and multinomial logit models analyzing the effects of congestion pricing. Due to project terms, they came with this conclusion that also nested logit is a more robust method, but in this case multinomial logit represent better results. For example, in some cases with overlaping routes, nested logit models were incapable of providing accurate results [Xu and Ben Akiva, 2009]. Similarly, Sugiyanto et al investigated the effect of pricing mode choice. The results showed that pricing can transfer demand from motorcycle to bus by 6.8 percent [Sugiyanto et al, 2009].

Kim et al. (2013) investigated determinants of acceptability of environmental (carbon) taxation, for which trust in government and environmental concern are additional determinants. Carbon taxation is an extension of fuel taxes and may be viewed as transport pricing [Kim et al. 2013]. Zheng et al (2014) investigated the public acceptance of pricing schemes in Australia using an ordered logit modeling approach [Zheng et al. 2014]. The survey data were analyzed to pinpoint important factors influencing people's attitude to a congestion

charge. They found that the amount of the congestion charge and financial benefits from implementing it significant influenced the respondents' support for the charge and their likelihood of taking a bus to city areas. As it is mentioned above, some limited studies have been conducted on determination of congestion pricing effects on increasing the choice of public transit over personal cars. The studies can be categorized on link pricing studies which considered bridges, tunnels or specific roads and also network pricing studies which mainly evaluated the effect of pricing on private cars. Studies showed that nested and multinomial logit are considered as main methodologies for modelling usres mode choice due to pricing. In this study, we tried to evaluate the change in users` mode choice from personal car to public transit. The following section discuss about research methodology.

3. Research Methodology

In this section, data collection, questionnaire design and modelling procedure has been discussed.

3.1 Case Study

In this study, the even and odd restricted area of Tehran (as it is shown in figure 1) is selected for surveying as the case study of this paper. The boundries of this region is shown in blue colors in the map of Tehran. The surveying had been accomplished on two working days and inside the cordons. This area had been divided to ten zones for data collection based on density and diversity of land uses.

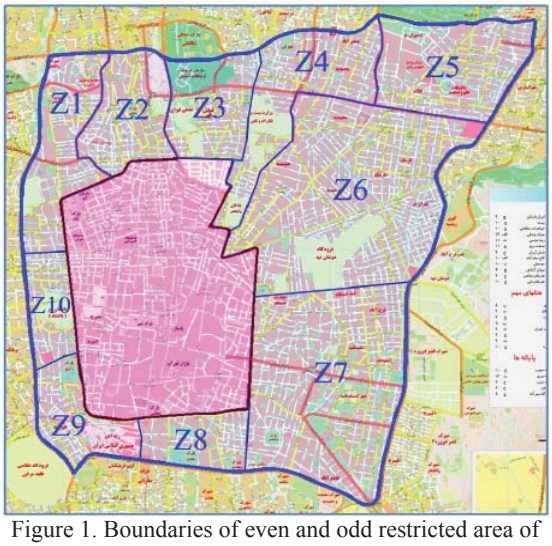

Figure 1. Boundaries of even and odd restricted area of Tehran

3.2 Data Collection

Unlike market services and commodities, a group of commodities and services may not have a particular market and obviously have no specific price. In cases which the market fails to offer such relevant information, pricing requires to find a willingness to pay criterion [MIT Portugal Program, 2009]. The models for determining Individuals' willingness to pay is categorized into modal split models. Modal split models are applied based on socioeconomic conditions, type of service and other effective factors to determine share of each mode. Transportation mode choice is performed based on a very complicated process controlled by trip chain, traveler characteristics and properties of transportation system. There are a large number of affecting factors in each group of these properties. To obtain such information, typically, there are two available approaches including revealed preference (RP) and SP method. Revealed preference is an economic theory of consumption behavior which asserts that the best way to measure consumer preferences is to observe their purchasing behavior. Revealed preference theory works on the assumption that consumers have considered a set of alternatives before making a purchasing decision. The problem with this method is that the scenarios should be performed in the real world to evaluate the consumers' reactions which is rare and expensive.

Hence, stated preference can be used in most cases. Through this approach, an illustrative market is designed and then the individuals are asked about their willingness to pay (WTP) or willingness to accept (WTA) to improve the quality of a given product. Since this approach directly deals with people's perspective about non-market commodities, it is also called as direct pricing. In this method an illustrative market is designed for unrated commodities and their demand for a given commodity and service is evaluated through their states. The most common method to achieve stated preferences of the users is to conduct interviews with individuals about their WTA or WTP to maintain or improve the quality of the studied commodity or service.

The sample of this study include all commuters in even and odd traffic area of Tehran. Since a similar pricing policy had not been applied in Tehran routes, the

required information were gathered through design of stated preference (SP) questionnaires. Through this survey, the travelers were asked about the lowest price which they tend to pay for entering the even and odd traffic area. Various levels of prices as well as their opinion about cancelling the trip or choosing an alternative mode were offered to respondents. The main parts of this questionnaire are as follows (a sample of the questionnaire is mentioned in the appendix):

Information about personal, social, and economic characteristics of individuals,

Trip information and their mode choice; and

Information concerning individuals' response to policies and changes expected by researcher.

The respondents were informed that toll payment for each entry into the priced area is mandatory. They also understood that the enforcing system can detect violators which are trying to enter the even and odd traffic area without paying toll and they would be charged with 3 times of entrance payment. Finally, the even and odd pricing alternatives were described for them and they were asked to define their choice according to every pricing alternative. Following choices were represented for respondents due to pricing alternatives:

First choice: paying the toll, choosing personal car and making the trip in peak hours.

Second choice: not paying the toll and choosing public transit (bus, subway).

Third choice: not paying the toll and choosing other alternatives.

In every question, different pricing alternatives are given to the respondents. In order to represent appropriate range of pay tolls, four different questionnaires were designed which include four different pricing scenarios. The toll range was determined by considering upper and lower limits of the toll which stated by users in the pilot study and 16 pricing scenarios were developed in questionnaires (which is shown in Table 1). The surveyors were instructed to inform respondents about benefits of congestion pricing (such as congestion mitigation, reducing air pollution, reducing travel time and etc). The samples were chosen randomly and in approximately all zones of Tehran even and odd restricted area. The minimum age of respondents was eighteen and all of them had driving licenses. The data were collected in four working days form 7 A.M to 7 P.M.

Also, every respondent was reminded that each trip

Table 1. Questionnaire pricing scenarios in restricted even and odd area of Tehran

Scenario	Area	Price (IRR)		
		Time period		
		6:30-11:00	11:00-16:00	16:00-19:00
1	Even and odd	120000	120000	120000
2	Even and odd	30000	15000	30000
3	Even and odd	60000	40000	60000
4	Even and odd	90000	70000	90000
5	Even and odd	30000	20000	30000
6	Even and odd	60000	60000	60000
7	Even and odd	90000	45000	90000
8	Even and odd	120000	95000	120000
9	Even and odd	60000	45000	60000
10	Even and odd	120000	60000	120000
11	Even and odd	90000	60000	90000
12	Even and odd	30000	30000	30000

choice has the following costs:
1- Public transit (bus and subway):
Only ticket price (if respondent walks to the bus station).
Ticket price with taxi fare (if respondent take a taxi to/ from the station).
Ticket price with costs of using personal car from/to the station.
2- Personal car:
Parking cost,
Fuel cost,
Entrance toll to even and odd restricted area,
3- Taxi choice: In this case, the only cost is taxi fare.

3.3 Number of Samples

Information about societies characteristics are always required by politicians, planners, engineers, and managers. Because of time and financial purposes, these data are generally obtained through random samples surveys. The target population of this work are all passengers in Tehran even and odd traffic cordon.
One of the most important issues in data collection procedure is to determine size of the sample. In this respect, the first step is to determine confidence level for the given estimations. Typically, the larger is the sample, the higher is the obtained confidence levels. In this work, simple random sampling was conducted to determine sample size. Equation (1) shows the sampling formulation [Hensher, 2000]:

$$n \geq (Z\text{^}2\ (1\text{-}P\_y))/(\varepsilon\text{^}2\ P\_y) \quad (1)$$

Where:
: Share of population which has the characteristic,
N: number of the sample,
: Confidence level,
: Rational error,
In equation (1), "Z" refers to the coefficient of reliability which is based on the assumption of normal distribution among collected data . With 95% significance level, Z is assumed 1.96. Also, regarding to the great numbers of vehicles entering the restricted even and odd area of Tehran, is estimated 0.6. Finally, assuming 0.05 error, the least number of observations is estimated 1024.
In this study, more than 3596 questionnaires were collected. Each questionnaire was made of 4 various pricing scenarios.
For data gathering, the restricted area of Tehran was surveyed due to dispersion of land uses and main trip attraction centers. As it can be seen in figure 1, 7 regions for data collection were defined and 10 interviewers for every region were dedicated. The data collection was performed mainly in governmental and nongovernmental bureaus, universities and education centers, and random samples which were encountered in streets or other trip attraction centers. After initial analysis on questionnaires, incomplete questionnaires were eliminated from study and finally 3250 of them were used for modeling.

3.4 The Reliability of Questionnaires

If investigated characteristics of a questionnaire can be examined again in a similar situation and similar data collection procedure, and results are quite similar to the previous ones, we can say that we have reliable questionnaire. Cronbach Alpha is a method for evaluating calculated by following equation (3) [Cronbach, 1951]. Cronbach's alpha is the most common measure of internal consistency ("reliability"). Cronbach's alpha will generally increase as the intercorrelations among test items increase, and is thus known as an internal consistency estimate of reliability of test scores. Because intercorrelations among test items are maximized when all items measure the same construct, Cronbach›s alpha is widely believed to indirectly indicate the degree to which a set of items measures a single one-dimensional latent construct. It is easy to show, however, that tests with the same test length and variance, but different underlying factorial structures can result in the same values of Cronbach›s alpha.
As much as Croncach Alpha gets closer to 1, the correlation among questions increase. Therefore, questions become more homogenous. Equation (2) shows the formulation for calculating this measure. In the case of this paper, the Cronbach Alpha turned out to be 0.71 which is considered as acceptable.

$$\alpha = \frac{k\bar{C}}{\bar{V} + (k-1)\bar{C}}$$

Or (2)

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k} S_i^2}{\sigma^2}\right)$$

Where:

k : Number of questions

S_i^2 : Variance of I question,

σ^2 : Variance of all of the questions

$\overline{C}$: The mean of covariance among questions

$\overline{V}$: The variance of means of questions.

3.5 Modelling

In mode choice models, it's assumed that traveler has a utility for each choice which is a function of characteristics of that choice and socio -economical characteristics of the traveler. The studies showed that choosing behavior of travelers has a probabilistic nature; i.e. a traveler follows a probabilistic function for choosing alternatives according to their characteristics. The mechanism of a probabilistic behavior is based on the assumption that the utility of alternatives is affected by some random factors with known distribution (like Probit or Logit). It is obvious that, every decision maker has a set of choices. But this set is not the same for all decision makers and is a function of socio-economic characteristics of decision makers [McFadden, 1974]. The probability of choosing each mode depends on its utility. In the other words, if utility of a mode is higher than others, the probability of choosing that mode will also increase. In the other words:

$$p\_n\ (i)=p[U\_in \geq U\_jn \qquad j \neq i\ ,C\_n] \tag{3}$$

Where:

= Probability of choosing i by person n,

= utility of choice i for person n,

= Set of acceptable choices for person n,

The Logit model is used in the current study which has some advantages over probit model. Among the mentioned advantages is that it is more easy to use and more operational. Being operational means that every option which is independent from others, could be entered in the model [Bowerman, 2007]. When more than two alternatives are available, multinomial logit model may be used. Then, the probability of choosing each alternative can be written by the following formula.

$$P_n(i) = \frac{e^{V_{in}}}{\sum_{j \in C_n} e^{V_{jn}}} \tag{4}$$

4. Results and Discussion

Based on collected data, a discrete choice model using socio-economic, trip chain characteristics and pricing strategies, has been calibrated and validated. In following section, detailed results has been discussed.

4.1 Modeling and Data Analysis

In order to determine the share of each mode due to pricing scenarios, a logit model was applied for modelling the behavior of users' mode choice. Table 3 shows the choices which are modeled in this study as dependent variables. The initial hypothesis for modelling was on nested behavior of alternatives due to pricing scenarios. This hypothesis is controlled by the logsum parameter, θ, (sometimes called the "dissimilarity parameter" or the "nesting coefficient"), is a function of the underlying correlation between the unobserved components for pairs of alternatives in that nest, and it characterizes the degree of substitutability between those alternatives. The value of the logsum parameter is bounded by zero and one to ensure consistency with random utility maximization principles. Different values of the parameter indicate the degree of dissimilarity between pairs of alternatives in the nest. The interpretation of different values of the logsum parameter is as follows (Kockelman et al, 2013):

If θ>1, Not consistent with the theoretical derivation. Reject NL model.

If θ = 1, Implies zero correlation among mode pairs in the nest so the NL model collapses to the MNL model.

If 0 < θ < 1, Implies non-zero correlation among pairs. This range of values is appropriate for the nested logit model. Decreasing values of θ indicate increased substitution between/among alternatives in the nest.

If θ = 0 Implies perfect correlation between pairs of alternatives in the nest.

In to our case, it is concluded that θ coefficient doesn›t have a significant difference with "1». Therefore, it is concluded that from statistical point of view, other nests can be merged with the reference nest and nested behavior of choices can be rejected.

So multinomial Logit model has been applied for modelling the willingness to pay of users due to pricing scenarios. According to choices, the data in database has been aggregated for multinomial logit modelling (As shown in table 3).

After validating and controlling the correlation between variables, various models were tested and finally table 4 and table 5 show the results for public transit personal car respectively.

Table 3. Defining choices used as dependent variables for multinomial logit

y	Definition
1	Public Transit (subway or bus)
2	Personal Car
3	Other alternatives

Table 4. Model results for public transit choice

Variable	Public transit choice		Description
	Value	P[|Z|>z	
FTMD1	0.6571	0.000	Dummy variable for the type of access to first station (1 if by foot and 0 otherwise)
PND	-0.9158	0.000	Dummy variable for having both even and odd plate numbers (1 for having and 0 otherwise)
JOBD1	-0.3458	0.001	Dummy variable (1 if the job is employee and 0 otherwise)
NP	-0.1558	0.000	Number of Passengers
S	-0.185	0.023	Dummy variable (1 for having a stop in the daily trip from origin to destination and 0 otherwise)
MODD3	-0.7133	0.000	Dummy variable (1 for having a expensive vehicle and 0 otherwise)
FT	0.6139	0.000	Dummy variable (1 for using transit and 0 otherwise)
HAD1	0.4213	0.003	Dummy variable (1 for living in restricted even and odd area and 0 otherwise)

Table 5. Model results for personal car choice

variable	Personal car choice		Description
	Value	P[|Z|>z	
PEP	-0.00028	0.000	Entrance toll for even and odd restricted area
MODD	0.005	0.061	Average price group of vehicle (million Iranian Rials) (group 1= 60, group 2= 160, group 3= 450, group 4= 900)
EDUDD	0.0081	0.000	Years of Education (choice 1 = 10 years, choice 2 = 15, choice 3 = Option 18, choice 4 = 22 years)
JOBD2	0.334	0.001	Dummy variable (1 if job is self-employee, 0 otherwise)
ACO	0.594	0.008	Average Car ownership per family (number of cars to the number of family members)

As it can be concluded from these tables, the results are:

a) The sign of all parameters are acceptable. For example, in utility function of personal cars in even and odd restricted traffic area, the cost variable which is shown as "PEP" has a negative coefficient. In other words, whenever the toll increases, the utility reduces.

b) In general, all parameters are non-zero at 90% level of significance.

c) The toll variable at peak hours is very significant in the model.

d) The average car ownership variable (ACO) has positive sign in utility function of personal car and negative sign in utility function of public transit. It means that when ACO increases, the willingness of respondent to use personal vehicle increases and meanwhile using public transit loses its attractiveness.

e) Increasing the price level of car (MODD) increase the utility of personal car and reduce the tendency to public transit.

f) The respondent living area affects his/her choice. Living in even and odd restricted area increase the respondent willingness to use public transit. Due to congested road network in this area and also existence of proper coverage and access to public transit services, the utility of choosing this mode of travel is higher.

g) More than one time entrance to the restricted even and odd area causes the reduction in tendency of user to use personal cars. Since the entrance payment is obliged per entrance, this result can be acceptable.

h) The users who should enter the restricted even and odd area every day (because of their trip purpose), have higher tendency to public transit. The payment of toll and using personal cars is more common among infrequent users (e.g. travel or shopping).

4.2 Validation

Table 6 shows the validation results for the calibrated models. The log likelihood function evaluated at the mean of the estimated utility parameters is a useful criterion for assessing overall goodness-of-fit when the maximum likelihood estimation method is used to estimate the utility parameters of binary and multinomial models. Through this process, it is required to determine whether the difference between L* (β) and L* (0) is significant for the given model. This test performs based on chi square distribution. To apply this test we have [Louviere et al, 2000]:

$$-2\left[L^{*}(0)-L^{*}(\beta)\right]\succ\chi^{2}_{N,1-} \quad (5)$$

As it can be seen here, the 2[L (-L (0)] statistic which has χ^2 distribution with N degree of freedom (N= number of variables) rejects null hypothesis of parameters at 99% significance level. On the other hand, 2[L (-L(C)] has χ^2 distribution with N-m+1 degree of freedom (m= number of choices) show that proposed model is superior to the market share model. Also, model fitness index and percent of correct predictions are reported in table 5. As it can be seen, the amounts of ρ^2 is appropriate and the percent of correct is 51 percent which show that the model can predicted more than half of the choices correctly.

Table 6. Validation results for choice models

Statistics	Value	Statistics	Value
No of observations	3596	ρ_c^2	0.156
No of independent variables	31	]2 ()L -()L [	1601.08
(L(0	-6643.16	]2 ()L -()L [	4229.46
(L(C	-5128.97	(N)	52.18
()L	-4328.43	(N-m+1)	47
ρ^2	0.328	Percent of Correct prediction	51

4.3 Discussion

Figure 2 shows the sensitivity of mode choices due to different entrance tolls for even and odd restricted area. In another word, it shows the changes for choosing personal car, public transit and other alternatives (e.g. Taxi, late departure time, cancelling the trip). As it can be seen, at toll price of 30000 IRR, the share of personal cars reaches to 48.66 percent. With increasing the amount of toll for personal cars, the share of using this mode will be reduced and shifted to other modes. In case of choosing public transit, it can be observed that with

increasing toll, the share of choosing this mode will also increase. With entrance toll of 30000 IRR, 24 percent of users will choose public transit. This will raise to 42.5 percent when the entrance toll increases to 150000 IRR. Comparing to similar researches, we can see that different researches had gained different prices for changing the mode choice to public transit. For example, as Bureua reported in his research, 0.3 Euros increase in toll, reduced 20 perecents reduction in entrance of personal cars. In another research, 10 percent increase in public transit had been reported due to pricing. As it can be seen, the results of pricing for different communities and different times can not be comparable. Parameters like the socio-economic characteristics of communities, accessibility of public transit and length of trips can effect their willingness to pay for using their private car or shifting to public transit.

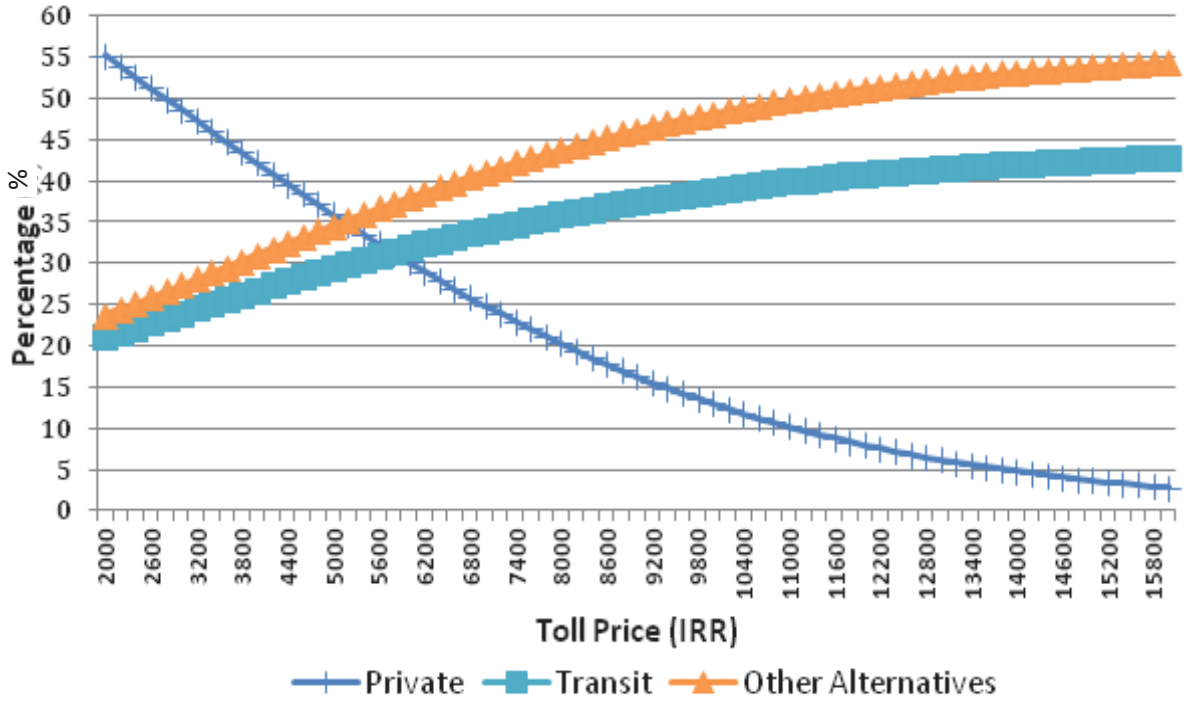

Figure2. Analysis results for mode shares due to different pricing scenarios

5. Conclusion

The aim of the current study was to investigate the effect of congestion pricing on respondent's willingness to use public transit. In order to determine utility function of respondents, the socio-economic characteristics and their willingness to pay were investigated. The stated preference method was used for designing pricing scenarios and gathering the needed data. The questionnaires included some questions regarding to socio-economic characteristics of respondents and represented various pricing scenarios. Based on the gathered data, a multinomial Logit model was applied for modelling public transit choice and also other modes in this study. In general, the results of this study can be summarized as follows:

-Results showed that pricing can be used as an effective tool for demand management. In this study, it was estimated that with 30000 IRR entrance toll, about 13 percent of personal car demand shifted to public transit and other modes.

-Variables like owning an expensive vehicle which can be an indicator of high income users, reduce the willingness to use public transit.

-The reliability of public transit found as an important factor for users. As it can be seen in the results, the employees with mandatory trip purposes have less

tendency to choose public transit which can be due to low reliability of this mode in current condition.

6. Endnotes

1- Iranian Rials

2- Tehran even and odd restricted traffic area include parts of Tehran city where the entrance of vehicles are controlled by the last number of their registration plates. Vehicles with last odd number in their plates are allowed to enter this area on Sundays, Tuesdays and Thursdays. Other vehicles (with even numbers) are allowed to enter this area on Saturdays (which is a working day in Iran), Mondays and Wednesdays.

7. References

- Bowerman, A. (2007) "The costs and benefits of road pricing: Comparing Nationwide charging with project-based schemes", IEA discussion paper, No.17-18.

- Bureau, B. and Glachant, M. (2008) "Distributional effects of road pricing: Assessment of nine scenarios for Paris", Transportation Research Part A: Policy and Practice, vol. 42, issue 7 , pp. 994-1007.

- Chen, Y. and Jana, R. (1990) "Using generalized second price Auction for congestion pricing", At-T labs Research Center.

- Cronbach, L. J. (1951) "Coefficient alpha and the internal structure of tests", Psychometrika , pp. 297-334.

- Eliasson, J., Hultkrantz, L., Nerhagen, L. and Rosqvist, L.S. (2009) "The Stockholm congestion-charging trial 2006: Overview of effects", Transportation Research Part A: Policy and Practice, vol. 43, issue 3, pp. 240–250.

- Frick, K.T., Heminger, S., Dittmar, H. (1996) "Bay bridge congestion-pricing project: Lessons learned to date", Transportation Research Record, pp. 29–38.

- Hensher, A. D. and Button, K. J. (2000) "Handbook of Transport Modeling", Emerald Group Publishing, Chiechester, West Susex, England.

- Kim, J., Schmocker, J. D., Fujii, S. and Noland, R. (2013) "Attitudes towards € road pricing and environmental taxation among US and UK students", Transportation Research Part A: Policy and Practice 48, pp. 50-62.

- Kockelman, K., Donna Chen, T., Katie, L. and Brice, G. (2013) "The economics of transportation systems: A reference for practitioners".

- Litman, T. (2011) "London congestion pricing implications for other cities", Victoria Transport Policy.

- McFadden, D. (1974) "The measurement of urban travel demand", Journal of Public Economics, Elsevier, vol. 3, No. 4, pp. 303-328.

- MIT Portugal Program. (2009) "Stated preference survey for new smart transport modes and services: design, pilot study and new revision", Transportation Systems Focus Area.

- Polak,J. (1992) "An assessment of some recent studies of travelers choice of time of travel", Transport studies unit, University of Oxford.

- Small, K.A. (1992) "Use the revenues from congestion pricing", Transportation 19, pp.359–381.

- Sugiyanto, G., Malkhamah, S., Munawar, A. and Sutomo, H. (2009) "Modeling the effect of congestion pricing on mode choice in yogyakarta", Jenderal Soedirman University, Indonesia.

- Xu, Shunan. and Ben Akiva, M. E. (2009) "Development and test of dynamic congestion pricing model", Massachusetts Institute of Technology.

- Zheng, Z., Liu, Z., Liu, C. and Shiwakoti, N. (2014) "Understanding public response to a congestion charge: a random-effects ordered logit approach", Transportation Research Part A: Policy and Practice 70, pp117-134.

Appendix:

Trip Information

1-What is your main trip objective from entering the even and odd traffic area with your personal car?
A: Work B:Education C:Shopping D: Visiting friends and relatives E:Personal issues F: Other …….

Please indicate your address (Excluding local detai2-
.....:(ls

.....3-what is your average travel time from origin to your main destination

(4-Is it possible for you to use public transit in your daily trips? Yes ..... No….. (End of question
Walk ..... Taxi….. Personal Car ?4-1-what is your access type from your origin to the public transit stop
…..... Others
4-2-How long is your access time from your origin to the public transit stop?..... mins
4-3- How long is your access time from your origin to destination by public transit stop? ..... mins

5-Have you had or will have other stops in your trip today? Yes ..... No…..
If ((Yes)),How many stops? (depending on your trip pyrpose) total number of stops……
Giving a ride to family members ….. stops shopping….. stops personal issues….. stops
Others ….. stops

6-what is the maximum number of occupants in your car today?
A: 1 occpant B: 2 occpants C: 3 occpants D: 4 occpants and more E:Personal issues
F: Other ……

7-what was the time of your first entrance to even and odd region today? ……

8-How many time will you enter the even and odd restricted area today?
A: 1 time B: 2 times C: 3 times and more

9- Pricing scenarios:
In this section the pricing scenarios were presented to respondents. For each type of qustionnaires, 4 pricing scenarios were asked and their mode choice were asked(The pricing scenarios and their mode choice alternatives are stated in the paper)

Personal Information

…Gender? male ..... female 10-

11- what is your job?
A: client B: manager C: personal buiness D: doctor E:academic staff F: student
G: client B: manager C: housekeeper D: retired E:workless F: other (……)
12- In which section do you work? A: govermental sector B: private sector
13- Do you have a full time or part time job? A: Full time B: Part time
Please indicate the address of your work or educational place (Excluding local detai 14-
.....(ls

What is your education? Diploma and below…. Bachelor of science…. Master of science …… 15- ..……PH.D

..……What is your age? 18 to 24…. 25 to 32…..33 to 45 …… 46 to 55…….. 56 to 69……..70 and more 16-

..……Are you married? Yes…. No 17-

How many are the members of your family? 1 person…. 2 persons …..3 persons …… 4 persons …….. 5 18- ..…… persons and more

?What is the type of your personal car 19-

Vehicle type	1-	2-	3-
Year of production	.....	.....	.....

Do you have a entrance liscence to even and odd area for at least one of the vehicles mentioned above? 20- ..…Yes ..... No

..…(What is the type of your vehicle plate? White (private) ..... Red (govermental 21-

..… What is the the latest number of your vehicle platenumber? odd ..... even 21-