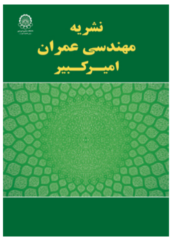

Amirkabir Journal of Civil Engineering

Amirkabir J. Civil Eng., 50(1) (2018) 47-50
DOI: 10.22060/ceej.2016.699

Modeling the Intra City Tours with Work Purpose by Using Weighted Multiple Regressions

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ABSTRACT: In this paper by using the aggregate socioeconomic features of each zone and considering the land use prosperities, the aggregate zonal tours were modeled. For that, classic 4-step modeling database was utilized in which less data collection cost needs. Due heteroscedasticity , appling weighted least square (WLS) method led to multiple weighted regressions by two exogenous independent variables; population and number of employers in zone. Heteroscedasticity affect the efficiency of regression. In comparing of two model, the F test of WLS method growth 27 percent and the amount t students for population reduced from 2.79 to 2.27 that in negligible. On the other hand, the amount of t students for number of employers increases from 2.62 to 3.40 (30 percent). Constant coefficient is negative but in comparison with the maximum number of observed tours (7202 tours) is 0.069 percent and the average number of observed tours (1386 tours) is 0.36 percent that is negligible and the R^2 goodness of fit index is 0.927 and acceptable.

Review History:

Received: 30 November 2015
Revised: 20 February 2016
Accepted: 2 August 2016
Available Online: 4 September 2016

Keywords:

Activity-based Model
Tour
Weighted Multiple Regressions
Qazvin

1- Introduction

Travel demand modeling, in recent years, has seen a paradigm shift with an emphasis on analyzing travel at the individual level rather than using direct statistical projections of aggregate travel demand as in the trip-based approach. Specifically, many researches and several metropolitan planning organizations are developing and implementing advanced travel demand models that are based on a behaviorally more realistic representation of demand for travel [1-4]. In literature, various structures of models, finalized to estimate the travel demand, are reported. Considered the complexity of the phenomenon and the variety of the adopted formulations, it is difficult to make a rigorous classification. However, there are two main approaches: a global approach, which reproduces the phenomenon by a single model, and a sequential approach which, by a system of sub-models, replicates the decisional process in successive stages which represent the corresponding dimensions of choice [5-7].

The sequential models differ for the elementary unit which represents the travel demand. This unit, in order of complexity, can be identified with the single movement from an origin to a destination (trip), the sequence of trips based at home (tour), or the daily/weekly travel program (pattern) [8, 9]. The tours have been characterized by the destination in which the major activity has been done. The primary destination has been chosen attributing to the activities a different hierarchical level, in function of the constraint degree which they determine in the space and the time [10]. In particular, four hierarchical levels of activity have been specified, attributing to work in a permanent address and study activities, more time-space constrained, the higher degree; the work activities, made in a non-habitual workplace, have been sited to the immediately inferior level; non-work and non-study activities have been unified in two different hierarchical levels, classifying the personal affairs and the person taking activities more constrained than the recreation and shopping ones. Finally, the calibrated models estimate the probability to generate a tour for the predominant activity and, subsequently, the probability to make some other activities during the same tour. In this paper, models have been specified and calibrated for the generation of tours with work purpose.

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2- METHODOLOGY, CASE STUDY AND RESULTS

Linear regression makes several key assumptions: Linear relationship, Multivariate normality, No or little multicollinearity, No auto-correlation and Homoscedasticity. The assumption of homoscedasticity, which also known as homogeneity of variance, could be checked by scatter plot. The Goldfeld-Quandt test can serve for heteroscedasticity analysis. In statistics, the Goldfeld-Quandt test checks for homoscedasticity in regression analyses. It does this by dividing a dataset into two parts or groups, and hence the test is sometimes called a two-group test. The Goldfeld-Quandt test is one of the two tests proposed in paper by Stephen Goldfeld and Richard Quandt (1965). Both parametric and non-parametric tests are described in the paper, but the term "Goldfeld-Quandt test" is usually associated only with the former. In the context of multiple regression (or univariate regression), the hypothesis to be tested is that the variances of the errors of the regression model are not constant, but instead are monotonically related to a pre-identified explanatory variable [11]. The method of weighted multiple regressions assumes that there is constant variance in the errors (which is called homoscedasticity). The method of weighted least squares can be used when the ordinary least squares assumption of constant variance in the errors is violated (which is called heteroscedasticity). The model under consideration is:

$$Y=\beta X+\epsilon \qquad (1)$$

Where now ϵ is assumed to be (multivariate) normally distributed with mean vector 0 and non-constant variance-covariance matrix. If we define the reciprocal of each variance, σ^2_i. As the weight, $w_i = 1/\sigma^2_i$. The weighted least squares estimate is then

$$\hat{\beta}_{WLS} = \arg\min_{\beta} \sum_{i=1}^{n} \epsilon_i^{*2} = (X^TWX)^{-1}X^TWY \qquad (2)$$

2- 1- CASE STUDY

Qazvin is the largest city and capital of the Province of Qazvin in Iran at the 2011 census, its population was 381,598. Qazvin located in 150 km (93 mi) northwest of Tehran, in the Qazvin Province. It is at an altitude of about 1,800 m (5,900 ft) above sea level. Based on Qazvin transportation master plan which conducted on 2011, traveler's tours with several legs are presented in Table 1. Table 2 presents dependent and independent variables in trip and tour generation [12].

Table 1. Descriptive analysis of traveler's tour in Qazvin

Statistic	Tour legs								
	2	3	4	5	6	7	8	9	10
Frequency	15924	760	156	27	18	11	0	2	1
Relative frequency	94.17	4.49	0.92	0.21	0.10	0.036	0	0.004	0.005
cumulative Relative frequency	94.17	99.66	99.58	99.79	99.89	99.926	99.991	99.995	100

Table 2. dependence and independence variables in traveler's tour generation modeling

Variable	Variable Type	Description
$Total\text{-}Tour_i$	Dependent	Number of tour in zone i
$Area_i$	Independent	Area of zone i
$Population_i$		Population in zone i
$Pop\text{-}Density_i$		Population divided by Area in zone i
HHs_i		Average of house hold size in zone i
$No\text{-}HH_i$		Number of House hold in zone i
$Sponsorship_i$		Average of Sponsorship in zone i
$Employee_i$		Number of employee in zone i
$Emp\text{-}Land\text{-}Use_i$		Area of Administrative land Use in zone i
$Com\text{-}Lane\text{-}Use_i$		Area of Commercial land Use in zone i
$Res\text{-}Land\text{-}Use_i$		Area of Residential land Use in zone i
$Emp\text{-}LU\text{-}Rate_i$		Area of Administrative land Use divided by population in zone i
$Com\text{-}LU\text{-}Rate_i$		Area of Commercial land Use divided by population in zone i

2- 2- RESULTS

In this paper, to modeling tour generation, both OLS and WLS regression models were investigated. Table 3 present error terms in several models and Table 4 presents an error squares of models.

Table 3. Error terms in several models

Error term	OLS			WLS	
	With only population as an independent Var.	With only No. employee as an independent Var.	With Both No. employee and population as an independent Var.	Weight based on Population	Weight based on No Employee
Minimum	-1681.09	-2701.99	-2019.30	-1209.00	-1995.55
Maximum	1332.62	1175.50	1199.59	1909.00	1410.56
Average	13.02	-44.71	-40.00	127.55	14.02
Standard error	416.09	414.52	400.57	434.42	403.02

Table 4. Error squares terms in several models

Error term	OLS			WLS	
	With only population as an independent Var.	With only No. employee as an independent Var.	With Both No. employee and population as an independent Var.	Weight based on Population	Weight based on No Employee
Minimum	0	0	0	0	1.81
Maximum (x10^6)	2.82	7.30	4.07	3.64	3.98
Average (x10^6)	1.71	1.72	1.60	2.03	1.61
Standard error (x10^6)	4.08	7.14	4.72	5.06	4.69

Finally the weighted multiple regressions based on employee's weight selected.

$$\text{Number of tour}=-5.024+0.178Popi+0.725EMPi \quad (3)$$

3- Conclusion

New approach of travel behavior study tries to focus more on individual activities rather than traditional aggregate models such as trip generation in four-step models. The tour-based models, unlike the previous models, take account of the time and space constraints among the trips of the same tour. The better-structured models simulate, in various stages, the tour generation and frequency, the space distribution (primary and secondary destination), the tour type and the mode choice. This study tries to address homoscedasticity as one of the assumptions of linear regression models for the case study of Qazvin. in this regards, by aggregation individual tours, for each zone, the OD matrix is generated. In this paper by using the aggregate socioeconomic features of each zone and considering the land use prosperities, the aggregate zonal tours were modeled. For that, classic 4-step modeling database was utilized in which less data collection cost needs. Because of heteroscedasticity, appling weighted least square (WLS) method led to multiple weighted regressions by two exogenous independent variables; population and number of employee in zone. Heteroscedasticity affect the efficiency of regression. In comparing of two model, the F test of WLS method growth 27 percent and the amount t students for population reduced from 2.79 to 2.27 that in negligible. On the other hand, the amount of t students for number of employee increases from 2.62 to 3.40 (30 percent). Constant coefficient is negative but in comparison with the maximum number of observed tours (7202 tours) is 0.069 percent and the average number of observed tours (1386 tours) is 0.36 percent that is negligible and the R2 goodness of fit index is 0.927 and acceptable.

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Please cite this article using:

A. R. Mahpour, S. E. Seyed Abrishami, A. R. Mamdoohi, A. H. Baghestani, Modeling the intra city tours with work purpose by using weighted multiple regressions. *Amirkabir J. Civil Eng.*, 50(1) (2018) 139-148.

DOI: 10.22060/ceej.2016.699