

ITS WORLD CONGRESS 2017

Macro Impact of Autonomous vehicles

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- ◆ The views expressed in this PPT slides are the authors' own and do not reflect the view of SIP-adus.

- Autonomous vehicles will significantly change the cost and cost structure of vehicle. Japanese industry might be affected most heavily.
- It might take over three decade for fleet replacement rate by autonomous vehicle attain some 80%.
- In the case where the price of autonomous vehicle is low, autonomous vehicle might have negative impact to make city compact.



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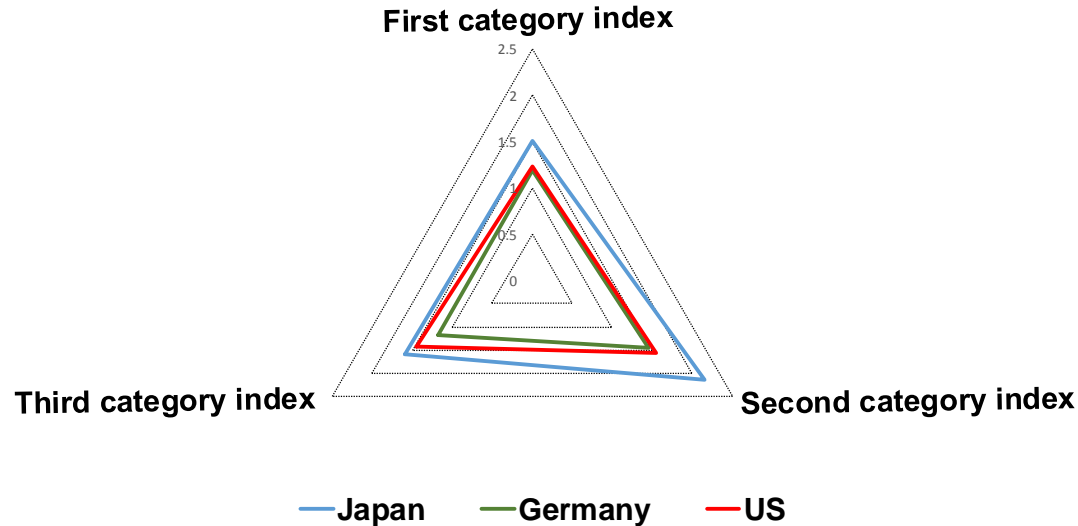
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**Industrial structural
changes caused by
autonomous vehicles**

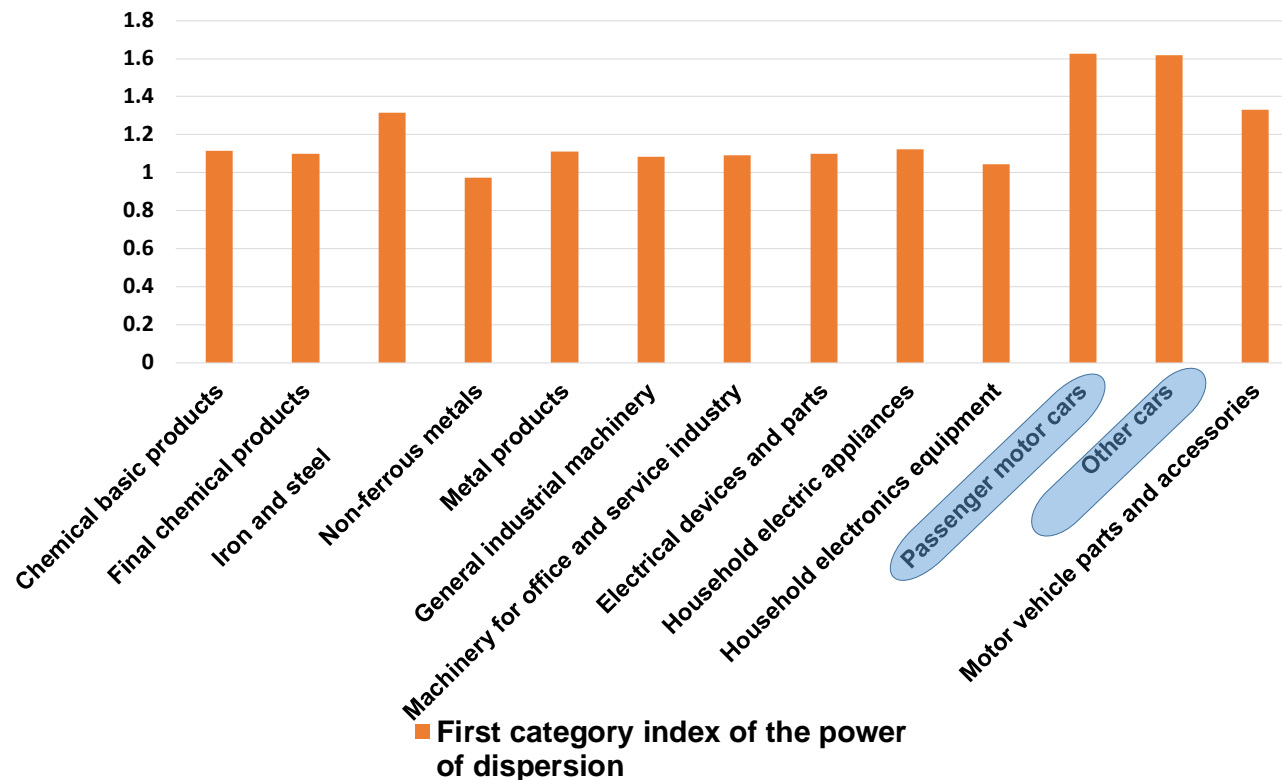
- ◆ Autonomous vehicles require a variety of special sensors, artificial intelligent software. This will significantly change the cost and cost structure of vehicle.
- ◆ Some experts claim that autonomous vehicles will results in decrease of vehicle sales and ownership due to further diffusion of vehicle sharing and ridesharing.
- ◆ These impacts are difficult to predict. Autonomous vehicle, however, should have a significant impact on industrial structure.
- ◆ Japanese industry might be affected most heavily.

Three categories of indexes are estimated using Leontief inverse matrix (domestic) .

- ◆ **First 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.



Hiroaki Miyoshi and Masanobu Kii, Macro Impact of Autonomous vehicles, Special Interest Session, ITS World Congress 2017, Montreal



Source) Prepared by author using Updated Input-Output Tables 2014, Ministry of Economy, Trade and Industry (METI), Japan



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**How long will it take for
autonomous vehicles to be
diffused to society?**

Draft – Please Do Not Quote or Circulate

- ◆ When discussing the effect from diffusion of autonomous vehicles, we should consider how long it will take for conventional vehicle fleet to be replaced by autonomous vehicles.
- ◆ The major determinants are fleet age structure, average life expectancy.
- ◆ It might take over three decade for fleet replacement rate by autonomous vehicle attain some 80%.

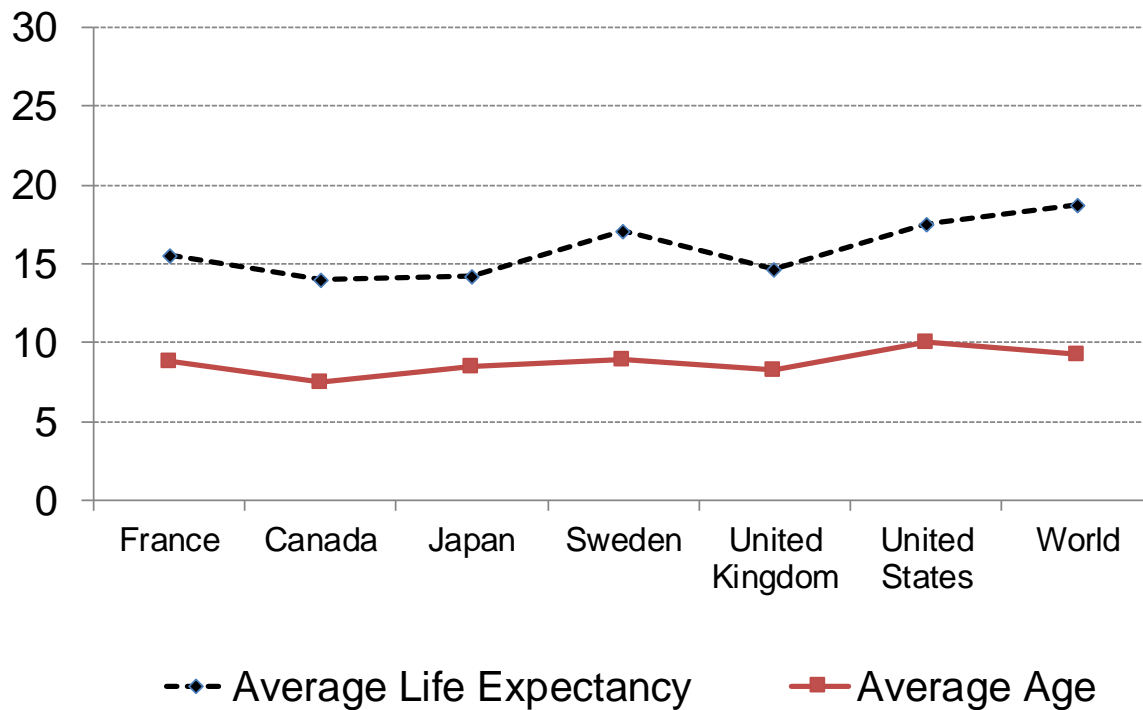
- ◆ The maximum number of years a vehicle may be used is 40.5 years,
- ◆ The rate at which vehicles are discarded obeys a Weibull distribution parameterized by the number of years of vehicle use dating from initial registration.
- ◆ The number of vehicles owned at the end of 2015 is a function of the number of vehicles sold over the past 41 years:

◆ Solving the following optimization:

$$\text{Minimize} \quad \varepsilon^2 = (Fleet_{2015} - Estimated_Fleet_{2015})^2$$

$$\begin{aligned} Estimated_Fleet_{2015} = & Sales_{2015} * \exp\left(-\left(\frac{0.5+0}{\eta}\right)^m\right) + Sales_{2014} * \exp\left(-\left(\frac{0.5+1}{\eta}\right)^m\right) + \\ & \dots + Sales_{1976} * \exp\left(-\left(\frac{0.5+39}{\eta}\right)^m\right) + Sales_{1975} * \exp\left(-\left(\frac{0.5+40}{\eta}\right)^m\right) \end{aligned}$$

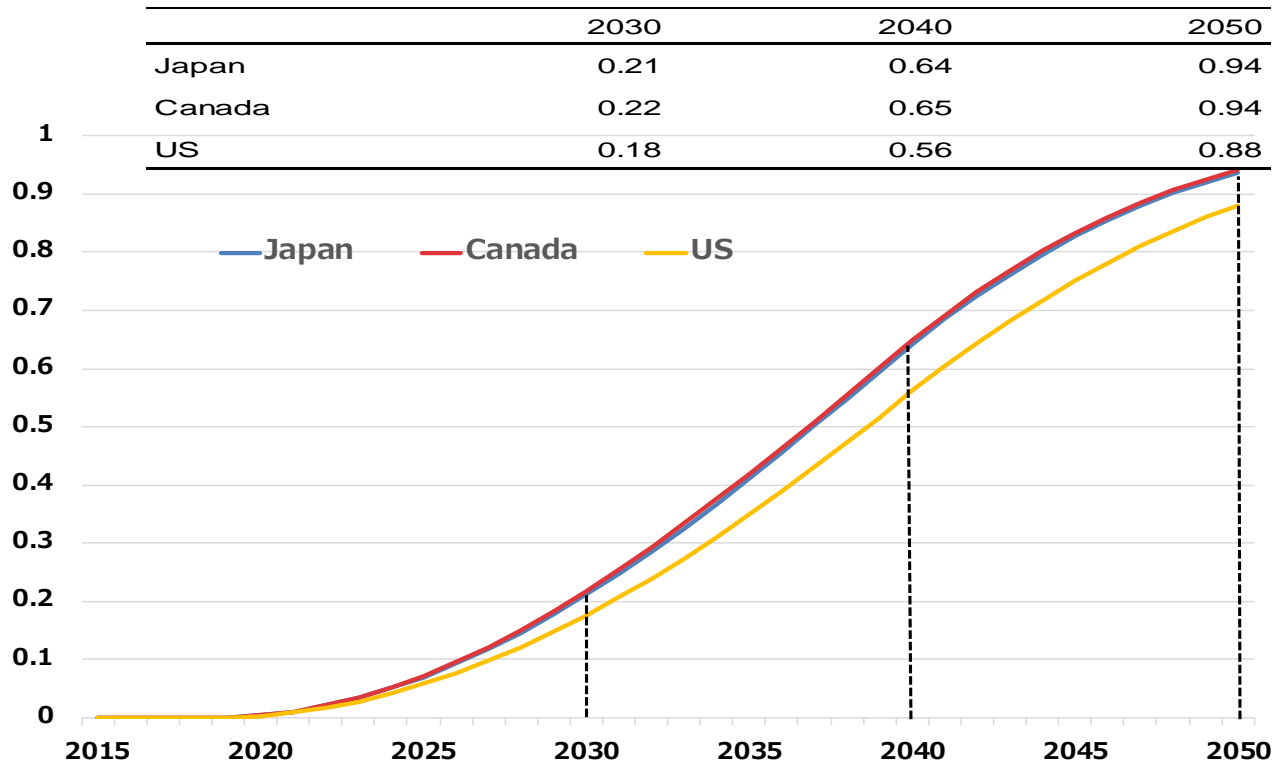
4-wheeled vehicle fleet



Source) Estimated by author

Note) Draft – Please Do Not Quote or Circulate

- ◆ Discarded vehicles are replaced by new cars,
- ◆ Autonomous vehicles are launched into the market in 2020,
- ◆ The ratio of autonomous vehicles to new cars attains 100% in and after 2040,
- ◆ The ratio of autonomous vehicles to new cars increases linearly from 2020 to 2040.



Source) Estimated by author

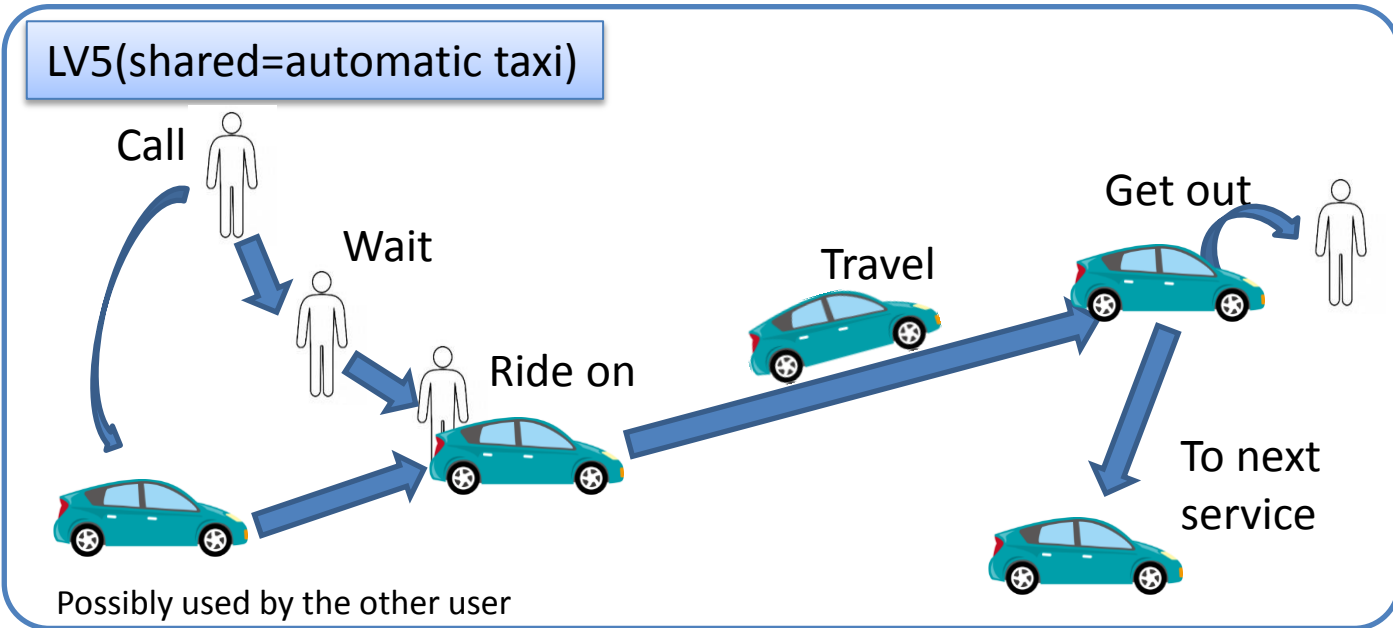
Note) Draft – Please Do Not Quote or Circulate



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Autonomous vehicles and urban structure

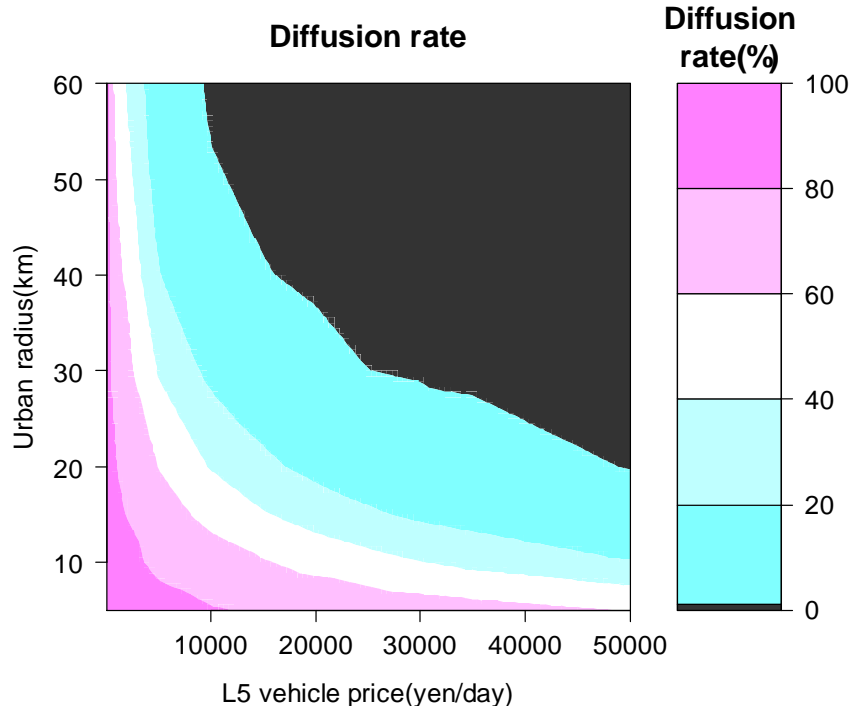
- ◆ In the case where the price of autonomous vehicle is high, autonomous vehicle might contribute to creating compact city.
- ◆ It is because autonomous vehicle diffuse only in compact city. It will induce people to move to the city.
- ◆ On the contrary, in the case where the price of autonomous vehicle is low, autonomous vehicle might have negative impact to make city compact.
- ◆ It is because autonomous vehicle diffuse also in wide-spread city.



Choice is based on “time” and “cost”

	Time	Cost
LV0	No waiting time	Owner bear full vehicle costs
LV5	Waiting time	Users share vehicle costs

- People live in circular shaped city and their residences are distributed uniformly in the urban space.
- Destinations are distributed uniformly over the urban space.
-> average travel distance is in proportion to urban radius.
- Travel demand is generated randomly over 24 hours (no peak hour is considered).



10,000yen \doteq 90USD
(at the rate of 110
Japanese Yen to USD)

Source) M. Kii, A. Yokota, Z. Gao and K. Nakamura, The Effect of Urban Conditions on Dissemination of Shared Fully-Automated Vehicle, *Papers of 54th Research Meeting on Civil Engineering Planning*, 2016 (In Japanese)

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Thank you