CEE 123 Transport Systems 3: Planning & Forecasting

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Homework #5 -- Trip Generation Analysis [Due: Friday, May 6th]

Problem 1 [20 points]
The data in **Table 1** was collected from 10 households (HH31-HH40). Variables include Household ID Number, HHID), daily trip productions per household (Trips), HH Income (HHInc, in $1,000s), number of cars in the HH (Cars), persons per HH (HHSize), and dwelling unit type (DU, 1=Single Family; 2=Multiple Family).

a. **Hypothesize** several alternate model structures [e.g., Trips = f(Inc)] and then **estimate** a valid bivariate trip generation model using these 10 data points, performing the calculations using Excel.
b. **Hypothesize** several alternate multivariate structures [e.g., Trips = f(Inc, Cars)] and **estimate** a valid multivariate trip generation model using these 10 data points (use Excel). Include Excel output.

Table 1. Sample Household Travel and Demographic Data

HHID	Trips	Inc	Cars	HHSize	DU
31	5	50.1	2	2	2
32	6	55.5	2	3	1
33	10	61.2	3	4	1
34	4	45.6	1	2	2
35	8	63.9	2	4	1
36	6	55.5	2	2	2
37	5	49.8	2	3	2
38	8	63.9	2	4	1
39	4	42.9	1	1	2
40	4	45.6	1	2	2

Problem 2 [10 points]
A base category distribution of households by number of cars per household (1, 2, or 3+) and type of dwelling unit (1=single family, 2=multiple family) is provided in **Table 2**. Each category cell contains the total number of trips and the total number of households, respectively, but only for the first 40 data points in **Table 8**. Add the remaining 10 households (HH41-HH50) to this table then build a *category trip generation model* by computing trip production rates for each cell (*and* for row and column totals) of the matrix. Round to nearest tenth of a trip.

Table 2. Trip Summary (HHs 1-40 only)

Cars/HH	Dwelling Type: 1=SF	Dwelling Type: 2=MF	Row Tot
1	12	31	43
	2	9	11
2	69	57	126
	10	11	21
3+	68	8	76
	7	1	8
Col Tot	149	96	245
	19	21	40

Problem 3 [10 points]
Compare your category model with the corresponding regression model (below).

1. Evaluate the estimation results statistically.
2. Interpret the model coefficients? What do these values imply about trips?
3. Compute regression estimates for each cell of the category model. Compare results.

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--------     O R D I N A R Y   L E A S T   S Q U A R E S     ---------
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 VARIABLE      MEAN    S.D.  OBS     CORREL  Cars      DU        Trips
 1. Cars     1.8200  0.7197   50      Cars   1.0000   -0.4425    0.8721
 2. DU       1.5800  0.4986   50      DU    -0.4425    1.0000   -0.6834
 3. Trips    5.6600  2.4042   50      Trips  0.8721   -0.6834    1.0000

 MODEL: Cat.Mod.Compar.   DEPENDENT VARIABLE => Trips Produced

 MULTIPLE R      0.9331   * ANOVA *  SUM OF SQR   df   MEAN SQR    F
 R-SQUARE        0.8706   MODEL SS       246.58    2     123.29  158.17
 ADJ R-SQUARE    0.8651   ERROR SS        36.64   47       0.78
 S.E. OF EST.    0.8829   TOTAL SS       283.22   49

        VARIABLE NAME       B         BETA     S.E. B     T
          1. Cars          2.3665    0.7084    0.1954   12.1095
          2. DU           -1.7840   -0.3700    0.2821   -6.3241
             Constant      4.1718
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Problem 4 [10 points]
Using the category and the regression production models, forecast the number of trips per household for the six HH holdout sample (HH54-HH59; see **Table 4**), comparing forecast and observed trip rates.

Table 4. Households for Validation Test

ID	Trips	Income	Cars	HHS	DU	ID	Trips	Income	Cars	HHS	DU
54	10	59.4	3	5	1	57	3	37.5	1	1	2
55	8	58.5	3	4	1	58	5	41.4	1	2	1
56	5	43.8	2	2	1	59	8	51.5	2	4	1

Problem 5 [10 points]
The 50 households in question were sampled from a study area divided into 3 zones (TAZs). The associate population-level distributions for these 3 zones are provided in **Table 5**. Compute the total number of trips produced per zone using your final category model from Problem 2.

Table 5. Population Distribution of Households

TAZ 1

D.U. Cars	1 SF	2 Other	Row Tot
1	0	0	0
2	50	0	50
3+	50	0	50
Col	100	0	100

TAZ 2

D.U. Cars	1 SF	2 Other	Row Tot
1	50	50	100
2	100	30	130
3+	50	20	70
Col	200	100	300

TAZ 3

D.U. Cars	1 SF	2 Other	Row Tot
1	20	80	100
2	20	70	90
3+	10	0	10
Col	50	150	200

Problem 6 [10 points]
The other side of the trip generation stage is estimating trip attractions. The following regression-based total trip attraction model was estimated for the region:

$A_j = 1.5\ POP_j + 2.9\ EMP_j$

Table 6 provides regional demographic information. Compute total attractions and compare these results with the estimates for total productions from Problem 5. Since every trip has a production and an attraction, normalize the attractions so that the total equals total productions.

Table 6. Demographic Data Summary

TAZ	HH	POP	EMP
1	100	300	0
2	300	1100	400
3	200	600	100
Tot	600	2000	500

HH = total households
POP = total population
EMP = total employment

Problem 7 [10 points Extra Credit]
Concisely analyze each of the following bivariate (Table 7A) and multivariate (Table 7B) regression total trip production models which were estimated using a **subset** of the household travel diary data set (see Table 8 below). Discuss which models are better and why.

Table 7A. Bivariate Regression Summary (variables defined in Table 8)

Model	A	B	C	D
INC	0.79			
(t)	(21.05)			
CARS		2.91		
(t)		(12.35)		
HHS			1.79	
(t)			(10.68)	
DU				-3.30
(t)				(-6.49)
Cnst	-7.58	0.36	0.79	10.87
R	0.95	0.87	0.84	-0.68
R-Sq	0.90	0.76	0.70	0.47
S.E.	0.76	1.19	1.32	1.77
F	443.10	152.52	114.06	43.12

Table 7B. Multiple Regression Summary

Model	E	F	G	H	I	J	K
INC	0.65	0.62	0.49	0.50	0.58		0.65
(t)	(8.99)	(8.61	(7.17)	(7.25)	(10.49)		(11.04)
CARS	0.66	0.27	0.68	0.87		2.08	
(t)	(2.27)	(0.79	(2.17)	(3.52)		(5.87)	
HHS		0.36	0.16		0.39	0.23	0.45
(t)		(1.95)	0.97		(2.82)	(0.96)	(2.95)
DU			-0.95	-1.02	-0.79	-1.68	
(t)			(-4.11)	(-4.59)	(-3.46)	(-5.57)	
Cnst	-6.40	-6.17	-2.80	-2.66	-3.98	3.90	-6.45
R	0.95	0.96	0.97	0.97	0.97	0.93	0.96
R-Sq	0.91	0.92	0.94	0.94	0.93	0.87	0.92

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S.E.    0.73    0.71    0.61    0.61    0.63    0.88    0.70
F     243.32  173.16  178.90  238.53  219.11  105.58  261.55
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Table 8. Household Travel Survey Data used in Problems 1-7

ID	Trips	Income	Cars	HHS	DU	ID	Trips	Income	Cars	HHS	DU
1	4	45.0	2	3	2	26	10	59.4	3	5	1
2	3	40.2	1	2	2	27	8	58.5	3	4	1
3	4	46.5	1	1	2	28	5	40.8	1	2	1
4	5	50.4	2	3	2	29	8	54.3	2	4	1
5	6	57.3	2	2	2	30	9	61.5	3	4	1
6	6	49.8	2	3	1	31	5	50.1	2	2	2
7	7	52.5	1	2	1	32	6	55.5	2	3	1
8	7	55.5	2	3	1	33	10	61.2	3	4	1
9	6	37.2	2	3	1	34	4	45.6	1	2	2
10	3	42.6	1	2	2	35	8	63.9	2	4	1
11	5	46.8	2	2	2	36	6	55.5	2	2	2
12	7	50.4	2	3	1	37	5	49.8	2	3	2
13	6	52.8	2	2	1	38	8	63.9	2	4	1
14	4	43.2	1	1	2	39	4	42.9	1	1	2
15	5	49.2	2	3	2	40	4	45.6	1	2	2
16	5	49.2	2	3	2	41	8	60.6	3	4	2
17	8	60.0	3	5	2	42	7	55.5	2	3	1
18	3	39.0	1	1	2	43	5	48.6	2	3	2
19	6	51.9	2	2	2	44	3	40.5	1	2	2
20	9	63.0	3	4	1	45	2	37.5	1	2	2
21	11	67.8	3	5	1	46	3	40.8	1	1	2
22	5	49.5	2	3	2	47	2	37.5	1	2	2
23	11	67.5	3	5	1	48	3	41.4	1	2	2
24	2	35.4	1	2	2	49	2	35.1	1	2	2
25	7	57.3	2	3	1	50	3	40.8	1	2	1

Key:

1. HH ID = household number
2. Trips = number of daily trip productions per household
3. HHInc = mean Household income (in $1000s)
4. Cars = number of cars per HH
5. HHS = Household size (persons per HH)
6. D.U. = Dwelling Unit Type (1=single family; 2=multiple family)

Review Questions: (do not need to be submitted with HW#6)

a. In terms of relationships between variables, how is a HBW production *category* model with two explanatory variables comparable to a HBW production *regression>/I> model with the same two explanatory variables?*
b. *What is required to complete a future forecast using the regression-based trip generation model for HBW productions from the previous review question?*
What is required to complete a future forecast using the category model trip generation model for HBW productions?
c. *Why is the category approach used for most trip production models while regression is used for attraction models?*

Last Updated: 25 Apr 2022