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Investigation of the impact of weather conditions to young drivers' behaviour and safety in cities

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Outline

- Objective
- Background
- Driving simulator experiment
  - Overview of the experiment
  - Experiment design
- Data Collection
- Methodology
- Analysis Results
  - Modelling Mean Speed
  - Modelling Accident Probability
- Conclusions
- Future Challenges

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Background

Precipitation (rainfall, rainfall intensity, snowfall)

- Driving in rain is **safety critical situation**, involving adversities like reduced pavement friction and impaired visibility
- Rainfall increases **crash risk** and most weather-related accidents occur during rainfall and in wet pavement conditions
- In **Mediterranean countries** drivers tend to compensate for the increased risk by adjusting their behaviour

Fog

- Fog-related crashes have remarkably **higher injury and fatality rates** due to low visibility conditions

Objective

- Investigate the **impact of weather conditions** on different driving performance measures of young drivers on urban roads, through a **driving simulator experiment**

- Specifically, examine the effect of driving in different **weather conditions** in combination with **road type** (urban road), **traffic characteristics** (high/low traffic) and **driver characteristics** (gender, annual mileage, and driving habits)

Driving simulator experiment

Driving simulator

- Foerst Driving Simulator (1/4 cab)

Road environment

- Urban: 1.7 km long, dual carriageway

Traffic scenarios

- QL : Low traffic - 300 vehicles/hour
- QH : High traffic - 600 vehicles/hour

Unexpected incidents at each trial

- Child crossing the road
- Old lady crossing the road

Experiment design

Sample

- 40 young drivers (18-30 years old)
- 24 men and 16 women

Familiarization

- The participant practiced in handling the simulator, keeping the lateral position of the vehicle, keeping stable speed, etc.

Procedure

- 6 trials - rainy, foggy and good weather conditions under (low and high traffic conditions)

Data Collection

- **Driving parameters** extracted from the driving simulator experiment
  - Mean driving speed
  - Average reaction time
  - Average of Revolutions per minute
  - Lateral position of the vehicle
  - Average of headway distance etc.
- **Demographic** and driving behaviour data obtained from the **questionnaire**
  - Age, gender, driving experience, accident history, driving behavior during adverse weather conditions

Methodology

Lognormal linear regression to model mean speed

- The basic equation of the lognormal linear regression model is:

$$yi = \beta_0 + \beta_1\chi_{1i} + \beta_2\chi_{2i} + \cdots + \beta_\kappa\chi_{\kappa i} + \varepsilon_i$$

$$log(yi) = \beta_0 + \beta_1\chi_{1\iota} + \beta_2\chi_{2i} + \cdots + \beta_\kappa\chi_{\kappa i}$$

Binary logistic regression to model accident probability

- If the “utility function” is given by U= $B_0 + B_i\chi_i$, then the probability P is given by P= $e^u/(e^u+1)$

Analysis results – Mean speed (1/2)

Independent variables	Mean driving speed			
	βi	t	Elasticity	Relevant elasticity
Driving in rain	-0,01	-1,66	-0,01	1
Gender	-0,02	-3,55	-0,01	2,88
Age	0,02	3,08	0,01	-3,09
Average of Revolutions per minute	0,01	10,78	0,06	-24,27
Lateral position of the vehicle	0,01	2,64	0,02	-7,45
Accident with material damages	-0,02	-2,87	-0,01	1,75
Enjoy driving	-0,04	-4,11	-0,03	10,57
Speed reduction in rain	-0,02	-2,69	-0,01	4,71
R^2	0,501			

Analysis results – Mean speed (2/2)

- The vast majority of **male drivers** displayed a **more unsafe behaviour** during their simulated routes, developing higher speed than female drivers

- The **higher the lateral position** of the vehicle, the higher the driving speed

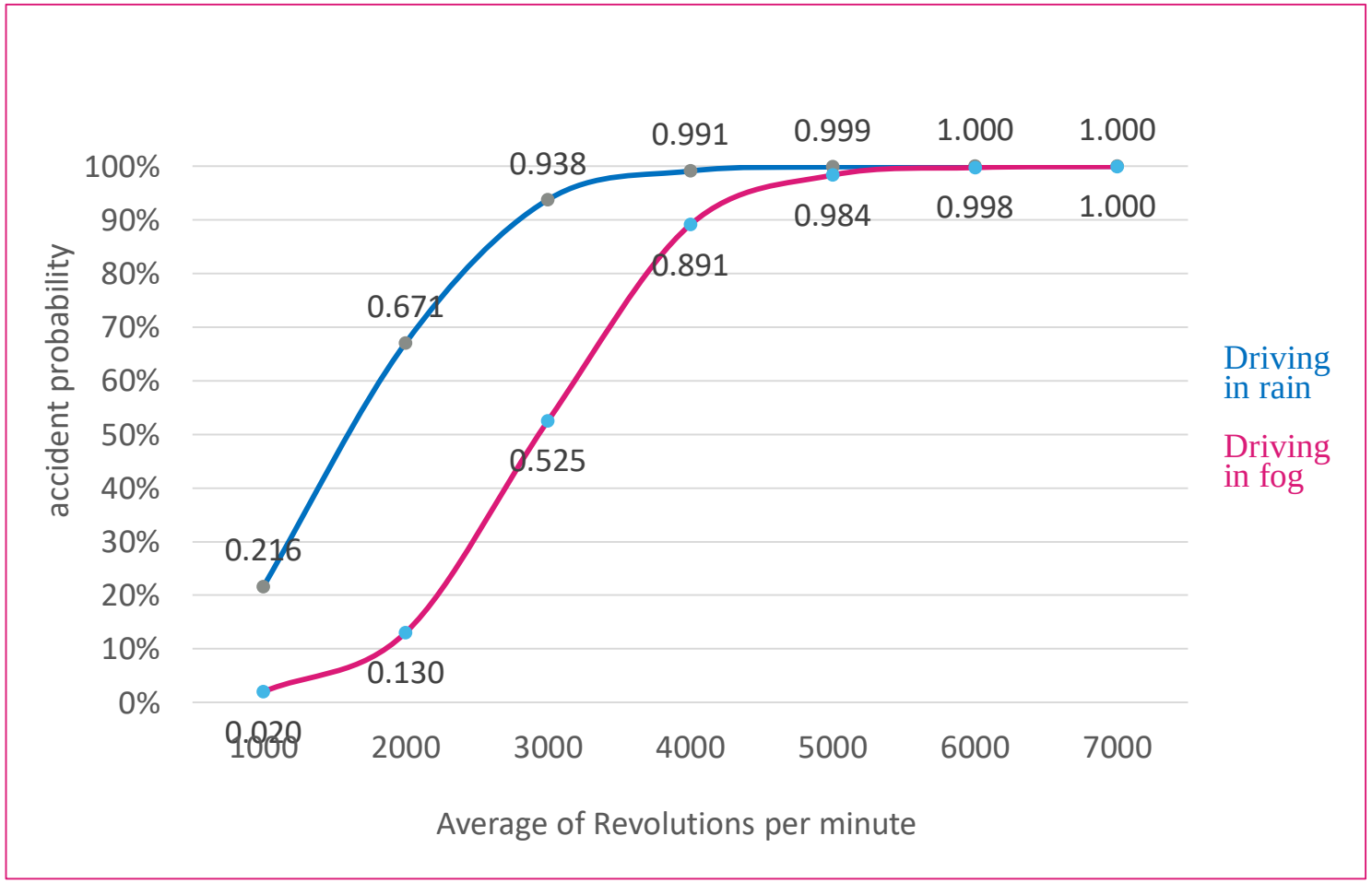
Analysis results – Accident probability (1/2)

Independent variables	Accident probability			
	βi	Wald	Elasticity	Relevant elasticity
Driving in rain	0,872	4,084	0,646	3,329
Driving in fog	-1,738	6,140	-0,690	-3,556
Traffic conditions	-1,172	6,397	0,194	1,000
Gender	0,693	2,675	-0,478	-2,466
Average of Revolutions per minute	0,002	3,843	2,031	10,469
Average of headway distance	0,014	2,841	0,445	2,296
Enjoy driving	-1,145	4,091	-0,420	-2,163
Null log-likelihood	214,316			
Final log-likelihood	172,595			
Degrees of freedom	6			

Analysis results – Accident probability (2/2)

- Accident probability increases with the **increase of the traffic density**

- Two driving behavioral measures that have a **negative effect on accident probability** seem to be the **average of revolutions** per minute and the average of **headway distance**



Conclusions

- **Driving in rain** leads to a small **reduction of the mean speed**, which however cannot outweigh the **increase of the probability** of getting involved in a road **accident**
- Driving under **foggy conditions** leads to a decreased accident probability, indicating drivers' **compensation in adverse weather**
- Regarding traffic conditions, results show that the **accident probability increases with the increase of the traffic density**, low to high traffic conditions

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Future Challenges

- **Larger** and more representative sample of drivers with different age groups
- Investigation of the effect of other **driving factors** (psychological status, fatigue or driving under influence of alcohol)
- Different **driving environments** and different traffic conditions should be further investigated
- Implementation of other statistical methods for **further statistical analysis** and export of additional models

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