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Measuring the effect of the infant industry protection
The Japanese Automobile Industry in 1955-1965

by Masato Nishiwaki

Measuring the effect of Infant Industry Protection:The Japanese Automobile Industry in 1955-1965*

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Abstract

This paper examines the Japanese automobile industry to measure the effect of import restriction policy for infant industry. Import restriction policy can provide large amount of domestic demand for producers and help them to acquire the experience of production. It has been said to be a key driving force of the dramatic growth of the Japanese automobile industry. Compared with a subsidy policy, however, an import restriction causes some types of distortions. Conducting the counterfactual exercise, I explore what it would have happened if instead the optimal subsidy had been provided to Japanese automakers. This exercise measures the welfare effect of an actual restriction policy in terms of an optimal one. That is, it quantifies how close the welfare level of the actual policy was to the level of the optimal subsidy policy. From the experimental exercise, I find the fact that the import restriction reached to only 55 percent of the optimal welfare level.

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1 Introduction

The Japanese automobile industry has been the icon of Japan's dramatic economic success since the end of the Second World War. In the last half of the century Japanese automakers have experienced an explosive growth and gained global recognition. The success of Japanese automakers has been drawing a great attention from many developing countries, and policy makers of these countries have been seeking the reason for this unprecedent success.

It has been said that governmental intervention was a driving force of the growth of the Japanese automobile industry. To protect domestic automakers, the Japanese government restricted import cars and also imposed tariffs heavily on them just after the Second World War. Particularly, during 1954-1965, a severe import restriction on the passenger's vehicle was applied. Under this protection, Japanese automakers have acquired the experience of producing passenger's cars and by the end of protection, they became competitive enough against foreign counterparts.

On the other hand, import restriction and tariff are not a welfare maximizing policy. Without any obstacles, some production subsidy policies are theoretically more desirable than any other policies. In fact, however, due to budgetary and political difficulties, production subsidy policy is rarely taken. Certainly, the Japanese government faced these constraints and they couldn't implement an optimal production subsidy policy (in terms of welfare) at that time.

The purpose of this paper is to evaluate the protection policy for the Japanese automobile industry, comparing it against an optimal policy. Melitz(2005) shows that without any constraint an optimal protection policy for an infant industry is a 'flexible' subsidy policy. A 'flexible' subsidy policy means that a policy maker can choose a subsidy level in response to the marginal cost reduction. The experimental analysis presents the counterfactual environment where the Japanese government could choose the optimal subsidy policy without any constraint. That is, in the experiment Japanese automobile makers compete against foreign makers with a subsidy. Conducting the counterfactual exercise, I explore what it would have happened to the Japanese automobile industry if the optimal policy had been implemented. The exercise measures how close the welfare level of the actual policy was to the level of the optimal policy.

The automobile industry has been at the center of the interest of policy makers all over the world. Particular, not a few countries have been trying to push up the automobile industry in the half of the century. Most of these countries used the protection policy as instruments leading their automakers to the growth as Japan experienced. In this paper I present findings relating to the economic welfare and industry growth, to analyze the experience of the Japanese automobile industry in 1954-1965.

The paper is organized as follows; section 2 gives an overview of the policy implemented for the automobile industry. Just after the Second World War, the Japanese government started their protection policy for the automobile industry. The aim of the Japanese government was to protect domestic passenger's cars. Particularly, during 1954-1965, a severe import restriction was implemented. This severe restriction was considered the key factor of the growth of the Japanese automobile industry. In that period, substantially Japanese market was closed against foreign competitors. Section 3 and section 4 present the estimation method of the demand and supply system. Following the recent literature on the demand estimation, I estimate demand parameters using random coefficient logit framework(Berry, Levinsohn and Pakes(1995)). Random coefficient logit can avoid the problem of unrealistic own- and cross- elasticity and unreasonable substitution patterns. Therefore, I can get more precise and reliable demand estimates than other alternatives. Cost side parameters are obtained without the detail cost data by utilizing demand parameter estimates and assuming the type of competition of the market. Section 5 conducts the counterfactual exercise to evaluate the policy for the automobile industry at that time. With demand and supply estimates, I create the counterfactual environment where the Japanese government could choose the optimal production subsidy policy and therefore Japanese makers faced competition against foreign counterparts with this subsidy. For the optimal environment as a benchmark, the counterfactual exercise enables me to analyze the outcome of the actual protection policy. It demonstrates that the Japanese protection policy achieved about fifty percent of the welfare level obtained by the optimal policy. Further it reveals that consumers gained less under the actual policy, relative to automobile producers.

2 The Japanese Automobile Industry in 1950-1965

The Japanese government started its protection policy for the automobile industry in 1950[1]. The main aim of this protection policy was the protection of domestic passenger's vehicles. Although only tariff was used as an instrument during the early period of the policy, in response to a surge of import cars in 1952-1953, the Japanese government decided to restrict import passenger's cars severely. This restriction substantially prohibited Japanese consumers to purchase import cars until 1965[2].

At that time, Japanese passenger's cars were far behind import cars in price and quality. Therefore, if no protection policy had been applied, the Japanese makers would have faced the tough competition against foreign makers in the passenger's car market and couldn't have survived. That is, due to a protection by import restriction, Japanese makers caught up quickly their potential competitors by the end of the protection.

Clearly this import restriction policy was a key driving force leading the Japanese au-

[1] Other industries, e.g. steel, textile and chemical, were protected by the same policy.

[2] There were a few exceptions. Taxi, hotel and broadcasting companies were allowed to buy import cars. Further, foreigners living in Japan also could purchase imports. During a protection period, sales quantities of imports were at most 2000 vehicles per year. Therefore, I exclude import vehicles from the demand and supply estimation in the next section

tomobile industry to the dramatic growth[3]. Therefore this paper focuses on the analysis of the effect of this severe import restriction policy on the passenger's car market during 1954-1965[4].

3 Demand Estimation

This section explains the model of demand for automobiles used in this study. Following the recently developed techniques of estimating the demand, Berry, Levinsohn and Pakes (1995) or Nevo(2000), I use the random utility discrete choice model of consumer behavior.

In this study, demand for automobiles are estimated at the product level, controlling for the imortant characteristics of automobile. Since the purchasing behavior of individuals and their individual characteristics can not be observed, I aggregate individuals to obtain the demand for automobile, while still allowing for heterogeniety across consumers.

3.1 Random Utility Model

Demand system in this study is obtained by aggregating a discrete choice model of individual consumer behavior. Because I don't have the data that match consumer characteristics to the automobile those consumers purchased, I have to rely on the product level data to estimate all of the parameters of the demand system.

The level of utility of individual consumer i from purchasing automobile j at year t is a function of observable characteristics, x_{jt}, unobserved characteristics, ξ_{jt}, and price, p_{jt}. In addition, the utility depends on consumer characteristics, demographics (income) D, consumers preference v, and idiosyncratic error ϵ. Thus, the utility derived by consumer i

[3]Using demand and supply parameters obtained in later sections, I conduct the experiment where the Japanese makers were not protected by any policy. The experiment shows that because prices of the Japanese cars were significantly higher to imports, demand for the Japanese were just about zero. This result indicates the Japanese automakers would not have survived without any protection.

[4]The data limitation prevents me to know the situation in 1954. Further, I exclude large class passenger's vehicle (over 2000cc) from my analysis. The reason is that demand for cars in this class was extremely low in that period.

from purchasing product j at t is given as

$$u_{ijt}(D_{it}, v_{it}, \epsilon_{it}, p_{jt}, x_{jt}, \xi_{jt}; \theta)$$

where θ is a vector of parameters to be estimated. This utility specification implies that consumers with different individual characteristics D, v, ϵ make the different choices.

Following the literature on the traditional discrete choice model, I assume consumers buy one unit of automobile at year t, which gives the highest utility. That is, consumer i chooses product j at t if and only if

$$\begin{aligned} u_{ijt}(D_{it}, v_{it}, \epsilon_{it}, p_{jt}, x_{jt}, \xi_{jt}; \theta) &\geq u_{ikt}(D_{it}, v_{it}, \epsilon_{it}, p_{kt}, x_{kt}, \xi_{kt}; \theta) \\ k &= 0, 1, ..., J. \end{aligned}$$

This implicitly defines the set of unobserved variables, v_i, ϵ_{ij}, that lead to the choice of product j at t.

This set can be written as

$$A_{jt} = (D_{it}, v_{it}, \epsilon_{it} | u_{ijt} \geq u_{ikt} \quad k = 0, 1, ..., J).$$

The set A_{jt} defines the consumers who choose automobile j at year t. Here, I assume ties cannot occur. Then, given this assumption, the market share of the car j at t is just a multi-dimensional integral over the mass of consumers region. Thus the market share of automobile j is described as

$$\begin{aligned} s_{jt}(p_{jt}, x_{jt}, \xi_{jt}) &= \int_{A_{jt}} dP(D, v, \epsilon) \\ &= \int_{A_{jt}} dP(\epsilon | D) dP(v | D) dP(D) \\ &= \int_{A_{jt}} dP(\epsilon) dP(v) dP(D), \end{aligned} \tag{1}$$

where $P(D, v, \epsilon)$ denotes the population distribution functions.

Given assumptions on the distribution of the consumer characteristics, the equation (1) can be computed analytically or numerically. Therefore, for a given set of parameters, the market share of automobile j at year t is obtained from the equation (1) as a function of its observable and unobservable characteristics, prices and unknown parameters to be estimated.

3.2 Random Coefficient Logit Model

Without any assumption on the distribution of consumer characteristics, it is hard to compute the multi-dimensional integral in the equation (1). Therefore, in order to obtain the share of automobile j at t, assumptions on the distribution of consumer characteristics are made. At the same time, those assumptions have important implications for the own- and cross-price elasticities of demand.

The simplest assumption on the distribution of consumer characteristics in the equation (1) is that consumer characteristics are common to all of the consumers. When this assumption is made, the distributions of consumer characteristics are degenerate. Then the share of automobile j at t becomes

$$s_{jt}(p, x, \xi; \theta) = \int_{A_{jt}} dP(\epsilon),$$

where only ϵ, random shock, is indicating consumer heterogeneity. Once I assume ϵ follows i.i.d type I extreme-value distribution, the share of automobile j is expressed as a succinct closed model. It is a simple logit model. However, a simple logit is appealing to its tractability, it shows the unrealistic own- and cross-price elasticities and substitution patterns.

Therefore, a more flexible model, which is able to deal with the interaction between consumer heterogeneity and product characteristics, is needed.

The indirect utility function is specified as the below

$$u_{ijt} = \alpha log(y_{it} - p_{jt}) + x_{jt}\beta + \xi_{jt} + \sum_k \sigma_k v_{ikt} x_{jk} + \epsilon_{ijt}. \tag{2}$$

In this utility specification, I allowing for the consumer characteristics to interact with the characteristics of automobile [5]. This interaction can mitigate the unrealistic prediction of

[5] I also use the first order approximation to the utility function (2), like Berry, Levinsohn and Pakes (1999).

own and cross elasticities and substitution patterns. The specification of demand system is completed with the introduction of an outside option; the consumer does not choose the passengers car. Without an outside option, an overall price increase of all of the passengers car does not affect quantities purchased. The utility from outside option is

$$u_{i0} = \alpha log(y_i) + \xi_0 + \sigma_0 v_{i0} + \varepsilon_{i0}.$$

Once again, I assume the distribution of ϵ is i.i.d type I extreme-value, then the share of the automobile j at t is expressed by

$$\begin{aligned} & s_{jt}(p, x, \xi; \theta) \\ = & \int \frac{e^{\alpha log(y_{it} - p_{jt}) + x_{jt}\beta + \xi_{jt} + \sum_k \sigma_k v_{ikt} x_{jk}}}{\sum_{j=0}^{J} e^{\alpha log(y_{it} - p_{jt}) + x_{jt}\beta + \xi_{jt} + \sum_k \sigma_k v_{ikt} x_{jk}}} dP(D) dP(v) \\ = & \int \frac{e^{\delta_{jt} + \mu_{jt}(p,x,y,v;\alpha,\sigma)}}{\sum_{j=0}^{J} e^{\delta_{jt} + \mu_{jt}(p,x,y,v;\alpha,\sigma)}} dP(D) dP(v), \end{aligned} \tag{3}$$

where $P(D)$ and $P(v)$ are the empirical and parametric population distribution functions respectively[6]. I use the information of the income distribution form population survey and estimate the mean and variance as a consumer characteristics distribution D. Further, I assume the consumer heterogenous preference, v, is the normal distribution with mean zero and its variance one[7].

In this approximation, price sensitivity is modeled as

$$\alpha_i = \frac{\alpha}{y_i}$$

where α is a parameter to be estimated. I use α_i to calculate individual consumer welfare in the later section.

[6] In the simple logit case, the predicted share is given by

$$s_{jt} = \frac{e^{x_{jt}\beta - p_{jt}\alpha + \xi}}{\sum_{j=0}^{J} e^{x_{jt}\beta - p_{jt}\alpha + \xi}}. \tag{4}$$

[7] To calculate the predicted market share, I approximate the equation (3) by

$$s_{jt}(p, x, \xi; \theta) = \frac{1}{ns} \sum_{i=1}^{ns} \frac{e^{\delta_{jt} + \mu(p,x,y,v;\alpha,\sigma)}}{\sum_{j=0}^{J} e^{\delta_{jt} + \mu(p,x,y,v;\alpha,\sigma)}},$$

where y=$(y_1, ..., y_{ns})$ and $v_k = (v_1, ..., v_{ns}), k = 1, ..., K$are ns random draws form the empirical distribution of $P(D)$ and the parametric distribution of $P(v)$.

3.3 Estimation and Instruments

A straightforward approach to estimate the equation (3) is to minimize the distance between the observed market share and the predicted share. But usually that approach is not taken. Price is likely to be correlated with unobservable characteristics, ξ, known to consumers and producers. Due to this correlation between price and unobservable characteristics, endogeniety problem arises in a straightforward estimation. Ignoring this endogeniety between price and unobservable characteristics, coefficient of price will be estimated upwardly.

To the best of my knowledge, there are two ways to solve this endogeniety problem in discrete choice framework. Berry (1994) developed the method of transforming an equation to linear form and enabled us to estimate parameters to use the traditional instrumental variable method (or Generalized Method of Moment). On the other hand, Petrin and Train (2005) solved endogeniety, using a control function as a proxy for unobserved characteristics. In this study, I use Berry's method to transform an equation to linear form to extract ξ[8].

Following Berry (1994), the simple logit model of the equation (4) can be transformed analytically

$$\xi_{jt} = ln(s_{jt}) - ln(s_0) - (\beta x_{jt} - \alpha p_{jt})$$

where s_0 is the share of outside option. Once an equation be changed the linear form, I can conduct IV estimation or GMM estimation in the usual manner.

In a random coefficient logit case, I use a contraction mapping theorem to extract the unobservable characteristics ξ (See Berry, Levinsohn and Pakes(1995)).

$$\xi_{jt}(s_t; \alpha, \sigma) = \delta_{jt}(s_t; \alpha, \sigma) - \beta x_{jt} \tag{5}$$

where β enters in a linear fashion on the other hand α, σ enter non-linearly. Treating the

[8]Strong assumptions are required to obtain a control function in my case where the number of products is large relative to the number of year (or market).

Table 1: The result of the demand estimation

demand parameters	variables	coefficients	std. error
Means(β's)	Const	-5.483	1.021
	Size	0.1885	0.1210
	HP/W	-0.0152	0.0158
	CC	0.1451	0.0761
Std. deviations (σ's)	Const	0.4932	0.0571
	Size	0.0424	0.0012
	HP/W	0.0534	0.0671
	CC	0.0327	0.0397
Term on price	$log(y-p)$	3.9787	0.9662

Maker and year dummies are also included, but not reported.

Standard errors are computed by bootstrapping.

unobservable characteristics as a error term, I set the moment condition,

$$E[Z\xi_{jt}] = 0 \tag{6}$$

where Z is instruments. I find instruments by using approximation to the optimal instruments discussed in Pakes(1994) and Berry, Levinsohn and Pakes(1995). The characteristics of own product, the sum of the chracteristics across other own-firm products and the sum of the characteristics across other firms are used instruments. With these instruments I conduct non-linear GMM to estimate demand parameters. The parameter estimates are shown in Table 1. Constant term indicates the utility difference from outside goods. Coefficients show reasonable value and sign except HP/W's. But, coefficient of HP/W is not significant. Standard deviations indicates that consumers shared relatively same preferences for characteristics among them.

4 Supply Estimation

Unfortunately, It is hard to obtain the cost side data for each model. Therefore, by assuming the type of competition in Japanese automobile market and utilizing demand parameters, I estimate supply side parameters.

Firm f's profit function at year t is

$$\Pi_{ft} = \sum_{j \in F} (p_{jt} - mc_{jt}) M s_{jt}(p, x, \xi; \theta) - C_f$$

where M is the potential market size and $s_{jt}(p)$ is the predicted share of automobile j at t from demand estimates.

Japanese auto makers are assumed to compete with each other in Bertrand-Nash fashion. That is, each firm set prices that maximize its profit given the characteristics of its own firm's products, and the prices and the characteristics of other competing firms products.

There are J (the number of products) first order conditions for static price setting competition.

$$s_{jt}(p, x, \xi; \theta) + \sum_{r \in J_f} (p_r - mc_r) \frac{\partial s_r(p, x, \xi; \theta)}{\partial p_j} = 0 \quad for\ j = 1, ..., J,$$

where the firm f is setting the price considering other product across own firm's products.

I assume makers have a marginal cost function that is a log-linear in the cost characteristics. Similar to the demand system, I assume that the cost characteristics are divided into two components ,the observable characteristics, ω and the unobservable characteristics ζ.

Given these assumptions, the marginal cost function can be written

$$log(mc_{jt}) = \gamma \omega_{jt} + \zeta_{jt}, \tag{7}$$

where mc_{jt} is an estimate obtained from the demand side parameters and the assumption the type of competition as previously described, and γ is cost side parameters to be estimated.

The characteristics of automobile are the same as in the demand system. Year and maker dummies are also included as in the demand estimation. In addtion, I include the cumulative output level, because I want the marginal costs to fall in response to the increase in output. This downward sloping supply curve plays a critical role in later analyses.

Table 2: The result of the supply estimation

cost parameters	variables	estimates	std. error
	Const	-3.0181	0.6129
	Size	0.97407	0.3942
	HP/W	-0.9114	0.186
	CC	1.9978	0.3043
	Cumulative Output	-0.15178	0.0269

Maker and year dummies are included, but not reported.

Concerning the correlation between these and unobserved characteristics ζ, the instrumental variables are used. The moment condition is given as

$$E[Z\zeta_{jt}] = 0 \tag{8}$$

where Z includes the same instruments as used in demand estimation.

The results of supply estimation are shown at Table 2. An unexpected sign of HP/W' coefficient is obtained, but it is not significant. Coefficient of cumulative output of the model indicates the marginal cost falls in response to the output level.

5 Counterfactual Exercise

It has been said that the Japanese automobile industry is the prominent example of a success of infant industry protection. The Japanese government severely restricted imports and, further, it imposed tariffs on them until 1965. Under that protection, Japanese automakers could acquire the adequate experience of production and as learning-by-doing they constantly reduced their production costs and prices in turn. By the end of protection, Japanese makers became competitive enough against foreign counterparts.

However, theoretically quota and tariff are inferior to a production subsidy policy. They cause the distortion on consumption side, creating a wedge between the marginal cost of the foreign good and domestic marginal cost. Therefore, the Japanese protection policy must have induced some distortions on the consumption side. I measure how big the distortion along with the policy was. I also check how producers were affected by policy.

In this section, I conduct the counterfactual exercise to explore what would have happened to the industry growth and welfare, if the optimal protection policy had been taken for the protection period, 1955-1965. Comparing the level of welfare attained under the counterfactual policy with what it was attained in the actual policy, I evaluate how the Japanese protection policy was close to the optimal protection policy.

5.1 The Optimal Protection Policy

The Japanese government used severe import restriction and tariff to protect domestic automakers. However, import restriction is not the best way to protect the domestic infant industry. There are alternatives which would induce better consequences. For example, domestic production subsidy clearly is the better alternative than a quota or tariff. Melitz (2005) shows that if a government planner could choose his protection policy without any constraints, the optimal policy to protect the domestic infant industry is a flexible production subsidy. A 'flexible' subsidy means that a policy maker can change the subsidy level in response to the marginal cost reduction. That is, the optimal production subsidy level at each year is determined by the difference between current marginal cost and its long-run level,

$$\sigma_t = c(Q_t) - \bar{c},$$

where Q_t is the cumulative production. Long-run level $\bar{c}$ is the marginal cost level which is attained once the infant industry becomes mature.

Although a flexible subsidy is an ideal tool for the infant industry protection, it is hard to be implemented. Budgetary or political constraints will prevent planners from utilizing that policy. Even without budgetary and political constraints, to give the production subsidy appropriately, they must have the information on marginal costs, which are not observable as usual. Due to these difficulties, this first best protection policy is rarely taken.

5.2 Counterfactual Scenario

In this section, the experimental analysis on the governmental intervention is conducted, leaving (domestic and foreign) automakers product mix unchanged[9]. I assume that the Japanese government could implement the flexible subsidy policy without any constraint at that time[10]. As Melitz (2005) says, it is the first best protection policy, which is maximizing a social welfare. In this experiment, I explore what would have happened to the industry growth and social welfare if the optimal production subsidy had been implemented instead of the import restriction. Comparing the difference of the welfare level between under the counterfactual environment and under the actual environment, I evaluate the protection policy for automobile industry.

To conduct the experiment under the counterfactual scenario, the long-run marginal cost level, $\bar{c}$ is needed. According to Automobile Year Book, the production level of 120000 vehicles per year was required to compete with foreign counterparts equally. Based on this information, I assume the makers have achieved this level of production. That is, they finish their learning periods and can produce their products at the long-run marginal cost, $\bar{c}$ [11]. They had produced the cumulative output of about 240000 vehicles until they reached to the production level of 120000 vehicles per year. That is, it means that the Japanese makers could attain the efficient marginal cost level when they have experienced the cumulative output of

[9]In the exercise, I ignore the effect of the counterfactual policy on the automaker's decision process. The different policy would have affected the maker's decision and changed the number of domestic or foreign makers and the number of automobiles in the market. While it would be interesting to consider the change of decision processes, I leave this problem to the future research and, assuming it constant, conduct the experimental analysis.

[10]In fact, the fiscal condition at that time would prevent the Japanese government to use the production subsidy policy. In this simulation exercise, without concerning the feasibility, the policy maker is assumed to choose any policy

[11]By 1965, only two makers, Toyota and Nissan, have reached to the production level of 120000 vehicles per year.

Table 3: Actual Policy versus Counterfactual Policy(price unit 10000 yen)

actual			counterfactual		
year	price	sales	price	domestic sales	import sales
1955	9.7233	8519	7.345	11379	8347.5
1956	9.0346	19075	6.3103	28638	13678
1957	7.8949	33902	6.4142	49202	17780
1958	7.4353	42822	5.1203	78219	18506
1959	8.0536	65282	5.8339	121310	26228
1960	6.3256	141099	4.3844	224540	32796
1961	5.2947	224297	3.8528	363070	45403
1962	4.8423	248858	3.9483	548110	52636
1963	4.4453	334243	4.0395	702510	66471
1964	4.3869	469660	3.9073	943700	93927
1965	4.285	568914	4.2093	1169700	114290

240000 vehicles. Therefore, I substitute the cumulative output into 240000 vehicles in each model to calculate the long-run marginal cost level per model. I approximate the optimal subsidy level to the difference of the average marginal cost and the average long-run level in each year.

I compute new equilibrium of the automobile market with the optimal production subsidy, using the demand equation (3) and the supply equation (6). In equilibrium, because restriction and tariff are not used as the instrument for protection, Japanese makers compete against foreign makers.

Under that circumstance, I compute yearly sales quantities, marginal costs and prices, and repeat this computation process with the optimal subsidy rule, $c_t - \bar{c}$, until the end of protection, 1965.

Table 3 presents the results of the simulation exercise with the actual data.

Second and third column represents prices and sales quantities under the actual policy environment. Fourth column shows if the optimal subsidy policy had have been taken price would have been lower than the actual price. Fifth and sixth columns indicate if the optimal production subsidy had been given to domestic automakers, sales quantities of domestic makers would have outweigh the level of sales quantities in the actual environment. Thanks to the production subsidy Japanese makers can set their price lower in the counterfactual environment than they did in the actual environment.

Table3 also shows if the optimal production subsidy had been given to domestic makers, they could have been competitive enough and overwhelm foreign competitors. That is, the optimal production subsidy policy would induce the higher level of the domestic production than the actual policy could, even with the existence of competition against import passenger's cars.

5.3 Welfare Analysis

The previous section shows that sales level would have been rather higher if the optimal policy had been taken. Here, I explore how consumer's and domestic producer's welfare would have been changed if the optimal policy had been used instead of the actual policy.

5.3.1 Consumer's Surplus

Following Nevo (2001) or Trajtenberg (1990), I calculate consumer's surplus from demand estimates. Consumer's surplus is the utility in terms of money that consumer receives from purchasing a product. Consumer chooses the product, which gives the highest utility. Therefore, consumer's surplus is described as

$$CS_{it} = \frac{1}{\alpha_{it}} max_j (V_{jt} + \epsilon_{jt} \ \ \forall j),$$

where

$$V_{jt} = \alpha log(y_{it} - p_{jt}) + x_{jt}\beta + \xi_{jt} + \sum_k \sigma_k v_{ikt} x_k.$$

The marginal utility of income, α_{it}, represents the conversion between utility and money. In a logit model, which means ϵ following i.i.d extreme value distribution, if the marginal utility of income is constant for each individual, then Williams (1977), McFadden (1981) and Small and Rosen (1981) shows that consumer's surplus for individual i becomes

$$CS_{it} = \frac{ln(\sum_{j=0}^{J} e^{V_{ijt}})}{\alpha_{it}}, \tag{9}$$

where α_{it} is the interaction term between consumer i's income and demand estimate α. [12] The mean concumer's surplus is given by

$$M \int CS_i dP(D) dP(v),$$

where M is the potential size of the market and $P(D)$ and $P(v)$ are empirical and parametric distribution functions respectively.

I also use compensating variation to measure the change of consumer's welfare from the counterfactual environment. For the benchmark I use the consumer's surplus attained from the optimal policy, where consumers can purchase both domestic cars and imports. This case, compensating variation can be expressed by

$$CV_{it} = \frac{ln(\sum_{j=0}^{J} e^{V_{ijt}})^{actual} - ln(\sum_{j=0}^{J_{opt}} e^{V_{ijt}})^{optimal}}{\alpha_{it}}, \tag{10}$$

where J_{opt} indicates the sum of the number of domestic models and import models.

Table 4 shows consumer's surplus and compensating variation in both environments.

Second column represents consumers surplus per individual consumer in the actual policy and third is consumers surplus in the optimal situation. Forth column indicates per consumer compensating variation and fifth represents total compensating variation weighted by sales quantities in each year.

Table.2 shows the actual level of consumer's surplus are smaller than the level of the counterfactual environment. This gap is caused by two factors. First, under the optimal policy consumers can gain the benefit from the lower price than under the reality. Second, in the counterfactual environment they can face the wider variety of automobiles than they

[12] I omit an unknown constant term which represents the fact that the absolute level of utility cannot be measured.

Table 4: Consumer's surplus and Compensating variation (10000 yen)

year	actual CS	optimal CS	CV	total CV
1955	0.030691	0.28558	-0.25489	-525.823
1956	0.037417	0.30107	-0.26365	-1185.2
1957	0.075158	0.39695	-0.32179	-2380.91
1958	0.059251	0.40641	-0.34716	-3654.72
1959	0.12701	0.68439	-0.55738	-9164.11
1960	0.50787	1.322	-0.81413	-26593.9
1961	0.81893	1.9462	-1.12727	-60610.2
1962	1.5277	3.1195	-1.5918	-148590
1963	1.7323	2.9211	-1.1888	-165445
1964	3.1344	4.9708	-1.8364	-364286
1965	3.7348	5.3338	-1.599	-466600
Total				-1249036

did in the actual environment. The larger consumer's surplus reflects these two factors in the counterfactual environment.

5.3.2 Producer's Surplus

In addition to the welfare analysis on the demand side, producers' welfare is considered. I calculate producers' surplus using prices and estimated marginal costs of each model in each year in both environments.

Table 5 presents the result. Second and third columns represent producer's surplus under the actual and counterfactual policy environment. Fourth column indicates the change of producer's surplus. Similar to consumers, producers would have been also well-off. If the Japanese government had have provided Japanese makers production subsidy properly, they would have produce their products at the lower level of marginal costs. The lower level of marginal costs would help automakers to set their prices at lower level than they did in fact. The lower prices would induce more consumers to purchase their products. Therefore, the optimal subsidy policy would help Japanese makers to gain more profits than the actual protection did.

Table 5: Producer's surplus (100000 yen)

year	actual PS	optimal PS	PS change
1955	13527.32	22415	-8887.68
1956	30004.98	49911	-19906
1957	56372.25	88217	-31844.8
1958	66138.58	138190	-72051.4
1959	107036.4	220900	-113864
1960	235804.6	393360	-157555
1961	408130.8	596960	-188829
1962	481814	888660	-406846
1963	687838.7	1142100	-454261
1964	1008924	1539700	-530776
1965	1306682	1960100	-653418
total			-2638240

Table 6: Total welfare change (100000 yen)

Total CV	Total PS change	Welfare change
-1249036	-2638240	-3887276

5.3.3 Total Welfare

In the previous analysis, I found both consumer's and producer's surplus would have outweigh what was attained in the actual environment if the government had have taken the optimal policy. Here I represent the total welfare change from the optimal policy for the protection period. Table 6 indicates the result.

I also represent the result where I measure the actual welfare in terms of the optimal welfare. Table 7 indicates the actual policy reached to about 55 percent of what the flexible subsidy policy could attain. However, consumers attained only 30 percent of what they could have gained if protection policy were managed optimally. On the other hand, producers could obtain about 60 percent of what they can obtain in the optimal environment.

This results shows that the distortion on consumption side was significant because Japanese consumers had to buy domestic products at higher prices. In addition, their choice set were limited within domestic products by restriction. The result also shows that relative to producers, consumers were more harmed.

Table 7: Rate of Consumer, Producer and Total Welfare

$CS^{actual}/CS^{optimal}$	$PS^{actual}/PS^{optimal}$	$TW^{actual}/TW^{optimal}$
0.278686	0.625277	0.55686

6 Conclusion and Extensions

The role of the governmental intervention is the center of the interest of policy makers and researchers. To grow their domestic industry, policy makers often use industrial and trade policies as instruments. Many have argued the protection policy contributed greatly to the growth of Japanese automobile industry. Further, the policy has been said to be the only example of the success of import restriction policy. Unfortunately, however, there is little empirical evidence on the effect of industrial policies on an industry growth and its welfare consequences. In this paper, I explore what would have happened to the growth of the Japanese automobile industry and welfare if the protection policy had have been implemented by the optimal subsidy policy. The results show that although the Japanese policy has seemed to be the successful one, it could achieve the only half of the welfare level under the optimal policy. Particularly, due to a severe import restriction, the distortion on consumption was relatively large. In comparison with counterfactual optimal policy, the actual import restriction reached to about 55 percent of welfare level.

Although I found that there was the large welfare loss, my counterfactual analysis depends on some assumptions. First, in the experiment the product mix of domestic and the number of foreign makers in the market are assumed unchanged. However, if the policy environment had have changed, their behaviors would have been affected by the policy and they would have altered their product mix or the entry/exit behaviors in response to the environmental change. Therefore, I have to add my analysis to the rule of the entry/exit decisions. Second, I analyzed Japanese automakers in a static equilibrium environment. Clearly, the richer model which includes dynamic price setting behaviors have to be introduced. These assumptions used in this study may cause a serious problem for the results. Therefore, in future work I have to deal with Japanese automobile industry using a dynamic oligopoly framework.

Appendix: Data

The data set used in this study is from 1955 to 1965 on a year basis. Estimating a differentiated product demand requires data on quantities sold (market share), prices, and characteristics in each year. Characteristics variables include automobile size, Size, horse power by weight, HP/W, size of engine, CC, and years passed after release year, Model Age. Also, the information of the distribution of demographics (income) is required in the estimation of a random coefficient logit model. Automodile's data, quantities, prices, and characteristics, are obtained from Automobile Yearbook and the automobile magazine, Motor Fan. Unfortunatelly, I couldn't find the data of these before 1954. Japanese government started its protection policy in 1951. I concern the lackness of data during 1951-1954 might affect the results.

In the counterfactual exercise, I also use tha data on import cars. The imformation of prices, characteristics of imports also are obtained from Automobile Year Book and the magazine, Motor Fan. However, these price data include a tariff. Therefore, I subtract a tariff (30 percent) from imports prices and use prices without a tariff in counterfactual exercise.

The income distribution are obtained from the Household Survey Data. I use that data to construct the empirical distribution of income.

Table A1: Summary statistics (Japanese automobiles)

Year	No of models	Price	Size	HP/W	CC	Model age	New	Small
1955	6	9.7233	9.8739	3.7793	12.547	1	0.16667	0
1956	6	9.0346	9.8739	3.7793	12.547	2	0.16667	0
1957	6	7.8949	9.809	4.127	12.547	3	0.16667	0
1958	6	7.4353	9.3935	3.9597	11.735	3.5	0.16667	0
1959	7	8.0536	9.7472	4.5524	12.719	4	0	0
1960	11	6.3256	8.6614	4.9286	10.823	3.0909	0.090909	0.27273
1961	13	5.2947	8.0595	5.0717	9.9115	3.1538	0.30769	0.30769
1962	17	4.8423	7.9152	5.0791	9.8181	3.3125	0.1875	0.3125
1963	19	4.4453	7.6991	5.5288	9.8035	3.1176	0.17647	0.29412
1964	23	4.3869	7.7212	6.0447	10.446	3.3478	0	0.21739
1965	21	4.285	7.9844	6.2539	11.149	4.3333	0	0.19048
All	132	5.6307	8.3695	5.2386	10.843	3.2879	0.11364	0.19697

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