



Statistical and Econometric Methods

Assignment #9

("Heterogeneity Models": Based on Example 13.1)

Recall from an earlier assignment, you were given 151 observations of a travel survey collected in State College Pennsylvania (See Example 13.1 on page 319 of the text for an estimation of a fixed-parameters logit model of these data). All of the households in the sample are making the morning commute to work. They are all departing from the same origin (a large residential complex in the suburbs) and going to work in the Central Business District. They have the choice of three alternate routes; 1) a four-lane arterial (speed limit = 35mph, 2 lanes each direction), 2) a two-lane rural road (speed limit = 35mph, 1 lane each direction) and 3) a limited access four-lane freeway (speed limit = 55mph, 2 lanes each direction).

You can use route distance as is done in the examples provided in this assignment or, as in an earlier assignment, you can develop a new model with a price variable in all three choice alternatives. Recall, the price variable is created as: $\text{set price} = ((\text{distance}/10)/\text{mpg}) * 1.05$.

Consider two heterogeneity models:

1. Mixed Logit (Random Parameters Logit). See Section 16.1 in the text (starting on page 375) and online slides and paper.
2. Latent Class Logit (Finite Mixture Logit). See online slides and paper.

Available distributions for Mixed Logit:

n = normal; l = lognormal; u = uniform; t = triangular; d = dome; e = Erlang; w = Weibull; p = exponential; c = nonstochastic (constant)

Variables available for your specification are (in file LOGIT-A1.txt):

Variable Number	Explanation
x1	Route chosen, rows: 1 - arterial, 2 - rural road, 3 - freeway
x2	Arterial row indicator; 1 for arterial row, 0 for others
x3	Rural row indicator; 1 for rural row, 0 for others
x4	Freeway row indicator; 1 for freeway row, 0 for others
x5	Traffic flow rate
x6	Number of traffic signals
x7	Distance in tenths of miles
x8	Seat belts: 1 - if wear, 0 - if not
x9	Number of passengers in car
x10	Driver age in years: 1 - 18 to 23, 2 - 24 to 29, 3 - 30 to 39, 4 - 40 to 49, 5 - 50 and above
x11	Gender: 1 - male, 0 - female
x12	Marital status: 1 - single, 0 - married
x13	Number of children
x14	Annual income: 1 - less than 20000, 2 - 20000 to 29999, 3 - 30000 to 39999, 4 - 40000 to 49999, 5 - more than 50000
x15	Model year of car (e.g. 86 = 1986)
x16	Origin of car: 1 - domestic, 0 - foreign
x17	Fuel efficiency in miles per gallon

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-> read;nvar=17;nobs=453;file=U:\00Work-Purdue\new_laptop\CE697N-disk\LOGIT-A1.txt$
-> create;cage=86-x15$
-> rplogit;lhs=x1;choices=arterial,rural,freeway;model:
    u(arterial)=dist*x7/
    u(rural)=rural*one+dist*x7+cager*cage/
    u(freeway)=freeway*one+dist*x7+malef*x11+cagef*cage
    ;fcn=dist(n);pts=200;halton$

```

Iterative procedure has converged
Normal exit: 13 iterations. Status=0, F= .9717994D+02

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Random Parameters Multinom. Logit Model
Dependent variable           X1
Log likelihood function      -97.17994
Restricted log likelihood    -165.89046
Chi squared [ 7](P= .000)   137.42102
Significance level          .00000
McFadden Pseudo R-squared   .4141921
Estimation based on N =    151, K = 7
Inf.Cr.AIC = 208.4 AIC/N = 1.380
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                Log likelihood R-sqrd R2Adj
No coefficients -165.8905 .4142 .4003
Constants only -124.2267 .2177 .1992
At start values -97.5733 .0040-.0196
Note: R-sqrd = 1 - logL/Logl(constants)
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Response data are given as ind. choices
Replications for simulated probs. = 200
Used Halton sequences in simulations.
Number of obs.= 151, skipped 0 obs

X1	Coefficient	Standard Error	z	Prob. z >Z*	95% Confidence Interval	

Random parameters in utility functions.....						
DIST	-.20495***	.05793	-3.54	.0004	-.31850	-.09140
Nonrandom parameters in utility functions.....						
RURAL	.09666	.36027	.27	.7885	-.60946	.80278
CAGER	.14331*	.07505	1.91	.0562	-.00378	.29040
FREEWAY	-.24577	.80710	-.30	.7607	-1.82766	1.33612
MALEF	.69713	.71413	.98	.3290	-.70254	2.09680
CAGEF	.26832**	.10624	2.53	.0115	.06009	.47655
Distns. of RPs. Std.Devs or limits of triangular.....						
NsDIST	.07699	.05521	1.39	.1632	-.03122	.18519

***, **, * ==> Significance at 1%, 5%, 10% level.
Model was estimated on Nov 14, 2016 at 01:44:24 PM

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-> lcllogit;lhs=x1;choices=arterial,rural,freeway;model:
u(arterial)=dist*x7/
u(rural)=rural*one+dist*x7+cager*cage/
u(freeway)=freeway*one+dist*x7+malef*x11+cagef*cage
;pts=2$

```

Iterative procedure has converged
Normal exit: 35 iterations. Status=0, F= .9010460D+02

Latent Class Logit Model

Dependent variable X1
Log likelihood function -90.10460
Restricted log likelihood -165.89046
Chi squared [13](P= .000) 151.57172
Significance level .00000
McFadden Pseudo R-squared .4568428
Estimation based on N = 151, K = 13
Inf.Cr.AIC = 206.2 AIC/N = 1.366

Log likelihood R-sqrd R2Adj
No coefficients -165.8905 .4568 .4324
Constants only -124.2267 .2747 .2420
At start values -97.5754 .0766 .0350
Note: R-sqrd = 1 - logL/Logl(constants)

Response data are given as ind. choices
Number of latent classes = 2
Average Class Probabilities
.680 .320
Number of obs.= 151, skipped 0 obs

X1		Coefficient	Standard Error	z	Prob. z >Z*	95% Confidence Interval	

Random utility parameters in latent class -->> 1.....							
DIST	1	-.55677	.47631	-1.17	.2424	-1.49032	.37678
RURAL	1	-.42568	2.06592	-.21	.8368	-4.47480	3.62344
CAGER	1	.33715	.41179	.82	.4129	-.46994	1.14424
FREEWA	1	3.79949	6.11884	.62	.5346	-8.19321	15.79219
MALEF	1	-.28126	2.91639	-.10	.9232	-5.99728	5.43475
CAGEF	1	.61880	.53079	1.17	.2437	-.42153	1.65913
Random utility parameters in latent class -->> 2.....							
DIST	2	-.00490	.07817	-.06	.9500	-.15812	.14831
RURAL	2	.60882	1.30634	.47	.6412	-1.95156	3.16920
CAGER	2	.06272	.15235	.41	.6806	-.23588	.36133
FREEWA	2	-1.49400	1.51087	-.99	.3227	-4.45526	1.46725
MALEF	2	.95709	1.56270	.61	.5402	-2.10574	4.01993
CAGEF	2	-.11285	.33767	-.33	.7382	-.77467	.54898
Estimated latent class probabilities.....							
PrbCls1		.67996**	.28764	2.36	.0181	.11620	1.24373
PrbCls2		.32004	.28764	1.11	.2659	-.24373	.88380

***, **, * ==> Significance at 1%, 5%, 10% level.
Model was estimated on Nov 14, 2016 at 01:44:32 PM

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-> lcllogit;lhs=x1;choices=arterial,rural,freeway;model:
u(arterial)=dist*x7/
u(rural)=rural*one+dist*x7+cager*cage/
u(freeway)=freeway*one+dist*x7+malef*x11+cagef*cage
;pts=3$

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Latent Class Logit Model
Dependent variable           X1
Log likelihood function      -85.19439
Restricted log likelihood    -165.89046
Chi squared [ 20](P= .000)   161.39213
Significance level           .00000
McFadden Pseudo R-squared   .4864419
Estimation based on N =     151, K = 20
Inf.Cr.AIC = 210.4 AIC/N = 1.393
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Log likelihood R-sqrd R2Adj
No coefficients -165.8905 .4864 .4500
Constants only -124.2267 .3142 .2656
At start values -97.5781 .1269 .0650
Note: R-sqrd = 1 - logL/Logl(constants)
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Response data are given as ind. choices
Number of latent classes = 3
Average Class Probabilities
.349 .074 .577
BHHH estimator used for asymp. variance
Number of obs.= 151, skipped 0 obs
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X1	Coefficient	Standard Error	z	Prob. z >Z*	95% Confidence Interval	
Random utility parameters in latent class --> 1.....						
DIST 1	-1.54991***	.28489	-5.44	.0000	-2.10828	-.99154
RURAL 1	-7.22726***	2.72664	-2.65	.0080	-12.57138	-1.88313
CAGER 1	1.04568	.75421	1.39	.1656	-.43254	2.52390
FREEWA 1	8.59180	7.11958	1.21	.2275	-5.36231	22.54591
MALEF 1	6.17543	8.19917	.75	.4513	-9.89464	22.24551
CAGEF 1	1.80083**	.71676	2.51	.0120	.39601	3.20566
Random utility parameters in latent class --> 2.....						
DIST 2	1.29019	9.44854	.14	.8914	-17.22860	19.80899
RURAL 2	2.75777	32.61067	.08	.9326	-61.15798	66.67351
CAGER 2	-1.81298	17.03629	-.11	.9153	-35.20349	31.57753
FREEWA 2	-15.1470	124.3849	-.12	.9031	-258.9370	228.6429
MALEF 2	-3.72070	54.63883	-.07	.9457	-110.81083	103.36944
CAGEF 2	-1.81071	11.11315	-.16	.8706	-23.59210	19.97067
Random utility parameters in latent class --> 3.....						
DIST 3	-.72451	1.14434	-.63	.5267	-2.96737	1.51836
RURAL 3	.70977	6.85780	.10	.9176	-12.73126	14.15081
CAGER 3	3.88201	6.03620	.64	.5201	-7.94873	15.71275
FREEWA 3	-.17567	7.00514	-.03	.9800	-13.90549	13.55415
MALEF 3	4.02797	6.44008	.63	.5317	-8.59435	16.65028
CAGEF 3	4.28558	6.66399	.64	.5202	-8.77560	17.34676
Estimated latent class probabilities.....						
PrbCls1	.34943***	.10595	3.30	.0010	.14177	.55708
PrbCls2	.07363**	.02916	2.53	.0116	.01648	.13079
PrbCls3	.57694***	.10905	5.29	.0000	.36321	.79067

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***, **, * ==> Significance at 1%, 5%, 10% level.
Model was estimated on Nov 14, 2016 at 01:44:47 PM
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