Benefits of Automated Driving Systems: Traffic Accident Reduction

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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)

<table>
<thead>
<tr>
<th></th>
<th>Death</th>
<th>Serious Injury</th>
<th>Slight Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monetary Losses</td>
<td>259</td>
<td>80</td>
<td>13</td>
</tr>
<tr>
<td>Non-monetary losses</td>
<td>1,753</td>
<td>71</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,012</td>
<td>150</td>
<td>15</td>
</tr>
</tbody>
</table>

- 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)

\[
\Delta S/S \approx \Delta D/D + \Delta A/A + \Delta L/L
\]

**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

\[
S = D \cdot A \cdot L 
\]

*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)

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

<table>
<thead>
<tr>
<th>System types</th>
<th>New user's Benefit</th>
<th>Externalities Enjoyed by</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomous</td>
<td>Avoidance of collisions with <em>all vehicles running ahead</em></td>
<td><em>All Vehicles</em></td>
<td>Increase of the probability of avoiding collisions with vehicles <em>running behind</em></td>
</tr>
<tr>
<td>Vehicle-to-Vehicle (V2V)</td>
<td>Avoidance of collisions with <em>equipped vehicles running ahead and behind</em></td>
<td><em>Already equipped vehicles</em> (Network externality)</td>
<td>Increase of the probability of avoidance of collisions with vehicles <em>running ahead and behind</em></td>
</tr>
</tbody>
</table>
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

Benefits derived from all non-users and their fellow passengers in types of vehicles not subject to the mandate

Benefits derived from a system user and his/her fellow passengers in a type of vehicle subject to the mandate

Thousand EUR (120,000 JPY)

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
