Measuring the effects of tariff-jumping FDI on domestic and foreign firms' profits: a case of U.S. motorcycle industry, 1983-1987*

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Abstract

This paper examines U.S. motorcycle safeguard to quantify the effects of tariff-jumping foreign direct investment (FDI) on domestic and foreign firms' profits. I estimate a structural model of demand and supply, and then implement counter-factual simulations based on the estimation results. Counter-factual simulation shows that tariff-jumping FDI reduced the domestic firm's benefit from protection by more than 50%. In addition, it reveals that some foreign firms gained from protection for some periods of protection by engaging in FDI activity.

Keywords: Tariff-jumping FDI; Discrete choice models; Motorcycles

JEL classification: F13; F14; L13; L62; O31

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1 Introduction

Who benefits from protection policies when foreign firms can evade the policies by substituting local production for their exporting? The theory of tariff-jumping foreign direct investment (FDI) considers the role of protection policy as an inducement to shifting of foreign firms' production location to the protectionist country to avoid the tariff, which reduces the domestic firms' benefit from protection. At an extreme case, protection policy can make the domestic producers worse off due to an increased domestic competition (Smith (1987), Motta (1992)). In addition, the effects on foreign firms' profits may differ if there are differences in ability to make FDI within foreign firms. Blonigen and Ohno (1998) present an oligopolistic competition model with multiple foreign firms in which an ability to make tariff-jumping FDI to be different among the foreign firms. Their model consider a situation in which the foreign firms having an advantage in local production may benefit from protection because it increase the cost of the other foreign firms whose cost of FDI is too high to make local production profitable in the presence of protection policy.

This paper examines U.S. motorcycle safeguard, placed on the imports of motorcycles over 700cc, from 1983 to 1987 to quantify the effects of tariff-jumping FDI on domestic and foreign firms' profits.[1] In particular, I focus on the difference in the effects on foreign firms that made tariff-jumping FDI and that did not. U.S. motorcycle protection is one of the most desirable case to investigate the effects of protection policy on the domestic and foreign firms' profits. First, the market was characterized by oligopolistic competition: one U.S. manufacturer, Harley-Davidson, and four Japanese, Honda, Kawasaki, Suzuki and Yamaha. Second, when the safeguard policy started, there were differences in ability to make local production among Japanese manufacturers: Honda and Kawasaki owned their plants in U.S., while Suzuki and Yamaha did not. The situation is very close to what the theory presumes; therefore, as Irwin (2002) argues, Honda and Kawasaki might favor the safeguard because it could protect them from their Japanese-based rivals Suzuki and Yamaha. Third, it is worth examining how much the local production harmed Harley's profit. Interestingly, Harley-Davidson requested the end of the safeguard before the scheduled date of termination. The fact may be related to a large negative effect on Harley's profit due to an increase in local production of Japanese firms induced by the imposition of safeguard tariffs.

In this paper, I employ a structural estimation method following Berry, Levinsohn, and Pakes (1999). To my knowledge, this paper first measure the effects of tariff-jumping FDI based on the structural estimation method. Previous empirical studies on tariff-jumping FDI primary focus on the role of protection policies, such as antidumping duties, on the FDI flows (Barrel and Pain (1999), Blonigen and Feenstra (1997)) or firm-level FDI decision (Belderbos and Sleuwaegen (1998), Blonigen (2002)), rather than the effect on domestic and foreign firms' profits. A sole exception is Blonigen, Tomlin, and Wilson (2004)

[1]In the previous work, Kitano (2007) focuses on the role of safeguard in the drastic recovery of domestic firm, Harley-Davidson, during the periods of safeguard. Kitano (2007) assume that no local production were made during the periods of safeguard because I intends to show that the safeguard did not function as an instrument to recover the domestic industry even at an extreme assumption, i.e. a case in which all the Japanese motorcycles over 700cc were subject to tariff.

that analyze the impact of tariff -jumping FDI on domestic firms' profits using an event study analysis. They find that affirmative U.S. antidumping decisions are associated with average abnormal gains of over 3% to a firm in the petitioning industry in the absence of tariff-jumping FDI, but much smaller and statistically insignificant abnormal gains in the presence of tariff-jumping FDI. The paper, however, focus only on the effect on domestic firms' profits but not on foreign firms' profits. From the methodological perspective, there is a growing number of studies that applies the structural estimation method to international trade; for example, Goldberg (1995), Berry, Levinsohn, and Pakes (1999), Goldberg and Verboven (2001), Friberg and Ganslandt (2006), and Clerides (2008).

The findings of this paper are summarized as follows. Simulation of the case of no-tariff-jumping FDI reveals that although domestic firm was not harmed from protection throughout the periods of protection, tariff-jumping FDI reduced a significant amount of the domestic firm's benefit from protection (more than 50%). The result is similar to findings in Blonigen, Tomlin, and Wilson (2004). In addition, simulation of the case of no-safeguard tariffs reveals that there were some periods when the foreign firms that evaded the safeguard tariffs gained from innovation due to the increased cost of other foreign firms that did not make tariff-jumping FDI.

The rest of papers is organized as follows. In section 2, I describe the local production in U.S. and the safeguard policy. In section 3, I implement a simple pass-through regression to see the difference in the effect of the safeguard among foreign firms that made an FDI and did not. Section 4 introduces the structural model of demand and supply in the presence of safeguard tariffs, and the estimation procedure and results are summarized in section 5. In section 6, I report the results of counter-factual simulations, i.e., the effects of tariff-jumping FDI on the domestic and foreign firms' profits. Section 7 concludes the paper.

2 Motorcycle market in U.S.

2.1 Local production: Honda and Kawasaki

Among the Japanese motorcycle manufacturers, Kawasaki first built the motorcycle plant in Lincoln, Nebraska in 1974. Kawasaki mainly produced heavy-weight motorcycles, engine displacement over 850cc, that were mainly targeted at U.S. customers. In 1987, Kawasaki made 908cc "Ninja" that had been acclaimed as one of the most exciting motorcycles ever.

Following Kawasaki, Honda started manufacturing motorcycles in the United States, Ohio in 1977, with building one model of motorcycles, CR250R of dirt bikes. Honda expanded its production capacity from 40000 to 70000 in U.S. in response to the safeguard. During the periods of safeguard, most of U.S.-made-motorcycles were also heavy-weight motorcycles and one of them had been the most popular motorcycles among Honda's models, GL1100.

I hereafter call Honda and Kawasaki as an FDI group, and Suzuki and Yamaha as a non-FDI group.

2.2 Motorcycle safeguard

In response to the Harley's request on the Section 201 escape clause, U.S. government adopted the safeguard policy to the imports of motorcycles over 700cc from April 1983. The safeguard took the form of tariff-rate-quota: each country could export without additional tariff to the amount of the quota, but once the export exceed the allocated level of quota, each country have to pay additional tariff for additional units of export. In the case of motorcycle safeguard, tariff rate was initially set at 45%, in addition to the normal rate 4.4%, and declined over five years. On the other hand, the level of quota in 1983 was set at 6000 units for Japan, and increased over five years. See table 2 that lists the level of tariff and quota for each year. The tariff-rate-quota was applied to all the countries, but the level of quota was large enough to allow the motorcycle manufacturers except for Japanese to export without additional tariff.

As is mentioned in the introduction, the safeguard initially scheduled to end in March 1988, but was removed before termination upon Harley's request. As a result, the safeguard was ended in October 1987.

3 First look at the effect of safeguard

I first investigate the effect of safeguard on Japanese firms using the simple pass-through regression on tariff and exchange rate.

3.1 Data

In the following analysis, I use the product-level data, such as price, quantity, characteristics and the location of production, in U.S. motorcycle market. Product-level data comes from several independent sources. Price and characteristics data for each model of motorcycles are obtained from *N.A.D.A. Motorcycle and Moped Appraisal Guide* and *N.A.D.A. Motorcycle, Moped and ATV Appraisal Guide*, published from National Automotive Dealers Association (N.A.D.A.). The data, available for me from 1977 to 1987, is updated three times a year: Jan.-Apr., May-Aug., and Sep.-Dec, which I hereafter label as first, second and third period, respectively. Characteristics in N.A.D.A. includes the size of engine displacement, dry-weight, number of forward speeds, number of cylinders and issued year and month that allows me to compute the age of each motorcycle.

N.A.D.A.'s publication contain three kinds of price related data, suggested list price, average retail used value, and prime retail used value. I choose the prime retail used value, price of the best condition used motorcycle, as transaction prices for each product. Although some studies on automotive market, such as Berry, Levinsohn, and Pakes (1999), use suggested list prices as transaction prices, I do not use them because it is time invariant, while transaction price is known to be discounted depending on the vintage. Prime retail used value varies over time which is likely to represent market condition, and is also likely to be close to the actual transaction price because the best conditioned motorcycle and new motorcycle should be close substitute.

Motorcycle Statistics by Make and Model, one of the publication from R.L. Polk, provides data of a (year-to-date) number of new registration for each model of motorcycles. The data is published monthly, and available from January 1983 to May 1987. In order to adjust the frequencies of data, I aggregate the quantity (number of new registration) data into periodical data. As a result, the data contain 13 time series, first period in 1983 to first period in 1987.

Motorcycle products are characterized by a frequent model change. N.A.D.A. provides the data for each model of motorcycles in every model years, while R.L. Polk reports the combination of quantity and name of motorcycle without distinguishing the model year. Therefore, I need to match these data. I use the latest model of motorcycles if there are multiple models in N.A.D.A. that correspond to the model name in R.L. Polk. By construction, the number of models offered in each period is based on the list in R.L. Polk.

The data of local production is constructed based on *Japanese Motorcycle History 1945 -1997*, publication from Yaesu Publishing, provides the complete list of the name of motorcycles made in Japan including motorcycles for exporting. The information allows me to identify the models of motorcycles that was produced in U.S.[2]

In addition to the product-level data, I use some information on U.S. motorcycle market, such as motorcycle population and the income distribution of motorcycle owners. The data is obtained from *Motorcycle Statistical Annual*, published by Motorcycle Industry Council. I also use exchange rate data from *International Financial Statistics* by International Monetary Fund.

3.2 Pass-through of tariff and exchange rate

Before implementing the structural econometric approach, I first estimate a simple pass-through regression. In this section, I only use the price and characteristics data for each model of motorcycles that have more longer time series. The purpose of the analysis is to see how much the tariff protection increased the price of the products subject to tariff on average and the effect on price differed between FDI and non-FDI firms.

The pass-through regression I implement is

$$\ln p_{jt} = \alpha + \beta_e \ln(e_t) + \beta_\tau \ln(1 + \tau_{jt}) + \gamma z_{jt} + \eta_{jt}, \tag{1}$$

where p_{jt} is a price of motorcycle j at time t, and e_t and τ_{jt} are dollar-yen exchange rate and tariff rate, respectively. Their coefficients, β_e and β_τ, are called the pass-through coefficients of exchange rate and tariff, respectively. If $\beta_e(\beta_\tau)$ is equal to 0, (U.S.) prices remain unchanged in response to exchange rate

[2]To check the validity of the data on local production, I also collected the information on local production from the articles in some newspapers and magazines that reported partial information about the name of made-in-U.S. motorcycles. The information was collected from *Lexis Nexis Academic*. I find my data on the local production to be consistent with the information in these articles.

(tariff rate) changes; in this case, exporters fully adjust their prices to absorb the exchange rate (tariff rate) changes. At the other extreme, prices fully respond to the exchange rate (tariff rate) changes if $\beta_e(\beta_\tau)$ is equal to 1; in this case, exporters do not alter their prices in exporter currency unit and the pass-through is characterized as complete. When the values of $\beta_e(\beta_\tau)$ between 0 and 1, the pass-through is called incomplete. z_j is a vector of characteristics of product j, which include the size of engine displacement (in 1000 cubic centimeter), dry-weight (in 1000 kg), and the number of forward speeds. η_{jt} is an error term.

Estimation results are summarized in table 1. Column 1 of the table reports the results of regression without distinguishing the differences in pass-through between FDI and non-FDI firms. The pass-through of tariff is 0.391 and significant at 99% level; the result indicates that a 1% increase in tariff rise the price by 0.391%. The pass-through estimates obtained here are considerably different from the results in a previous study, Feenstra (1989), that reported the pass-through of more than unity. I consider that the difference may attribute to the fact that the regression in Feenstra (1989) did not include the characteristics variables, in particular the size of engine displacement. The reason is as follows. In response to the safeguard, Japanese firms introduced the motorcycles with 699cc of engine displacement, in place of the motorcycles with around 750cc, to avoid the tariff. The replacement should increase the average size of engine displacement within the products over 700cc if the quality of the other motorcycles did not change. Obviously, the increase in the average quality of the motorcycles resulted in an increase in average price within the class of engine displacement. Therefore, the large rate of pass-through can not be interpreted as a standard notion of the pass-through, but may be due to the changes in the quality of Japanese motorcycles after the imposition of the safeguard.

To confirm the effect of the quality change, I implement the regression without using the characteristics variables. The estimation result is summarized in the second column of table 1. The estimated pass-through of tariff takes the value of 1.000 that is very close to the results in Feenstra (1989). Therefore, I guess that the large estimate of pass-through coefficient does not imply that the Japanese manufacturers were highly responsive to the imposition of the tariff, but is due to the quality change.[3]

The exchange rate pass-through coefficient lies between 0 and 1, that is an incomplete pass-through. The result is consistent with the previous study of the exchange rate pass-through (see Goldberg and Knetter (1997) for survey).

Column 3 of table 1 reports the results of the regression that allows the pass-through coefficient on tariff and exchange rate to be different between FDI group and non-FDI group. The coefficient on *FDI**ln(1+*Tariff*), where *FDI* is a dummy variable that takes 1 if product j is produced by the firms in FDI group, captures the difference. The coefficient is significantly negative, which implies that increase in the price of the firms with local production facilities are lesser than that of firms without local production facilities.

The value of exchange rate pass-through is about 0.293, corresponds to an incomplete pass-through,

[3] See also Feenstra (1988) that analyze the role of trade policy on exporters' quality choice.

and slightly small for the FDI group. Also, the coefficients on the characteristics basically are basically reasonably estimated both in (i) and (ii) of table 1.

The analysis provided here indicates that the FDI group successfully jump the tariff to some extent. The results implies that the non-FDI group was likely to decrease their profits, while it is ambiguous that the FDI group In the next section, I investigate the effects on profits more in detail using a structural approach.

4 Model

This section describes the structural econometric model used to analyze the effect of innovation and the temporary protection policy in the U.S. motorcycle market from 1983 to 1987. I first introduce the discrete chioce models to derive the demand for motorcycles and then turn to the cost structure of the motorcycle manufacturers.

4.1 Demand

I first explain a random-coefficient logit model of motorcycle demand. Random coefficient logit model allows the substitution patterns among products to depend on the proximity of the attributes of products. That is, compared to the conventional logit model that sometimes impose an unrealistic substitution patterns on the demand, random coefficient model allows us to estimate the richer substitution patterns among products.[4]

Random coefficient logit model

I use the present owners of motorcycle as the purchasing entity because most of the new sales of motorcycles are repurchase from the incumbent owners. Each consumer i is assumed to have a unit demand to maximize the indirect utility function at time t by choosing motorcycle brand j among $J_t + 1$ alternatives. Alternative zero is the outside option, which include not purchasing a motorcycle. For simplicity, time subscript is ommited in the following.

Consumer i's indirect utility from purchasing product j is

$$u_{ij} = \mathbf{x}_j\boldsymbol{\beta} + \xi_j + \alpha \ln(y_i - p_j) + \sum_k x_{jk}\nu_{ik}\sigma_k + \epsilon_{ij} \quad j = 1, 2, \ldots, J, \tag{2}$$

[4] Note that the nested logit model is alternative method to estimate the demand. However, as Berry (1994) mentions, the model is still restrictive because it allows substitution patterns to depend only on the grouping of products, but not on the continuous characteristics, while random coefficient logit model allows to depend on both. In the analysis of motorcycle market, the correlation pattern should depend on the proximity of engine displacement, a continuous variable, because the purpose of motorcycle usage usually depends on the size of engine displacement.

and the utility from the outside option is

$$u_{i0} = \xi_0 + \alpha \ln(y_i) + \sigma_0 \nu_{i0} + \epsilon_{i0}, \tag{3}$$

where p_j is a real price (adjusted by the overall CPI) of product j, and $\mathbf{x}_{jt}$ is the $K \times 1$ vector of product j's observed attributes including contant and period dummies. The k-th component of this vector is denoted by x_{jk}. $\boldsymbol{\beta}$ is the $K \times 1$ vector of parameters to be estimated.

y_i is the consumer i's income. The functional form of utility function corresponds to the Cobb-Douglas utility function, which accounts for an income effect. Since the income variable is not available, I assume that the income follows log-normal distribution with known mean and variance which are computed from the information on the income of motorcycle owners.[5]

ξ_{jt} represents an unobserved (by an econometrician) product quality of product j with $E\left(\xi_j\right) = 0$. Unobserved quality of outside good, ξ_0, is not separately identified with that of inside good, and hence is normalized to zero. The coefficient on individual specific constant term, σ_0, also can not be estimated separatedly from the as the radom coefficient on the constant of inside good. Hence, the random coefficient on the constant term captures the variance in the consumer's taste on the outside option, which can be interpreted as the individual specifc taste on the motorcycle holdings.

Following Berry (1994), I decompose the above utility function into two terms: the mean utility, δ_j, and the deviation from the mean, $\mu_{ij} + \epsilon_{ij}$, where

$$\delta_j \equiv \mathbf{x}_j \boldsymbol{\beta} + \xi_j, \tag{4}$$

and,

$$\mu_{ij} \equiv \alpha \ln(y_i - p_j) + \sum_k x_{jk} \nu_{ik} \sigma_k. \tag{5}$$

Note that all β-parameters are the same for all the consumers. μ_{ij} represents the consumer i's taste heterogeneity on the product characteristics. ν_{ik} is the consumer specific taste of characteristics k and assumed to follow i.i.d. standard normal. $\boldsymbol{\sigma} = (\sigma_1, \ldots, \sigma_K)'$ is the vector of parameters to be estimated, and σ_k represents the standard deviation of the coefficient on characteristics k. Note that to simplify the notation, I specify the model in which all characteristics have radom coefficients. In the estimation, I set the random coefficients only on the following three characteristics: engine displacement, Harley dummy variable and constant term.

ϵ_{ij} is the idiosycratic taste of consumer i for product j, and assumed to follow the type I extreme value. Under this distributional assumption, I have the consumer i's choice probability of brand j,

$$s_{ij} = \frac{\exp\left(\delta_j + \mu_{ij}\right)}{1 + \sum_{l=1}^{J} \exp\left(\delta_l + \mu_{il}\right)}. \tag{6}$$

[5] The mean and variance of income distribution are 24,487 and 15,434 (in terms of 1983 constant USD), respectively.

Then, the market share of product j can be derived by integrating the above choice probability by the income and taste heterogeneity on characteristics. Under the distributional assumptions on y and ν, I have the market share of model j as follows.

$$s_j = \int_\nu \int_y s_{ij} P_\nu (d\nu) P_y (dy), \tag{7}$$

where $\nu \equiv (\nu_1, ...\nu_K)'$, and $P_\nu (d\nu)$ and $P_y (dy)$ are the respective cumulative distribution functions for ν and y. Note that ν is a $K \times 1$ vector, and y is a scalar.

Multiplying the market share by the market size M which is defined as the number of motorcycle owners, I have the demand for product j:

$$q_j = M s_j. \tag{8}$$

4.2 Supply

Next, I describe the firm behavior. Although the motorcycle safeguard took the form of tariff rate quota in reality, I employ the simple tariff model because the tariff-rate-quota is difficult to model under the multi-product oligopolistic competition. Since I neglect the quota and assume all the Japanese motorcycles over 700cc subject to tariff, the effect of safeguard have to be overestimated.

Motorcyle markets are characterized by the multiproduct oligopolistic competition. Time subscript is omitted for simplicity. The profit function of firm f is

$$\pi_f = \sum_{j \in J_f} \left[\left(\frac{p_j}{1 + \tau_j} \right) - mc_j \right] \cdot M s_j, \tag{9}$$

where J_f is the set of brands produced by firm f, τ_j is the tariff rate of product j, and mc_j is the marginal cost of product j.

The first order conditions for the profit maximization problem are

$$\frac{s_j}{1 + \tau_j} + \sum_{r \in J_f} \left[\left(\frac{p_r}{1 + \tau_r} \right) - mc_r \right] \frac{\partial s_r}{\partial p_j} = 0 \tag{10}$$

for $j = 1, 2, \ldots, J$. I can invert this system of equations to solve the marginal cost, that is,

$$\mathbf{mc} = (\mathbf{1} + \boldsymbol{\tau})^{-1} \mathbf{p} - \boldsymbol{\Delta}^{-1} (\mathbf{1} + \boldsymbol{\tau})^{-1} \mathbf{s}, \tag{11}$$

where $\mathbf{p} = (p_1, \ldots, p_J)'$, $\mathbf{s} = (s_1 \ldots, s_J)'$, $(\mathbf{1} + \boldsymbol{\tau}) = \mathrm{diag}(1 + \tau_1, \ldots, 1 + \tau_J)$, $\mathbf{mc} = (mc_1, \ldots, mc_J)'$ and $\boldsymbol{\Delta}$

is $J \times J$ substitution matrix whose (j, r) element is

$$\mathbf{\Delta}_{jr} = \begin{cases} -\frac{\partial s_r}{\partial p_j} & \text{if } \exists f \ \text{ s.t.}(j, r) \subset J_f \\ 0 & \text{otherwise} \end{cases}. \tag{12}$$

$-\mathbf{\Delta}^{-1}\mathbf{ts}$ is the vector of markups for each product and is calculated from the estimation results of demand.

Notice that the matrix $\mathbf{\Delta}$ depends on the assumption of market conduct. For example, each element of the matrix takes non-zero value if all the firms collude.

As shown in equation (11), I can calculate the unobserved marginal cost vector using the price, share and tariff data, and the estimation results of demand. Notice that the substitution matrix in equation (12) is derived from the demand estimation results. Hence, I can estimate the marginal cost function. I specify the cost function as follows.

$$\ln(mc_j) = \mathbf{w}_j\boldsymbol{\gamma} + \omega_j, \tag{13}$$

where $\mathbf{w}_j$ includes the variables that shift the marginal cost and ω_j is the unobserved productivity term of product j. In order to take account of cost differential between U.S. and Japan, w_j includes the U.S. production dummy variable.

5 Estimation

I first explain the econometric procedure in the next section, and then reports the results from the estimation with the description of dataset used in the estimation.

5.1 Estimation Procedure

I outline here the estimation procedure of the demand and cost functions.

Contraction Mapping

Following Berry (1994), I estimate the demand side parameters from mean utility levels $\boldsymbol{\delta}$. Berry (1994) shows the mean utility vector can be expressed as the function of market share under mild regularity condition of consumer tastes. For the logit and nested logit models, I can calculate the mean utility levels analytically, while for the random coefficient models, this calculation is implemented numerically. Berry, Levinsohn, and Pakes (1995) proposes the contraction mapping methods to compute the mean utility levels given the set of parameters $\boldsymbol{\theta}$ that is included in the heterogenous taste on the product characteristics, μ_{ij}.[6] Formally, the contraction mapping procedure is written as

$$\boldsymbol{\delta}_t^{h+1} = \boldsymbol{\delta}_t^h + \ln \mathbf{s}_t - \ln \mathbf{s}_t\left(\mathbf{p}_t, \mathbf{x}_t, \boldsymbol{\delta}_t^h; \boldsymbol{\theta}\right), \ t = 1, \ldots, T, \tag{14}$$

[6] See also Nevo (2000), which provides the transparent guide of the estimation of random coefficient logit models.

where $\mathbf{p}_t$ and $\mathbf{x}_t$ are $J_t \times 1$ vector of price and $J_t \times K$ matrix of motorcycle attributes. $\mathbf{s}_t$ is the $J_t \times 1$ vector of actual market share, while $\mathbf{s}_t(\cdot)$ is $J_t \times 1$ vector of predicted market share computed from eq.(7). [7] Superscript h represents the number of iteration. For a given $\boldsymbol{\theta}$, $J_t \times 1$ vector of mean utility $\boldsymbol{\delta}_t$ is the value $\boldsymbol{\delta}_t^H$ such that the distance between $\boldsymbol{\delta}_t^H$ and $\boldsymbol{\delta}_t^{H-1}$ is smaller than some tolerance level. Since the contraction mapping procedure can be implemented for a given $\boldsymbol{\theta}$, the mean utility vector is a (non-linear) function of $\boldsymbol{\theta}$, i.e. can be expressed as $\boldsymbol{\delta}(\boldsymbol{\theta})$. Notice the mean utility is linear in the unobserved characteristics or demand shock ξ_j. Then, treating ξ_j as an error term, I can estimate the parameters $(\boldsymbol{\beta}, \boldsymbol{\theta})$ from the moment condition related to ξ_j.

Instruments

I now discuss about the identification of the model. As I mentioned, ξ_j can be interpreted as the unobserved characteristics and demand shock, which are observable to the consumers but not to the econometrician. Similar to the standard demand and supply discussion, the error term should be correlated with the price becasue high unobserved characteristics and positive demand shock will shift the demand curve outward. Therefore, the unobserved characteristics ξ_j should be positively correlated with the price.

Due to the endogeneity in price, I employ the instrumental variable technique to estimate the parameters. The instruments should be correlated with the price, but not the unobserved characteristics. I choose the sum of the characteristic k across other own-firm products and the sum of the characteristic across competing firms as the instruments. These set of instrumnents are the first-order approximation of the optimal instruments from the mean independence condition, $E[\xi_j(\boldsymbol{\beta}, \boldsymbol{\theta})|\mathbf{X}] = 0$.[8]

Intuitively, the set of instruments are valid for the following reasons. The competing firms characteristics and own firm characteristics are related to the cost of production and hence the price of the products. Under the multi-product oligopolistic competition, firms decide the price of their products in account of the competing firms' pricing and own pricing. Then, the set of instruments have to be correlated with the price. Since the identification (mean independence) assumption ensures the no correlation between the observed and unobserved characteristics, the set of variables has the desirable properties as the instruments. This set of instruments is frequently used in the discrete choice literature, such as Berry, Levinsohn, and Pakes (1995) and Petrin (2002).

In addition to the instruments that relate to the characteristics, I use the exchange rate as an instrument.[9] Exchange rate would be correlated with price becasue Japanese manufacturers maximize their profit in the Japanese currency unit, that is, changes in exchange rate will affect the Japanese firms' pricing policy. Also, exchange rate can be considered exoneous to the event of motorcycle market.

[7] When deriving the market share, I employ the simulation approach to compute the integer in eq.(7). With respect to the simulation methods, see Train (2003), for example.

[8] Notice that the ξ_j is the function of $\boldsymbol{\beta}$ and $\boldsymbol{\theta}$ because $\xi_j = \delta_j(\boldsymbol{\theta}) - \mathbf{x}_j\boldsymbol{\beta}$.

[9] Exchange rate is often used as an instrument in the analysis of international competition. See Goldberg (1995), Berry, Levinsohn, and Pakes (1999), Goldberg and Verboven (2001), for example.

GMM Estimation

Let $\mathbf{z}_j$ be the vector of instruments for product j, then the demand side parameters are estimated by the nonlinear GMM. The GMM estimator is

$$(\hat{\boldsymbol{\beta}}, \hat{\boldsymbol{\theta}}) = \arg\min_{\boldsymbol{\beta},\boldsymbol{\theta}} \boldsymbol{\xi}(\boldsymbol{\beta}, \boldsymbol{\theta})' \mathbf{Z}\boldsymbol{\Omega}\mathbf{Z}' \boldsymbol{\xi}(\boldsymbol{\beta}, \boldsymbol{\theta}) \tag{15}$$

where $\mathbf{Z} = (\mathbf{z}'_1, \ldots, \mathbf{z}'_J)$, and $\boldsymbol{\Omega}$ is the weighting matrix.

After obtaining the estimated parameters on demand, I can calculate the price cost margin for each product. Since the price for each product were decomposed into the mark-up and marginal cost as shown in equation (11), I can recover the marginal cost for each product. Using the marginal cost as the dependent variable, I estimate the cost side parameters by the heteroscedasticity robust OLS.

Notice that simultaneous estimation of demand and supply is efficient. However, I estimate demand and cost functions separately in order to avoid the biased estimate of demand due to the misspecification of supply that results from the ignorance of quota.

5.2 Estimation results

5.2.1 Demand

I first estimate the demand side parameters. The characteristics variables included in the estimation are engine displacement, dry-weight, number of forward speeds, number of cylinders, and dummy variable for Harley's motorcycles. In addition to the characteristics variables, periodical dummy variables and yearly trend and its squared variables are incorporated in the estimation. These trend variables are allowed to differ between Japanese and Harley motorcycles.

I set the engine displacement, the Harley dummy variables, and the constant to have random coefficients. The random coefficient on the engine displacement represents capture the fact that the purpose of motorcycle usage depends on the size of engine displacement. Several industry sources pointed out the presence of Harley enthusiasts, which implies the heterogenous taste on the Harley's motorcycles. Incorporating the random coefficient on Harley dummy variable allows the existence of Harley freaks in the market. The random coefficient on constant captures the heterogenous taste on the outside option, the choice of non-purchase.

Estimation results are summarized in table 3. In general, most of the coefficients have the expected signs and are precisely estimated: price coefficient is negative, and the coefficients on engine displacement, dry-weight, and number of forward speeds are significantly positive. The standard deviation of engine displacement is significantly different from zero (3.19): the estimate implies that the substitutability among products increase as the sizes of engine displacement get closer. The standard deviation of Harley dummy variable is also significant (2.67). The result implies the existence of taste heterogeneity toward the brand of Harley, which is consistent with the industry description that reports the existence of Harley enthusiasts. The taste heterogeneity for Harley dummy variable indicates that substitution between the models of Harley were seen as much closer substitute than motorcycles of Japanese. Notice that the taste heterogeneity on Harley's motorcycles implies the existence of taste heterogeneity in Japanese motorcycles because the choice set includes only Harley and Japanese motorcycles. Therefore substitution within the models of Japanese is also higher. The close substitutability among Japanese motorcycles indicates a possibility of the case in which FDI-group firms benefited from protection.

In the demand side specification, I include the log of the number of products introduced in each period, following Ackerberg and Rysman (2005). Negative estimate of its coefficient is consistent with the suggestion made by Ackerberg and Rysman (2005), though it is insignificant.

5.2.2 Cost

The cost estimation results are summarized in table 4. The coefficients on the characteristics variables indicate reasonable signs. The coefficient on the local production dummy is significantly positive (0.17), which indicates that production in U.S. needs more cost than that in Japan. Therefore, the benefit of tariff-jumping FDI was mitigated due to the high cost in U.S. In the simulation analysis, I take account of the cost differential between U.S. and Japan.

6 Simulation

In this section, I implement a counter-factual simulation to quantify the effect of tariff-jumping FDI on the domestic and foreign firms' profits. I consider two counter-factual cases: (1) all the Japanese motorcycles were made in Japan and therefore exported with safeguard tariffs, and (2) the safeguard tariffs were not imposed. The results from (1) and (2) reveal the effects of tariff-jumping FDI on domestic firms' profits, and the effects on the profit of the FDI and no-FDI group firms, respectively.

Throughout the simulation analysis, I assume that the the number of products available in each periods and the characteristics of the products in counter-factual are the same as those in actual. Under the assumption and the estimated parameters of demand and cost functions, I solve the equilibrium vector of price and quantity for each motorcycle and then compute the variable profits for each firm.

Table 5 summarizes the effect of tariff-jumping FDI on the domestic firm's profits. The results indicate that the tariff-jumping FDI reduced the benefit from protection by more than 50%, though Harley did not harm from protection. The result is similar to the estimates in Blonigen, Tomlin, and Wilson (2004) that also report the reduction in benefit of more than 50% due to the tariff-jumping FDI.

Simulation of a case of no-safeguard tariffs is summarized in table 6. As shown in the table, although the total effects of protection was negative, Honda and Kawasaki, the FDI group, benefited from protection for some periods: May-Aug. and Sep.-Dec. in 1984, Jan.-Apr. in 1985, Jan.-Apr, May-Aug. and Sep.-Dec. in 1986 for Honda, and Sep.-Dec. in 1984 for Kawasaki. The results are consistent with presumption in theory of tariff-jumping FDI.

7 Conclusion

This paper examines U.S. motorcycle safeguard to measure the effects of tariff-jumping FDI on domestic and foreign firms' profits based on the structural estimation method. Structural estimation of demand and supply and the counter-factual simulation results reveal that tariff-jumping FDI reduced the domestic firm's benefit from protection by more than 50%. In addition, there were some periods when the foreign firm that evaded the safeguard tariffs gained from innovation due to the increased cost of other foreign firms that did not make tariff-jumping FDI.

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Table 1: Safeguard policy: tariff-rate-quota

Time	Tariff rate (%)	Quota (units)
Apr. 1983 - Mar. 1984	45	6000
Apr. 1984 - Mar. 1985	35	7000
Apr. 1985 - Mar. 1986	20	8000
Apr. 1986 - Mar. 1987	15	9000
Apr. 1987 - Mar. 1988	10	10000

Note: The safeguard initially scheduled end in Mar. 1988 but removed in Oct. 1987 upon Harley's request.

Table 2: Estimation results: pass-through regression

Variables	(i) Coef.	S.E.		(ii) Coef.	S.E.		(iii) Coef.	S.E.	
ln(*Exchange rate*)	0.290	0.086	***	0.003	0.201		0.293	0.085	***
*FDI**ln(*Exchange rate*)							-0.005	0.002	
ln(1+*Tariff rate*)	0.391	0.069	***	1.000	0.244	***	0.498	0.083	***
*FDI**ln(1+*Tariff rate*)							-0.210	0.104	
ln(*Engine displacement*)	0.444	0.049	***				0.442	0.050	***
ln(*Dry-weight*)	0.940	0.094	***				0.941	0.095	***
ln(*Speeds*)	0.031	0.041					0.027	0.041	
Constant	0.553	0.575		7.760	1.152	***	0.567	0.572	
Num. Obs.	568			305			568		
R-sq.	0.905			0.634			0.906		

Note: ***significant at 1%, **5%, *10%
Engine displacement are dry-weight are in 1000cc and 1000kg, respectively. Speeds is a number of forward speeds. Issued year dummy variables are included in the estimation but not reported here.

Table 3: Demand estimation result

Variables	(ii) IV Coef.	S.E.	
α	-58.64	24.31	**
Engine Displacement	4.74	2.17	**
Dryweight	14.40	4.75	***
Speeds	0.63	0.11	***
Cylinder	-0.09	0.11	
Age	-0.08	0.02	***
ln(#J)	-0.48	0.55	
Harley	-0.25	1.27	
Constant	-10.68	2.69	***
Engine Displacement	3.19	1.34	**
Harley	2.67	0.64	***
Constant	1.02	0.68	
R^2	-		
J-statistics (degrees of freedom)	23.40 (12)		
1st stage R^2	0.93		
1st stage partial F-statistic	21.61		
Number of observations	785		

Note: ***, **, *, indicate significance at the 99-, 95- and 90-confidence levels.
The variables of engine displacement and dryweight are divided by 1000.
#J represent a number of products in a set J.
Periodical dummy, yearly trend variables are included in the estimation,
but not reported.

Table 4: Cost estimation result

Variables	Coef.	S.E.	
ln(Engine displacement)	0.52	0.06	***
ln(Dryweight)	1.00	0.09	***
ln(Speeds)	0.16	0.08	**
ln(Cylinder)	0.07	0.03	**
Local	0.17	0.02	***
Const	8.60	0.16	***
R^2	0.87		
Number of Observations	785		

Note: ***, ** and * indicate significance at the 99-, 95- and 90-confidence levels.
Local is a dummy variable for U.S. production.
Make dummy variables are included in the estimation, but not reported.

Table 5: Simulation results when no-foreign firms make tariff-jumping FDI

Year	Period	Effects on domestic firm's profit		
		(i) w/o tariff-jumping FDI (mil. USD)	(ii) w/ tariff-jumping FDI (mil. USD)	(iii) Rate of change (%)
1983	May-Aug.	0.98	0.34	65.28
1983	Sep.-Dec.	0.11	0.04	64.17
1984	Jan.-Apr.	0.33	0.11	66.05
1984	May-Aug.	0.95	0.39	59.23
1984	Sep.-Dec.	0.05	0.02	58.29
1985	Jan.-Apr.	0.24	0.13	43.23
1985	May-Aug.	0.24	0.13	44.00
1985	Sep.-Dec.	0.03	0.01	47.29
1986	Jan.-Apr.	0.20	0.10	52.53
1986	May-Aug.	0.18	0.10	43.01
1986	Sep.-Dec.	0.05	0.02	51.04
1987	Jan.-Apr.	0.13	0.07	44.81
	Average	0.29	0.12	53.24

Table 6: Simulation results under no-tariff: A case of foreign firms' benefit from protection

		(i) Actual Profit (mil. USD)					(ii) Counter-factual profit (mil. USD): No-safeguard				
		U.S. firm	FDI group		No-FDI group		U.S. firm	FDI group		No-FDI group	
Year	Period	Harley	Honda	Kawasaki	Suzuki	Yamaha	Harley	Honda	Kawasaki	Suzuki	Yamaha
1983	May-Aug.	8.34	47.26	9.49	9.54	13.16	7.70	63.72	18.69	31.45	60.35
1983	Sep.-Dec.	3.99	14.36	2.53	2.58	3.52	3.92	17.83	6.16	8.20	15.78
1984	Jan.-Apr.	5.66	27.22	4.46	4.71	8.10	5.44	29.39	10.34	16.65	24.24
1984	May-Aug.	9.94	**40.27**	8.57	6.94	14.87	9.37	**39.79**	14.05	16.69	38.31
1984	Sep.-Dec.	2.89	**12.39**	**1.86**	1.34	1.95	2.86	**12.16**	**1.83**	4.42	7.43
1985	Jan.-Apr.	6.49	**21.09**	6.66	2.36	3.95	6.39	**20.44**	9.79	5.92	15.34
1985	May-Aug.	7.75	33.92	11.81	6.30	7.83	7.64	34.69	13.42	10.04	16.04
1985	Sep.-Dec.	4.42	7.56	2.82	1.17	1.37	4.40	8.22	3.34	1.91	2.96
1986	Jan.-Apr.	7.11	**17.87**	5.44	3.71	4.66	7.00	**17.55**	7.13	7.36	9.66
1986	May-Aug.	9.98	**24.44**	8.51	5.38	8.03	9.90	**23.90**	10.09	8.89	12.67
1986	Sep.-Dec.	4.11	**6.37**	2.45	2.17	2.24	4.09	**6.34**	2.83	3.81	3.52
1987	Jan.-Apr.	8.54	13.36	5.65	3.50	6.38	8.48	13.51	6.31	6.24	8.97