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The Effect of Mobility Characteristics on Road Safety in European Cities

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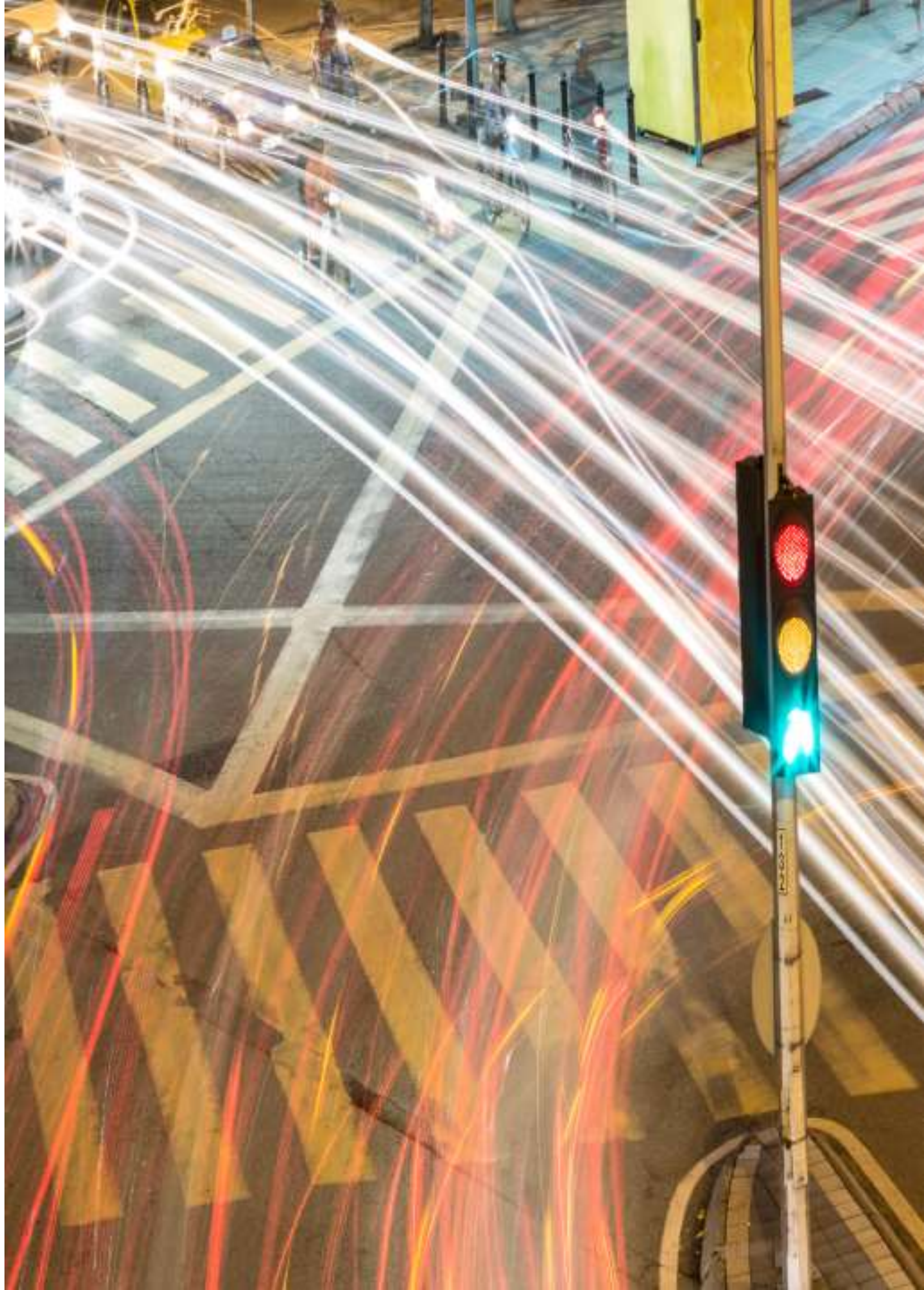
Overview

- More than 1,2 million people are killed in road accidents worldwide annually.
- The increasing urbanization and the rapid motorization in many cities worldwide have led to an increase in road fatalities inside urban areas.
- In the EU, over three-quarters of the population lives in urban areas.
- In 2017, 38% of the fatalities in road accidents occurred inside urban areas in the EU.
- The majority of urban road fatalities (70%) concern VRUs, with 40% of them being pedestrians.



Objectives

- To explore the effect of mobility characteristics on road safety in the European cities.

- More specifically, the relationship of indicators related to
  - modal split,
  - vehicle fleet and
  - road network

  with fatalities in road accidents in cities is examined.

- Comparative analysis of the effects of mobility indicators on fatalities in different types of accidents.

Methodology

- A cross-city analysis is performed to estimate the relationship between the mobility characteristics and the number of road fatalities in Europe.

- Various mobility indicators related to modal split, distribution of vehicle fleet by type of vehicle and road network characteristics were examined.

- Demographic and economic indicators were also included in the analysis, reflecting the different background of the cities.

- Models for different types of accidents (fatalities by road user type and lighting conditions) were developed with the same indicators.

Data Collection

- Data on
  - the number of vehicles in traffic by type of vehicle,
  - trips per transport mode,
  - population density,
  - road network characteristics and
  - per capita Gross Domestic Product (GDP)

  were collected from the **UITP Mobility in Cities Database** for 25 European cities for 2012.

- Data on road fatalities were collected from the **EU CARE Database**.

- Data from the different sources were selected in such a way in order to ensure that they **refer to the same administrative divisions**.

Modelling Process

- Generalized Linear Models were developed
- One model for all road accident fatalities
- A set of five models for fatalities in different types of accidents
  - Fatalities in darkness
  - Fatalities in daylight
  - Pedestrian fatalities
  - Car Occupant fatalities
  - PTW fatalities

Cities Examined

City	City
Paris	Dublin
London	Vienna
Madrid	Budapest
Athens	Warsaw
Berlin,	Copenhagen
Hamburg	Gothenburg
Barcelona	Turin
Rome	Zurich
Lisbon	Prague
Birmingham	Oslo
Glasgow	Helsinki
Stockholm	Geneva
Milan	

Variables Examined

- Gross Domestic Product (GDP) per inhabitant (euro)
- Urban population density (persons/ha)
- Length of roads per urban hectare (meters/hectare)
- Motorcycles per population (motorcycles/thousand inhabitants)
- Public Transport Capacity offered (place*kilometres/inhabitant)
- Percentage of daily trips by bicycle

Modelling all fatalities

Indicator	Estimate	Wald Chi-square	Sig.	e_i	e_i^*
Intercept	11,041	9,265	0,002		
LN (GDPcap)	-0,526	3,523	0,061	-1,893	-22,386
LN (Population density)	-0,402	2,507	0,113	-0,351	-4,149
Road Network Density	-0,007	7,774	0,005	-0,351	-4,149
Motorcycles/pop.	0,019	28,145	0,000	0,293	3,469
PT Capacity	-0,462	2,523	0,112	-0,170	-2,009
% Trips by Bicycle	-0,067	3,872	0,049	-0,085	-1,000
(Scale)[a]	0,213				
Omnibus Test					
Likelihood Ratio Chi-square	23,913		0,01		
Degrees of freedom	6				
Goodness of Fit					
Log Likelihood	-16,161				

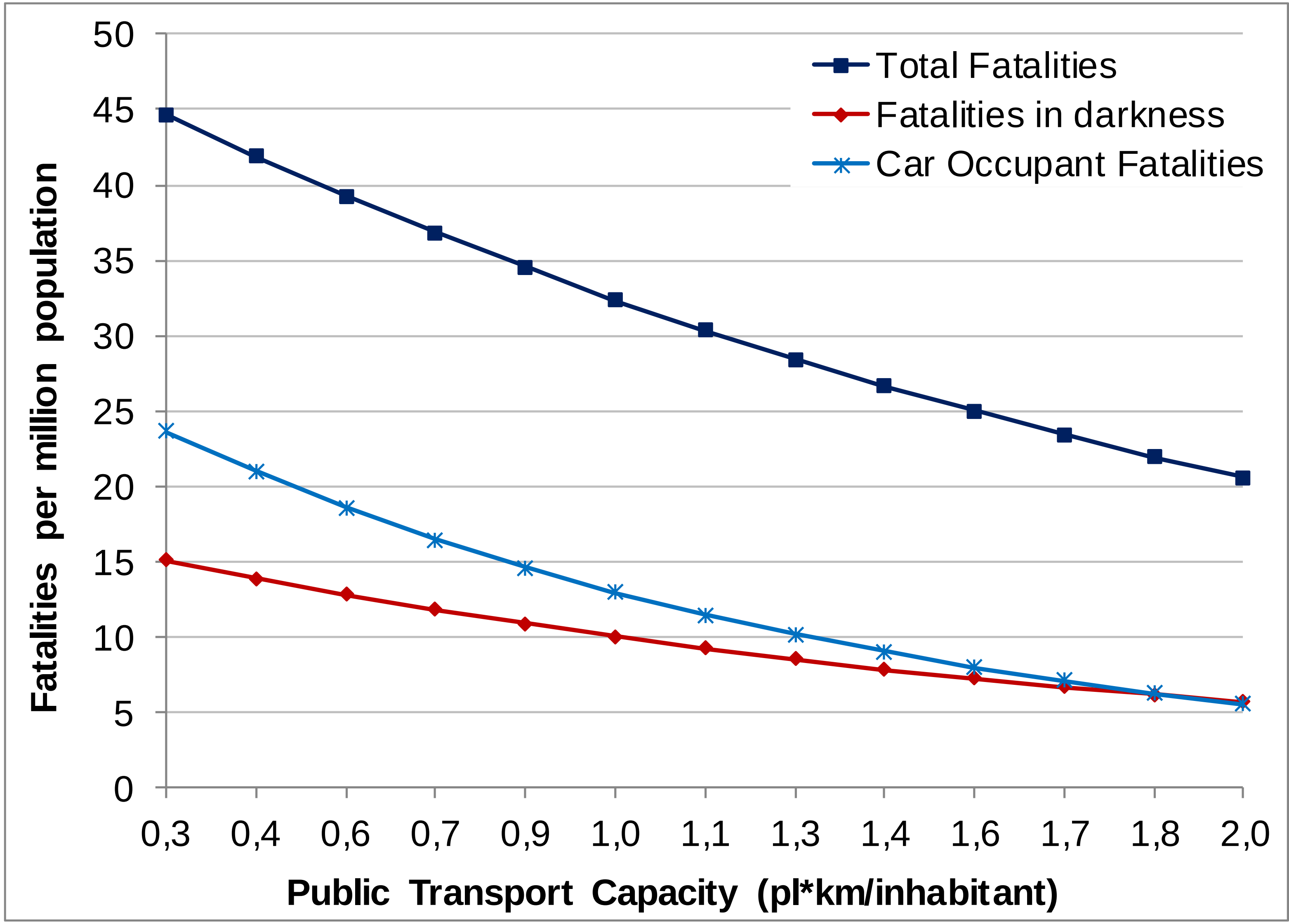
Dependent Variable: LN(F/P)

Modelling fatalities in different types of accidents

	Indicator	Intercept	LN(GDPcap)	LN(Population Density)	Road Network Density	Motorcycles /pop.	PT Capacity	% Trips by Bicycle
LN(F/P) darkness	Estimate	17,435	-1,086	-0,687	-0,013	0,027	-0,585	-0,065
	Wald Chi-square	11,355	8,190	3,626	6,032	16,696	1,759	1,946
	ei		-5,734	-1,393	-0,901	0,599	-0,322	-0,150
	ei*		-38,273	-9,300	-6,017	3,998	-2,147	-1,000
LN(F/P) daylight	Estimate	10,878	-0,455	-0,611	-0,013	0,020		-0,092
	Wald Chi-square	10,782	3,510	7,003	14,931	23,425		9,542
	ei		-2,127	-1,010	-0,848	0,360		-0,161
	ei*		-13,192	-6,262	-5,259	2,234		-1,000
LN(F/P) Pedestrians	Estimate	9,841	-0,691		-0,004	0,011		-0,035
	Wald Chi-square	12,897	11,444		3,857	17,838		1,975
	ei		-3,801		-0,305	0,260		-0,069
	ei*		-54,907		-4,404	3,762		-1,000
LN(F/P) Car Occupants	Estimate	13,124	-0,579	-0,928	-0,009	0,024	-0,864	-0,161
	Wald Chi-square	10,029	3,270	10,262	8,851	33,236	6,771	17,174
	ei		-1,323	-0,642	-0,459	0,361	-0,107	-0,366
	ei*		-12,355	-6,001	-4,292	3,372	-1,000	-3,419
LN(F/P) PTWs	Estimate	15,744	-0,978	-0,820	-0,010	0,027		-0,132
	Wald Chi-square	8,837	5,697	4,905	6,233	25,320		7,080
	ei		-9,863	-3,278	-1,355	0,603		-0,612
	ei*		-16,358	-5,438	-2,247	1,000		-1,015

Sensitivity Analysis (1/6)

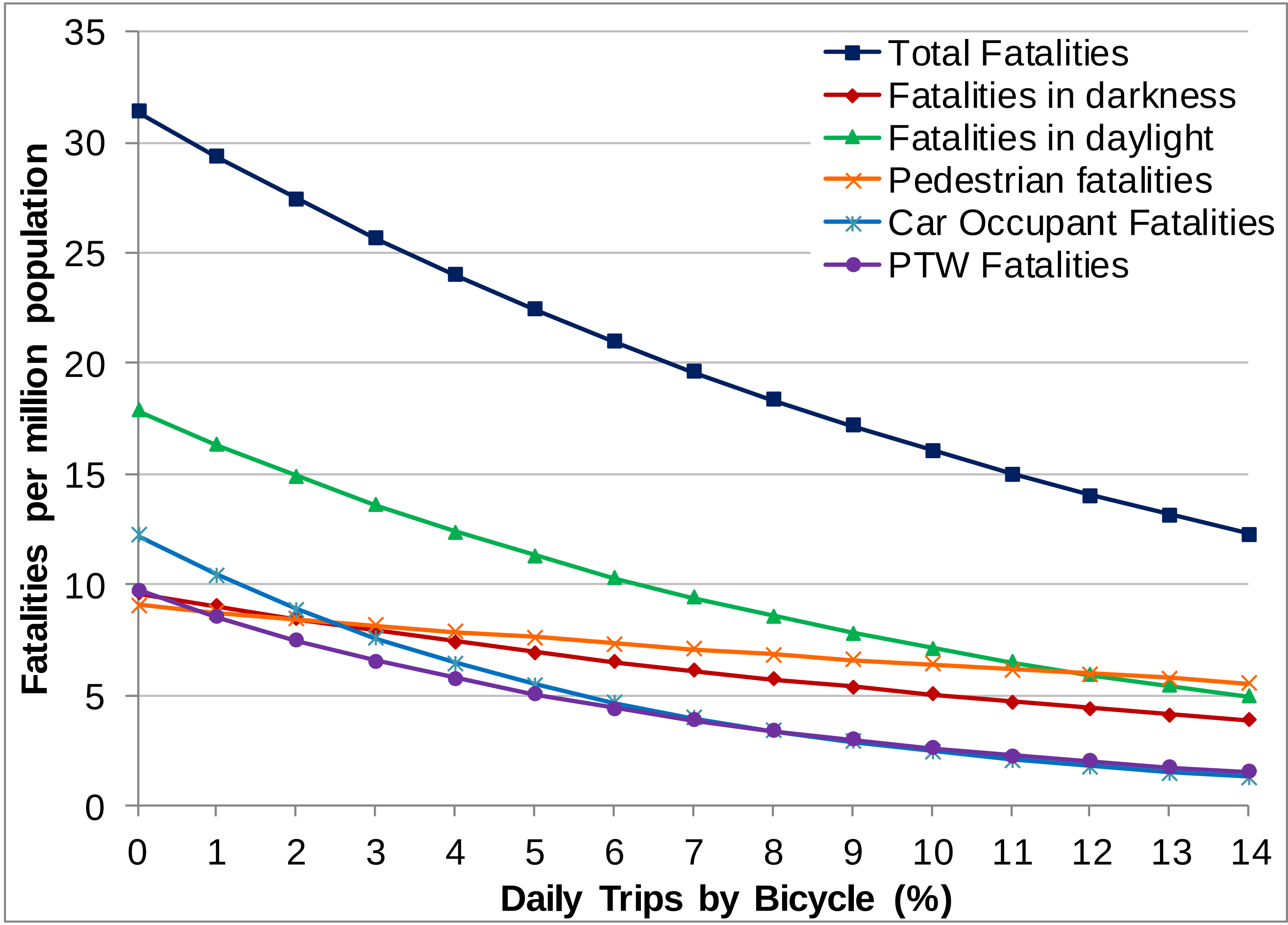
- Increase in the **offered public transport capacity** leads to decrease in road fatalities.
- **Car occupant fatalities** and fatalities in **darkness** present higher rates of decrease compared to the total number of fatalities.



Sensitivity Analysis (2/6)

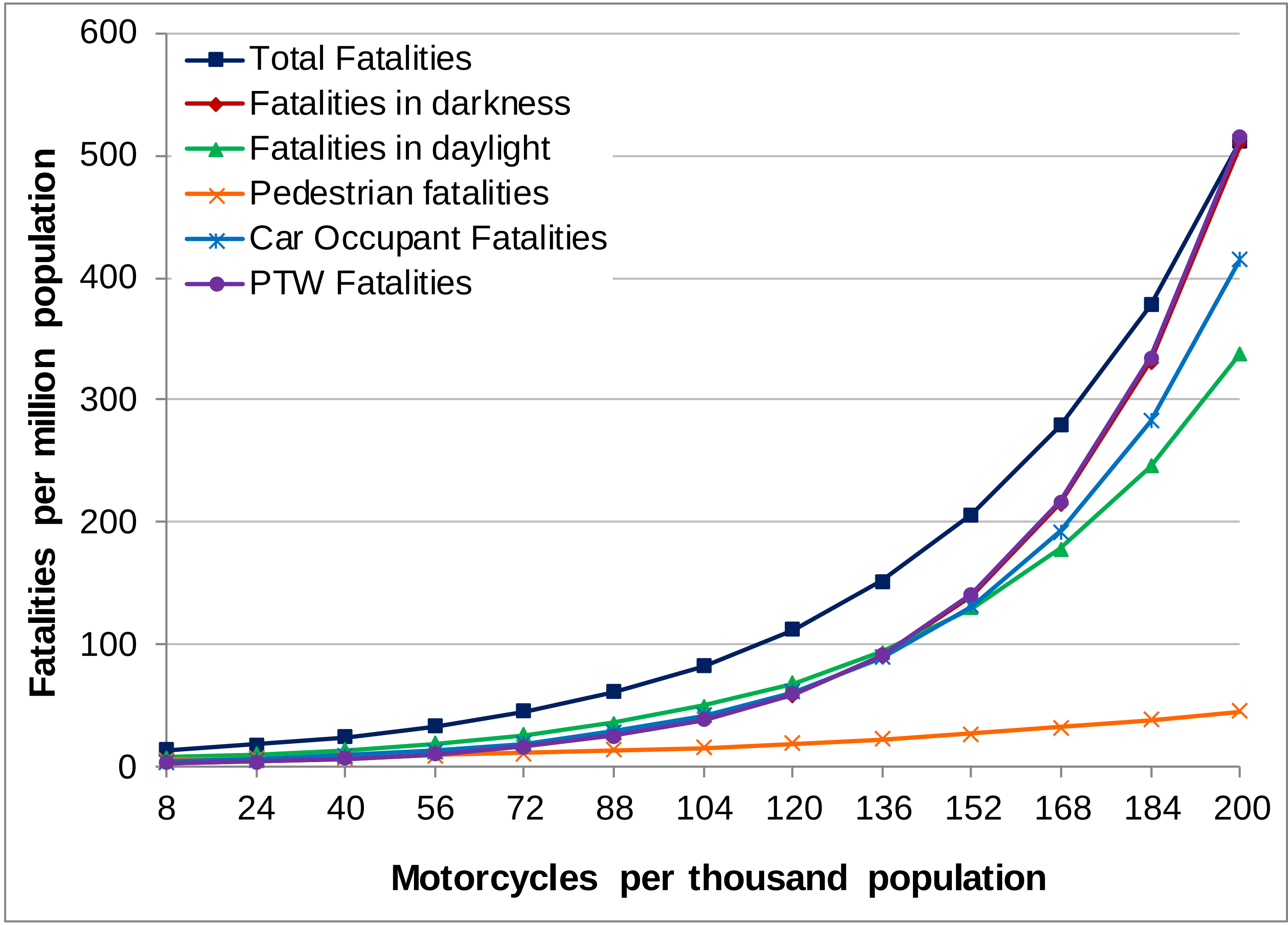
- Increase in the **daily trips by bicycle** is related to decrease in urban road fatalities (safety in numbers).

- An increase in trips by bicycle affects more **car occupant fatalities** and fatalities **during daylight** compared to fatalities in other types of accidents.



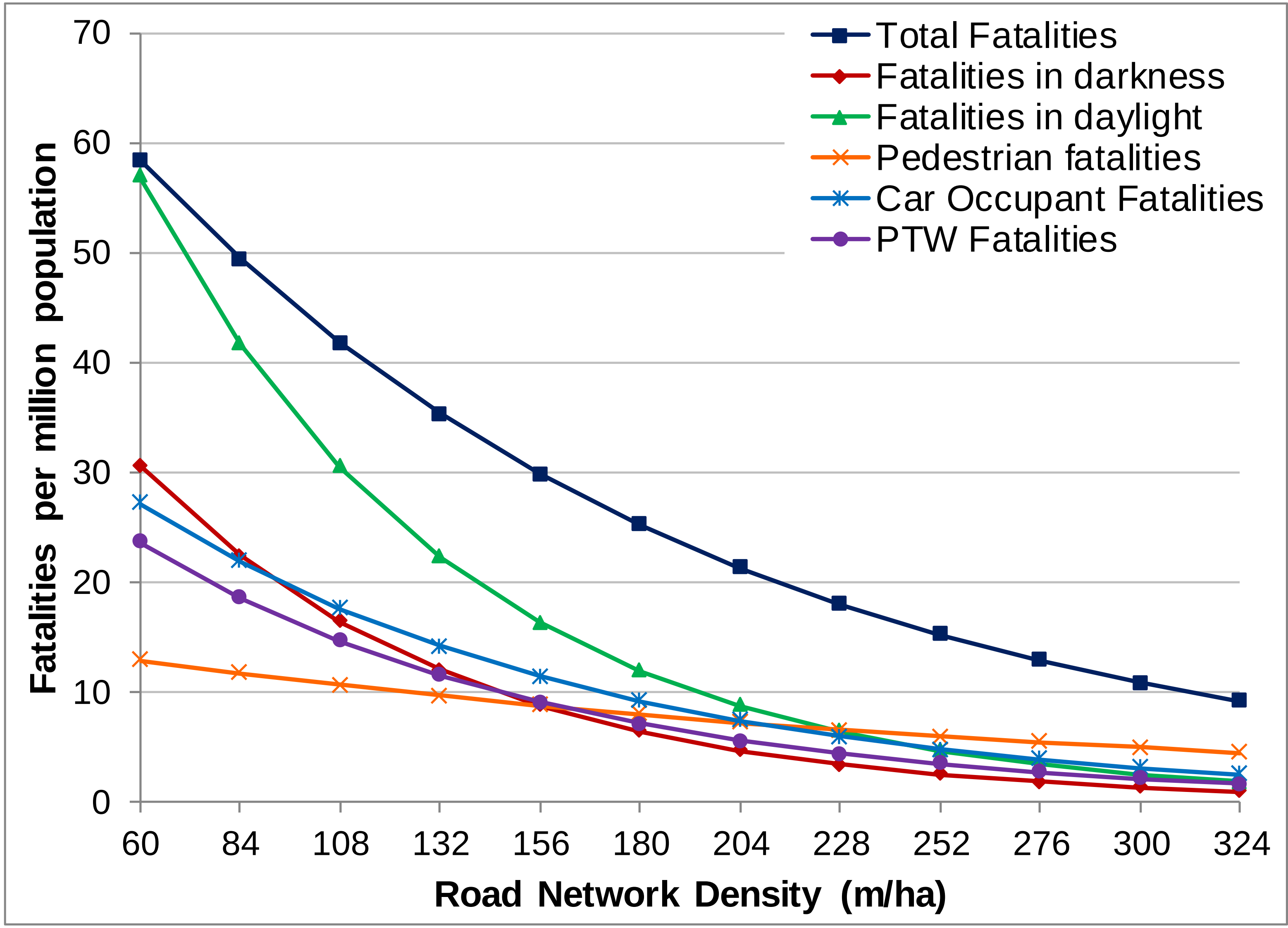
Sensitivity Analysis (3/6)

- Increase in **motorcycles in traffic** leads to increase in road fatalities.
- The increase in the number of motorcycles leads to higher increase in **PTW fatalities** and fatalities in **darkness**.



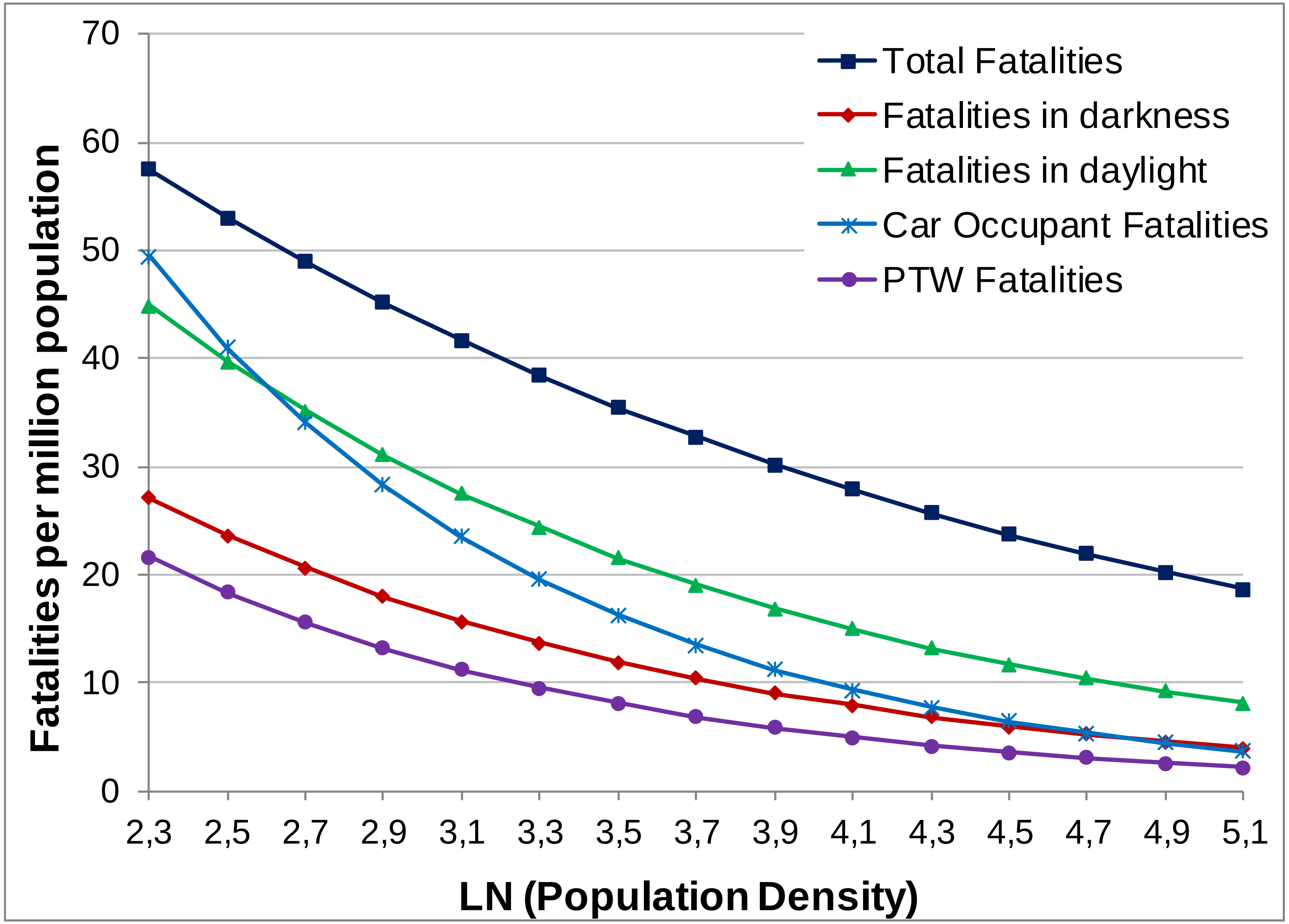
Sensitivity Analysis (4/6)

- Increase in the **road network density** of a city is associated with a decrease in road fatalities.
- Changes in the road network density affect more **car occupant fatalities** and fatalities occurring **during the daylight** compared to the remaining examined types of accidents.



Sensitivity Analysis (5/6)

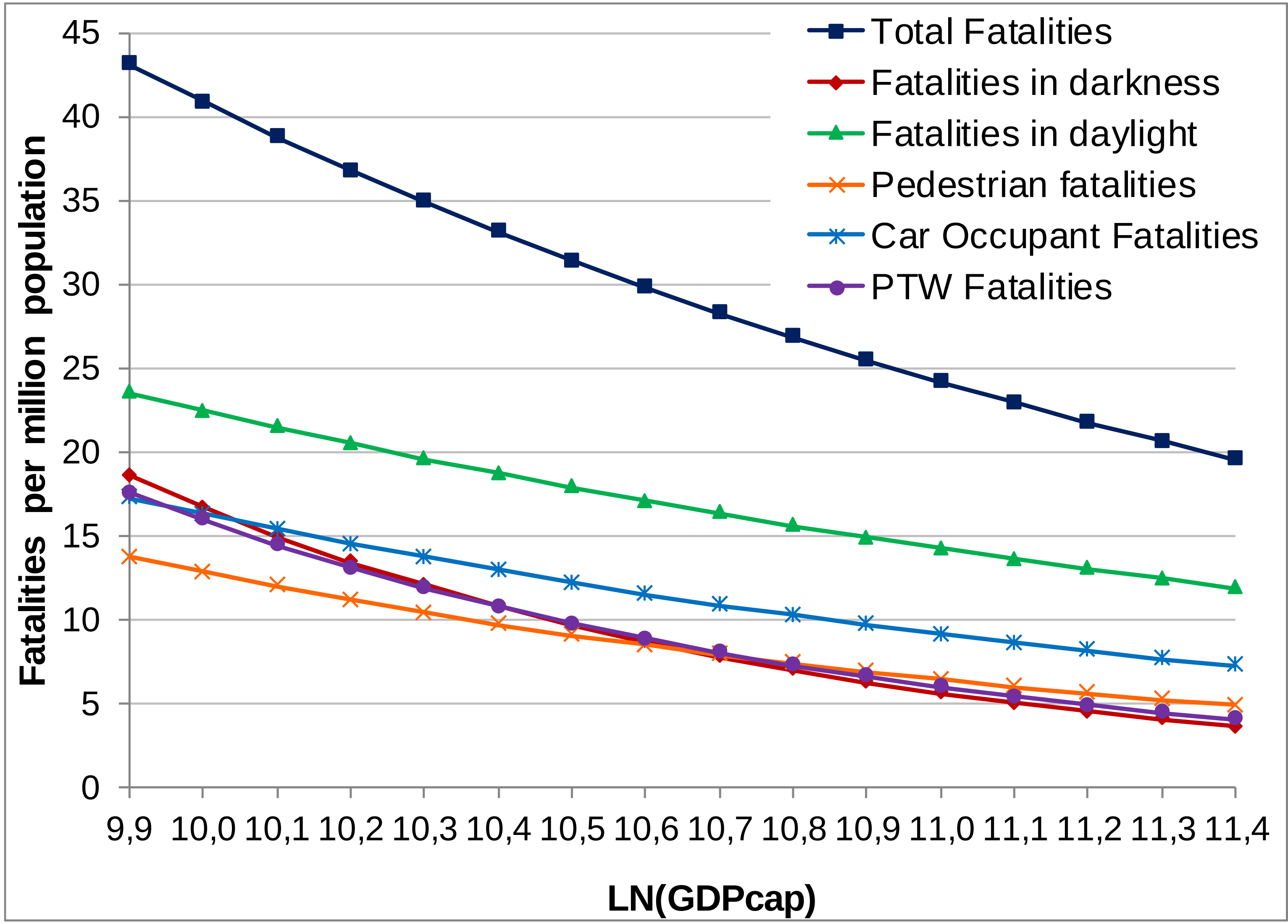
- Population density is negatively correlated with fatalities in the cities.
- Fatalities in darkness are affected more by changes in the population density.



Sensitivity Analysis (6/6)

- Increase in the **GDP per capita** of the cities is associated with a decrease in road fatalities.

- An increase in the GDP per capita has higher effect on the fatalities occurred in **darkness** and the **PTW fatalities**.



Conclusions (1/2)

- Road safety performance of the cities depends on many factors related not only to mobility but also to demographics and the economic performance.

- The offered public transport capacity plays a significant role in the improvement of road safety of a city.

- Increase in the offered public transport capacity by a city leads to greater use of public transport and therefore, to a lower likelihood of being involved in a road accident.

- Especially fatalities in road accidents occurred in darkness were found to be affected more by an increase in offered public transport.

Conclusions (2/2)

- **Bicycle** as an alternative option also leads to a decrease of fatalities on urban roads.

- **Increase of motorcycles** in traffic is associated with increase in urban fatalities, since motorcyclists have a higher level of risk.

- **Population density** and **road network density** have a negative relationship with the number of fatalities, which may be explained by lower traffic speeds and higher congestion.

- The **better economic performance** of the cities is linked to a better road safety culture and a higher road safety performance.

Recommendations

- In order to improve city safety, there is a need not only to create a safer road environment, but also to provide incentives to the citizens for the use of alternative means of transport.
  - increase of the offered capacity in public transport
  - promotion of the bicycle as one of the main transport modes for the daily trips
- Emphasis should be given on safe motorcycle traffic.
- Speed management with focus on road safety.
- An integrated approach is needed for the improvement of road safety at city level.

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