Integrating real-time traffic data in road safety analysis

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Introduction

Road Safety:

- Road accidents are an issue of major concern for all countries independently to their level of development.
- An estimated 1.2 million of people are killed worldwide each year, while another 50 million are injured.
- Research on road safety has attracted considerable interest in the past three decades.
- Major factors known to affect safety are:
  i. driver characteristics,
  ii. vehicle features,
  iii. exposure to risk (e.g., traffic volumes),
  iv. traffic control,
  v. weather conditions, and
  vi. roadway design characteristics.

➢ To predict the safety of transportation systems, traffic engineers model crash rate or frequency as a function of the above mentioned factors.

Traffic data used in safety analysis:

1. The Average Annual Daily Traffic (AADT)
2. Aggregated data over shorter periods of time (month or day)
3. Deduced hourly traffic characteristics by combining AADT and a 1-day hourly traffic profile for the site analyzed

But:

- the use of AADT to approximate vehicle kilometers traveled at a site might reduce the natural variance that exists in exposure data and may result in heavy underdispersion.
- even hourly measures cannot consider the short-term variation of traffic flow and are rather not well suited for application to real-time operations.
- nowadays most freeways are equipped with continuous surveillance systems, disaggregate traffic data collection is possible as well as readily available.

Objective:

✓ To establish a framework for the integration of real-time traffic data in road safety analysis.

Summary:

We explore the effects of traffic parameters on type of road crash and on the injury level sustained by vehicle occupants.
Multivariate and ordered Probit models are specified on 4-years of data from the A4-A86 highway section in the Ile-de-France region, France.
We use a disaggregate approach in which the units of analysis are the crashes themselves (rather than aggregations of crashes over time), and traffic data are measurements of volume, speed, and density over 6-minute intervals.

Empirical Setting – Data used

The site:

- The A4-A86 highway section
- Few miles to the east of Paris
- Length of 2.3 kilometers
- Four lanes per direction (to and from Paris).

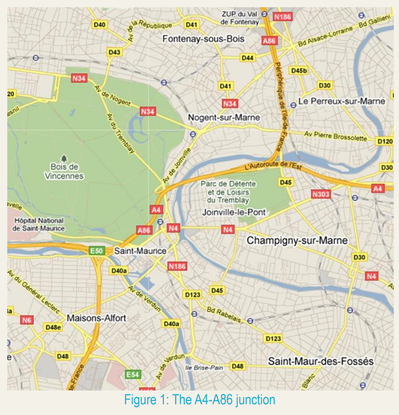

Figure 1: The A4-A86 junction

Accident data:

- Bulletins d'Analyse des Accidents Corporels
- Verbal Proceedings
- Including information such as crash type for all accidents, location and time, lighting conditions, and infrastructure characteristics such as road curvature and alignment. Detailed weather data are available on a 30-minute basis.
- 381 accidents were recorded during the periods 2000-2002 and 2006.

Weather Data:

- closest meteorological station and for the 30-minute interval into which the reported time

Traffic Data:

- 2000-2002 and 2006
- recorded on 6-minute intervals.
- aberrant values discarded.

Methodology

➢ Any road accident can be regarded as an event whose outcome is the type of crash that finally occurred (rear-end, side-swipe etc.). The binomial Probit model can be used for estimating factors contributing or preventing a specific crash type versus all other types. Under this assumption, this model provides the probability of occurrence of a crash type (alternative 1) for each of the n accidents.

➢ The severity function determining the severity level for each individual can be expressed by the standard ordered probit model. We further allowed fir heterogeneity among individuals by adding an error term that is correlated with the unobserved factors in the standard error term

Empirical Results

Table 1. Model estimation for crash type models

	Dependent Variables									
	rear-end with 2 vehicles		sideswipe with 2 vehicles		rear-end with > 2 vehicles		other multiple collisions		single-vehicle crash	
Independent Variables	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
constant	1.07	1.46	-1.48	-5.70	-1.79	-5.00	-1.28	-4.67	-0.78	-4.03
speed (km/h)	-0.17	-2.21					0.01	1.68		
density (veh/km)	-0.22	-2.47			0.08	1.79				
volume (veh)			0.01	1.92						
nighttime	-0.32	-1.51					-0.41	-1.75		
holiday					0.44	1.76				
gradient			0.03	1.54			-0.47	-1.75	-0.62	-2.01
curve									-0.51	-2.13
observations	235									
p-value (x^2 test)	0.040		0.068		0.007		0.039		0.039	

Table 2. Model estimation for severity models

	Fixed Parameters		Random Parameters	
Independent variables	coefficient	t-statistics	coefficient	t-statistics
constant	0.426	0.33	2.429	6.48
holiday	-0.737	-7.71	-1.680	-9.62
nighttime	0.930	10.17	1.544	10.18
wet road surface	-0.508	-5.32	-1.064	-6.39
curve	0.629	7.09	0.764	5.59
'*Ancienw1*'	-0.009	-8.69	-0.067	-3.46
2-wheels	0.627	-6.74	1.805	-10.79
heavy vehicle	-0.626	6.74	-0.481	1.69
'*VQ1*'	0.017	1.26	0.015	8.59
volume (veh)	-0.001	-0.83	-0.012	-6.96
Thresholds				
μ_1	0.988	22.36	1.93	13.52
μ_2	2.011	33.13	4.33	16.65
Number of observations	893			
Log-likelihood with constant only LLI	-1207.487			
Log-likelihood at convergence LL(β)	-1045.860		-590.441	
=(LLI-LL(b))/LL(c)	0.134		0.511	

Conclusions

- The empirical results indicate a strong and critical impact of prevailing traffic conditions upon accident occurrences.
- Traffic speed and volume were found to almost exclusively define crash type and to significantly affect the injury severity level sustained by vehicle occupants involved in accidents.
- From a methodological standpoint, disaggregation minimized possible bias and provided better estimates.
- Based on the analysis of historical data performed, typical traffic patterns recorded prior to accidents may then act as real-time identifiers.

Discussion

Research useful for researchers and practitioners in:

➢ estimating accident and congestion external costs
➢ measuring safety performance of interventions
➢ real-time monitoring of safety levels
➢ locating hazardous spots on the road networks
➢ dynamic safety management (variable speed limits)
➢ non-recurring congestion mitigation strategies

In conclusion, the attempt to further study and develop accident models, and in particular the integration of real-time data, can significantly contribute to the elaboration of a better-structured incident response system with predictive power. Thus, accident counts would be decreased and their consequences would be further limited. Apart from human lives saved, an economic burden would be taken off from societies; non-recurrent congestion would be decreased, while environmental gains would occur.

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