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Travel Behavior and Network Model Courses
@The University of Tokyo

Reassessing accident risk indicators: A risk-benefit perspective

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Contents

1. Reassessing accident risk indicators
   - Conceptual discussions
   - Empirical analysis

2. Needs for further activity-based research
   - Evaluative aspects

Conventional risk analysis

Fact-Value separation

(e.g., US National Council, 1983; European Commission, 2003)

Step1: Risk assessment

Capturing phenomenal fact by quantifying risk

In case of accident risk analysis…
Measuring accident risks

Step2: Risk management

Making value judgment on the phenomenal fact

In case of accident risk analysis…
Policy discussions

Perspective-dependency

How to quantify the risk depends on our perspective/ value judgment on the risk

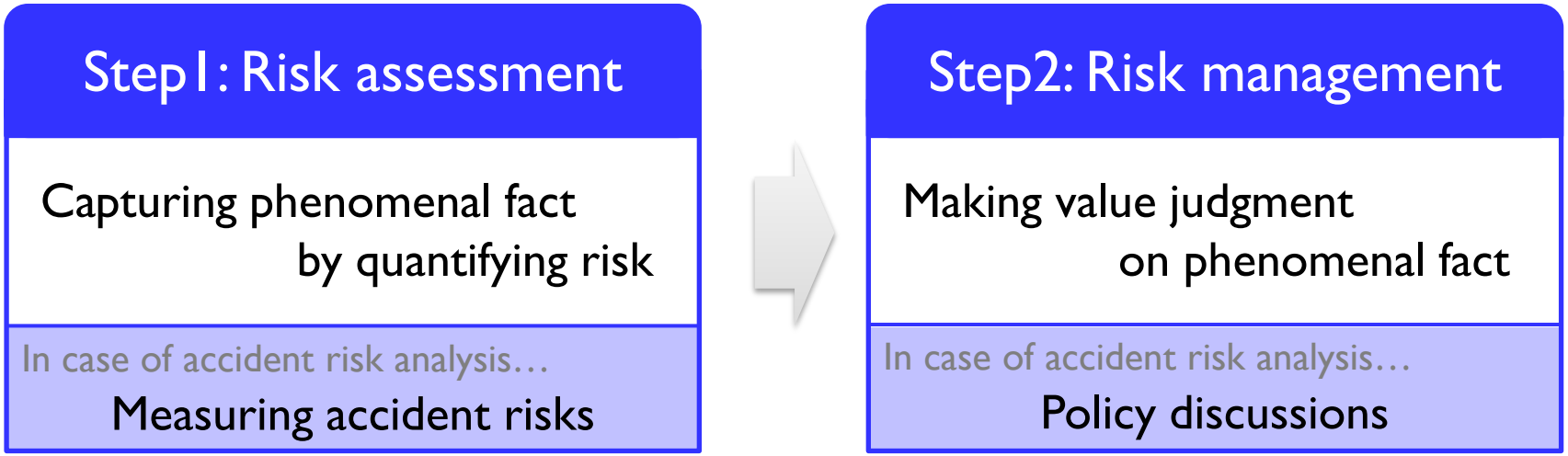
Examples:

- Can accident risk be regarded as a voluntary risk?
- Vehicle accident risk can be discussed separately from other travel modes' accident risk?
- What is the benefit from travel (what is the fundamental reason for accepting accident risk)?

Conventional risk analysis

~~Fact-Value separation~~

(e.g., US National Council, 1983; European Commission, 2003)



Reflect a certain perspective/value judgment
(not value-free risk quantification)

Risk-benefit perspective

In general, we accept a certain level of accident risk to obtain certain benefits

- Demand side
  - Road users' perspective/value judgments
- Supply side
  - Governments' perspective/value judgments

Research Objectives

1. What kinds of value judgments we have made?
   - Reviewing historical shift in governments' perspective on accident risk and the benefit from travel
   - Clarifying (hypothetical) current government perspective
2. How have we reflected the judgments in quantitative accident risk analysis?
   - Reassessing the conventional accident risk indicator and proposing an alternative indicator
   - Conducting empirical analysis in the US context

Historical shift in governments' perspectives on traffic safety

Early 20th century

Drivers' responsibilities

Drivers were considered to be completely responsible

Since 1950s

Car companies' responsibilities

Statement on the responsibilities of vehicle manufactures and safety organizations

Ex) Vehicle Safety Standards

Since 1960s

Multiple stakeholders' responsibilities

Statement on the all stakeholders related to traffic safety including national/local governments

Ex) Traffic Safety Policies Basic Act

Since 1990s

Changes in concept

"It can never be ethically accepted that people are killed or seriously injured by road travel"

Ex) Vision Zero

vision ZERO
ZERO Fatalities
ZERO Injuries
ZERO Motor Vehicle Accidents
ZERO Net Environmental Emissions
ZERO Tolerance of Unsafe Behaviour & Practices

Historical shift in governments' perspectives on traffic safety

- Vision Zero
  - Emphasizing the importance of forward-looking responsibility (Fahlquist, 2006)
    - Backward-looking responsibility
      - Who should take a responsibility on the accident already happened
        - » Responsibility ascriptions to be fair/morally justified
    - Forward-looking responsibility
      - Who can actually control the accident risks
        - » Responsibility ascriptions to practically solve problems

        Ex) Improving public transit service, bike lane, etc.

Value judgments on benefits

- The implicit (practical) value judgment
  - benefit of travel is higher than accident costs

- Travel
  - Sphere of citizenship as the right to participate in social, economic, political, and cultural activities that are essential to living (Vasconcellos, 1997)
    - Accessibility (not mobility)
    - The value of activities

The (hypothetical) current governments' perspective

In public policy discussions on traffic safety, the "forward-looking responsibility" approach should be focused on to reduce the number of accidents in a proactive way, while safety measures that reduce the level of accessibility should not be considered. Providing access to desired destinations is the primary goal of transportation systems—and because of this—accident risk can be justified.

Definition of accident risk

$$AR = \frac{AC}{E}$$

Conventional risk indicator

$$\frac{\text{Number of fatalities}}{\text{Total vehicle distance travelled}}$$

International Transport Forum (2012)
Papadimitriou et al. (2013)

AR:	Accident Risk
AC:	Total number of accidents
E:	Total exposure, or total number of trials

The state-of-the-art of accident risk indicator

$$\text{Accident Risk} = \frac{\text{Number of fatalities}}{\text{Total vehicle distance travelled}}$$

Theoretical basis: (value-free) objective fact

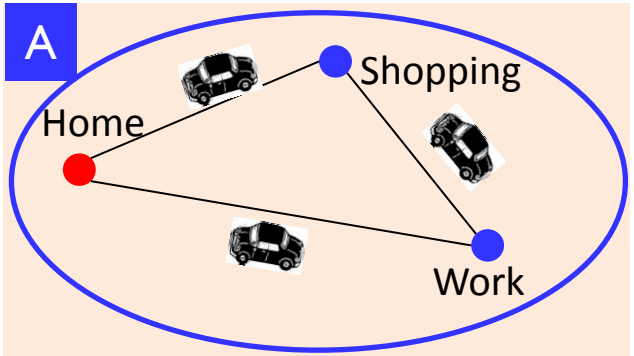
- Papadimitriou et al. (2013)

  "The number of trials, which is defined as the number of times road users are exposed to possible accidents, should be the best theoretical measure of risk exposure."

  "The most appropriate measures of exposure are vehicle- and person-kilometres of travel, because they are closer to the theoretical concept of exposure and can be available, in theory, to a satisfactory level of detail."

Problems of conventional indicator

A

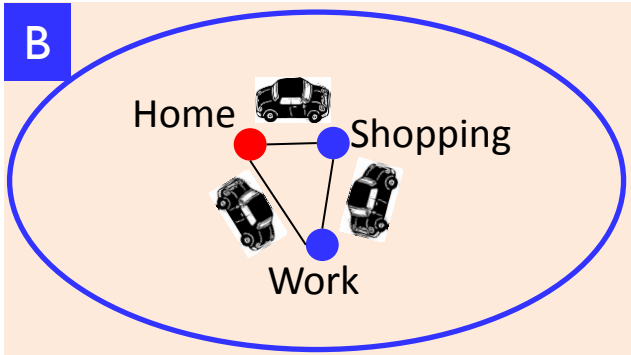


Population = 1,000,000
Av. car travel distance = 20 [miles]
Av. number of trips = 3
# of accidents = 100

Conventional indicator:
A is safer than B

Changing urban forms

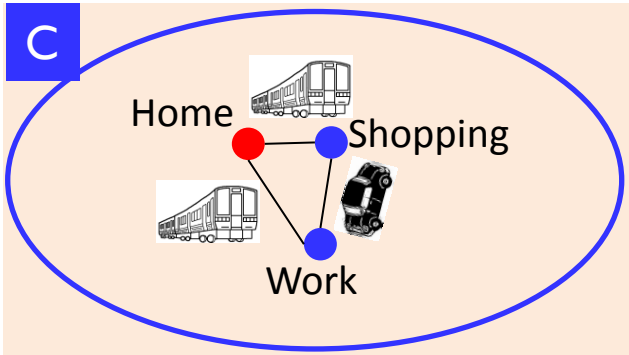
B



Population = 1,000,000
Av. car travel distance = 5 [miles]
Av. number of trips = 3
# of accidents = 50

Promoting public transit

C



Population = 1,000,000
Av. car travel distance = 1.5 [miles]
Av. number of trips = 3
# of accidents = 25

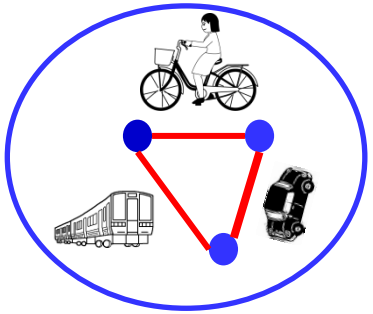
Conventional indicator:
B is safer than C

Problems of conventional indicator

- Delimitation issue
  - Conventional: Focus only on car travel

    → focus on whole transport systems
- Exposure metric
  - Conventional: Vehicle kilometer (mobility-based)

    → Need to focus on the benefit from travel (accessibility-based), e.g., number of trips

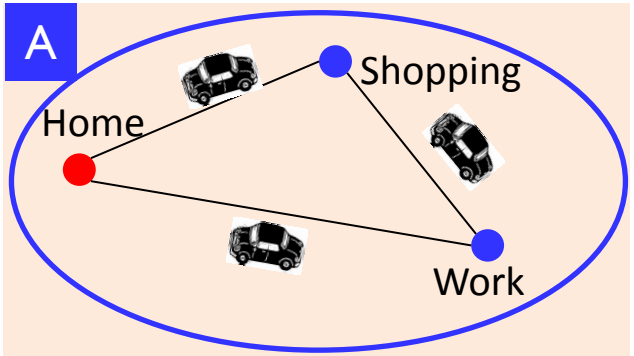


An alternative accident risk indicator:

$$\text{Accident Risk} = \frac{\text{Number of fatalities}}{\text{Number of trips made by all modes}}$$

An alternative risk indicator

A



Population = 1,000,000
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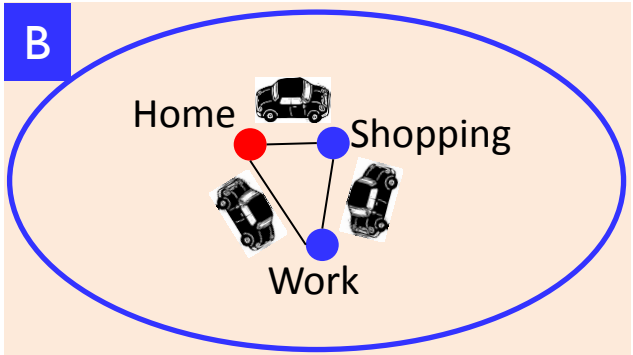
# of accidents = 100

Alternative indicator:
B is safer than A

Conventional indicator:
A is safer than B

Changing urban forms

B



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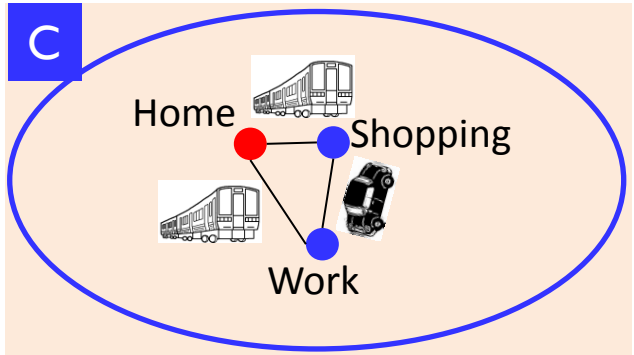
Promoting public transit

C



Population = 1,000,000
Av. car travel distance = 1.5 [miles]
Av. number of trips = 3
# of accidents = 25

Conventional indicator:
B is safer than C

Alternative indicator:
C is safer than B

Empirical Data

- Accident data (2010)
  - Fatality Analysis Reporting System (FARS)
    - Number of fatalities
- Exposure data (2009)
  - National Household Travel Survey (NHTS)
    - Travel distance
    - Number of trips

Risk indicators to be compared

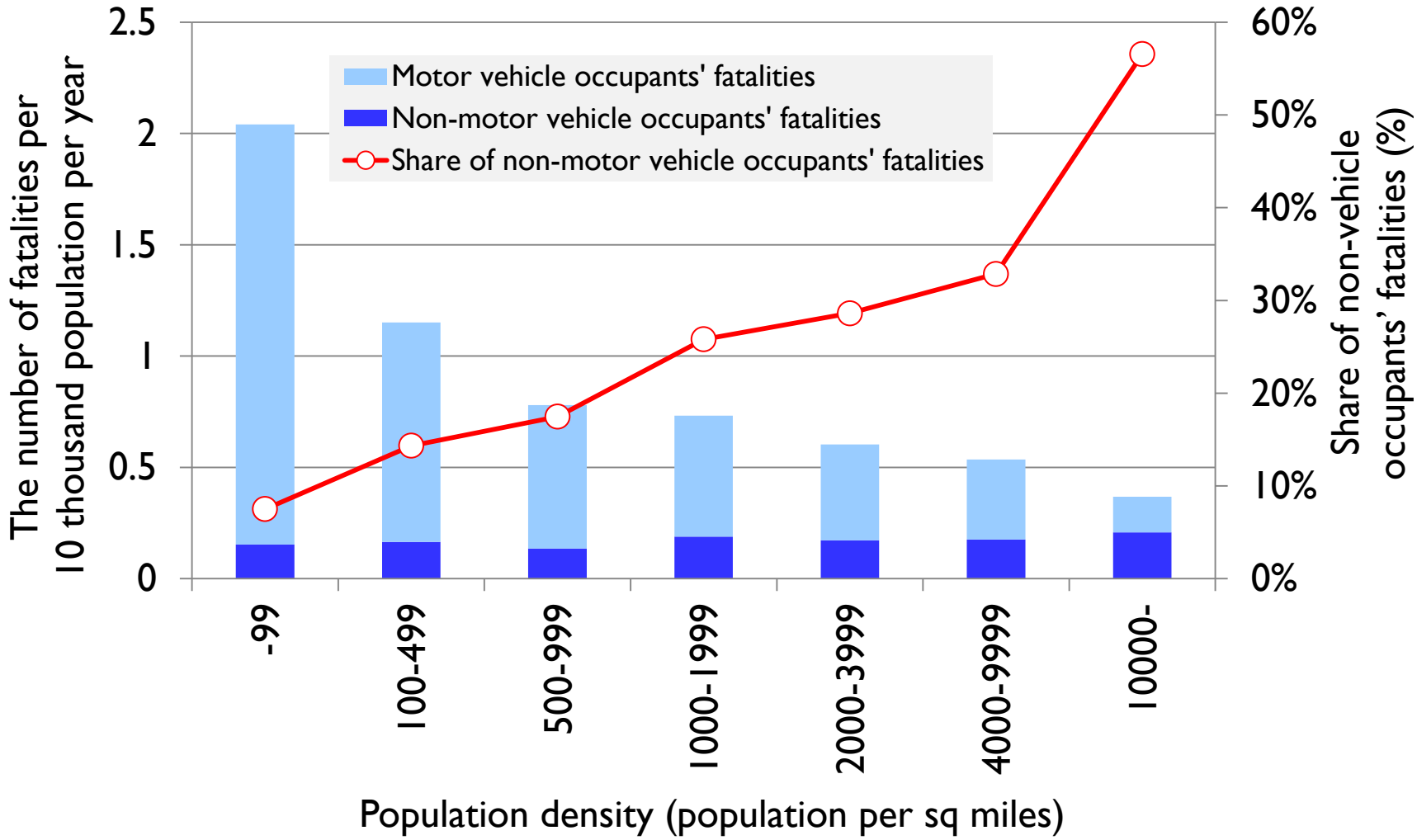
- Conventional accident risk indicator

$$\text{Accident Risk} = \frac{\text{Number of fatalities}}{\text{Vehicle travel time}}$$

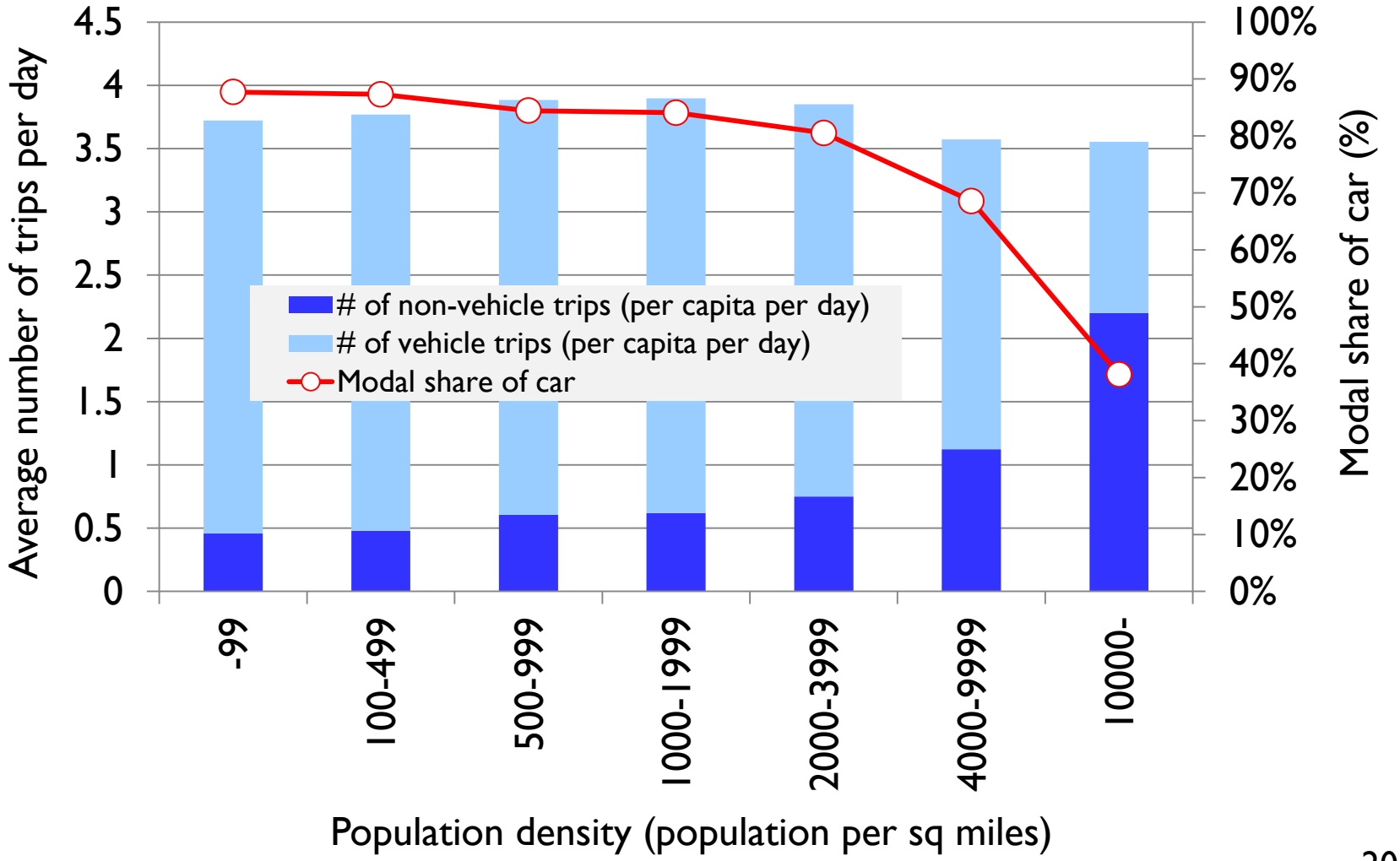
- Alternative accident risk indicator

$$\text{Accident Risk} = \frac{\text{Number of fatalities}}{\text{Number of trips made by all modes}}$$

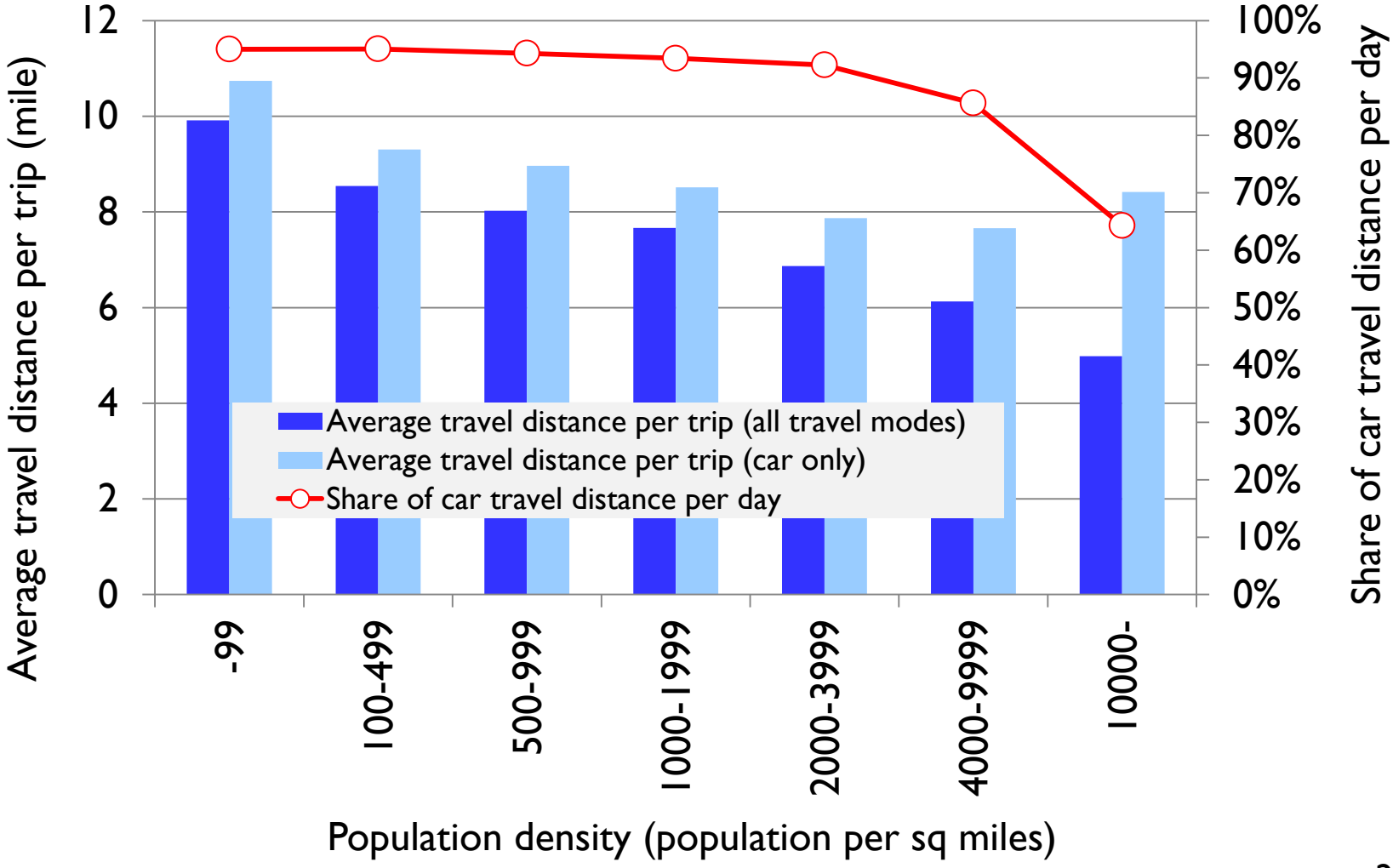
Accidents by population density



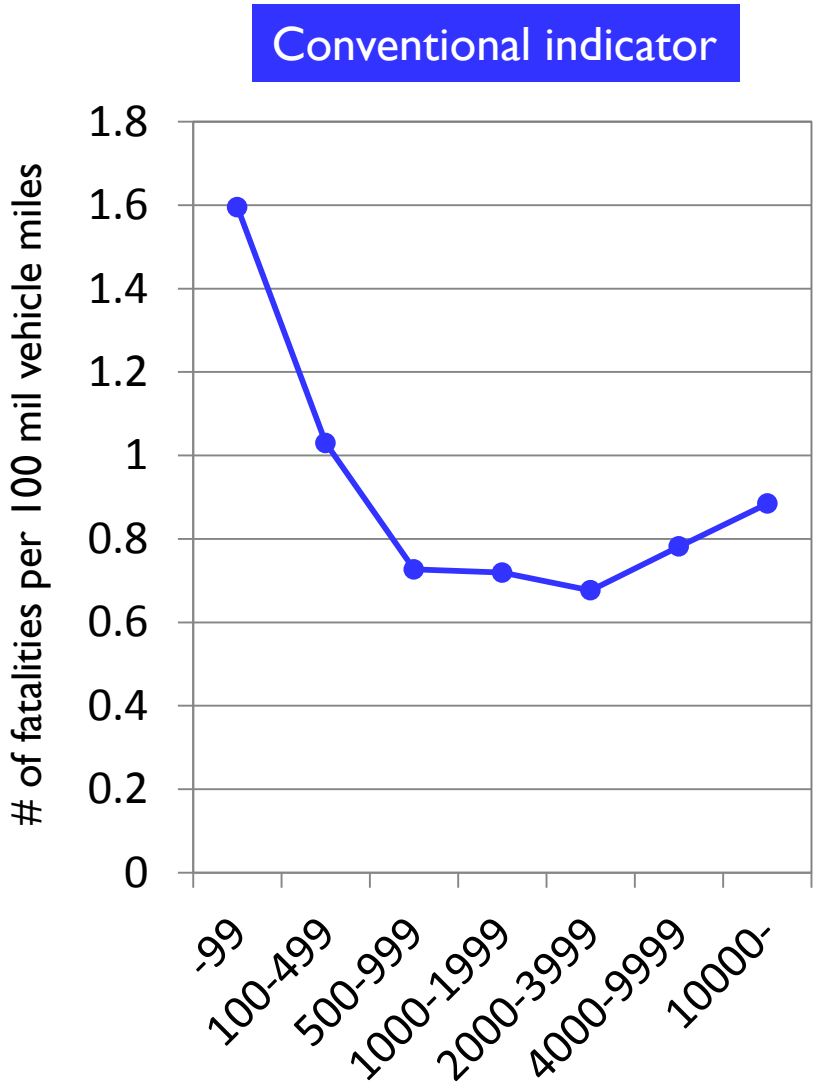
Exposures (the number of trips)

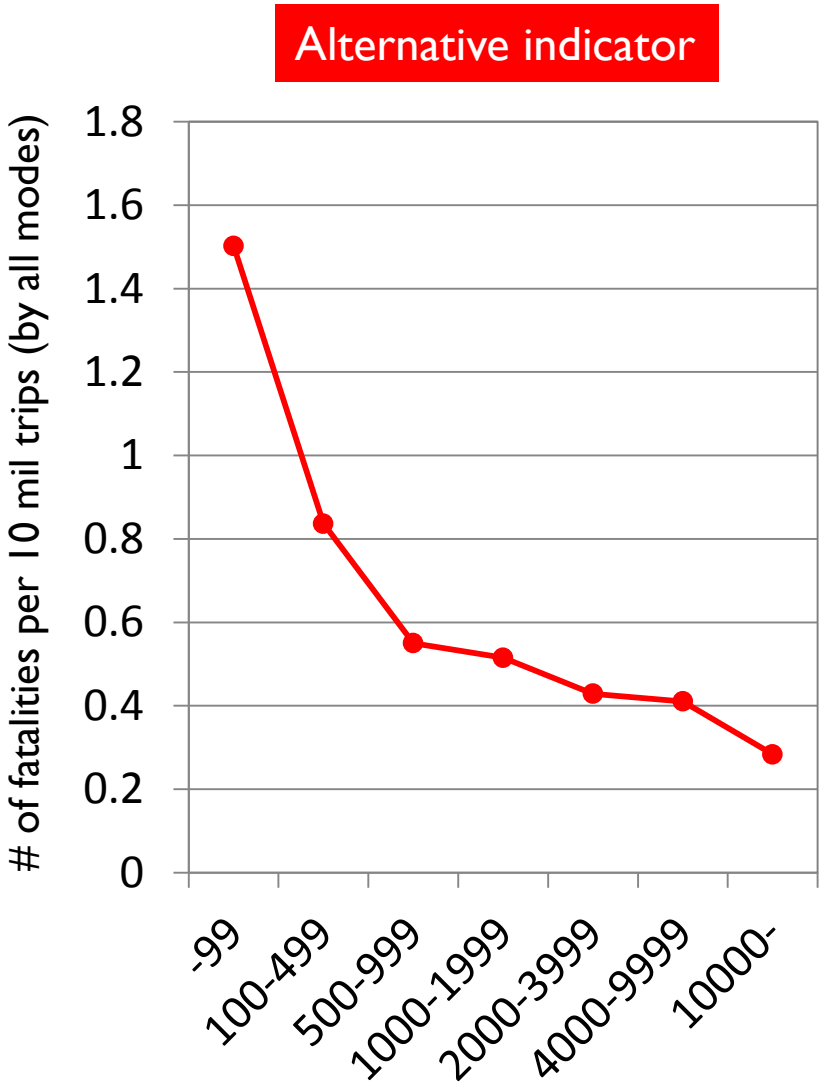


Exposures (travel distance)



Comparison of risk indicators





Rankings of accident risks

	National average		Age 65 or over	
	Conventional risk indicator	Alternative risk indicator	Conventional risk indicator	Alternative risk indicator
Less than 100	7	7	4	7
100-499	6	6	5	6
500-999	3	5	1	4
1000-1999	2	4	3	5
2000-3999	1	3	2	3
4000-9999	4	2	6	2
10000 or over	5	1	7	1

1: lowest risk ----------7: highest risk

Summary

- Reassessing accident risk indicator
  - A conventional indicator may not be really consistent with the current governments' perspective
  - We may have to focus on (1) the safety of whole transport systems, and (2) the benefit from travel in the quantification of accident risks
- There would be no value-free risk indicator

  → Making clear "perspective" we are taking is one of the crucial aspects in accident risk analysis
- Limitation of empirical analysis: benefit calculation

Needs for further activity-based research

Risk-benefit perspective

- Difficulties in the calculation of benefits
  - Although the number of trips may be one of the proxy indicators of benefits, further improvement is certainly needed

- Activity-based approach
  - "choices to travel are conceptualized as being dependent on the value of participating in the activities that travel makes possible" (Garling, Axhausen & Brydsten, 1993)

    → The benefits from travel may not be able to be calculated from travel behavior per se

Activity-based approach

- Limitations
  - Most studies have focused on behavioral descriptions (fact) rather than evaluative aspects (value), while the central foundation of activity-based approach is in the value of participating in activities

- Possible research directions
  - Valuing activity participation as a productive outcome
    - The myth of travel time saving (Metz, 2008)

Possible research directions

- Valuing productive time spent
  - Utilizing utility-based time use model
    - The productivity of time (Becker, 1965)
  - Study on the value of unpaid work
    - Replacement cost method (if we ask professional service…)
    - Opportunity cost method (if we work…)
  - Questionnaire based methods
  - etc.
- Demand side perspective
  - Quality of life
- Supply side perspective
  - ?????

Appraisal requirements and capabilities under each perspective (Jones, 2009)

Paradigm expansion	Vehicle trip based	Person trip based	Activity based	Dynamics based	Attitude based
Generally used appraisal variables	• Operating costs • Accident costs • Air pollution and noise	• Travel time savings by purpose	• Health benefits		• Quality of a journey
Missing or very limited variables		• Travel time variability	• Value of activity participation • Value of access/choice • Value of generated travel	• Implications of turnover on valuation • Option values for potential future needs	• Value of improved information • Value of enhanced quality