12th Japan ITS Promotion Forum

Automated Driving System

Impact Assessment

(Social Impacts)

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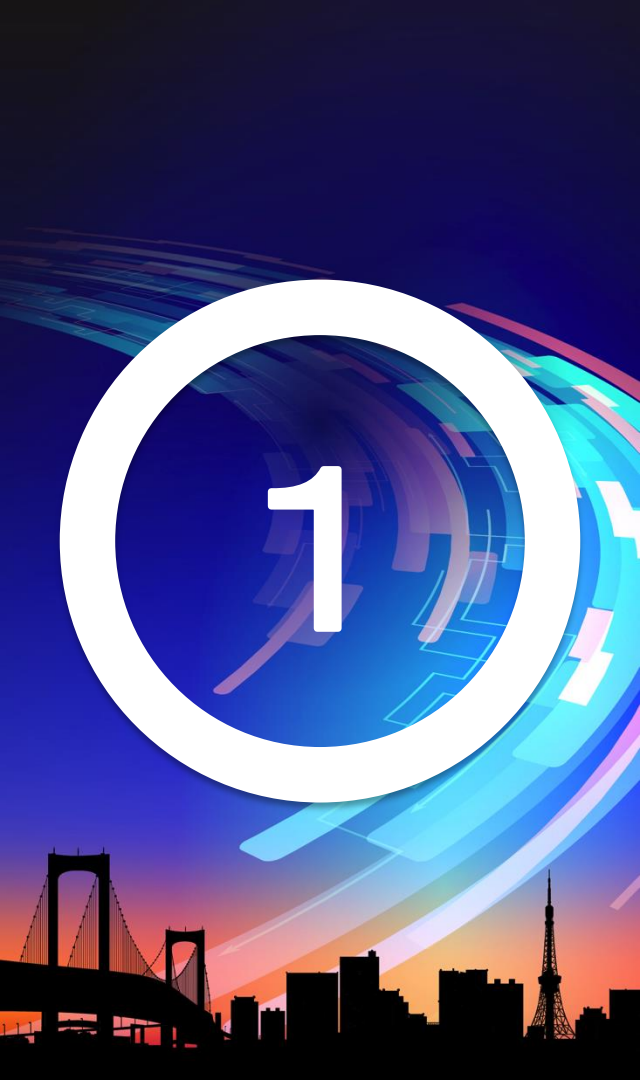
<Translated Version>

SIP

Cabinet Office

INDEX



Economic feature of automated driving systems

Active safety technology is technology that protects not only the passengers in vehicles in which it is installed, but also the other party in an accident. In other words, it is “safety-sharing technology.”

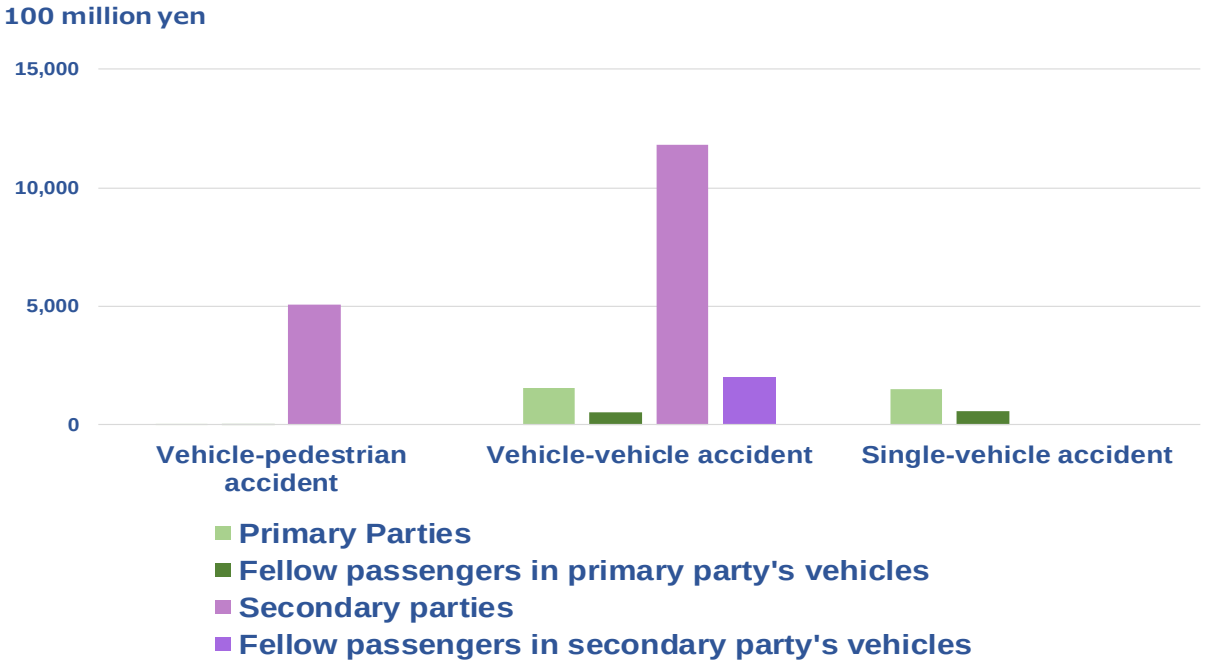
However, how safety is shared and the economic feature differ depending on the form of the automated driving system (standalone, cooperative, etc.).

Measures that take this into consideration are necessary to diffuse this technology

Benefits of Automated Driving Systems (Using Rear-end Collision Prevention Technology as an Example)

System		Benefits to new purchaser	Benefits to other vehicles (externality)	
			Automated driving vehicles using same system	Manually-driven vehicles or automated driving vehicles using a different system
Standalone		Avoid colliding into preceding vehicle	Avoid rear-end collisions from following vehicle	
Cooperative	Vehicle-to-vehicle cooperation (or vehicle-to-cloud)	Avoid accidents with other automated driving vehicles using same system	Increase in avoidable accidents	None
	Vehicle-to-infrastructure cooperation	Avoid colliding into preceding vehicle	Avoid rear-end collisions from following vehicle	

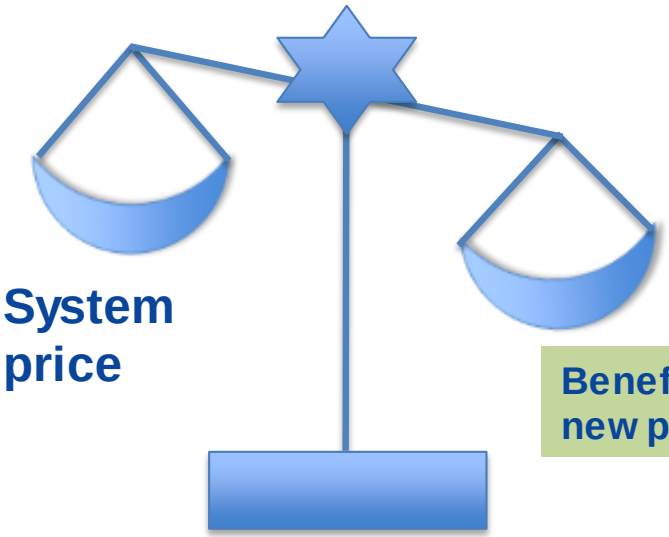
Loss Amounts by Accident Type and by Party Concerned (2015)



Note) Accidents where vehicles of "primary parties" are four-wheeled vehicles and those of "secondary parties" are four-wheeled vehicles, motorcycles, mopeds, bicycles, pedestrians, or other, were tabulated.

Data) Loss amounts (see Reference Materials) and number of victims by injury level in 2015 were used. The number of victims was tabulated using ITARDA's traffic accident data aggregator.

Possible Lack of Diffusion with Market Mechanism



Benefits to new purchaser

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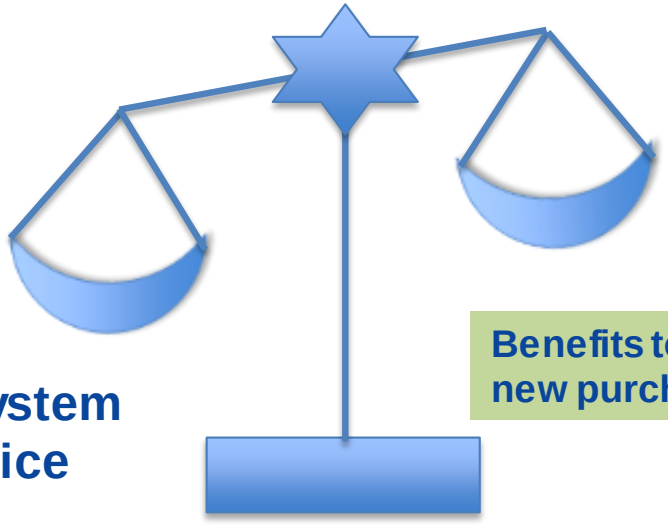
Benefits to other vehicles



Benefits to new purchaser

Necessity of economic incentives, etc.

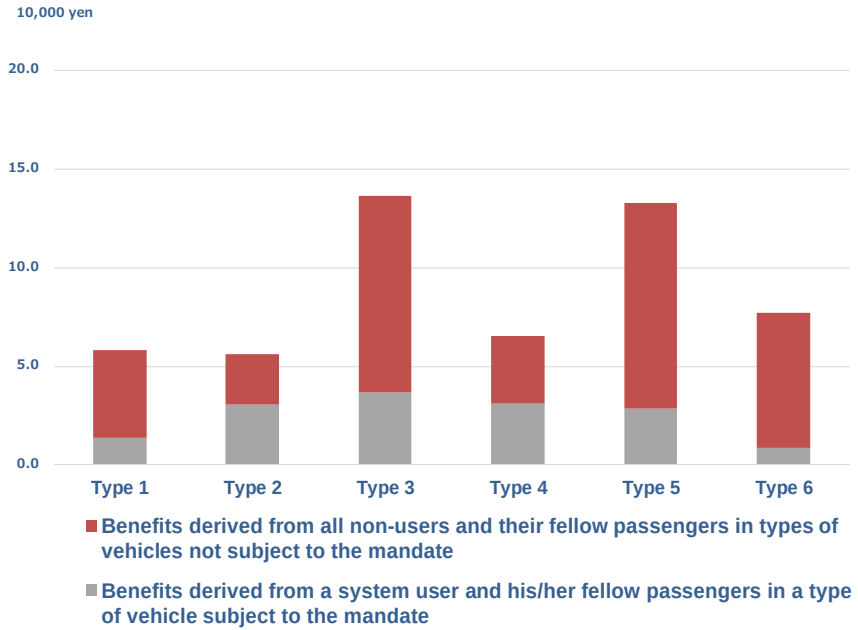
Measures for diffusion of automated driving systems

To make automated driving systems diffuse appropriately throughout society, measures that are based on the economic feature of automated driving systems are necessary

- **Introduction of economic incentives for equipping a vehicle with an automated driving system,**
- **Making it mandatory to install an automated driving system,**
- **Control of demand by combination of technologies.**

Benefits from Mandatory Installation -1- (Rear-end Collision Prevention System)

Benefits per vehicle subject to the mandate



Note 1) The benefits (net present value) during the average use years of each vehicle type were calculated by assuming that it is 100% possible to avoid collision accidents between four-wheeled vehicles by installing system,

Note 2) Calculated by using the loss amounts (see Reference Materials) and number of victims by injury level in 2015. For the number of victims, the Japan Traffic Accidents General Database (macro data) was used,

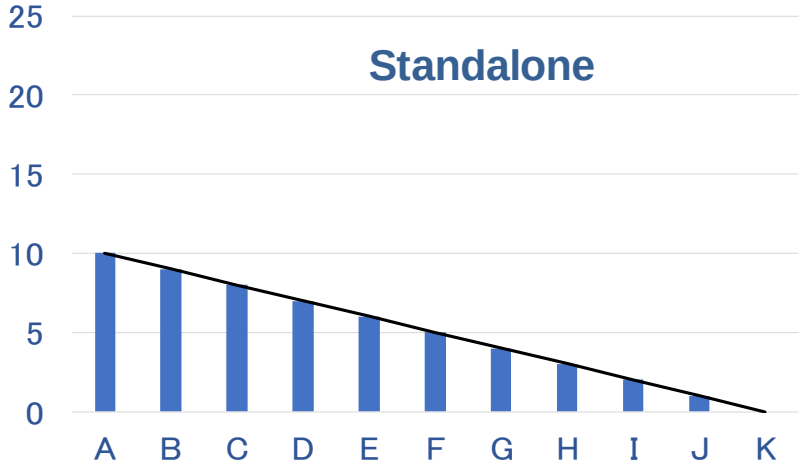
Note 3) Benefits include those that are not directly received by parties involved in the accident (avoidance of business entities' loss, public institutions' loss, and monetary loss covered by insurance benefits),

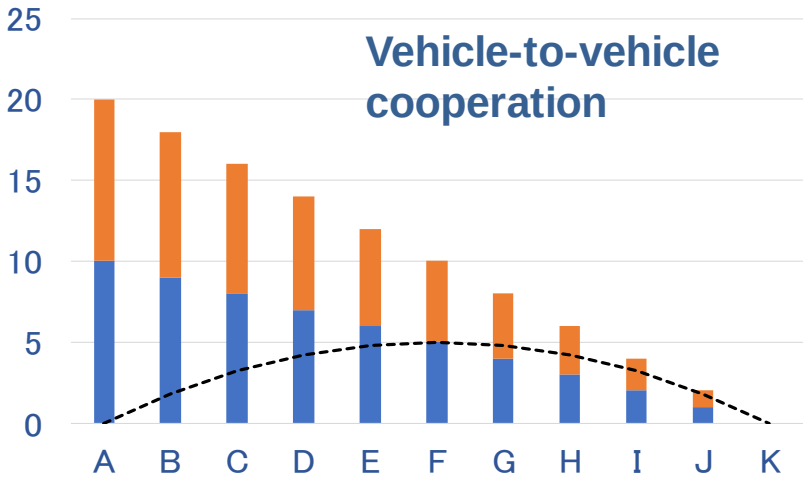
Note 4) Benefits derived from a system user includes the benefit of being able to avoid collisions from behind by vehicles of the same type.

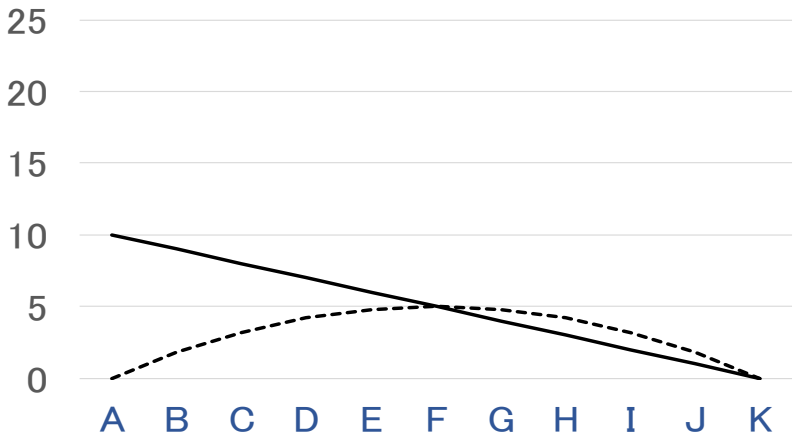
Type 1: standard/small buses, Type 2: standard/small passenger vehicle for private use,
Type 3: standard/small passenger vehicle for commercial use (taxis), Type 4: mini vehicle,
Type 5: standard/small truck at over 3.5 ton GVW, Type 6: standard/small truck at 3.5 ton or less GVW

Source) Hiroaki Miyoshi, Economic Feature of and Diffusion Policies for Automated Driving Systems, *The 19th Annual Workshop of the Institute for Traffic Accident Research and Data Analysis (ITARDA)*, Oct. 2016, p.18 https://www.itarda.or.jp/ws/pdf/h28/19_ppt.pdf
(For details on the various assumptions and conditions used for calculations, please refer to this document)

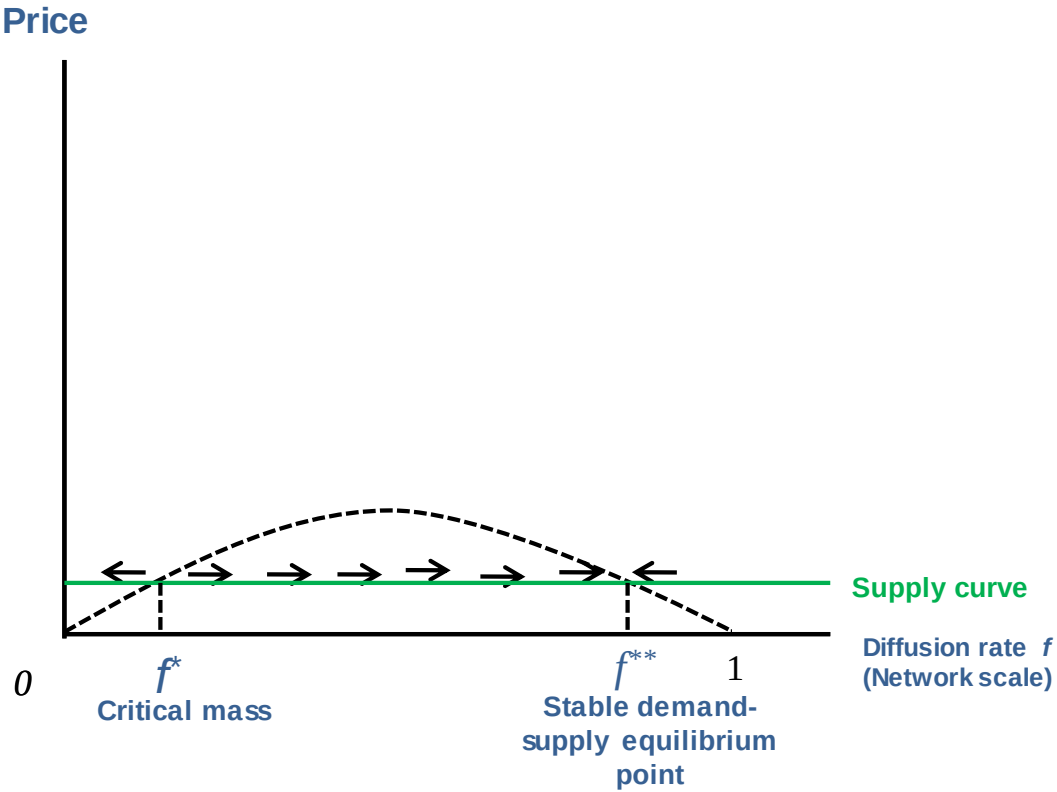
Shapes of Demand Curves





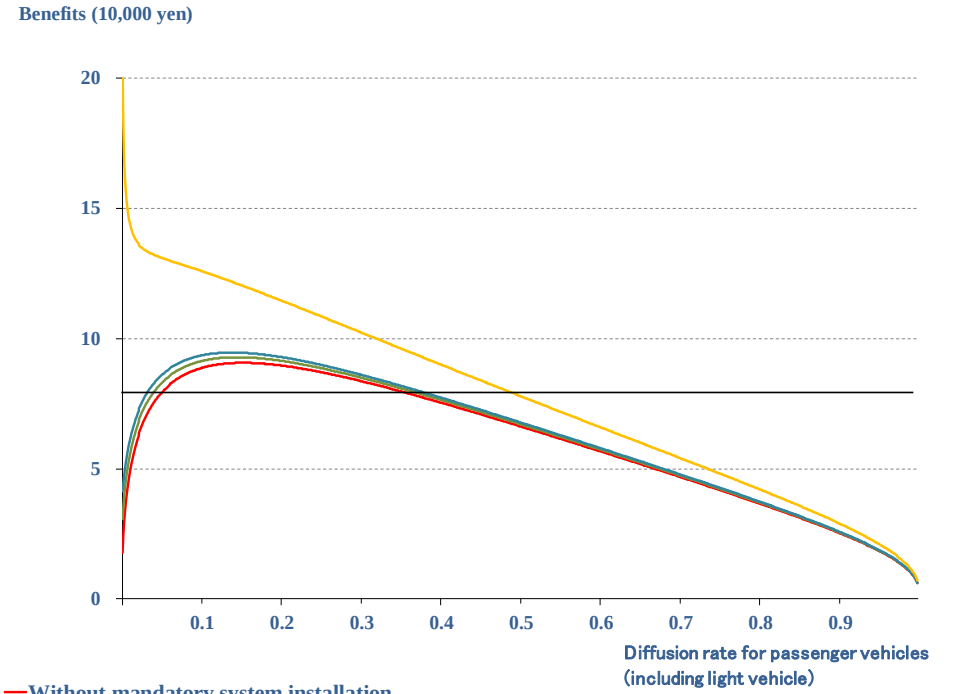


Critical Mass of IC-related Goods and Services



Source) Prepared by author based on Rohlfs, J.H., A Theory of Independent Demand for a Communications Service. *Bell Journal of Economics and Management Science* 5 (1), 1974, pp.

Benefits from Mandatory Installation -2- (Vehicle-to-Vehicle Cooperation)



Source) Estimated by author

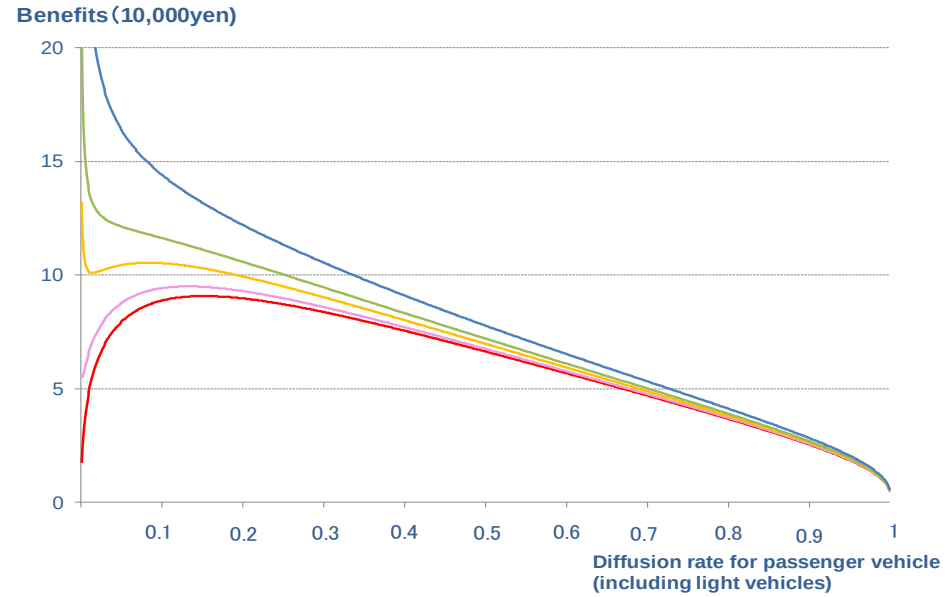
Note 1) The benefits (net present value) during the average use years of passenger vehicles were calculated by assuming that it is 100% possible to avoid collision accidents between four-wheeled vehicles by installing system,

Note 2) The graph indicates how the demand curve for passenger vehicle's system changes depending on mandatory installation of system in other vehicle types,

Note 3) For calculations, the loss amounts (see Reference Materials) and number of victims by injury level in 2012 were used. The number of victims was tabulated using ITARDA's traffic accident data aggregator,

Note 4) Benefits include those that are not directly received by parties involved in the accident (avoidance of business entities' loss, public institutions' loss, and monetary loss covered by insurance benefits).

Benefits from Combinations of Different Technologies



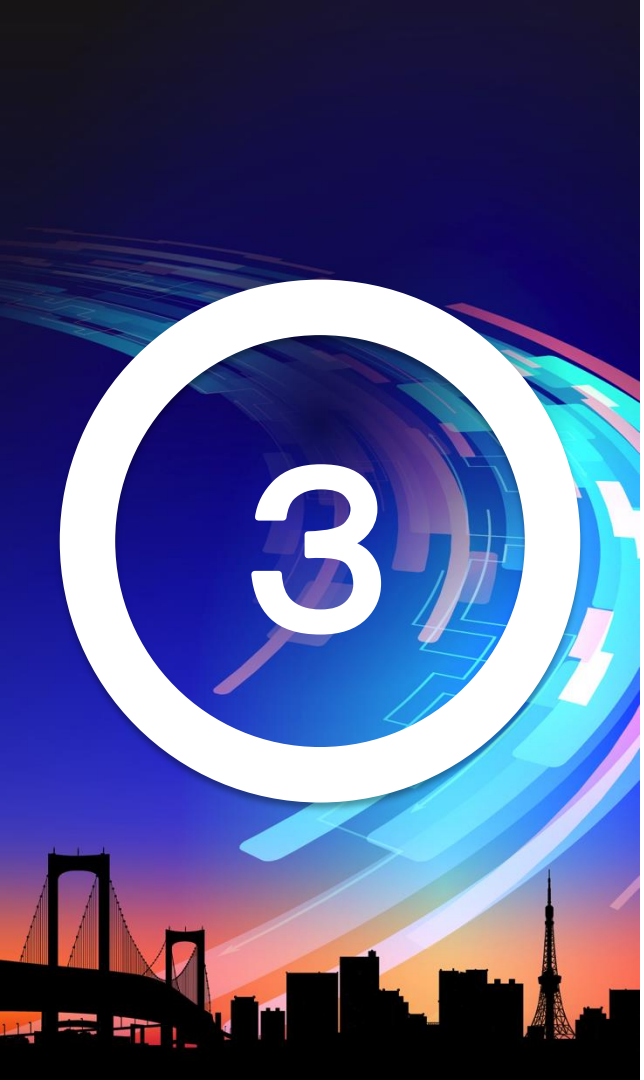
Note 1) The benefits (net present value) during the average use years of passenger vehicles were calculated by assuming that it is 100% possible to avoid collision accidents between four-wheeled vehicles by installing system,

Note) The graph indicates how the demand curve for passenger vehicle's system changes depending on combinations with standalone types and vehicle-to-vehicle cooperation types,

Note 3) For calculations, the loss amounts and number of victims by injury level from 2012 were used. The number of victims was tabulated using ITARDA's traffic accident data aggregator,

Note 4) Benefits include those that are not directly received by parties involved in the accident (avoidance of business entities' loss, public institutions' loss, and monetary loss covered by insurance benefits).

Source) Prepared by author by modifying Fig. 3 in Hiroaki Miyoshi, Economic Effects of Combining Technologies in Advanced Driving Assistance Systems (Scientific Paper), *ITS World Congress 2017*, Montreal (For details on the various assumptions and conditions used for calculations, please refer to this document)



The automobile industry in Japan's industrial structure

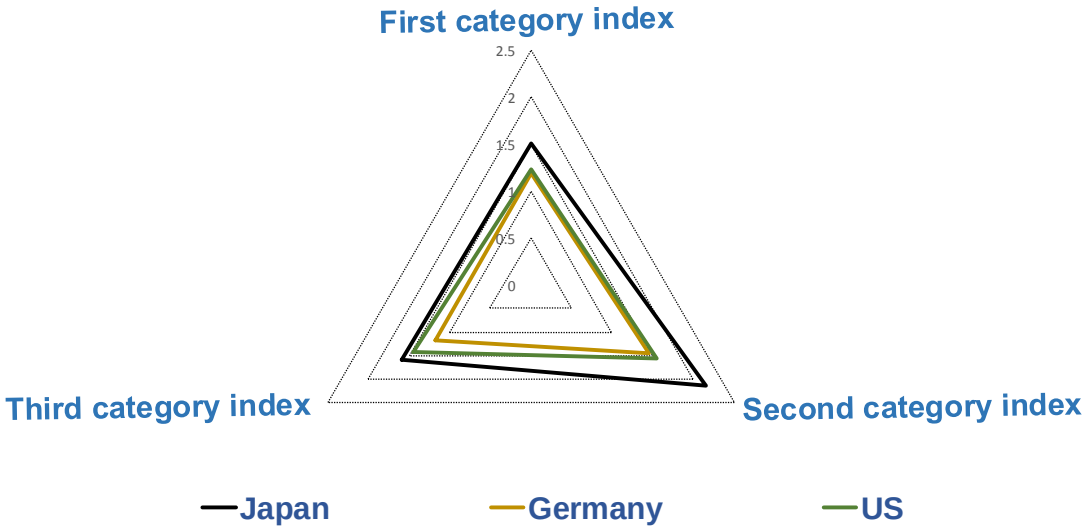
The automobile industry is a sector with the largest power of dispersion among Japanese industries, and changes in input and in final demand have a large impact on the Japanese economy.

Power of Dispersion

- 3 types of powers of dispersion
  - Fist category index : Defined as relative size of influence on the entire industry (including the self-sector) in case where final demand of the industry increases by one unit,
  - Second category index: The direct effect of 1.0 to the self-sector is excluded,
  - Third category index: The self-sector are completely eliminated and only the effects on the other sector is considered.

Source) Prepared by author by referring to the Ministry of Internal Affairs and Communications Website, "Indexes and their Calculation Method for Input-Output Analysis" (http://www.soumu.go.jp/toukei_toukatsu/data/io/bunseki.htm)

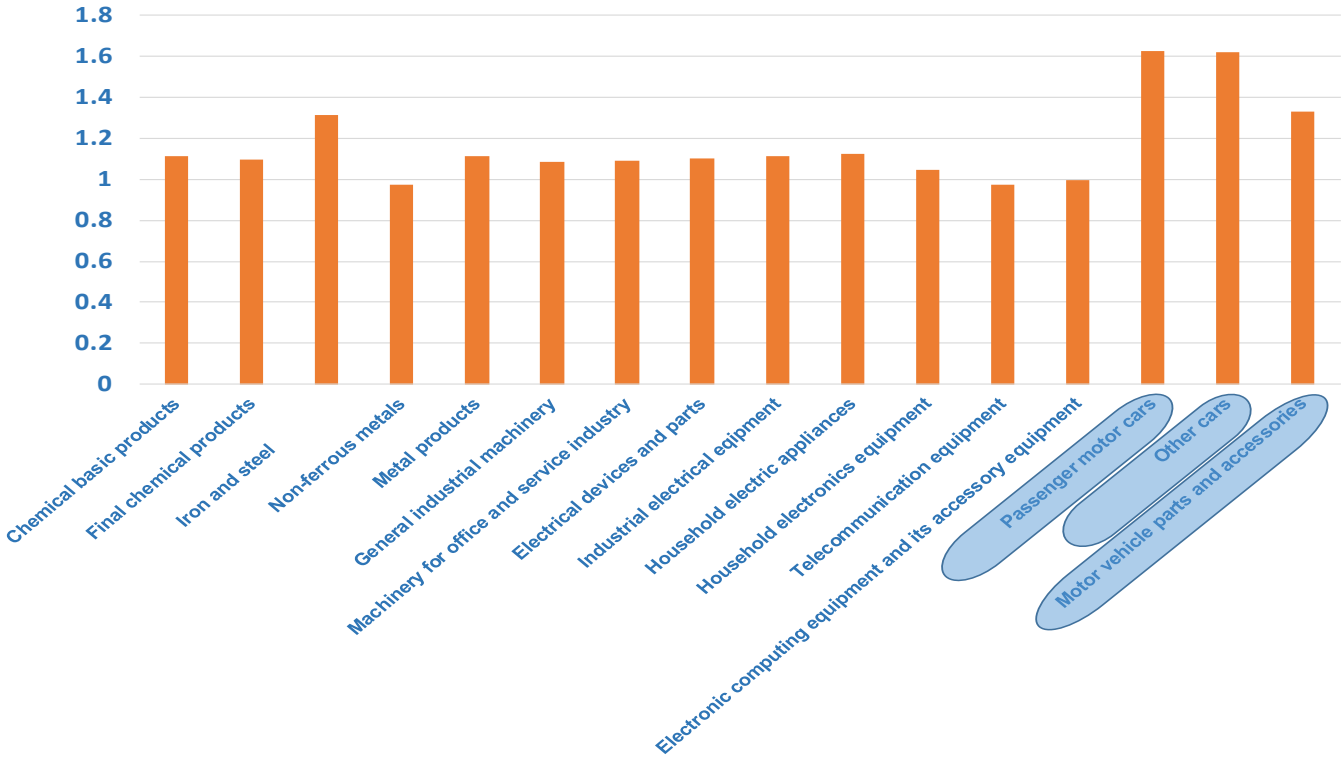
Power of Dispersion of the Automobile Sector



Note) Calculated using 2011 Input-Output Tables compiled by OECD. Stat (http://stats.oecd.org/Index.aspx?DataSetCode=IOTS)
For the automobile sector, "Motor vehicles, trailers and semi-trailers" was used

Source) Hiroaki Miyoshi and Masanobu Kii, Macro Impact of Autonomous Vehicles, Special Interest Session, *ITS World Congress 2017*, Montreal (http://itsworldcongress2017.org/wp-content/uploads/2017/11/miyoshi_20171031.pdf)

Sector Comparisons of Fist Category of Power of Dispersion



Note) Calculated using Updated Input-Output Tables 2014, Ministry of Economy, Trade and Industry (METI), Japan

Source) Prepared by author modifying the figure in Hiroaki Miyoshi and Masanobu Kii, Macro Impact of Autonomous Vehicles, Special Interest Session, ITS World Congress 2017, Montreal (http://itsworldcongress2017.org/wp-content/uploads/2017/11/miyoshi_20171031.pdf)

Acknowledgements

- This work was supported by JSPS Grants-In-Aid for Scientific Research #25281071 (Policies to Promote the Diffusion of Next-Generation Vehicles and their Global Benefits) and #16K12830 (Analysis on Social Welfare of Automated Driving Systems).
- In addition, results obtained as a visiting researcher at the Institute for Traffic Accident Research and Data Analysis (ITARDA) are also partially used.


Thank you

Reference Materials

Loss Amounts Due to Traffic Accidents

	Amount of losses (billion yen)					Losses for a victim (thousand yen)		
	Deaths	Injuries with residual disability	Injuries without residual disability	Property damage accidents	Total	Death	Injury with residual disability	Injury without residual disability
Monetary losses	223	649	1,837	1,269	3,979	31,518	9,667	1,619
Personal losses	201	528	630	-	1,359	28,315	7,864	555
Medical expenses, lost wages due to missed work, funeral costs, etc.	114	428	290	-	832	16,025	6,379	256
Payment for pain and suffering	87	100	340	-	527	12,290	1,485	300
Material losses	3	26	433	1,249	1,711	382	382	382
Losses incurred by corporate entities	6	14	61	-	81	797	207	54
Losses Incurred by various public institutions	14	82	712	20	828	2,025	1,214	628
Non-monetary losses	1,509	577	269	-	2,355	213,000	8,587	237
Total (without payment for pain and suffering)	1,646	1,126	1,766	1,269	5,807	232,228	16,769	1,557
Total (with payment for pain and suffering)	1,733	1,226	2,106	1,269	6,334	244,518	18,254	1,856

Source) Prepared from Tables 6-1 and 6-4 in Cabinet Office Director General for Policies on Cohesive "Report of the Survey on Economic Analysis on the Damage and Loss of Road Traffic Accidents, March 2012 (in Japanese)" (hereinafter Cabinet Office (2012))

Non-monetary Losses

Although non-monetary losses are categorized as below, only "victim himself/herself" is included in the loss amounts on the previous page.

Entity		Contents
Victim	Victim himself/herself	Pain, suffering, etc. that victim endures due to being in a traffic accident
	Friends and family of victim	Grief, etc. endured due to victim being in a traffic accident
Perpetrator	Perpetrator himself/herself	Decline in quality of life , etc. due to decreased credibility and unemployment of perpetrator due to having caused a traffic accident
	Family and friends of perpetrator	Grief, etc. endured due to perpetrator having caused a traffic accident
Third party		Grief, etc. that one feels through information stating that traffic accident has occurred

Source) Definitions from Cabinet Office (2012), p. 17

Loss Amounts by Personal Injury Level Used in This Analysis

Injury levels in the ITARDA's traffic accident data		Corresponding categories in Cabinet Office (2012)	Loss amount per victim (10,000 yen)	
			2012	2015
Death	→	Death	23,403	24,145
Serious injury	→	Injury with residual disability	1,747	1,802
Slight injury	→	Injury without residual disability	178	183

Source) The 2009 values established by the Cabinet Office (2012) are adjusted by using GDP-deflator.