

Statistical and Econometric Methods for Transportation Data Analysis

Chapter 13 – Discrete Outcome Models

Example 13.7

Discrete Outcome Data – FIML Nested Logit II

You are given injury-severity data from 2,273 single-vehicle motorcycle crashes in the state of Indiana. There are four possible severity outcomes: No-injury (property damage only and possible injury); non-incapacitating injury; incapacitating injury; fatality. The four injury levels result in a Limdep file that is 9092 rows (2,273 x 4). An initial analysis found that no-injury and non-incapacitating injury share unobserved effects and should be nested. However, you could test alternate model formulations.

Your task is to estimate a nested logit model of motorcyclists' injury severity (the likelihood of an individual rider being involved in a crash that is: No-injury (property damage only and possible injury), non-incapacitating injury; incapacitating injury or fatality).

1. The results of your best model specification.
2. A discussion of the logical process that led you to the selection of your final specification (the theory behind the inclusion of your selected variables). Include *t*-statistics and justify the signs of your variables.

Variables available for your specification are (in file Ex13-7.txt):

Variable Number	Explanation
SEVERITY	Crash severity: 1 if the crash resulted in the severity level specified, 0 otherwise
PDO	1 if PDO, 0 otherwise
NONIN	1 if non-incapitating injury, 0 otherwise
INCAP	1 if incapacitating injury, 0 otherwise
FATAL	1 if fatal injury, 0 otherwise
MASTER	Master record number for the crash
VEHAGE	Motorcycle age in years
HARLEY	1 if Harley, 0 otherwise
HONDA	1 if Honda, 0 otherwise
YAMAHA	1 if Yamaha, 0 otherwise
SUZUKI	1 if Suzuki, 0 otherwise
KAWASAKI	1 if Kawasaki, 0 otherwise
SPORTBIK	1 if Sportbike, 0 otherwise
PASSNGR	1 if passenger on bike, 0 otherwise
ANIMAL	1 if collision with animal, 0 otherwise
GUARDRL	1 if collision with guardrail, 0 otherwise
TREE	1 if collision with tree, 0 otherwise
PEDBIKE	1 if collision with pedestrian or bicycle, 0 otherwise
CURB	1 if collision with curb, 0 otherwise
POLE	1 if collision with pole, 0 otherwise

VEHICLE	1 if collision with parked vehicle, 0 otherwise
WALL	1 if collision with wall, 0 otherwise
CULVERT	1 if collision with culvert, 0 otherwise
DITCH	1 if collision with ditch, 0 otherwise
EMBANK	1 if collision with embankment, 0 otherwise
TRAFCONT	1 if traffic control devices were present, 0 otherwise
AGE	Rider age in years
FEMALE	1 if female, 0 otherwise
EJECTED	1 if ejected, 0 otherwise
PINNED	1 if pinned, 0 otherwise
HELMET	1 if wearing helmet, 0 otherwise
MONTH	Month of crash:1= January....12=December
YEAR	Year of crash
LOCAL	1 if on local roads, 0 otherwise
STATEUS	1 if on state or US roads, 0 otherwise
INTSTATE	1 if on interstate, 0 otherwise
RURAL	1 if in rural area, 0 otherwise
DAWNDUSK	1 if crash at dawn or dusk, 0 otherwise
DARK	1 if crash in dark, 0 otherwise
LIGHTED	1 if roadway lighted, 0 otherwise
WETPAVE	1 if pavement wet, 0 otherwise
INTSECT	1 if at intersection, 0 for otherwise
HC	1 if on horizontal curve, 0 for otherwise

GRADE	1 if on grade, 0 otherwise
CREST	1 if on crest vertical curve, 0 otherwise
VEHFAIL	1 if vehicle failure identified, 0 otherwise
OFFRD	1 if crash is run-off-the-road, 0 for otherwise
ALCOHOL	1 if alcohol involved, 0 for otherwise
SPEEDING	1 if speeding involved, 0 otherwise
NL	1 if no license, 0 otherwise
PO	1 if probationary operators license, 0 otherwise
MC	1 if operator license with motorcycle endorsement, 0 otherwise
LM	1 if learner license, 0 otherwise
LP	1 if learner permit, 0 otherwise
OP	1 if operator license, 0 otherwise
CD	1 if commercial driver's license, 0 otherwise
CH	1 if chauffeur's license, 0 otherwise
BRCMONTH	Number of months since Basic Rider Course was completed
BRCPASS	1 if passed Basic Rider Course, 0 otherwise
SPDLIMIT	Posted speed limit in miles per hour

```

--> RESET
--> Rows;10000$
--> READ;NVAR=60;NOBS=9092;NAMES=SEVERITY, PDO, NONIN, INCAP, FATAL, MASTER,
VEHAGE, HARLEY, HONDA, YAMAHA, SUZUKI, KAWASAKI, SPORTBIK, PASSNGR, ANIMAL,
GUARDRL, TREE, PEDBIKE, CURB, POLE, VEHICLE, WALL, CULVERT, DITCH, EMBANK,
TRAFCONT, AGE, FEMALE, EJECTED, PINNED, HELMET, MONTH, YEAR, LOCAL, STATEUS,
INTSTATE, RURAL, DAWNUSK, DARK, LIGHTED, WETPAVE, INTSECT, HC, GRADE, CREST,
VEHFAIL, OFFRD, ALCOHOL, SPEEDING, NL, PO, MC, LM, LP, OP, CD, CH, BRCMONTH,
BRCPASS, SPDLIMIT
;file=D:Ex13-7.txt$
--> CREATE ;IF(BRCMONTH>24) BRC4=1; (ELSE) BRC4=0$
--> CREATE ;IF(MONTH=4) APRIL=1; (ELSE) APRIL=0$
--> CREATE ;IF(MONTH=7) JULY=1; (ELSE) JULY=0$
--> CREATE ;IF(SPDLIMIT>50) OVER50=1; (ELSE) OVER50=0$
--> CREATE ;IF(VEHAGE<5) NEW5=1; (ELSE) NEW5=0$
--> NLOGIT
;LHS=SEVERITY
;CHOICES = PDOPOSS, NONIN, INCAP, FATAL
;TREE = NOTINJ (PDOPOSS, NONIN) , THREE (INCAP) , FOUR (FATAL)
;MODEL:
U(PDOPOSS) = PDOPOSS*ONE+WETPAVE1*WETPAVE+HELMETN*HELMET+
INTSECT*INTSECT+NEW5*NEW5/
U(NONIN) = SPEEDN*SPEEDING+ALCOHOLN*ALCOHOL+PASSN*PASSNGR+
FEMALE1*FEMALE/
U(INCAP) = INCAP*ONE+TREEF*TREE+POLEF*POLE+DARKF*DARK/
U(FATAL) = FATAL*ONE+SPEEDF*SPEEDING+APRILF*APRIL+
JULYF*JULY+BRC4*BRC4/
U(NOTINJ) = HC*HC+AGE*AGE+ALCOHOL*ALCOHOL+
SPEED*SPEEDING+HELMET*HELMET+OVER50*OVER50
;IVSET: (THREE) = [1] / (FOUR) = [1]$

```

Normal exit from iterations. Exit status=0.

```

+-----+
| FIML: Nested Multinomial Logit Model
| Maximum Likelihood Estimates
| Dependent variable           SEVERITY
| Weighting variable           ONE
| Number of observations       9092
| Iterations completed         36
| Log likelihood function      -2021.476
| Restricted log likelihood    -3481.499
| Chi-squared                  2920.046
| Degrees of freedom           25
| Significance level           .0000000
| R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj
| No coefficients      -3481.4991  .41937  .41704
| Constants only      -2137.1365  .05412  .05034
| At start values     -2900.1278  .30297  .30018
| Response data are given as ind. choice.
| The model has 2 levels.
| Coefs. for branch level begin with HC
| Number of obs.= 2273, skipped 181 bad obs.
+-----+

```

Variable	Coefficient	Standard Error	b/St.Er.	P[Z >z]	Mean of X
Attributes in the Utility Functions					
PDOPOSS	-1.370788854	.11455332	-11.966	.0000	
WETPAVE1	.8936985709	.30698149	2.911	.0036	
HELMETN	.5285550980	.11748866	4.499	.0000	
INTSECT	.3834521006	.13448870	2.851	.0044	
NEW5	.2786834143	.11637242	2.395	.0166	
SPEEDN	.6728629476	.19310303	3.484	.0005	
ALCOHOLN	1.443931795	.43379097	3.329	.0009	
PASSN	.6541125712	.17223381	3.798	.0001	
FEMALE1	.7649952647	.21918226	3.490	.0005	
INCAP	-2.497151258	.24120314	-10.353	.0000	
TREEF	.7584532158	.37330212	2.032	.0422	
POLEF	.3924853807	.31116839	1.261	.2072	
DARKF	.3178077102	.14414592	2.205	.0275	
FATAL	-4.224339272	.28114498	-15.025	.0000	
SPEEDF	.8359299560	.28137223	2.971	.0030	
APRILF	.7636814573	.33923771	2.251	.0244	
JULYF	.6080355271	.28807765	2.111	.0348	
BRC4	.9245421046	.49592177	1.864	.0623	
Attributes of Branch Choice Equations					
HC	-.4636616354	.11844827	-3.914	.0001	
AGE	-.1729329992E-01	.45620789E-02	-3.791	.0002	
ALCOHOL	-1.198469902	.42453969	-2.823	.0048	
SPEED	-.7463006854	.23076145	-3.234	.0012	
HELMET	.6284484774	.13355383	4.706	.0000	
OVER50	-.3299483343	.12304614	-2.682	.0073	
Inclusive Value Parameters					
NOTINJ	.4845039214	.25280781	1.916	.0553	
THREE	1.000000000 (Fixed Parameter).....			
FOUR	1.000000000 (Fixed Parameter).....			