Day 2

Socio-economic impact of CAD

Benefits of Automated Driving Systems : Traffic Accident Reduction

Hiroaki Miyoshi

Professor

Doshisha University

hmiyoshi@mail.doshisha.ac.jp

Subject of Research

- **Technologies**: ADAS (Advanced Driver Assistance Systems) or Levels 1 and 2 Automated Driving Systems.
- **Benefits**: Reduction of traffic-accident losses through the use of the technologies.
- **Type of traffic-accident** : Accidents between four-wheeled vehicles.
- **Purpose**: Considering public policies that contribute to the diffusion of the technologies.

Classification of Economic Losses due to Road Traffic Accidents (1)

Monetary Losses

Personal losses: e.g., medical expenses and lost wage for missed work.

Material losses: e.g., damage to vehicles or structures requiring repairs.

Losses incurred by corporate entities: reduction of value-added due to missed work, death, residual disability.

Losses incurred by various public institutions: e.g. emergency transportation costs and costs of handling the accident by the police.

Source: Cabinet Office, Government of Japan (2012) (slightly modified and translated by author)

Classification of Economic Losses due to Road Traffic Accidents (2)

Non-monetary Losses

Physical or emotional suffering on the part of *victims* stemming from bodily harm or damage to material property.

Emotional pain and suffering experienced *by the families and friends of the victims*.

Psychological burdens experienced by *the persons responsible for causing the accident*, as well as their families and friends.

Source: Cabinet Office (2012) (slightly modified and translated by author)

Note: Second and third non-monetary losses are not included in our study.

Economic Losses for a Victim (at 2015 prices)

Thousand EUR (at the rate of 120 Japanese Yen to EUR; the same shall apply hereinafter)

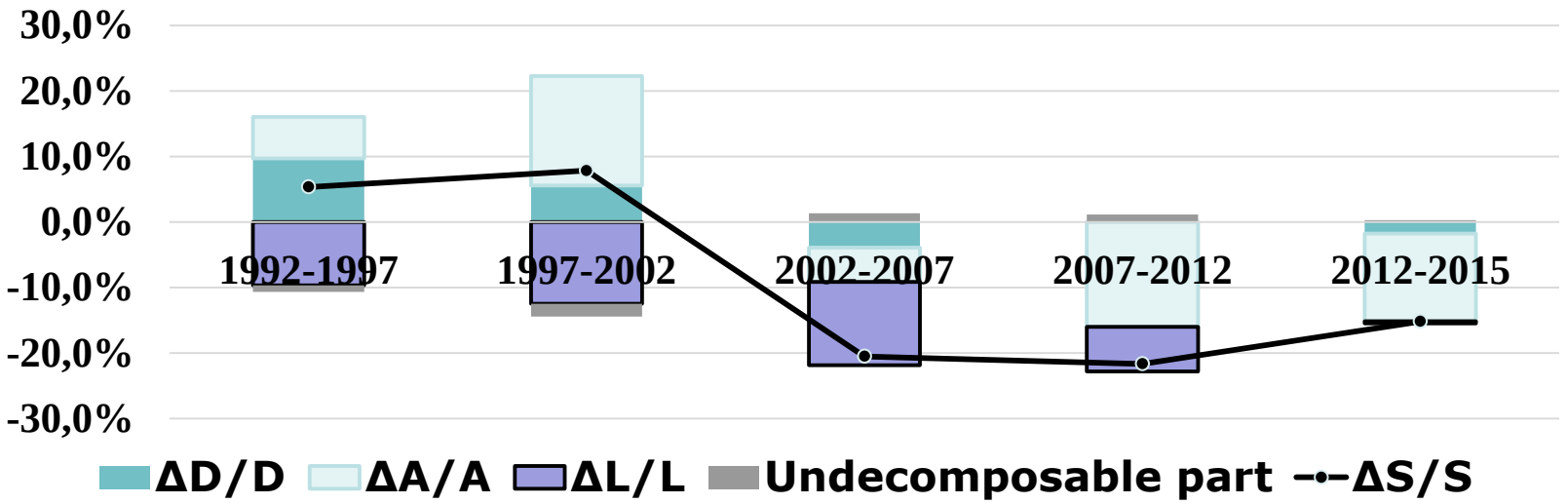
	Death	Serious Injury	Slight Injury
Monetary Losses	**259**	**80**	**13**
Non-monetary losses	**1,753**	**71**	**2**
Total	**2,012**	**150**	**15**

- Source: The 2009 values established by Cabinet Office (2012) are adjusted by using GDP-deflator.
- Note 1: "Deaths" are cases in which a traffic accident results in death within 24 hours of the accident. "Serious injuries" are injuries requiring medical treatment for 1 month (30 days) or more. "Slight injuries" are injuries requiring medical treatment for less than 30 days.
- Note 2: Cabinet Office (2012) categorizes injuries into two sectors of "Injuries with residual disability " and "Injuries without residual disability," while Japan Traffic Accidents General Database, J-TAD (macro), classifies injuries into two classes of "Serious injuries" and "Slight injuries." Here, we have assumed that J-TAD (macro) categories of "Serious Injuries" and "Slight Injuries" correspond to "Injuries with residual disability" and to "Injuries without residual disability" in Cabinet Office (2012) respectively.

Conclusion 1

- **Passive safety technologies have contributed significantly to the reduction of economic losses due to road traffic accidents in Japan.**
- **It seems that the magnitude of additional contribution from passive safety technologies have lessened considerably in recent years.**
- **Diffusion of active safety technologies will be needed in order to reduce the economic losses dramatically.**

Decomposition of the Rate of Change of Economic Losses due to Road Traffic Accidents in Japan (Accidents between Four-Wheeled Vehicles)



S : Economic losses due to road traffic accidents
D: Total distance traveled (billion vehicle-kilometers)
A: The number of accidents per billion vehicle-kilometers
L: Economic losses per accident

$$S=D\cdot A\cdot L \quad \rightarrow \quad \Delta S/S \fallingdotseq \Delta D/D + \Delta A/A + \Delta L/L$$

Note: Losses due to accidents involving special purpose vehicles are not included
Source: Miyoshi (2016) using J-TAD (macro)

Conclusion 2

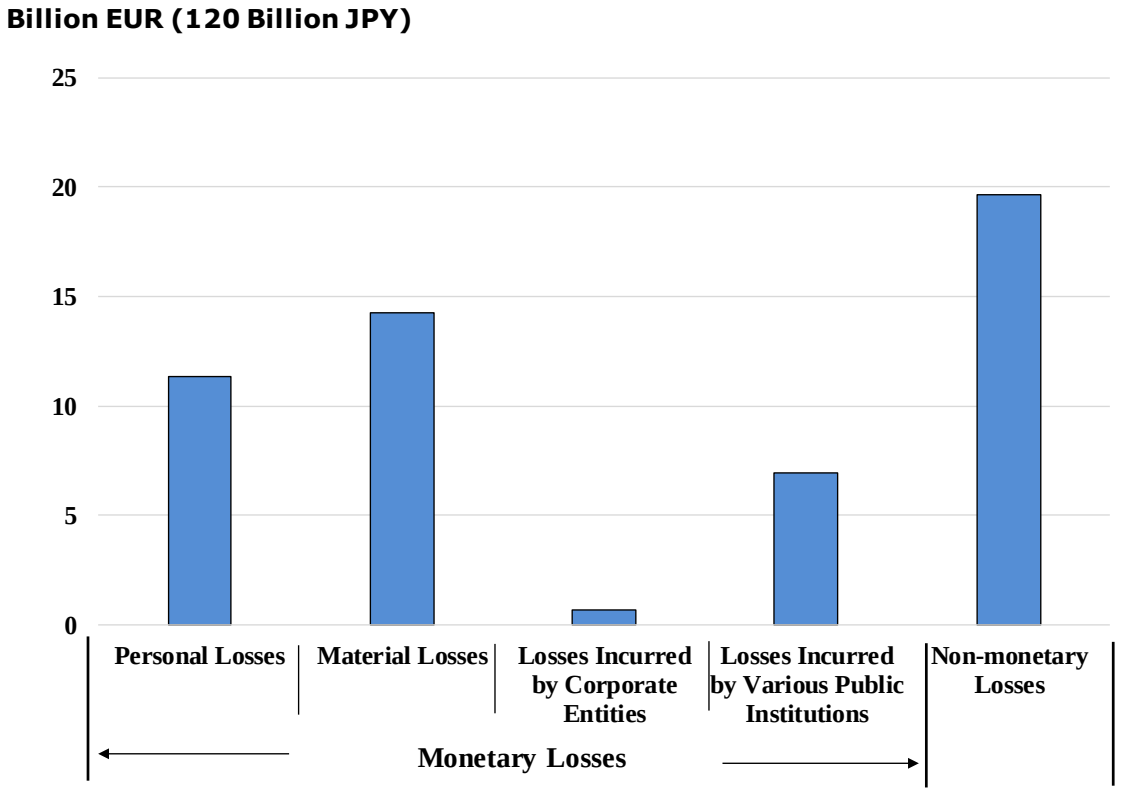
- **Economic benefits of the automated driving systems will be enjoyed not only by the users but also by many economic entities including non-users, firms, public institutions.**

- **It can also be said that Automated Driving Systems are *safety-sharing system.***

- **Magnitude of benefits and their attribution differ depending on utilized technologies.**

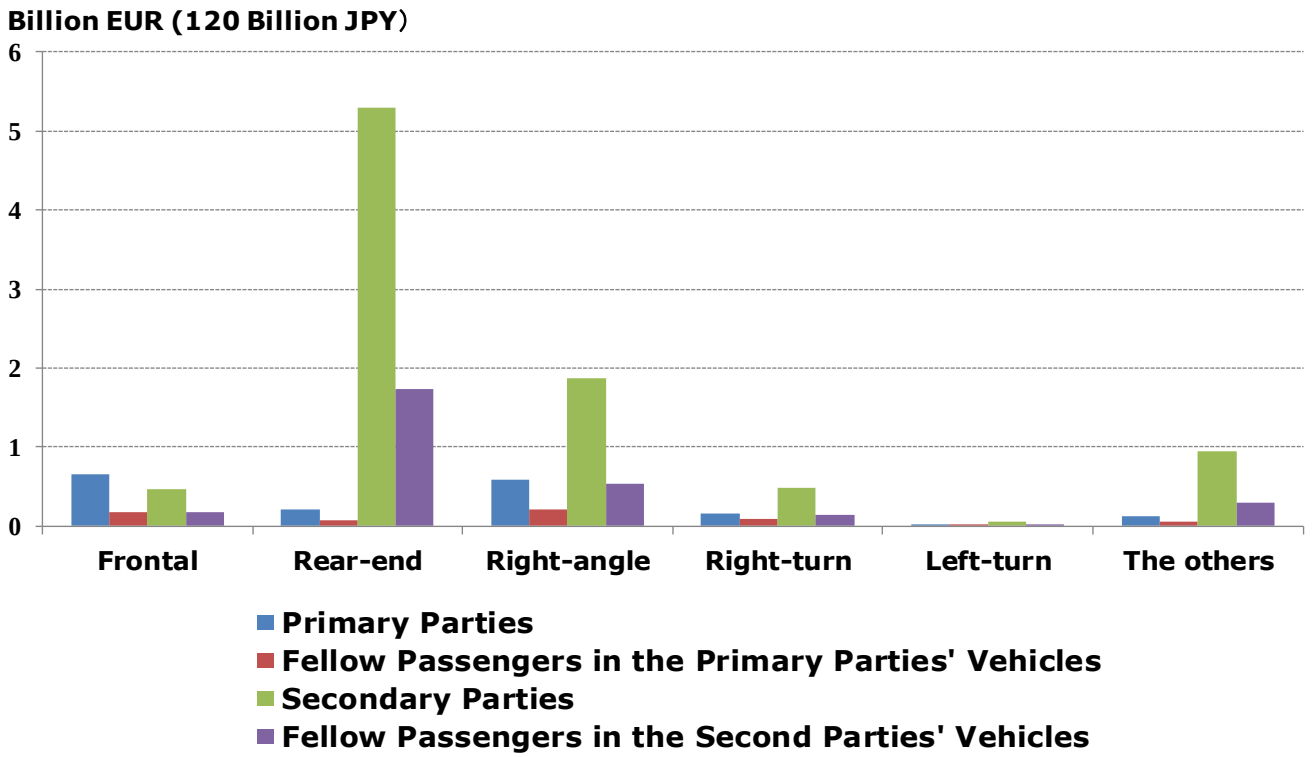
- **Redistribution of costs burden among the related economic entities will be necessary for facilitating diffusion of the automated driving systems in the society, considering economic features of each technology**

Economic Losses due to Road Traffic Accidents in Japan (2009) (All Types of Road traffic Accidents)



Source: Prepared by author in reference to Cabinet Office (2012)

Losses by Accident Type in 2015 (Accidents between Four-Wheeled Vehicles)



Source : Calculated by author using 2015 data provided by ITARDA

Economic Features of the Technologies : Rear-End Collision Prevention

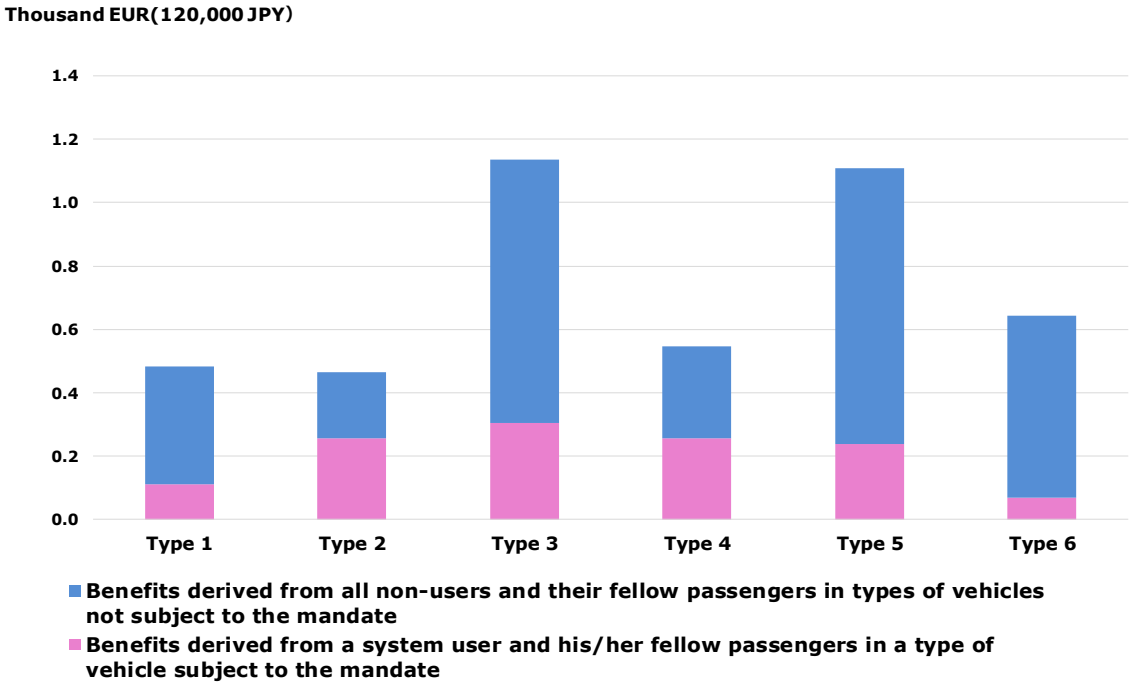
System types	New user's Benefit	Externalities	
		Enjoyed by	Contents
Autonomous	Avoidance of collisions with *all vehicles running ahead*	*All Vehicles*	Increase of the probability of avoiding collisions with vehicles *running behind*
Vehicle-to-Vehicle (V2V)	Avoidance of collisions *with equipped vehicles running ahead and behind*	*Already equipped vehicles* (Network externality)	Increase of the probability of avoidance of collisions with vehicles *running ahead and behind*

Conclusion 3

- **Japanese safety regulations for road transport vehicles call for mandatory installation of (autonomous) collision-mitigating brakes and lane-departure warning devices on new trucks at over 3.5 ton GVW and new buses with capacity for 10 or more passengers (stepwise introduction from heavy vehicles)**

- **Our analysis finds it appropriate to assign high priority for mandatory installation of collision-mitigating brakes to trucks at over 3.5 ton GVW and *Taxis*.**

Benefits from Mandatory Installation of Autonomous Devices for Rear-end Collision Prevention



Type 1: standard/small buses, Type 2: standard/small passenger vehicle for private use,
Type 3: standard/small passenger vehicle for commercial use (taxis), Type 4: mini vehicle,

Type 5: standard/small truck at over 3.5 ton GVW, Type 6: standard/small truck at 3.5 ton or less GVW

Note: Estimated based on the assumption that the installation of devices is 100% effective in averting accidents.
Source: Miyoshi (2016) using 2015 J-TAD (macro)

Thank you for your kind attention!

References

Cabinet Office, Government of Japan (2012), *Report of the Survey on Economic Analysis on the Damage and Loss of Road Traffic Accidents,* March 2012 (in Japanese)

Hiroaki Miyoshi (2016), Economic Features and Diffusion Policies of Automated Driving Systems, *The 19th Annual Workshop of the Institute for Traffic Accident Research and Data Analysis* (ITARDA), Tokyo, Japan (in Japanese)