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KITANO Taiju
Hitotsubashi University

Research Institute of Economy, Trade & Industry, IAA
The Research Institute of Economy, Trade and Industry
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KITANO Taiju†
Hitotsubashi University

Abstract

The US government criticized Japanese environmental policies, which promoted eco-friendly car (eco-car) purchases via measures such as tax exemptions and subsidies, as disguised forms of protection by arguing that the fuel economy standard for the subsidy qualification was designed to be more beneficial to domestic firms. This paper examines Japanese environmental policies from 2005-2009 to assess whether or not they were adequately formulated from an environmental perspective. The analysis compares the outcomes between the actual fuel economy standard for subsidy qualification introduced in Japan and an alternative standard suggested by the US government. Simulation results based on the structural econometric model of multi-product oligopolistic competition show that although both alternative and actual standards are comparable for the average fuel economy of new cars sold, the former is inefficient in improving the fuel economy because it requires much larger subsidies to achieve the same average fuel economy level as that of the latter.

Keywords: Discrete choice model, Micro moments, Disguised protection, Environmental policy, Car market
JEL Classification: F18; L62; Q56

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†2-1 Naka, Kunitachi-shi, Tokyo 186-8603, Japan. Email: kitano@iir.hit-u.ac.jp

1 Introduction

With increasing concern on the greenhouse gas emission from car use, a number of countries have introduced environmental policies that aim at diffusing low-emission and fuel-efficient automobiles. In Japan, the government has employed several forms of environmental policies, including tax incentives and subsidies for purchasing such eco-friendly cars (hereafter, eco-cars). Of all the Japanese environmental policies so far, the set of policies introduced in 2009 that included subsidies for purchasing eco-cars with scrap incentives had a significant impact on the market. As is shown in Table 1, for the first time since 1993, the average car age for existing passenger cars decreased in 2010, which is one year after the introduction of the policy.

Although environmental policies as those above will be useful in terms of resolving negative externality of car use,[1] trade experts often express concerns about the use of environmental policies as the secondary means of trade barriers. Indeed, in the case of the Japanese policies, the US Trade Representative (hereafter, USTR) criticized the policies as a case of disguised protection as the Japanese models were more likely to be qualified for the subsidy, while only a handful of the US models were qualified.[2] In particular, USTR saw a method to measure fuel economy as problematic and requested to modify the method to increase the number of the US car models that meet the fuel economy standard for the subsidy qualification.[3]

When and why do countries have the incentives to use their domestic policies (including environmental policies) as a disguised form of protection? Theories on the first best show that trade policies are the most efficient means for pursuing trade goals, such as terms of trade gains and domestic firms' competitive edge; while domestic policies, such as production taxes and subsidies, are the most efficient means for dealing with any production distortions (Markusen (1975)). However, when countries face difficulty in using the trade policies, they have the incentives to distort their domestic policies by reason of the terms of trade gain (e.g., Copeland (1990), Ederington (2001), and Ederington (2002)) and domestic firms' competitive edge (e.g., Barrett (1994), Conrad (1993), and Kennedy (1994)). In the presence of the World Trade Organization (WTO) system and the progress of the formation of free trade areas, countries have been facing pressure to lower tariff protections; thus, the case of disguised protection has been a real problem.[4] Note that it is natural to consider that

[1]See Parry, Walls, and Harrington (2007) for the survey on the externality on car use.

[2]See "Kirk Comments on Release of List of U.S. Autos Models That Qualify For Japan's Cash for Clunkers Program." http://www.ustr.gov/about-us/press-office/press-releases/2010/february/kirk-comments-release-list-us-autos-models-qualif

[3]In Section 2.3, I will explain the dispute on the fuel economy measurement more in detail.

[4]Note that the WTO does not allow nations to set their domestic policies freely. Under the National

the foreign government also has the incentives to distort other countries' policies for its own profits, in addition to the domestic countries' incentives to distort their policies. As is mentioned, the USTR proposed the alternative standard in order to expand the target of eco-car subsidy for the US car models; however, as it is evident, there is no reason why the alternative one is better than the actual one. Judging the validity of these competing standards is obviously an empirical task.

The purpose of this paper is to settle the dispute on the environmental policies in the Japanese car market. To achieve this goal, the analysis compares two different standards, the actual standard introduced in Japan in 2009 and the alternative standard suggested by the US government, and assesses which of these is more efficient with regard from an environmental perspective. I regard the average fuel economy of new cars sold in Japan as the indicator of environmental quality, which is a frequently used measure of the environmental quality criterion in the car markets, as is the case in the US Corporate Average Fuel Economy (CAFE) regulation. In the assessment, I implement counter-factual simulations based on a structural econometric model to obtain what would happen in the absence of the environmental policies and if the fuel economy standard was relaxed as the US government suggested. The model used in this paper is a standard oligopolistic competition framework (e.g. Berry, Levinsohn, and Pakes (1995)), i.e., a discrete choice model to estimate car demands and a multi-product oligopolistic competition model to recover an unobserved marginal cost for each car model. The structure of the demand model is static, but exploiting the recent development in the dynamic demand model (Adda and Cooper (2000) and Schiraldi (2011)), I allow consumers' choices to depend on the state of car ownership, i.e. the ages of cars that they own, in order to take the dynamic aspect of consumer behavior into account. In identifying the effects of car age, I incorporate micro moments based on the evolution of car age distribution, as in Petrin (2002).

Several studies have investigated car markets on the basis of structural econometric models and assessed environmental policies and trade policies independently. The literature on environmental policies includes studies that focus on the effects of Corporate Average Fuel Economy (CAFE) standards in the US (Goldberg (1998)), of replacement subsidy in France

Treatment (NT) principle, the member countries have to apply the same level of internal taxes and subsidies and other regulations to domestic-like foreign products. However, under the GATT Article XX, the WTO members can apply measures that may affect competition between domestic and foreign firms if the measures are related to the conservation of exhaustible natural resources. Note that the GATT XX does not mean that a government can frame its policies freely, even if they are environment-related. It only specifies that the policies cannot constitute means of "arbitrary or unjustifiable discrimination" and "disguised restriction on international trade." Therefore, although the Japanese environmental policies superficially aim at improving the environmental quality, they could go against the WTO rule if they are designed to promote domestic industries rather than to improve environmental quality.

(Adda and Cooper (2000)), of tax incentives on hybrid car demands introduced in the US (Beresteanu and Li (2011)), and of replacement subsidy in Italy (Schiraldi (2011)). The studies on trade policies include those on the effects of Voluntary Export Restraints (VER) against Japanese car imports to US in the 1980s (Berry, Levinsohn, and Pakes (1999)), of absolute and relative quotas in Europe (Goldberg and Verboven (2001)), of trade liberalization in used car markets in Cyprus automobile industries (Clerides (2008)), and of a safeguard introduced in the US motorcycle market (Kitano (2011)). In contrast to these, the current paper investigates the link between trade and environment, thus contributing to the theme on trade and environment disputes, which has been a focus of discussion under the WTO.[5]

Further, this paper provides additional empirical evidence on trade and domestic policy linkage. In particular, while previous studies usually focus on the impact of environmental regulations on trade flows at cross-industry level (Ederington and Minier (2003); Ederington, Levinson, and Minier (2005); Kellerberg (2009)), this paper investigates the effects of the environmental policy at an industry level.

The remainder of this paper is organized as follows. Section 2 describes the evolution of the Japanese environmental policies on car purchase and holding for fiscal years 2005–2009, and the US critique on these policies. Section 3 deals with the structural model of demand and supply. Section 4 introduces moment conditions used in Generalized Method of Moments (GMM) estimation, discusses the identification of the structural parameters, and shows the estimation results. Section 5 presents simulation results and reports the effects of environmental policies on Japanese firms. Section 6 concludes and outlines the direction for future research.

2 Environmental policies in the Japanese car market and the US critique

The Japanese car market, in which about 3 million passenger cars are sold annually, is the second largest market in the world, next to the US. Toyota is the largest Japanese car manufacturer, holding around 43% of market share, and Nissan and Honda are the second and third largest, with 17% and 15%, respectively, followed by Daihatsu, Mitsubishi, Mazda, Suzuki, and Subaru. More than 90% of the cars sold in Japan are Japanese; thus, the import cars are still less prevalent. In particular, the sales of the US manufacturers are around 4,000, and therefore, their share is tiny.

[5] In the following section, I introduce some related theoretical studies on the trade and environment in the literature of international trade. This paper is also relevant to the case of trade and environment in the WTO. (See Irwin (2009), Esty (1994) and Vogel (1997))

2.1 Environmental policies in the Japanese car market

Japanese government has employed environmental policies in promoting the sales of low-emission and fuel- efficient cars in order to meet the need for CO2 reduction. In this section, I explain the policies on passenger cars that were in effect from 2005 to 2009.[6]

2.1.1 Tax reduction

Car users in Japan need to pay various taxes at the stages of car purchase and ownership.[7] At the purchase stage, consumers need to pay 5% automobile acquisition tax on 90% of the car price[8] in addition to 5% consumption tax. At the ownership stage, consumers ought to pay tonnage and automobile taxes. The amount of the tonnage tax payments depends on car weights, at the rate of 6,300 JPY (ca. 70 USD[9])/500kg, while the automobile tax depends on the size of engine displacement; for example, the tax for cars with less than 1000 cc is 29,500 JPY, and that for cars with 1000–1500cc is 34,500 JPY. While consumers are required to pay the acquisition tax once at the time of car purchase, they need to pay the automobile and tonnage taxes every year.

The Japanese government has undertaken tax incentive measures in order to promote eco-cars. From fiscal year 2005 to 2009, cars that caused low emissions of Green House Gases (GHG) such as NOx and CO2, and those with fuel economy certifications were eligible for tax reduction, which was scale-dependent. From 2005 to 2008, the tax system was slightly revised over time, as is summarized in Table 2. The automobile tax was reduced by up to 50%, while the acquisition tax was reduced by up to 15,000 JPY for the gas car, and by up to 44% for the hybrid vehicle.[10]

On April 1, 2009, the government expanded the scope of tax exemption for eco-cars. Under the new tax system, the tonnage tax became a target of the tax exemption, and the amount of the automobile and acquisition tax reductions was increased; in particular, the taxes of hybrid vehicles were reduced by 100%, and that of the rest by 75% or 50%,

[6] The market structure and policy regarding Japanese car markets are well written in *The Motor Industry of Japan*, an annual publication of Japanese Automotive Dealers Association (JAMA).

[7] In addition to these taxes, consumers are subject to gasoline taxes at the usage stage. However, the gasoline tax is out of the scope of environmental policies.

[8] This rate is applied to new car purchases. The acquisition taxes for used cars that are outside the scope of this paper are varied according to car ages. Since this paper only focuses on the new car market, the acquisition tax rate can be set to 4.5% for no eco-car.

[9] 1 USD was approximately equal to 90 JPY at the end of 2009.

[10] As shown in Table 2, the incentives on the automobile taxes took the form of deduction. The maximum amount eligible for deduction is 300,000 JPY; thus, at the acquisition tax rate of 5%, the maximum amount of tax reduction was 15,000 JPY. During the period of this paper, the prices of all car models exceeded 300,000 JPY, so the amount of tax reduction should be 15,000 JPY for the car models that satisfied the criteria of eco-car in Table 2.

depending on the amount of the emissions and fuel economy.

The reductions of the automobile and tonnage taxes were not applied for all periods of car ownership. While the automobile tax reduction could be applied only for the first year of purchase, the tonnage tax reduction would be in effect for 3 years, i.e. a period between a time of purchase and the subsequent car inspection.[11]

2.1.2 Subsidy

In addition to the tax reduction, the Japanese government passed the "Green" Vehicle Purchasing Promotion Measures on May 29, 2009, in order to induce consumers to purchase new eco-cars. These measures went into effect on June 19, 2009, but was retroactive up to April 10, 2009. These measures aimed at further accelerating the reduction of CO2 emissions and improving fuel economy by providing incentives to scrap older, less fuel-efficient cars.

The program had two features: one for consumers replacing an older passenger car to a new eco-car ("replacement program") and one for those purchasing a new eco-car without an older car to replace ("non-replacement program"). In order to apply for the replacement program, consumers had to scrap a passenger car that had been first registered 13 years ago or earlier. Under the replacement program, these consumers were eligible for up to 250,000 JPY if they purchased new cars that comply with 2010 fuel economy standards, which are detailed in Table 3. On the other hand, the consumer could apply for the non-replacement program, which had no restriction on car scrapping; however, the target for the car to be eligible for the subsidy was more severe as it had to comply with ♠, as shown in Table 2. By using the non-replacement program, the consumer could get up to 100,000 JPY through subsidy.

The introduction of the subsidy policy had a great impact on car ownership in Japan. As shown in Table 1, after the introduction of the policy, the average car age for the existing cars in Japan turned around and decreased for the first time since 1993. The result indicates that the subsidy actually contributed to the consumers' car replacement behavior.

2.2 Subsidy qualification and the US critique

In principle, cars sold in Japan must have the information on their fuel economy measured based on the Japanese method under the Type Designation System. However, under Preferential Handling Procedure (PHP), import cars whose volume of sales is less than 2000

[11] Although the tonnage tax is placed on a yearly basis, it is levied only at the timing of car inspection. The first car inspection is held 3 years after new car purchases and thus the car owners have to pay the tax for three years at a time. Therefore, the tax reduction was applied to the tax payment at the time of purchase.

can be sold without the fuel economy information. The first critique posed by the USTR was the use of the information on the fuel economy measured based on the Japanese method as a premise of subsidy qualification. Since the most of US cars were imported under the PHP, they were out of the subsidy program because of the absence of the fuel economy information.

Upon the criticism, Japanese government modified its rule and opened its program to qualifying cars imported under the PHP. Under the modified rule, fuel economy measured in its home countries' method was used just the same as that under the Japanese method. In the case of the US cars, Japanese government used the US Environmental Protection Agency (EPA) "city" mileage rating as a criteria for qualification and then 8 of the US car models were eligible for the subsidy. This modification was once welcomed by the USTR, but it showed its disappointment because of the small number of US car models qualified. The USTR criticized the use of "city" mileage and requested the use of the EPA "combined" rating, the fuel economy based on the combination of the "city" driving program and the "highway" driving program, that ususally generate greater fuel efficiency. However, the Japanese government did not accept the USTR's request by arguing that the "city" mileage rating was similar to the Japan's official fuel economy based on 10-15 mode[12].

Note that although the original USTR request that was seemingly aiming at giving the US car models more advantage was problematic, it is still worth evaluating whether or not the Japanese fuel economy standard was set from an environmental perspective. In this paper, partially accepting the USTR request, I analyze what would happen if the fuel economy standard relaxed with respect to not only US car models but also all car models, as the USTR suggested. Based on this alternative standard for qualification, this paper assesses the validity of the Japanese standard from the environmental perspective[13].

3 Model

Here, I introduce the structural econometric model of demand and supply to assess the role of environmental policies on a market outcome. I employ a discrete choice method to model consumer behavior and a multi-product oligopolistic competition model to reveal firm behavior.

[12]The average of speed under the 10-15 mode driving test is 25.4 km/h, while that under "city" mileage is 32 km/h. See "From 10-15 to JC08: Japan ' s new economy formula" (http://cars.about.com/od/fueleconomyinfo/a/epa_mpg_testing.htm) for the detail of the calculation of 10-15 mode, and "How the EPA tests fuel economy" (http://cars.about.com/od/fueleconomyinfo/a/epa_mpg_testing.htm) for the detail of the calculation of the EPA methods.

[13]Detail of the assessment will be introduced in Section 5.2.

3.1 Demand

The demand model is closely related to Goldberg and Verboven (2001), which allows consumer choices to depend on their income in nested logit framework. Here, I follow the nested logit model but allow the choices to depend not only on income but also on the age of a car that each consumer owns.

I consider a household as a unit that makes a car choice. Under this assumption, market size M_t is the number of households in Japan at time t. Each unit chooses one alternative that gives the highest utility from $J_t + 1$ alternatives: J_t motorcycle models offered at time t, and an outside option representing the decision not to purchase new cars. The outside option includes the used car choice and keeping an existing car.

Consumer i's utility obtained from alternative j at time t is as follows.

$$u_{ijt} = v_{ijt} + \epsilon_{ijt}, \tag{1}$$

Here, v_{ijt} is the deterministic part of the utility obtained from product j and ϵ_{ijt} is a random part of the utility. For the utility obtained from the outside option, I normalize the deterministic part v_{i0t} to be zero. I further decompose v_{ijt} into two parts as follows.

$$v_{ijt} = \delta_{jt} + \mu_{ijt}, \tag{2}$$

where δ_{jt} is common to all consumers, and hence, is called the mean utility, while μ_{ijt} varies across individuals. The mean utility is specified as

$$\delta_{jt} = \mathbf{x}_{jt}\boldsymbol{\beta} + \xi_{jt}, \tag{3}$$

where $\mathbf{x}_{jt}$ is $1 \times K$ vector of characteristics of car j and $\boldsymbol{\beta}$ is $K \times 1$ vector of parameters to be estimated. ξ_j represents a characteristic and demand shock specific to the car j that are unobservable to researchers but observable to consumers and producers.

μ_{ijt} depends on individual characteristics, namely, consumer i's income y_{it}, car age a_{it}, and time t when the car was purchased.

$$\mu_{ijt} = -\alpha_{it}[(1.05 + T_{1jt})p_{jt} - S_{jt}(a_{it}) + T_{2jt}] + \gamma a_{it}, \tag{4}$$

where p_{jt} is the price of car j at time t, and $\alpha_{it} = \frac{\alpha}{y_{it}}$ is the price sensitivity of consumer i. Under this setting, high-(low-)income consumers are less(more) sensitive to car prices. T_{1jt} is an acquisition tax that is to be paid at the time of purchase in addition to the 5% consumption tax. T_{2jt} is a sum of tonnage and automobile taxes. Consumers are required to pay theses taxes at the time of car purchase, but I set T_{2jt} to be the amount of taxes that have to be paid at the time of purchase.[14] $S_{jt}(a_{it})$ is the subsidy for purchase and replacement of low-emission and fuel-efficient cars that came into effect from Apr. 2009, which is expressed as a function of the age of a car that the consumer i holds:

$$S_{jt}(a_{it}) = \begin{cases} 250000 & \text{if } a_{it} \geq 13, t = 2009, \text{ and the car } j \text{ meets fuel economy standards in Table 3,} \\ 100000 & \text{if } a_{it} < 13, t = 2009, \text{ and the car } j \text{ meets } \spadesuit \text{ in Table 2,} \\ 0 & \text{otherwise.} \end{cases} \tag{5}$$

The last term in eq.(4) means that the preference on the outside option depends on the car age.[15] If γ is positive, consumers who own older cars are more likely to replace their cars. The parameters to be estimated in μ_{ijt} are (α, γ).

ϵ_{ijt} represents taste heterogeneity on car models. I assume ϵ_{ijt} to follow generalized extreme value that allows substitution pattern of the cars to depend on the groups that they belong to. I classify all car models into 5 groups: compact, sedan & wagon, minivan, sports utility vehicle(SUV), and specialty cars. In addition, I also define the outside option as one group in the choice set. In total, all the alternatives that each consumer faces are categorized into 6 groups. Under this setting, the probability of consumer i choosing a car j at time t can be decomposed into the consumer's choice probability of the car j conditional on choosing a group $g(j)$, the group that the car j belongs to, $s_{ig(j)}$, $s_{ij/g(j)}$, and the probability of choosing group $g(j)$:

$$s_{ijt} = s_{ijt/g(j)} s_{ig(j)t}. \tag{6}$$

The first term in the above equation is given by:

$$s_{ijt/g(j)} = \frac{e^{v_{ijt}/\lambda}}{\sum_{l \in g(j)} e^{v_{ilt}/\lambda}} = \frac{e^{v_{ijt}/\lambda}}{e^{I_{ig(j)t}}}, \tag{7}$$

where

$$I_{ig(j)t} = \ln \left(\sum_{l \in g(j)} e^{v_{ilt}/\lambda} \right), \tag{8}$$

which is a logit inclusive value; that is, the expected utility obtained from choosing group

[14] The alternatives are to compute the discount value of the taxes or add a parameter on T_{2jt}.

[15] Recall that the deterministic utility of the outside option, v_{i0t}, is normalized to be zero.

$g(j)$. On the other hand, the second term in eq.(6) is given by

$$s_{ig(j)t} = \frac{e^{\lambda I_{ig(j)t}}}{e^{v_{i0t}} + \sum_{g \in G} e^{\lambda I_{ig}}}, \tag{9}$$

where $G = \{compact, sedan\&wagon, minivan, SUV, specialty\}$. Here, the utility obtained from the outside option is normalized to be zero.

λ is the distributional parameter of the nested logit and captures the pattern of dependency across products in the same group. To be consistent with random utility maximization, λ has to lie in between 0 and 1 (McFadden (1978)). In particular, if $\lambda = 1$, the nested logit structure reduces to a logit model, and thus, the substitution pattern among products becomes independent of the groups to which the products belong. On the other hand, if λ is close to zero, the dependency among products of the same group becomes stronger; at the extreme, the products in the same group become a perfect substitute.

Since the data is market-level data for each car model rather than individual-level data on car choices, I compute market share s_{jt} by integrating the individual choice probabilities of eq.(6) over income y_{it} and car age a_{it} distribution:

$$s_{jt} = \int_a \int_y s_{ijt} dP_y(y) dP_a(a), \tag{10}$$

where $P_y(\cdot)$ and $P_a(\cdot)$ are the distributions of income and car ages. I use the empirical distribution functions of income and car ages for each year to approximate the demographics of Japanese households. In constructing the empirical distribution, I assume that each household owns at most one car. Then, the data on the number of cars by car ages corresponds to the car age distribution for the households that own their cars in Japan. Note that this assumption is problematic because some households owns multiple cars in Japan. However, a significant fraction of households that have multiple cars own a combination of a standard-sized car ($\geq$ 660cc) and light car ($<$ 660cc), rather than multiple standard-sized cars. Since this paper focuses only on the market for standard-sized cars, the assumption of owning at most a single car is reasonable.

3.2 Multi-product oligopolistic competition

I now specify the supply side of the model to obtain marginal costs for each product, under the assumption that all manufacturers in the market compete in prices. The variable profit function of firm f is

$$\pi_{ft} = \sum_{j \in J_{ft}} \left[p_{jt} q_{jt} - c_{jt}(q_{jt}) \right], \tag{11}$$

where J_{ft} is the set of cars produced by firm f and $c_j(q_{jt})$ is a cost function of product j.

Solving this profit maximization problem, we have the following first order condition for each car model j:

$$\mathbf{mc}_t = \mathbf{p}_t - \boldsymbol{\Delta}_t^{-1}\mathbf{s}_t, \tag{12}$$

where $\mathbf{p}_t = (p_{1t}, \ldots, p_{J_t})'$, $\mathbf{s}_t = (s_{1t}. \ldots, s_{Jt})'$, and $\mathbf{mc}_t = (c'_1, \ldots, c'_J)'$. c'_j is the first derivative of c_j and, hence, a marginal cost of product j. Here, I assume that the marginal costs are constant over quantity. Figure 1.05 captures the 5% consumption tax in Japan. $\boldsymbol{\Delta}_t$ is a $\#J_t \times \#J_t$ matrix whose (j, r)th element $\Delta^*_{jrt} \times H_{jrt}$: Δ^*_{jrt} is an (j, r) element of $\#J_t \times \#J_t$ substitution matrix of the demand system; that is,

$$\frac{\partial s_{rt}}{\partial p_{jt}} = \begin{cases} \int_a \int_y \alpha_i(1.05 + T_{1jt}) s_{ijt} \left[\frac{1}{\lambda} - \left(\frac{1-\lambda}{\lambda}\right) s_{ijt/g(j)} - s_{ijt}\right] dP_y(y) dP_a(a) & \text{if } j = r \\ -\int_a \int_y \alpha_i(1.05 + T_{1jt}) s_{irt} \left[\left(\frac{1-\lambda}{\lambda}\right) s_{ijt/g(j)} + s_{ijt}\right] dP_y(y) dP_a(a) & \text{if } j \neq r, r \in g(j) \\ -\int_a \int_y \alpha_i(1.05 + T_{1jt}) s_{irt} s_{ijt} dP_y(y) dP_a(a) & \text{if } j \neq r, r \notin g(j); \end{cases} \tag{13}$$

and under the price competition assumption, H_{jrt} takes 1 if both j and r are produced by the same firm, and takes 0 otherwise.

Note that $\boldsymbol{\Delta}_t$ can be computed from the demand estimates. Hence, the (unobserved) marginal cost vector can be recovered from eq. (12). In the simulation analysis, I use the demand estimates and the marginal costs to obtain counterfactual outcome.

4 Estimation

This paper follows Petrin (2002), which uses micro moments based on the relationship between car choice and demographic variables, in addition to moment conditions proposed in Berry, Levinsohn, and Pakes (1995) (hereafter, BLP). Based on the two sets of moments condition, I implement a 2-step efficient generalized method of moments (GMM) estimation by Hansen (1982).

4.1 BLP's moments

BLP's moment assumption is on ξ_{jt}, which gives the first component of a GMM objective function. The problem here is that ξ_{jt} should be correlated with p_{jt} because the positive unobservable characteristics or demand shocks induce higher prices. To deal with this endogeneity problem, I use the following standard identification assumption: $E[\xi_{jt}|\mathbf{x}_{1t}, \ldots, \mathbf{x}_{\#J_t t}] = 0$ for all j. This assumption is justified if firms specify the observed characteristics of their car models before realizing ξ_{jt}. Given the identification assumption, the characteristics of all other products are valid instruments for prices because the pricing of each car model depends on the location of the model in the characteristic space: if the characteristic of the model is located in a crowded area in the characteristic space, the markup should be smaller, and vice versa.[16] Based on the assumption, I use the set of instruments similar to Goldberg and Verboven (2001): for $j \in J_{ft}$, (1) the sum of characteristic k of other products belonging to the same group, $\sum_{r\in\{g(j)\setminus j\}} x_{rkt}$, (2) the sum of the characteristic k of products belonging to other groups, $\sum_{r\in\{J_t\setminus g(j)\}} x_{rkt}$, and (3) the sum of the characteristic k of products belonging to the same group and made by the same firm, $\sum_{r\in\{J_{ft}\cap g(j)\}} x_{rkt}$.

Note that the mean utility for each car model δ_{jt} can be computed by BLP's contraction mapping, given the parameters in μ_{ijt}. Therefore, the first component of GMM objective function is a non-linear function of the parameters to be estimated.

4.2 Micro moments

Car age distribution shown in Table 4 depends on consumers' behavior of scrapping old cars and purchasing new or used cars. Since my structural model aims at revealing the replacement behavior of consumers according to car ages, the evolution of the car age distribution provides important clues to identify the structural parameters. Here, I introduce micro moments based on new car sales and the evolution of the car age distribution over time in order to identify the parameters on car age.

Let $n_{a,t}$ be the number of cars of age a at year t (see Table 4). The idea to construct the micro moments is to match the new car sales by car ages with the changes in car age distribution between two adjacent time periods, calculated as $n_{a,t} - n_{a-1,t-1}$. A larger $n_{a,t} - n_{a-1,t-1}$ implies that a majority of consumers who owned the cars of age $a-1$ scrapped at time $t-1$, while a smaller value implies that a majority chose to retain their cars. Since the large fraction of consumers who scrapped their cars are likely to make a replacement purchase, this information can be useful in identifying consumer behavior on new car choice by car ages.

The problem here is that those who scrap their old cars do not always purchase a new one. Some consumers may purchase used cars, while some others may make no replacement. The latter one does not matter so much because it is known that the consumers who scrap their cars but do not replace them with newly purchased cars are a tiny fraction of the population. To deal with the former one, I assume that the ratio of new car sales to all car

[16] See Bresnahan, Stern, and Trajtenberg (1997) for the discussion on the justification of the instruments.

sales is same for all car ages. Let ρ_t to be the ratio; that is,

$$\frac{\text{Total new car sales}}{\text{Total new car sales} + \text{Total used car sales}}. \tag{14}$$

If car owners purchase new cars only when they scrap their cars, the micro-moment condition can be made by matching the predicted new car sales for car age t with $\rho_t(n_{a,t} - n_{a-1,t-1})$. Obviously, this premise is not always true because some consumers purchases new cars without scrapping, but with selling the old cars in a used car market. However, this option is less feasible for consumers who own older cars that are estimated at a negligible value in the market. Here, I consider 10 years of age is sufficiently large, and thus I can use three moment conditions as follows:

$$\begin{aligned} &E\left[i \text{ purchases new vehicle}|a < a_i < a+1\right] = \rho_t(n_{a,t} - n_{a-1,t-1}), a = 11, 12 \\ &E\left[i \text{ purchases new vehicle}|13 < a_i\right] = \rho_t(n_{a,t} - n_{a-1,t-1}), \end{aligned} \tag{15}$$

4.3 Data

The dataset used in this paper covers fiscal years 2005–2009. I constructed the dataset based on several independent sources. Price and characteristics data for each automobile model are obtained from the *Saishin Kokusan & Yunyuu-sha Konyuu Guide* (*Current Domestic & Import Cars Purchase Guide*), published by the JAF publishing. Quantity sold for each automobile model is obtained from *Jidousha Touroku Tokei Jouhou: Shinsha-hen* (*New Car Registration Statistics*), published monthly by Japan Automobile Dealers Association. This paper focuses only on the standard-sized cars (>660cc). In addition, I use only the data on Japanese cars, and not on the imported cars. As is mentioned in Section 2, the share of import cars has been tiny in the Japanese car market, and thus the effects of the policies on the environment can be obtained even though the analyses are based only on the Japanese car models. Of course, it is desirable to directly assess the effects on imported cars, detailed information on them is unavailable[17].

Moreover, I collected the information on the individual characteristics distribution: the number of cars by car ages from *Sho-do Touroku Nen-betsu Jidousha Hoyuu Sharyou-suu Toukei* (*Number of Vehicle holdings by first registration years*), published annually by Automobile Inspection & Registration Information Association, and income distribution from *Kokumin Seikatsu Kiso Chosa* (*Comprehensive Survey of Living Conditions of the People on Health and Welfare*), released annually by the Ministry of Health, Labor and Welfare.

In order to compute ρ_t in the micro moments, I also collected the numbers on used car

[17]In particular, the quantity for each import car models are unavailable.

sales from *Jidousha Touroku Tokei Jouhou: Chukosha-hen* (*Used Car Registration Statistics*), published monthly by Japan Automobile Dealers Association.

4.4 Estimation results

In addition to the model introduced in Section 3, I also implement standard demand estimation based on a standard nested logit framework as in Berry (1994). The estimation equation is as follows:

$$\ln(s_{jt}) - \ln(s_{0t}) = \delta_{jt} - \alpha p_{jt} - (1-\lambda)\ln(s_{jt/g(j)}). \quad (16)$$

In the estimation of the standard nested logit, I do not directly include the volume of tax reduction and subsidy, but include a dummy variable for eco-car, which takes 1 if the car is eligible for tax reduction or subsidy and 0 otherwise, to see the effects of the environmental policies.

First, I implement the estimation of the standard nested logit by OLS and GMM to see whether the bias in parameter estimates are corrected by instrumenting. The data used in the estimation is summarized in Table 5. There are two endogenous variables, that is, price p_{jt} and the log of conditional share $\ln(s_{jt/g(j)})$. As is mentioned before, the price and unobserved characteristics are positively correlated; thus, the price coefficient should be upwardly biased. In addition, positive (negative) ξ_{jt} induces higher share within the group where product j belongs: given positive correlation between ξ_{jt} and $s_{jt/g(j)}$, the estimate of λ should be downwardly biased. As is shown in Table 6 (i) and (ii), the price coefficient $-\alpha$ and λ get lower after instrumenting. The coefficients on the car characteristics are also reasonably estimated; for example, the coefficient on car size and fuel cost takes positive and negative value, respectively. In particular, the coefficient on the eco-car dummy variable is positive, suggesting that the environmental policies had positive impacts on the car demand.

Now, I turn to the results of the estimation with individual characteristics, namely, income and car age. I implement the estimations with and without micro moments. The estimation results are summarized in Table 6 (iii) and (iv). First of all, price coefficient $-\alpha$ is negative and significant for both specifications. λ lies in between 0 and 1, and thus, the estimation results are consistent with random utility maximization problem. In particular, as the estimate of λ is significantly different from 1, the results indicate that the substitution pattern among products depends on the groups to which the products belong. The coefficients on car characteristics also have a reasonable sign.

The estimation results also show the effects of car ages on the consumers' car choices: a consumer who owns an older car is more likely to replace his car. Note that the estimate of γ is significant in the estimation with micro moments, while it is not significant in the estimation without micro moments. The results suggest that incorporating micro moments plays an important role in identifying the parameters.

5 Simulation

Based on the estimates, I now implement counterfactual simulation to assess the effects of the environmental policy in Japan. Further, I investigate the possibile consequences of the Japanese government, following the suggestion of the US government, expanding the scope of eco cars that are eligible for the subsidy.

5.1 Effects of the environmental policies on the Japanese car market

Here, I investigate the effects of the environmental policies on the market outcome. I simulate counterfactuals in the absence of the environmental policies: no tax exemption and no subsidy.[18] Then, I focus on the effects of these policies on the firms' profits and the average fuel economy of new car sales.

The effects on the firms' profits are summarized in Table 7. As shown in the table, the firms that gained large benefits from the environmental policies are Honda and Toyota. This is because Honda and Toyota produce a larger number of car models equipped with the hybrid engine, such as Prius, whose purchase the government particularly supported.

Table 8 shows the effects of the environmental policies on the average fuel economy of new cars. As is shown in the table, the effects on the average fuel economy are unsubstantial from 2005 to 2008. However, the changes in the policy in 2009 had a large impact on the average fuel economy: the average fuel economy was improved by about 2.4%.

5.2 Disguised protectionism?

The environmental policies of Japan have been criticized by US car manufacturers because they are designed to be more beneficial to Japanese firms. Although the Japanese government, upon USTR's request, modified the subsidy qualification for imported cars, USTR has continued to criticize the fuel economy measurement employed by the Japanese

[18] In implementing simulation, I assume the car ages distributions in the counterfactual to be the same as in the actual. The assumption is problematic because changes in new car sales in one year should change the car age distribution in the following years. In future analysis, I would like to account for the changes in distribution in the simulation.

government for the provision of the subsidy and requested the expansion of the scope of subsidy provision.

As is mentioned in Section 2.3, the original request by the USTR was the change of the fuel economy measurement only with respect to the US car models. This is obviously nonsense, and in this paper, I assess what would happen if the fuel economy standard for all car models (incl. Japanese car models) was relaxed as the USTR suggested. With regard to this, I consider a situation in which the target fuel economy standard is lowered by 10%. The reasoning behind this calculation is as follows. Japan's calculation of the fuel economy was based on 10–15 mode fuel economy, under which the ratio of driving on ordinary street (10 mode) to driving on express way (15 mode) is set at 3:1, while the one proposed by the US was EPA "combined" rating in which "city" fuel economy and "highway" fuel economy are almost equally weighted. In this analysis, I treat fuel economy based on 10 mode as "city" and 15 mode as "highway"[19]. Since the fuel economy on the express way is less than that on an ordinary street by about 50%,[20] the fuel economy would be declined by about 10% compared to the current calculation if the standard proposed by the US is applied. Based on this assumption, I construct a new set of cars that are applicable to subsidy and assess the impacts of average fuel efficiency of new car sales. The analysis focuses on the effects in 2009, when foreign manufacturers criticized the environmental policies of the Japanese car market. Note that because of the data limitation, this paper analyzes the effects on Japanese car models but not on foreign car models. However, since the car sales by Japanese firms has been accounted for a majority of the car sales in Japan[21], the effects of the policies on the environment would not be much different from the overall effects.

Table 9 shows the effects of the changes in the fuel economy standard on the firms' variable profits. Since the alternative standard expands the range of the car models that meet the requirements of subsidy, most firms see an increase in their profits. However, Suzuki and Subaru see a slight reduction in their profits. This is because the car models that compete against the car models of Suzuki and Subaru becomes a target of the subsidy under the alternative standard.

Thereafter, I calculate the effects of the alternative standard on the average fuel economy of the newly sold cars. In particular, I focus on the amount of subsidy required to improve the average fuel economy of new car sales by 0.1km/l to see the efficiency of the subsidy

[19] This assumption should be problematic because these pairs are not good match for each other. See footnote 12 in this regard.

[20] Before 10–15 mode, Japan's fuel economy calculation was based on 10 mode, which only uses the fuel economy on the ordinary street. After the change in the mode, several fuel economy standards were modified accordingly. I use this information to calculate the difference between fuel economies of an ordinary street and an express way.

[21] See Section 2.

policy in terms of improving fuel economy. The first row in Table 10 shows the result of the effects on average fuel economy. Since the alternative standard expands the range of the eco-car, the average fuel economy under the alternative standard is lower than that under the actual standard. Although the decrease in the average fuel economy is tiny, the alternative standard is inefficient in improving the average fuel economy, as shown in the second row in Table 10: it requires 44.731 billion JPY($\approx$ 0.473 billion USD[22]) under the actual standard, in order to improve the average fuel economy by 0.1km/l, while it requires 48.007 billion JPY ($\approx$ 0.507 billion USD) under the alternative standard.

Note that since the alternative eco-car certification expands the target of eco-cars, it increases the number of car replacements compared to the actual one. Thus, it might be effective in terms of improving the fuel economy by inducing more replacements. However, the simulation results indicate that the alternative eco-car certification system increases the sales by 6465, which is amount to merely 0.238% of total car sales in Japan. Nonetheless, the budget for the subsidy was limited. Under the budget constraint, the subsidy policy would have lasted longer than the alternative one; thus, the effects on quantity should not be emphasized heavily. Given these considerations, it is reasonable to conclude that the actual standard is more efficient in terms of achieving environmental goals.

6 Conclusion

This paper examines the Japanese car markets to assess the impacts of environmental policies on the market outcome. Based on the structural econometric model of demand and supply, this paper assesses the environmental policies introduced in the Japanese car market. In the estimation of demand, I incorporate the micro moments in order to identify the effects of the car age on the automobile replacement.

This paper shows that the environmental policies had a large impact on the firms' profits. In particular, Honda and Toyota significantly earned from the environmental policies. Although the policy improved the average fuel economy of newly sold cars by only a little from the fiscal years 2005 to 2008, the revised policy introduced in 2009 has a large impact on the average fuel economy. In order to investigate whether or not the Japanese environmental policies were the case of disguised protection, I further investigate the alternative standard for the eco-car certification suggested by the USTR. This simulation results show that although the effects on average fuel economy under the alternative fuel economy standard is comparable to that under the actual, the alternative is inefficient in terms of improving

[22]This is based on an average exchange rate in 2009: 1 USD = 94.65 JPY. I use this rate in the following conversion.

fuel economy: it requires much larger amount of subsidy in order to achieve the same fuel economy level. Therefore, the set of environmental policies introduced in 2009 has some rationale compared to the alternative one.

A few limitations of this paper should be noted. First, the analysis conducted in this paper is insufficient because the assessment was not based on the comparison between the actual and optimal policies; the policy that achieves the lowest average fuel economy was not determined. If the policies were set for domestic firms' profits rather than for achieving environmental goals, they should be regarded as disguised protection. Second, although this paper focused on the average fuel economy of new cars sold, there are other cars that need to be assessed. Further, the average fuel economy of all existing cars should be better than the that of the new cars sold. The investigation of an ideal car shows welfare effects for both miles driven and the consequent volume of CO2 emission.

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Table 1: Average Car Age, 1990–2010

Year	Average Car Age
1990	4.40
1991	3.67
1992	3.14
1993	2.93
1994	2.94
1995	3.07
1996	3.28
1997	3.53
1998	3.90
1999	4.37
2000	4.82
2001	5.22
2002	5.63
2003	6.03
2004	6.38
2005	6.66
2006	6.89
2007	7.14
2008	7.26
2009	7.49
2010	7.48

Table 2: Tax Incentives, Fiscal Years 2005–2009

FY 2005		Gas Vehicle		Hybrid Vehicle
		Fuel Economy Certification		
		Performing 4% better or more compared to to 2010 target fuel economy standards	Meeting 2010 target fuel economy standards or better	2010 target fuel economy standards +25%
Environmental Performance Certification	Emissions down by 75% from 2005 standards	Automobile Tax: 50% reduction Acquisition Tax: 300000 JPY deductible Tonnage Tax: None	Automobile Tax: 25% reduction Acquisition Tax: 200000 JPY deductible Tonnage Tax: None	Automobile Tax: 50% reduction Acquisition Tax: 44% reduction Tonnage Tax: None
	Emissions down by 50% from 2005 standards	Automobile Tax: 25% reduction Acquisition Tax: 200000 JPY deductible Tonnage Tax: None	None	-

FY 2006		Gas Vehicle		Hybrid Vehicle
		Fuel Economy Certification		
		2010 target fuel economy standards +20%	2010 target fuel economy standards +10%	2010 target fuel economy standards +25%
Environmental Performance Certification	Emissions down by 75% from 2005 standards	Automobile Tax: 50% reduction Acquisition Tax: 300000 JPY deductible Tonnage Tax: None	Automobile Tax: 25% reduction Acquisition Tax: 150000 JPY deductible Tonnage Tax: None	Automobile Tax: 50% reduction Acquisition Tax: 44% reduction Tonnage Tax: None

FY 2007		Gas Vehicle		Hybrid Vehicle
		Fuel Economy Certification		
		2010 target fuel economy standards +20%	2010 target fuel economy standards +10%	2010 target fuel economy standards +25%
Environmental Performance Certification	Emissions down by 75% from 2005 standards	Automobile Tax: 50% reduction Acquisition Tax: 300000 JPY deductible Tonnage Tax: None	Automobile Tax: 25% reduction Acquisition Tax: 150000 JPY deductible Tonnage Tax: None	Automobile Tax: 50% reduction Acquisition Tax: 40% reduction Tonnage Tax: None

FY 2008		Gas Vehicle		Hybrid Vehicle
		Fuel Economy Certification		
		2010 target fuel economy standards +25%	2010 target fuel economy standards +15%	2010 target fuel economy standards +25%
Environmental Performance Certification	Emissions down by 75% from 2005 standards	Automobile Tax: 50% reduction Acquisition Tax: 300000 JPY deductible Tonnage Tax: None	Automobile Tax: 25% reduction Acquisition Tax: 150000 JPY deductible Tonnage Tax: None	Automobile Tax: 50% reduction Acquisition Tax: 36% reduction Tonnage Tax: None

FY 2009		Gas Vehicle		Hybrid Vehicle
		Fuel Economy Certification		
		2010 target fuel economy standards +25%	♠2010 target fuel economy standards +15%	♠2010 target fuel economy standards +25%
Environmental Performance Certification	Emissions down by 75% from 2005 standards	Automobile Tax: 50% reduction Acquisition Tax: 75% reduction Tonnage Tax: 75% reduction	Automobile Tax: 25% reduction Acquisition Tax: 50% reduction Tonnage Tax: 50% reduction	Automobile Tax: 50% reduction Acquisition Tax: 100% reduction Tonnage Tax: 100% reduction

Note: All the consumers can obtain subsidy when purchasing the cars that satisfy ♠.

Table 3: 2010 Target Fuel Economy Standards (km/l)

Weight	Fuel Economy Standards	Fuel Economy Standards+10%	Fuel Economy Standards+15%	Fuel Economy Standards+20%	Fuel Economy Standards+25%
– 703kg	21.2	23.3	24.4	25.4	26.5
703–828kg	18.8	20.7	21.6	22.6	23.5
828–1016kg	17.9	19.7	20.6	21.5	22.4
1016–1266kg	16.0	17.6	18.4	19.2	20.0
1266–1516kg	13.0	14.3	15.0	15.6	16.3
1516–1766kg	10.5	11.6	12.1	12.6	13.1
1766–2016kg	8.9	9.8	10.2	10.7	11.1
2016–2266kg	7.8	8.6	9.0	9.4	9.8
2266kg–	6.4	7.0	7.4	7.7	8.0

Table 4: Car age distribution, 2005–2010 (Number of cars according to age)

Car age	2005	2006	2007	2008	2009	2010
1	1022998	1000633	893269	903196	631084	884592
2	3360166	3323627	3089041	2899000	2753322	2618982
3	3371919	3344078	3305518	3066885	2883932	2738161
4	3384903	3301118	3273161	3222259	3006745	2826529
5	3380193	3337076	3247963	3209111	3172801	2972044
6	3287717	3272803	3230018	3126308	3118174	3095997
7	3105332	3184605	3163291	3104485	3021215	3057364
8	3209156	2952492	3029445	2983129	2966970	2928299
9	3548638	3074905	2829798	2895774	2857176	2884513
10	3380220	3279890	2854238	2626986	2720941	2698472
11	2822653	3053283	2999782	2614486	2419562	2554663
12	2287247	2459407	2702221	2642966	2323367	2181251
13+	6615036	7163363	7611664	8174404	8923956	8978053

Source: *Sho-do Touroku Nen-betsu Jidousha Hoyuu Sharyou-suu Toukei* (English translation: *Number of Vehicle holdings by year of first registration*), Automobile Inspection & Registration Information Association.
Note: The figures in the table are the number of cars at the beginning of a fiscal year. The figure of car age 1 is the number of cars that is registered only from Jan–Mar for each year, and thus, is smaller than the figure for the other car ages. The figure of car age 13+ is the number of cars that registered more than 13 years ago.

Table 5: Summary Statistics

Variables	Mean	Std. Dev.
Sales	23481	30418
Price (in mil. JPY)	2.5134	1.3849
Car Size = Length*Width*Height (m^3))	3.8688	1.168
HP (ps)/Weight(1000kg)	8.1242	2.4121
Engine Displacement (1000cc)	2.111	0.8301
Wheelbase (m)	2.669	0.1894
Fuel Cost = Gasoline Price(JPY)/Fuel Economy(km/l)	10.336	2.9627
Eco-car dummy	0.1369	0.3438
Num. of Obs.	577	

Table 6: Estimation results

	Standard Nested Logit (Linear Model)						Nested Logit with Individual characteristics					
	(i) OLS			(ii) GMM			(iii) No micro moments			(iv)Micro moments		
Variables	Coef.	S.E.		Coef.	S.E.		Coef.	S.E.		Coef.	S.E.	
Car Size	0.377	0.047	***	0.299	0.058	***	0.349	0.049	***	0.349	0.056	***
HP/Weight	-0.009	0.026		0.085	0.034	**	0.149	0.061	**	0.147	0.083	*
Engine Displacement	0.204	0.094	**	0.266	0.157	*	0.640	0.174	***	0.836	0.249	***
Wheelbase	0.598	0.234	**	0.819	0.340	**	1.274	0.325	***	1.474	0.453	***
Fuel Cost	-0.220	0.018	***	-0.191	0.023	***	-0.153	0.022	***	-0.189	0.020	***
Eco-car dummy	0.254	0.072	***	0.762	0.104	***	-	-		-	-	
Constant	-7.580	0.553	***	-11.051	0.852	***	-11.329	0.628	***	-10.833	0.852	***
$-\alpha$	-0.103	0.057	*	-0.471	0.151	***	-13.622	2.402	***	-15.987	2.402	***
λ	0.597	0.025	***	0.892	0.040	***	0.806	0.002	***	0.804	0.002	***
γ	-	-		-	-		-0.01	0.042		0.041	0.020	**
$R^2/J-stat$ (dof)	0.63			36.25(16)			14.22(16)			16.45(16)		

Table 7: Effects on variable profits of firms (in mil. JPY)

	(i) Actual Variable Profits				
	2005	2006	2007	2008	2009
Daihatsu	6013	9777	4721	3185	3051
Honda	272850	229038	233828	212787	273539
Mazda	109161	95844	92042	74949	79214
Mitsubishi	45642	40923	47630	29618	38611
Nissan	374857	298110	284993	241613	255577
Subaru	77147	58541	50283	44348	47734
Suzuki	39019	40465	40609	38468	28460
Toyota	1083195	1027185	1000488	865932	1052414
Total	2007884	1799883	1754594	1510900	1778601

	(ii) Counterfactual: No Environmental Policy				
	2005	2006	2007	2008	2009
Daihatsu	5581	9130	4448	2986	2772
Honda	239149	200863	206632	186431	200567
Mazda	97324	85135	82698	69511	71668
Mitsubishi	40556	36370	43189	26693	33538
Nissan	338932	267933	257233	219441	216363
Subaru	74390	55583	47560	41420	44213
Suzuki	34949	35698	37249	34402	23942
Toyota	981522	927235	911125	781504	846552
Total	1812403	1617947	1590134	1362387	1439615

	(iii) Effects of the Environmental Policies: (i)–(ii)				
	2005	2006	2007	2008	2009
Daihatsu	433	647	273	199	279
Honda	33701	28174	27196	26356	72973
Mazda	11837	10710	9345	5439	7546
Mitsubishi	5086	4553	4441	2925	5073
Nissan	35925	30176	27760	22172	39214
Subaru	2757	2959	2723	2929	3521
Suzuki	4070	4767	3359	4066	4518
Toyota	101673	99950	89363	84428	205862
Total	195481	181936	164460	148513	338986

	(iv) Rate of Change				
	2005	2006	2007	2008	2009
Daihatsu	7.75	7.08	6.14	6.65	10.08
Honda	14.09	14.03	13.16	14.14	36.38
Mazda	12.16	12.58	11.30	7.82	10.53
Mitsubishi	12.54	12.52	10.28	10.96	15.13
Nissan	10.60	11.26	10.79	10.10	18.12
Subaru	3.71	5.32	5.73	7.07	7.96
Suzuki	11.65	13.35	9.02	11.82	18.87
Toyota	10.36	10.78	9.81	10.80	24.32
Total	10.79	11.24	10.34	10.90	23.55

Table 8: Effects of Actual Standard on Average Fuel Efficiency

	Actual(km/l)	Counterfactual(km/l)	Difference	Rate of Change(%)
2005	15.686	15.665	0.022	0.137
2006	15.938	15.906	0.032	0.202
2007	16.414	16.359	0.055	0.335
2008	17.054	17.018	0.036	0.212
2009	19.234	18.785	0.449	2.388

Table 9: Effects of the change in the fuel economy standard (in mil. JPY)

	(i) Actual	(ii) Counterfactual: Alternative eco-car certification	Effect of Subsidy	Rate of Change
Daihatsu	3051	3081	29	0.95
Honda	273539	273542	2	0.00
Mazda	79214	79411	198	0.25
Mitsubishi	38611	38644	33	0.08
Nissan	255577	255756	178	0.07
Subaru	47734	47636	-98	-0.21
Suzuki	28460	28404	-56	-0.20
Toyota	1052414	1055571	3157	0.30
Total	1778601	1782044	3443	0.19

Table 10: Effects of the actual and the alternative standards

	Actual standard	Alternative standard
Average Fuel Economy (km/l)	19.234	19.213
Effects of subsidy on average fuel economy (km/l)	0.449	0.427
Subsidy required to improve the average fuel economy by 0.1 km/l (bil. JPY)	44.731	48.007