The impact of prevailing traffic conditions on incident characteristics

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The impact of prevailing traffic conditions on incident characteristics
**Terminology**

- **Incident**: occurring event causing some disruption/deviation to a system’s normal operational conditions.

- **Transportation incident**: infrastructure, operational, or vehicle dysfunction due to human, natural, mechanical, or other causes.

- **Road incident**: event causing reduction to roadway capacity or an abnormal increase in demand.

- **Traffic accident**: a road user or its vehicle collides with anything that causes damage to other road users, vehicles, and roadway features, or in which the driver loses control of the vehicle.
Road Safety Analyses

- **Europe:**
  - 97% of total transport accident cost
  - 166 billion Euros (ETSC, 1997)

- **Worldwide:**
  - 1.2 million fatalities each year (WHO, 2004)
  - leading cause of death among young people

- Considerable research interest
- Frequency- or severity-oriented
- Models of stochastic nature
- Problems in data collection and fusion
- Traffic data aggregation (AADT)
  - underdispersion
  - biased probability estimation

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Main objective:

To use highway traffic data collected on a real-time basis in order to:

1. explore the effects of traffic parameters on type of road crash,
2. investigate the influence of traffic parameters on the injury level sustained by vehicle occupants, and to
3. explore possible implications in incident management strategies.
Aggregation

- Conventional road safety approaches
- Serious factor of inaccuracy

✓ In crash taxonomy:
  - type, number of vehicles
  - collision type
  - maneuvers
  - crash location

✓ In traffic data:
  - detailed vehicle movement data would be the best data source
  - AADT/ daily or hourly profiles
  - real-time traffic data

Problems: (a) high risk sites identification, (b) targeted countermeasures, (c) relationship to independent variables

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Objective:

- Effect of various traffic parameters on crash type

  **type of crash**

- By-crash-type analysis
- Disaggregate traffic data
- Control for environmental factors

**Unit of analysis:** single accident
The Variables

Independent Variables:

1. General accident information
   - direction, type of day, weather, lighting
2. Road geometry
   - curvature, gradient
3. Traffic characteristics
   - speed, volume, variation of speed and volume

Dependent Variables:

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>F (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rear-end (2 veh)</td>
<td>27.2</td>
</tr>
<tr>
<td>Sideswipe (2 veh)</td>
<td>21.2</td>
</tr>
<tr>
<td>Rear-end (&gt;2)</td>
<td>18.5</td>
</tr>
<tr>
<td>Other multiple collisions</td>
<td>18.0</td>
</tr>
<tr>
<td>Single-vehicle</td>
<td>15.1</td>
</tr>
</tbody>
</table>

Method: Multivariate Probit

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The site:
- A4-A86 junction, Ile-de-France
- 2.3 km
- 4 lanes/direction

Traffic data:
- loops ~500m
- Q, V, K
- 6 minute- intervals
- Time lag: 12-6 min

Accident data:
- BAAC
- 381 registrations
- verbal proceedings

Weather data:
- Closest station
- 30 minutes aggregation

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### Univariate Probit Models

- Separate binary probit model for each crash type

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Independent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Con.</td>
</tr>
<tr>
<td>Rear-end (2)</td>
<td>+</td>
</tr>
<tr>
<td>Sideswipe(2)</td>
<td>-</td>
</tr>
<tr>
<td>Rear-end(&gt;2)</td>
<td>-</td>
</tr>
<tr>
<td>Multiple col.</td>
<td>-</td>
</tr>
<tr>
<td>Single-vehicle</td>
<td>-</td>
</tr>
</tbody>
</table>

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Multivariate Probit Model

- Fundamental diagram

![Diagram showing V vs Q with categories: multiple (non rear-end) collisions, sideswipes with 2 vehicles, rear-ends with more than 2 vehicles, and rear-ends with 2 vehicles.

- No difference in the way of influence (sign)
- Most non traffic-related parameters: non significant
- Interrelations between crash types

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**Analysis outputs**

- Diverse effect of accident contributing factors to each crash type
- Interdependencies that would have been neglected under a univariate analysis context
- Simultaneous analysis of accident frequency by crash type and vehicle involvement
- Empirical results seem promising in establishing real-time crash type predictors
Severity Investigations

- Of particular concern to decision makers and researchers
  - Expressed by the crash-injury level sustained by road-users
  - Depicted on a 3- or 4-point ordinal scale
  - Factors increasing severity:
    - Increased driver age
    - Alcohol
    - Head-on collisions
    - Heavy vehicles
    - 2 wheels
    - Poor lighting
    - Rural areas
    - Curvature

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**Analysis key-points**

**Objective:**

- Effect of various traffic parameters on severity
  - Disaggregate traffic data
  - Control for environmental and geometric factors

**Unit of analysis:** vehicle occupant
The Variables

Independent Variables:

- General accident information: direction, weather, lighting
- Road geometry: curvature, gradient
- Traffic characteristics: speed, volume
- Road user: retired, unemployed, age
- Vehicle: type, age

Dependent Variable:

Vehicle Occupant

- No injury (0)
- Slight injury (1)
- Severe or fatal injury (2)

Method: Random Parameters Probit

Site: same

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### Major Findings

Qualitative results for random parameters ordered probit model

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Effect on severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>working day</td>
<td>-</td>
</tr>
<tr>
<td>daylight</td>
<td>+</td>
</tr>
<tr>
<td>dry road surface</td>
<td>-</td>
</tr>
<tr>
<td>new drivers - bad weather</td>
<td>-</td>
</tr>
<tr>
<td>2-wheels</td>
<td>-</td>
</tr>
<tr>
<td>heavy vehicles</td>
<td>+</td>
</tr>
<tr>
<td>low traffic</td>
<td>-</td>
</tr>
<tr>
<td>speeding under dense traffic</td>
<td>-</td>
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</tbody>
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Analysis outputs

- Diverse effect of accident contributing factors to severity outcomes
- Heterogeneity would have been neglected under a fixed-parameters approach
- Traffic volume has a consistent effect, while speed has a differential effect with respect to volume
- Empirical results seem promising in establishing real-time severity predictors
Real-time traffic data applications

- Incident management:
  a) travel time estimation,
  b) incident detection
    - Limited use
    - Reactive approach

- Road Safety:
  a) attempt to identify appropriate crash precursors that could act as identifiers of potentially dangerous situations
    - Promising results
    - Proactive approach
Classify approaches

Preventive Strategies

<table>
<thead>
<tr>
<th>Primary</th>
<th>Proactive</th>
<th>Reactive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>active</td>
<td>passive</td>
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<tr>
<td></td>
<td>✓</td>
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</tr>
<tr>
<td>Secondary</td>
<td>active</td>
<td>passive</td>
</tr>
<tr>
<td></td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Tertiary</td>
<td>active</td>
<td>passive</td>
</tr>
<tr>
<td></td>
<td>✓</td>
<td>✓</td>
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</table>

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**Conceptual framework**

- **Crash type analysis:**
  Estimated probabilities as input to real-time different EU location
  - ✔️ *Primary reactive approach*

- **Severity analysis:**
  Estimated probabilities as input to real-time ambulance relocation
  - ✔️ *Primary reactive approach*

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**Conclusions:**

- Real-time traffic little utilized in incident management
- Integrating road safety analyses to incident management shows great potential for accident mitigation and enhanced response

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Conclusions and discussion

❖ **Major findings:**

- Aggregation introduces serious inaccuracies
- Real-time traffic data show great potential, while being little utilized
- Introducing safety outputs to incident management seems very promising

❖ **Limitations and further research:**

- Traffic Data: 6-min, analysis not / lane
- Not all parameters as independent variables
- Linearity assumption of the utility function
- Transferability of results
- Incident management application using real-time traffic data
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