

Take-aways

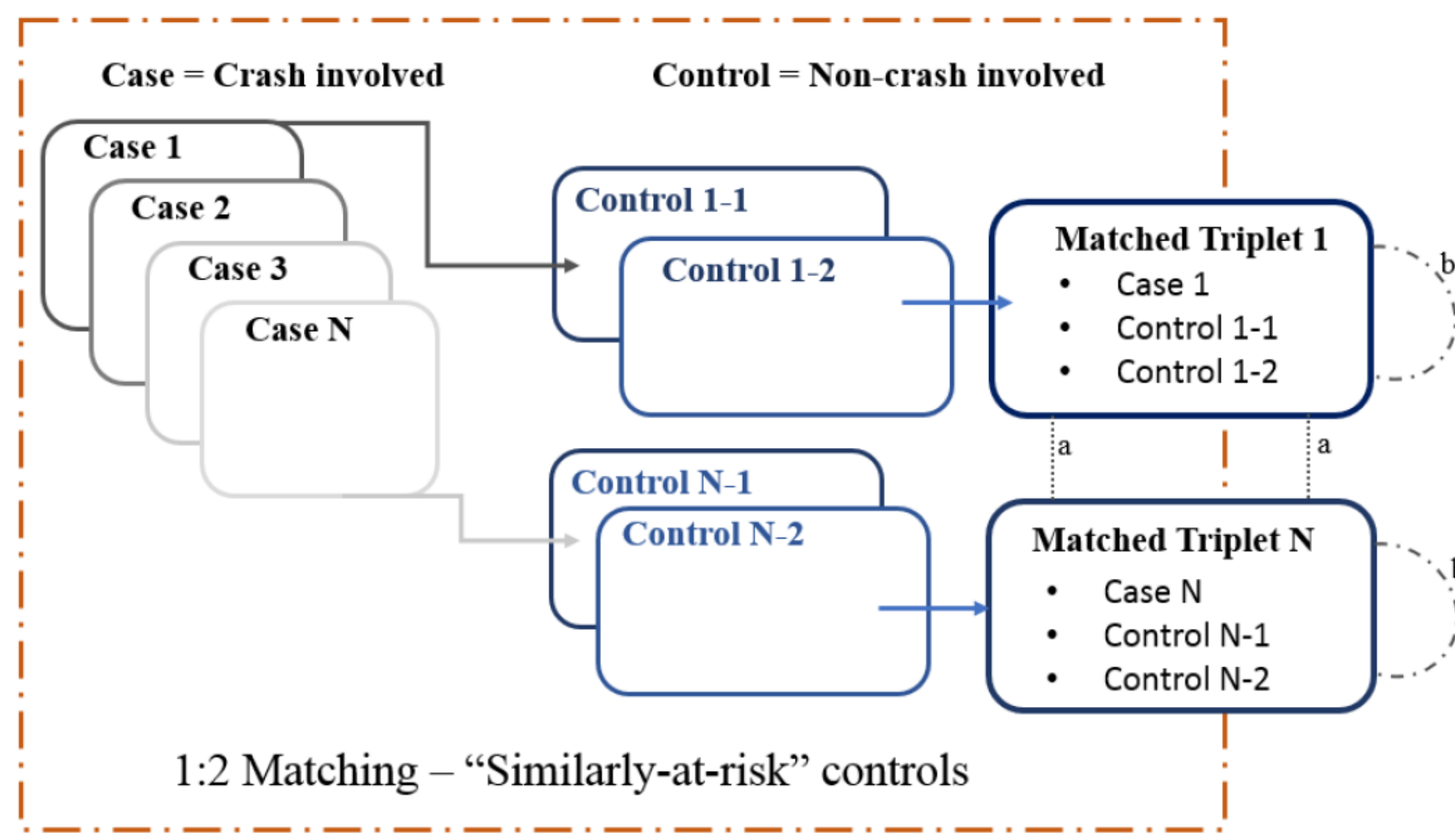
- Motorcycle Crash Causation Study (MCCS) in the U.S.
- Tight matched case-control study design.
- Effects of different “policy-sensitive” factors on risk of MC injury crash propensity.
- Rigorous heterogeneity-based case-control analysis framework is presented.
- Effects of key variables on injury crash propensity:
 - Lack of motorcycle rider conspicuity – dark (red) color upper clothing (↑)
 - Motorcycle-oriented lower clothing (↓)
 - Formal training in recent years (↓)
 - Riders with less sleep prior to crash/interview (↑)
 - Least intrusive US-DOT compliant partial helmets (↓)
- Observed & unobserved heterogeneity in effects of speed as a function of alcohol/multiple drug involvement.
- Future: Need to quantify the number of lives that can be saved or injuries prevented with “high-priority” interventions.

Conceptual Framework

Research Question

- How different “policy-sensitive” factors relate to the risk of motorcycle injury crashes?

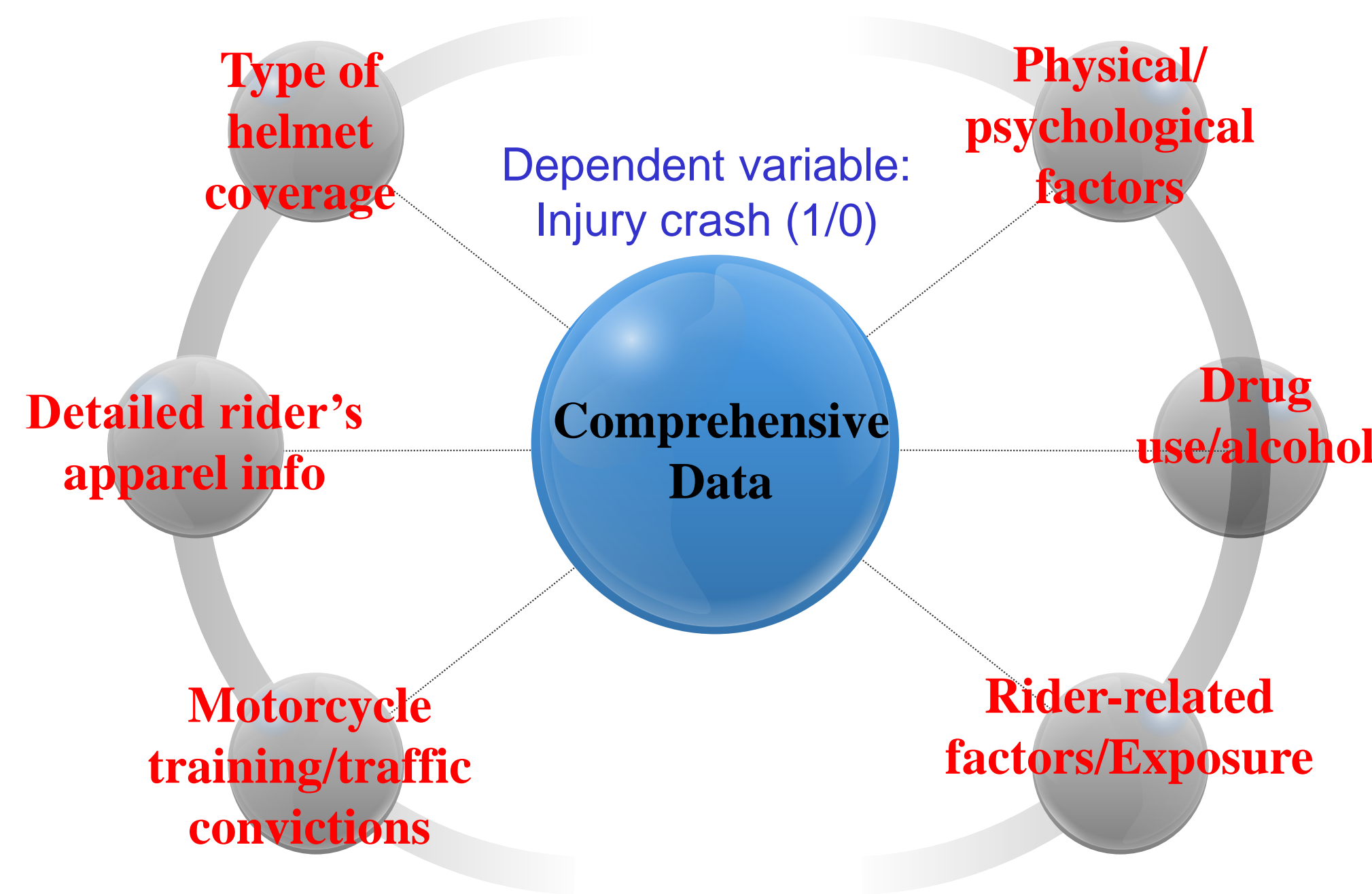
- Data: Orange County, California.
- 351 cases (riders involved in injury crashes)
- Similarly-at-risk 702 matched controls (riders not involved in injury crashes)
- Cases matched with controls by *time of day, day of week, road type, urban/rural, location, & travel direction.*



1:2 Matching – “Similarly-at-risk” controls

FIGURE 1: A Retrospective Matched Case-Control Approach

Data Linkage and Assembly



Methodological Framework

Proposed Approach:

- Random parameters logit models.
- Random parameters logit with *heterogeneity-in-means*.
- Models operating at individual observation & matched-triplet levels.

Motivation:

- Captures between-observation or between-triplet unobserved & observed heterogeneity.
- More accurate estimates/deeper insights.

Model Selection

Goodness of Fit Measures	Models for individual observations (ignoring matched-triplet structure)				Models for matched-triplets (accounting for matched-triplet structure)		
	Model 1*	Model 2**	Model 3***	Model 4****	Model 5**	Model 6***	Model 7****
N (obs.)	1053	1053	1053	1053	1053	1053	1053
# of triplets	---	---	---	---	351	351	351
Degrees of Freedom	24	31	32	39	31	32	40
Log-likelihood with constant only, Lo	-670.24	-670.24	-670.24	-670.24	-670.24	-670.24	-670.24
Log-likelihood at convergence, Lc	-305.7	-288.623	-288.74	-277.6	-293.68	-294.11	-291.4
Chi-square statistic [2(Lc - Lo)]	729.08	763.234	763	785.28	753.12	752.26	757.68
AIC	659.4	639.2	641.5	633.2	649.4	652.2	662.8

Model 4 highlighted in bold is the best-fit model

Notes:

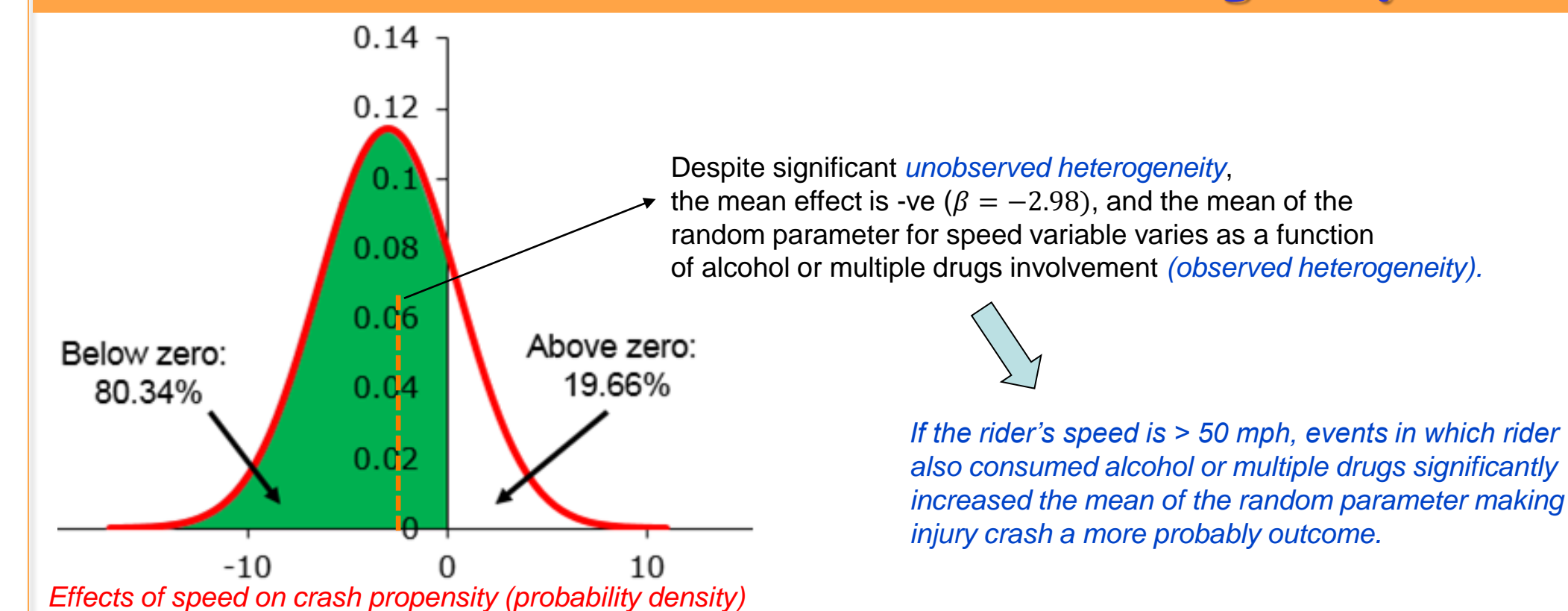
- * Fixed parameter model
- ** Random parameters model
- *** Random intercept and random parameters model
- **** Random parameters/random intercepts with heterogeneity-in-means

Selected Results (Relative Risk Estimates)

Variables	Model 1 Fixed Parameter Logit		Model 2 Random Parameter Logit		Model 4 Random Parameter Logit - Heterogeneity in Means	
	Direction of effect	% change in crash risk	Direction of effect	% change in crash risk	Direction of effect	% change in crash risk
Exposure-related factors						
Total miles driven prior to event	↓	-0.300	[↓]	-2.57	[↓] ^a	-0.80
Number of traffic convictions in last 5 years						
One traffic conviction	↑	56.05	[↑]	22.38	[↓] ^a	-26.58
Two traffic convictions	↑	128.87	↑	127.28	↑	133.96
Three traffic convictions	↑	62.26	[↓]	-98.93	[↓] ^a	-101.00
Clothing color						
Lower clothing motorcycle oriented	↓	-77.62	[↓]	-98.91	[↓]	-99.85
Dark Upper body clothing color: Red	↑	209.88	↑	254.31	↑	297.49
Driver-related factors						
Motorcycle license being held by the rider for 30 or more years	↓	-38.18	↓	-35.85	↓	-30.23
5 hours or less sleep	↑	150.93	↑	191.54	↑	197.43
Female driver	↑	50.68	[↓]	-6.39	[↑] ^a	47.70
Driver is not the owner	↓	-52.34	[↓]	-58.19	[↓]	-68.65
Hispanic or Latino driver	↑	72.29	↑	101.78	↑	115.98
Driver age in years	↓	-2.86	↓	-2.96	↓	-3.92
Driver weight in pounds	↓	-0.399	↓	-0.60	↓	-0.70
Driver is college/university graduate	↓	-25.55	↓	-25.32	↓	-24.42
Trip-related factors						
Origin: Home	↓	-91.46	↓	-95.04	↓	-95.40
Origin: Work	↓	-71.06	↓	-81.40	↓	-87.63
Destination: Friend/relative place	↑	289.62	↑	341.94	↑	371.15
Frequency of road use						
Road used daily	↑	58.41	↑	57.93	↑	64.87
Road used once per month	↓	-57.26	↓	-66.14	↓	-65.35
Type of helmet coverage						
Partial coverage – USDOT compliant least intrusive helmet	↓	-53.23	↓	-51.81	↓	-49.34
Year of training						
Training between 2001-2010	↓	-65.01	↓	-70.09	↓	-68.34
Training between 2011- 2015	↓	-73.55	↓	-77.26	↓	-76.07
Speed before crash/interview						
Speed greater than 50 mph	↓	-75.71	[↓]	-93.19	[↓] ^a	-94.92

(*) Brackets indicate heterogeneous effects for the random-held parameters; (a) indicates random parameters with observed heterogeneity-in-means.

Illustration: Observed & Unobserved Heterogeneity Effects



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