Japanese Fuel Economy Regulation Review

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1. Background of Fuel Economy Regulation (FER) Implementation

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3. Influence of FER in the Future to Calculate CAMPATH (CO2 Analysis Model for PAssenger car TecHnologies)

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Background of FER Implementation

- In Japan, around 20% of CO2 emission volume comes from the transportation sector.
- Automotive exhaust is around 90% of that.

Source: Ministry of the Environment
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Process of Japanese FER Implementation

Japanese regulations have been updated many times:

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<td>Cars</td>
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Source: Japan Automotive Manufacturers Association, Inc. (JAMA)
Recent Effects of FER Implementation

Implementation of regulations has led to improved fuel economy of both new cars and in-use cars.

New cars

In-use cars

Source: The Institute of Energy Economics, Japan
Automotive Makers’ Approach to Achieving FER

Automotive makers rapidly popularized improved fuel economy technologies.

**Improved Engine Efficiency**

- Gasoline Engine
  - Variable valve timing
  - 4-valve DOHC
  - Low friction
  - EFI
- Engine performance
- Environmental performance

**Improved Aerodynamics**

- Improved body configuration
- Gasoline Engine
  - Common rail (180MPa)
- Engine performance
- Environmental performance

**Reduced Vehicle Weight**

- Expanded use of lightweight materials
- Improved body structure

**Improved Drive System**

- Engine performance
- Integrated vehicle control
- 8AT
- DCT
- CVT
- 6AT
- Flex lockup
- Transmission control
- Environmental performance

**Reduced Rolling Resistance**

- Low rolling-resistance tires

**Other**

- Electric power steering
- Idling prevention
- Hybridization

Source: JAMA
Government-led Approach to Achieving FER

The Japanese government implemented tax credits for cars meeting FER.

<table>
<thead>
<tr>
<th>Fuel economy (F.E.)</th>
<th>Emissions</th>
<th>Low emission 4 stars</th>
<th>Source: JAMA</th>
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<tr>
<td>Cars achieving F.E. of 2015 regulations</td>
<td>Automotive tax: 50% reduction Acquisition tax: 60% reduction</td>
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<td>Cars achieving F.E. 10% higher than 2015 regulations</td>
<td>Automotive tax: 75% reduction Acquisition tax: 80% reduction</td>
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<td>Cars achieving F.E. 20% higher than 2015 regulations</td>
<td>Automotive tax: 100% reduction Acquisition tax: 100% reduction</td>
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Government-led Approach to Achieving FER

The Japanese government implemented a subsidy for eco-cars. (Hybrid cars, clean diesel cars and electric cars, etc.)

Source: JAMA
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Concept of the CAMPATH Model

CAMPATH: CO2 Analysis Model for PAssenger car TecHnologies

- JARI developed the CAMPATH model.
- This model was developed based on a multinomial logit model.
- CAMPATH calculates the number of in-use cars (Mini, Small, Middle, Hybrid), average fuel economy and CO2 emission by 2030.

\[
U_i = \alpha \times \frac{Cost_i}{Inc} + \beta \times \log(M_i) + \gamma \times Y_i \quad \cdots (1)
\]

\[
P_i = \frac{\exp(U_i)}{\sum(\exp(U_i))} \quad \cdots (2)
\]

- P: Penetration, i: Target car, U: Utility, Cost: Annual total cost
- Inc: Annual income, M: Number of model, Y: Year's type
- \(\alpha, \beta, \gamma\): Coefficient
Assumptions of our model
(Improving Fuel Economy for New Cars)

- This study has 2 cases: the "BaU Case" and the "Technology Advance Case".

![Graph showing improvement in fuel economy ratio with time. The x-axis represents years from 2010 to 2030, and the y-axis represents the improvement in fuel economy ratio. Two lines are plotted: one for "Advance" case and one for "BaU" case. The "BaU" case line is horizontal at 0.1, indicating no improvement, while the "Advance" case line shows a gradual increase from 2010 to 2030, reaching a peak around 2025.]

* BaU = Business as Usual
Results for the Number of In-use Passenger Cars

- Hybrid cars increase slightly every year and become over 10% of total cars.
- The share of each gasoline class will keep the current level in the future.
Results for Fuel Economy and CO2 Emission

- In the Advance Case, fuel economy of in-use cars is 75% higher in 2030 than the fuel economy of 2010.

- In the Advance Case, CO2 is reduced 47% by 2030 (Based on 2010).
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FER of Other Asian Countries

- **Korea**: Fuel efficiency targets implemented since the 1990s and updated in 2005. **New fuel efficiency targets will be adopted from 2015.**
  - Average fuel economy standards were 12.4 km/L for vehicles with 1500cc engines or less, and 9.6 km/L for engines greater than 1500cc displacement.
  - 17 km/L or 140 gCO2e/km (equivalent to 150 gCO2/km under the New European Drive Cycle) for model year 2015.

- **China**: FER has been implemented since 2005 and regularly updated. In addition, the 4th regulations are being considered.
  - FER of passenger cars is adopted under 3500kg of curb vehicle weight for gasoline and diesel vehicles. This FER sets a target of fuel economy of each class, and adopts CAFE (Corporate Average Fuel Economy).
  - Average fuel economy target of the 4th FER is 30% stricter than the 3rd FER.

- **India**: FER will be adopted from 2016.
  - Target fuel economy is calculated with a linear formula using curb vehicle weight.
  - FER adopts CAFE. FER is adopted under 3500kg of gross vehicle weight, under 9 person capacity, gasoline cars, diesel cars, LPG cars, CNG cars.

- **Thailand**: FER has been considered, based on exhaust emission regulations.
Comparison of FER of Asian Countries

This graph shows a comparison of latest FER in each country.

↑ Relaxed
18
16
14
12
10
8
6
4
2
0

↓ Strict
600
1100
1600
2100
2600

Fuel economy (L/100km)

Curb vehicle weight (kg)

Thailand
Japan (2010)
China (2012)
Japan (2020)
India (2016)
Four Approaches of Achieving FER in Japan

- **Implementation of a top-runner approach**
  - This approach has been to set a target based on the vehicle performance of the best current fuel economy.
  - Particular types of cars such as electric, plug-in hybrids and manual transmission cars are excluded from the top runners.

- **Fuel economy of ensuring consistency for each class**
  - Segmentalized so that competition will become fair in each category.

- **Implement CAFE approach**
  - By imposing obligation on each manufacturer, competition occurs between manufacturers to introduce advanced technologies.

- **Relatively loose penalties**
  - Purpose of the energy saving law is not to regulate manufacturers but to promote efforts by manufacturers to improve energy efficiency of each product.
  - Even if Fuel Economy Standards are not met, there is no immediate penalty.
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Conclusion

- In Japan, regulation of passenger cars and heavy duty cars is implemented and regularly updated, and has the effect of improving fuel economy. FER is achieved by the efforts of automotive makers and the government.

- The Japanese 2015 & 2020 FER have strict targets for gasoline cars and we need to popularize hybrid cars more. We also must implement more improving fuel economy technologies.

- In Asia, we have many environmental issues to consider, including the reduction of CO2. Implementing FER and popularizing next-generation vehicles are important. In addition, it is important to analyze any effects in the long term.

- JARI has been calculating CO2 emission for Asian countries. In the future, we hope you will join us in projects to use our knowledge and experience to create a healthy motorized society for us all.
Thank you for your attention.

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