The government regulates the official price in a following method. For new pharmaceuticals, the official price ($\overline{P}$) has been determined either by cost information including production and R&D expense, or by comparison with existing similar pharmaceuticals. For already marketed pharmaceuticals, the official price has been determined by the wholesale price (P) as a benchmark. Because the wholesale prices differ significantly by transactions or by hospitals and pharmacies, the Japanese government conducts a nation-wide survey of the wholesale prices before the revision. The government updates the official price by applying the special formula to surveyed data on the wholesale price in market. For example, in 1992 the government adopted the formula called "reasonable zone method" as shown in (1).

$$\overline{P}_t = P_{t-1}(1+u_t) + R_t \cdot (\overline{P}_{t-1} - P_{t-1}) \tag{1}$$

The rate of R_t was initially set 0.15 for fiscal year of 1992. It was reduced in stepwise at every update. As of fiscal year of 2000, R_t was reduced to 0.02. Consumption tax u_t had been 0.03, it was raised to 0.05 after April 1995. The Japanese price regulation affect income of participants.

Economic loss of wholesalers due to lowering the wholesale price is mostly compensated through rebates provided by pharmaceutical firms. A distribution system consisting of pharmaceutical firms, wholesalers, hospitals/physicians, and the National Health Insurance has institutionalized the long-run decline of pharmaceutical price, which fact is quite unique of Japanese pharmaceutical regulation.

3. Estimation Model

a. Hedonic Price Model for the Price Ratio

This study applies "hedonic price model" to data. The simplest hedonic price model is given by equation (2).

$$P_{hit} = \beta^0_{hi} + \sum_{m=1}^{M} \beta^m X_{hit} + \varepsilon_{hit} \tag{2}$$

where price P_{hit} is explained by a constant term, product characteristic X_{hit} and its coefficient β^m, and error term ε_{hit}. Hedonic price is marginal contribution of price with respect to a change in X_{hit}.

$$\frac{\partial P_{hit}}{\partial X_{hit}} = \beta^m \tag{3}$$

This study applies hedonic price model to Japanese pharmaceutical price data. There are three candidates for price indexes; official price $\overline{P}_{hit}$, wholesale price p_{hit} , and the price ratio $\overline{P}_{hit}/P_{hit}$. Because a relationship between the official price and the wholesale price is a special concern in price regulation, we use the price ratio to be accounted for in equation.

$$\Pr ice\_Ratio_{hit} = \frac{\overline{P_{hit}}}{P_{hit}} = \beta_{hi}^{0} + \sum_{m=1}^{M} \beta^{m} X_{hit} + \varepsilon_{hit} \qquad (4)$$

The equation indicates that the "price ratio ($\Pr ice\_Ratio_{hit}$)" defined as the ratio of the official price ($\overline{P}_{hit}$) to the wholesale price (P_{hit}) is explained by a constant term β_{hi}, explanatory variables X_{hit} and its coefficients β^{m}, and error terms ε_{hit}. The subscripts represent the *i-th* "product" of the *h-th* firm's in the *t-th* period. Explanatory variables X_{hit} include various individual product characteristics M_{hi} which vary with products but are constant over time periods. They are product age, generic competiton, strenth, package volume, does form, co-promotion/co-marketing, level of official price (highly priced product).

$$M_{hi} = \{product\ \ age, generic\ \ competitio\ n, strength, package\ \ volume, dose\ \ form, copromotio\ n, level\ \ of\ official\ \ price\} \qquad (5)$$

We distinguish products by marketing firm (h), ingredients (i), and time periods (t). Product profiles M_{hit} are captured by several product-specific dummy variables. Products have different dose forms and strengths. For example, a certain anti-infective has both table and capsule forms of 50mg or 100mg ingredient per unit. Because the prices are applied to each product by dose forms and different strength, we classify individual dummy variables. This study uses "dose forms" by using "capsule and table", and "injection" dummy variables compared with "Powder, Syrup, and Others". Product strength is classified into two "LOW_STRENGTH (weak strength)" and "HIGH_STRENGTH(strong strength) by using the "recommended minimum daily dosage" as criteria. A product faces with competition by generic drug is denoted as "GE_COMPETITION". Because volume discount is applied to the wholesale prices, the price ratio may change by transaction volume. We use "small volume package," "medium volume package", and "large volume package" depending on how many doses in patient-days are transacted in a transaction package. This is particularly important in transaction of capsule and tablet because transaction volume differ significantly, for example, 50 tablets, 100 tablets, and 500 tables. By using the total ingredients in a transaction divided by "recommended minimum daily dosage", we form dummy variables for "small package" (less than 50 patients days)," "medium package (50-149 patients days)", "large package (more than 150 patient days)". Products are classified into "new products" and "old products" by the number of time-periods since the introduction to market[1]. Co-promoted products are defined as "Co-PROMOION". Highly priced product (HIGH_PRICED_PRODUCT) is one that official price for a minimum recommended dosage is higher than 3500 yen (350 Points).

$$\Pr ice\_ratio_{hit} = \mu_{hi} + \sum_{m=1}^{M} \alpha_m M_{hit} + \sum_{y=1990}^{2001} \beta_y T_{hit}^{y} + \sum_{s=1}^{3} \sum_{d=0}^{3} \gamma_{-d}^{s} REV_{hit}^{s}(-d) + \upsilon_{hit} \qquad (6)$$

In addition to product specific characteristics, time dependent variables are included to account for the time-specific effects. First we use "fiscal year dummy variables (T_y)" for each year ranging from 1990 to 2002, which dummy variables take unity when an observation falls into the year. Second we use "time dummy for the period of the official prices revision R_{-d}^{s}, $d = 0,1,2,3$". Price revisions usually occur once in two years. So R_0 is the periods when the official prices are revised (Quarter of April-June of 1990, 1992, 1994, 1996, 1997, 1998, 2000, 2002). In order to examine persistent effects of the price reduction, we use lagged dummy variables by 1 to 3 quarters. The effects of price reduction may differ across time periods, so we use dummy variables depending on three sub-samples, s=1 for the sub-sample 1990-1994, 2 for 1995-1998, and 3 for 1999-2002 fiscal year.

b. Determinants of Demand

The second empirical question is how pharmaceutical demand is determined in Japan. Based on economic theory, demand for a product is usually specified as a function of prices and income. Japanese pharmaceutical demand, however, requires a different specification. Because major part of medical expenditure is paid by the insurer, the insured only paid 20 or 30 percent medical expenditure as co-payment. Under this institutional setting, physicians prescribe drug, they are not concerned with patient's income but with the official price and the wholesale price. We specify a demand equation (7) where demand for pharmaceutical (q_{hit}) depends on three types variables as explanatory variables. They are price related variables ($price_{hit}$), individual characteristics variables (M_{hi}), and time related variables ($time_t$). This study uses panel data of the h-th firm's i-th product at –th period. Among them price related variables ($price_{hit}$) vary with h-th firm and i-th product and t-th time period. Individual characteristics

[1]To be more specific, each product is defined by the "four years plus periods since the introduction multiplied by 0.21 as mean laps of the years. Sample observations are classified into "old products" whose years of lapse is longer than the average on rolling base.

(M_{hi}) are assumed to vary with h-th firm's i-th product but be constant over time periods.

$$q_{hit} = f\{price_{hit}, M_{hi}, time_t\} + \varepsilon_{hit} \tag{7}$$

In equation (7), there are three price related variables including the official price ($\overline{P_{hit}}$), wholesale price (p_{hit}), and the price ratio ($\overline{P_{hit}} / P_{hit}$). Individual characteristics (M_{hi}) in a previous section are used to account for product-specific effects on demand. Time related variables ($time_t$) are assumed to be constant with h-th firm's i-th product. As time related variables, this study uses "each quarterly period dummy variables" as ($Q\_YearMonth_t$) where $YearMonth$ stands for the beginning month of each period. In order to account for the quarterly effects of the official price revision, this study uses time dummy variables by denoting them as ($Q\_YearMonth$). In order to capture the effects of the periods when the government revises the official price, we use time dummy variables around the periods when the official prices are revised. For the seasonally time effects, "quarterly dummy variables ($QUARTER\_d_t$) are used as d=1 for April-June period, d=2 for July-September period, d=3 for October-December period, and d=4 for January-March period. For year effects, "year dummy variables "($YEAR\_Y_t$)" are used for periods representing fiscal year. To capture the structural change over periods, this study also uses "sub-sample period dummy variables (S_Period_t)" for the period of 1990-1994, 1995-1998, and 1999-2002. Because quarterly effects differ in the sub-sample, we construct the "the price revision dummy variables ($\mathrm{Re}vision_t$)" as a product of S_Period_t and $QUARTER\_d_t$.

This study measures demand for a product in number of "patient-days" which is constructed based on a recommended standard minimum dosage. The price of a product is measured in prices for a patient-day. The price differs significantly across products. In equation for estimating demand, we use price and quantity in percent change. This general specification has some drawbacks. First, because the official prices change only in periods when the official prices are revised, the changes in the official price ($\Delta\overline{P_{hit}} / P_{hit}$) take zero value for most observations. Second, when the official price is reduced, wholesale prices are reduced accordingly to fend off rival products. Our trial estimation does not yield significant coefficients for the official price and the wholesale price when they are included with the price ratio. So we specify equation (8) instead.

$$\frac{\Delta q_{hit}}{q_{hit}} = \delta\left(\frac{\Delta(\overline{P}_{hit}/P_{hit})}{\overline{P}_{hit}/P_{hit}}\right) + \sum_{m=1}^{M}\phi_m M_{hit} + \sum_{d=1}^{4}\eta^d QUARTER\_d_{hit} + \sum_{n=1}^{N}\omega^n (Q\_YearMonth)_{hit}^n + \varepsilon_{hit} \tag{8}$$

In order to examine the effects of year and quarterly period for the period of the official price revision, we also specify equation (9).

$$\frac{\Delta q_{hit}}{q_{hit}} = \delta\left(\frac{\Delta(\bar{P}_{hit} / P_{hit})}{\bar{P}_{hit} / P_{hit}}\right) + \sum_{m=1}^{M}\phi_m M_{hi} + \sum_{d=1}^{4}\eta^d QUARTER_t^d + \sum_{y=1990}^{2001}\psi_y T_{hit}^y + \sum_{s=1}^{3}\sum_{d=0}^{3}\eta_{-d}^s \ REV_{hit}^s(-d) + \varepsilon_{hit} \tag{9}$$

An econometric problem arises because there is an endogenous relationship between demand and the price ratio of a product. This is due to the fact that the firm lowers the wholesale price when it faces with declining demand. We estimate (8) by instrumental variable (IV) method. As instruments of $(\Delta\overline{P_{hit} / P_{hit}})$, we use current and one period lag of the official price, current and one period lag of the wholesale price, and one period lag of the price ratio.

4. Data

This study uses popular 36 ingredients of anti-infective or antibiotics marketed in Japan (Table 2)[2]. This study classifies "product" based on "firm", "ingredient", "dose form" (e.g. "capsule & tablet", "injection", or "syrup, powder, and others"), "strength" (weight of ingredient in a unit of product, e.g. 100mg or 200 mg in a tablet), "transaction volume" in a package (e.g.100 capsules or 500 capsules for transaction purpose). The official price of each product is taken from "*Yakka-kijyun Ten-su Hayami-Hyo* ("Official Price List" in Japanese". In Japan, data on the wholesale price (p_{hit}) and transaction volume are collected and compiled by various wholesalers for their internal. This study uses a data set provided by a major wholesaler for research use. It covers all transactions of products in Tokyo and other two metropolitan prefectures (Chiba, Kanagawa) in the period between January 1990 and July 2002.

The official price and the wholesale price are defined for each product based on "standard daily dose", which is based on "recommended daily dose" of a product for an average adult. The recommended daily dose is taken from a formal label of pharmaceutical product collected in Mizushima et al. "*Kon-nichi no Chiryoyaku,1999* ("*Today's Pharmaceutical Products* " in Japanese). The quantity of transaction volume is converted to "patients days" based on the standard daily dosage. Products are classified into "old product" and "new product" depending on whether years at market exceed the sample mean or not. Marketed date for a product is taken from Kokusai Syogyo Syuppan,

[2]Data is drawn from the same data set in Anegawa (2005).

"*Kokusai Iyakuhin Jyoho* (biweekly)". "Strength" of each product is measured as the ratio of the "strength" of the product to the "standard strength." Dummy variables for "LOW_STRENGTH" is assigned to products whose ratio is less than unity, "HIGH_STRENGTH" to products equal and more than unity. Dummy variables of "GE_COMPETITION" are assigned to products which has generic versions. "CO_PROMOTION" are assigned to products which are co-promoted or co-marketed by other firms. Data on existence of generic products and a status of co-promotion or co-marketing is taken from "*Yakka-kijyun Ten-su Hayami-Hyo*". "Package volume" is measured in the number of "patients-days" in a package unit. Dummy variables for "Small Package" is assigned when a product has less than 50 patients days in a unit package, "Medium Package" between 50 and 150, and "Large Package" more than 150. "All Sample" data is constructed by limiting "product" to those with a popular dose form, strength, package volume, and enough number of transactions in a record. "All Sample" is decomposed into subsets depending on product profiles by "dose form" ("Capsule & Tablet", "Injection", and "Syrup, Powder, and Others") or by "package volume". "All Sample" is divided into subsets by time periods, 1990-1994, 1995-1998, 1999-2002.

5. Empirical Results

a. Determinants of the Price Ratio

In this section, we report estimation results accounting for "price ratio" ($\overline{P}_{hit}/P_{hit}$) by applying "hedonic price model" to data. Table 3 and Figure 1 show that the median "price ratio" was high as 1.40 in 1990. It implies that there is 40 percent difference between the official price and wholesale price. The ratio, however, has continued to decline to 1.12 in 2000. This reflects the official price reduction by the government. In particular, the "new price control regime" introduced in 1992 and the official price reduction n 1992, 1994, 1996, 1997, 1998 contribute to the decline of the ratio. The variance of the price ratio has been shrunken significantly through the period. The downward trend, however, seems to reach the bottom in the late 1990s, and the price ratio has started to increase recently. The government's efforts are no longer effective to reduce the price ratio.

—Table 3—

—Figure 1—

This study uses three types of explanatory variables; individual characteristics, year dummy variables, and quarterly dummy variables. First we focus on the traditional effects of individual characteristics. This study uses product age after marketing (OLD_PRODUCT), existence of generic competition (GENERIC_COMPETITION), product with high strength (BRAND_HIGH_STRENGTH), transaction volume per package (MEDIUM_PACKAGE, LARGE_PACKAGE), co-promotion with other firms (COPROMOTION). We distinguish dose forms into capsule and tablet (CAPSULE & TABLET), injection (INJECTION), and others (SYRUP,POWDER, OTHERS), Instead of pooling all observations, we divide sample periods into three sub-samples, 1990-1994, 1995-1998, 1999-2002. Table 4 and 5 summarize the estimation of the price ratio by OLS.

Because old products lower both official price and wholesale price, the ratio of two prices may or may not be large. Our estimates show that coefficient of "OLD_PRODDUC" is insignificant. When we divide the sample into three periods, coefficient is positive (0.090) in the first period, and negative (-0.041) in the third period. Generic competition has negative effects on the third period (-0.035). We can infer that although old products have higher price ratio in the early 1990s either by maintaining high official price or low wholesale price, which facts disappear in the second and third period. Highly priced product (HIGH_PRICED_PRODUCT) has positive effects in the first period (0.068) and its coefficient is much larger in the third period (0.124). We conclude that that the price ratio has been changed to a situation where new and highly priced products have higher price ratio. Compared with "Powder, Syrup, and Other Forms", capsule and tablet used to have negative effects on the price ratio in the first period (-0.062), while it turns to be positive in the third period (0.061). Products with high strength (BRAND_HIGH_STRENGTH) have higher coefficient by 0.062 compared with products with low strength. "LARGE_PACKAGE" has positive and large coefficient as much as 0.183 compared with "SMALL_PACKAGE". The wholesale prices of products sold in a large package are more discounted than in small package. Compared with "Powder, Syrup, and Other" dose forms, "INJECTION" has higher ratio by 0.042, while "CAPSULE & TABLE" form is not significantly different from zero. Co-promoted products have substantially higher coefficient (0.104), which indicates that they either maintain higher official price or lower wholesale price due to co-promotion[3].

In addition to individual characteristics, this study investigates time effects in determining the price ratio. We find that coefficients of year dummy variables (YR_1991, ... YR_2002) are all significant. By transforming equation (6) without a constant term, we estimate effects of each year starting from "YR_1990" to "YR_2002".[4] Coefficients show

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[3]We need to adopt different method to examine which cases hold.

[4]When all year dummy variables are used, they are perfectly correlated with a constant term. So first I"YR_1990" is dropped from an equation, and coefficients of each year dummy variables should be interpreted as the effects of the year compared with those of year 1990. Next a constant term is dropped from equation, and coefficients for each year is interpreted in a straightforward manner.

that year dummy variables have declined from 1.61 for YR_1990 to 0.92 for YR_1998. This downward trend reaches the bottom in 1998 and is reversed. We also investigate the effects of quarterly dummy variables for official price revision. We divide period into sub-sample to first period (1990-1994;FP), second period (1995-1998, SP), and third period (1999-2002;TP). FP_REVSION_D takes unity for the period of April 1990, April 1992 and April 1994. In order to capture persistent effects, we us lagged dummy variables by one, two , three periods (FP_REVISION_D{1}, FP_REVISION_D{2}, FP_REVISION_D{3}). Quarterly dummy variables for the official price reduction have negative effects on the price ratio in the first period 1990-1994, while the same effects are not found in the second and third period. In response to the official price revisions, wholesalers do not lower the wholesale price in 1990, 1992, and 1994, while they lower the wholesale price accordingly in the second and third period.

Our estimation has small R-squared (0.227) and low Durbin=Watson Ratio (D.W.Ratio=0.136). These results imply that some important explanatory variables are omitted in our specification. Possible individual characteristics might be those related to product safety, effects, and quality.

— Table 4 —

— Table 5—

b. Determinants of Demand

Table 6 reports results based on equation (8) for "All Sample", "Capsule & Tablet", and "Injection".

$$\frac{\Delta q_{hit}}{q_{hit}} = \delta\left(\frac{\Delta(\overline{P}_{hit} / P_{hit})}{\overline{P}_{hit} / P_{hit}}\right) + \sum_{m=1}^{M}\phi_m M_{hi} + \sum_{d=1}^{4}\eta^d QUARTER\_d_{ht} + \sum_{n=1}^{N}\omega^n (Q\_YearMonth)^n_{ht} + \varepsilon_{hit} \qquad (8)$$

—Table 6—

Coefficient of the "change in the price ratio" is 0.410 and significant, which result should be interpreted that 1 percent increase in the price ratio would increase demand by 0.41 percent. The effects are much higher for the sub-sample for "Capsule & Table" (3.557) and negative for "Injection" (-0.346). In particular, demand for "Capsule & Tablet" is highly elastic with respect the price ratio compared with other dose forms. These results accord with the previous literatures as Nanbu and Shimada (2000), Onda and Sato (2002)). We conclude that although the price ratio itself decreased substantially, it is still an important determinant for pharmaceutical demand.

Product age dummy variables (OLD_PRODUCT) do not affect demand, and generic competition

(GE_COMPETITION) has weak positive effects on demand (0.033 for "All Sample"). "LARGE_PACKAGE" do not promote demand. "HIGH_STRENGTH" ,"COPROMOTION", and "HIGH_PRICED_PRODUCT" do not affect demand. These individual characteristics are either unimportant determinant for demand. We need to be cautious about the interpretation since the individual characteristics must be captured by the price ratio itself. So the effects of individual characteristics in this specification is those for unexplained by the price ratio. Also policy makers should be cautious when they implement the price regulation. The government seems to apply the same universal method to all products without accounting for individual characteristics. But in reality, the effects of the prices ratio differ significantly across dose forms.

We also find that demand fluctuates significantly over time periods. The QUARTER3 (October-December) dummy variable has a large positive effect (0.355) while fourth quarter (January-March) has negative effect (-0.259). Similar results are found for "Capsule & Tablet" and "Injection". This may reflect actual transactions between hospitals/pharmacies and wholesalers. We can conclude that demand will surge in the third quarter and decrease in the fourth quarter. This result, however, does not allow a straight interpretation since Japanese wholesalers negotiate the sales price long after they supplied products to hospitals/pharmacies. It takes sometime several months after delivery. We need more information to analyze the reasons behind the demand fluctuation over quarters.

Period time period dummy variables are assigned to the period for price revision in 1992, 1994, 1996, 1997, and 1998 and 2000. We exclude 1990 and 2002 official price revisions due to small number of observation. In the period of the official price revision, we find large increase in demand (all periods except for Q_199204 and Q_199704 for "All Sample", and all periods for "Capsule & Tablet". These effects are fairly short and do not persist more than two quarters. We conclude that when the government reduces the official prices, it would decrease demand through the shrinking price ratio, but would increase demand in the period. This implication is very important in price regulation. When the government revises the official price, it does not account for the change in demand caused by the revision. In fact, the price revision could increase demand for product significantly.

Next we use equation (8) to assess year effects and quarterly effects for the official price revision.

$$\frac{\Delta q_{hit}}{q_{hit}} = \delta\left(\frac{\Delta(\bar{P}_{hit} / P_{hit})}{\bar{P}_{hit} / P_{hit}}\right) + \sum_{m=1}^{M} \phi_m M_{hi} + \sum_{d=1}^{4} \eta^d QUARTER_t^d + \sum_{y=1990}^{2001} \psi_y T_{ht}^y + \sum_{s=1}^{3}\sum_{d=0}^{3} \eta_{-d}^s \; Subperiod\_REVISION_{ht}^d + \varepsilon_{hit} \tag{9}$$

Time effects include "quarter effects". The effects of the price revision are estimated by the "year time variables" for each year, and the product of quarterly dummy variables and sub-sample period dummy variables. In order to evaluate lingering effects of the price revision we use one to three quarters lag for the variables. This specification assumes that effects of the official price revision may continue in the same fiscal year and that quarterly effects are different in the periods with or without the official price revision. Table 7 reports the results.

— Table 7—

Coefficients of year dummy variables are all positive. Years with the official prices revision (1990, 1992, 1994, 1996, 1997, 1998), they all increase demand significantly, while years without the official price revision, their positive effects are limited. This result does not hold for year 2000 as show by small coefficient of YR_2000. We conclude that official price reduction has long increased demand up to 1998. Because we do not have many observations after 2000, we cannot conclude whether these effects become smaller latterly.

When compared estimation of equation (8) with that of (7), quarterly effects have the same effects which indicates there are decline in demand in the QUARTER1, QUARTER2, and QUARTER4. We find that coefficients for quarterly dummy variables for the first period and second periods are all significant ($Subperiod\_Q\_\mathrm{Re}v_{-d}$). When we do not include these sub period quarterly dummy variables for the official price revision, explanatory power of the model declines significantly. Figure 3 depicts the constructed sum of the effects of year dummy variables, quarterly dummy variables, and quarterly dummy variables for price revision in three periods. For example, the effects in year 1992, quarter 1 , and the price revision effects are constructed as follows.

$$\frac{\Delta q_{hit}^{E}}{q_{hit}^{E}} = +1.230(YR\_1992) - 0.363(QUARTER\ 1) - 0.780(FP\_\mathrm{Re}\,vision\_D) = 0.088$$

Figure 3 is the constructed estimates of effects of year and quarter. The official price revision previously increases demand significantly, while years without revision have negative effects on demand. These negative effects, however, almost disappear after the late 1990s.

—Figure 3—

6. Conclusion

This study investigates price regulation and competition in Japanese pharmaceutical market. The price regulation has established a long-term downward trend of pharmaceutical prices in Japan. The price difference between the official price and the wholesale price has played a key role in pharmaceutical market. This study investigates two empirical questions. One is how the price difference ratio (divided by the official price) is determined. The other is how demand for each product is determined. We focus on various product profiles including "age", "corporation " , "ingredient", "form", "strength", "package volume transaction", "generic competition", "co-promotion/co-marketing". We also focus on "quarterly effects" on the price difference and demand. This study uses detailed transaction data on popular anti-infective and cardio-vascular products in 1990-2002 when the government had conducted aggressive price reduction.

This study finds that the price difference ratio is explained by individual characteristics in the framework of "hedonic price model". The ratio is higher for "co-promoted products", "higher strength products", "larger package volume product", "INJECTION" form, and "HIGH_PRICED_PRODUCT". However, the ratio is found to be lower for products facing with generic competition (GE_COMPETITION). There is no difference between "OLD_PRODUCT" and "NEW_PRODUCT". The structural change is found to exist between the early 1990s (1990-1994) and the rest of the period. Although OLD_PRODUCT enjoyed higher price ratio in the early 1990s, its effects disappeared in the late 1990s.

This study also finds that demand for product is well explained by our model. The price ratio is an important determinant of demand. Individual characteristics do not capture demand. It might be due to the fact they are already reflected in the differences in the price ratio as shown in our hedonic price model. Significant differences in dose forms are found. Our model explains demand for "Capsule & Tablet" while it fails to explain demand for "Injection".

This study concludes that Japanese pharmaceutical price regulation has significantly affected pharmaceutical prices as well as demand. Because the government applies the same pricing formula to all products, it does not reflect product-specific characteristics. In particular, it fails to capture the differences between "Capsule & Tablet" and "Injection". The government should take the unexpected response of the regulation into account. In particular, the official price reduction could increase demand. These results have policy implications for countries like Taiwan, Korea, and others who have newly establish a nation-wide health insurance and are committed to tight price regulation.

This study evaluates Japanese pharmaceutical price regulation by using anti-infective products. This study finds that the "price difference ratio (Dif)" had declined to 10 percent in 1998. The trend, however, was reversed after 1998. There is a structural change of the effects of price regulation between the first period (1990 1Q-1998 2Q) and the second period (1998 2Q-2002 2Q). In the first period, "old product", "high strength", "large package" increase the price difference ratio. "Capsule & tablet" and "old product" contribute to higher demand. In the second period, "large package" increase the price difference ratio. Suppliers can increase demand for "capsule & tablet" by the combination of "old product" and "medium strength" for smaller package, or by "high strength" for larger package. The effects of the price difference ratio are high for the "large package" in the second period.

Although the government seems to have achieved the goals as intended, our interpretation is not that straightforward. The effects of the "price difference ratio" on demand have become even larger, in particular for large package. The role of the price difference has not yet disappeared. To promote demand, suppliers can target hospitals and pharmacies that purchase products with high volume and discount. The upward trend of the price difference ratio after 1998 can be explained by this behavior. Regulators should be cautious about the differences in product profiles when they implement pharmaceutical price regulation. In particular, when they apply the uniform price formula, suppliers and consumers could react to it by utilizing differences in product profiles, which might cause unintended results.

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Table 1. Pharmaceutical Transactions and Prices

Pharmaceutical Firms

↓ ···············Manufacturer's Sales Price P^M (listed price)

Wholesalers

↓ ···············Wholesale Price P^W

Hospitals/Pharmacies

↓ ···············Official Price $\overline{P}$ for the National Health Insurance Purpose

Patients

Table 2. Sample of Anti-infective Products

	Brand Name	Ingredient Name
#1	Cefspan	cefixime
#2	Cefmetazon	cefmetazole sodium
#3	Dalacin	clindamycin
#4	Tarivid	ofloxacin
#5	Tienam	impenem/cilastatin
#6	Doyle	aspoxillin
#7	Tosuxacin	tosufloxacin
#8	Tomiron	cefteram pivoxil
#9	Tomiron	cefteram pivoxil
#10	Baccidal	norfloxacin
#11	Pasetocin	amoxicillin
#12	Pasetocin	amoxicillin
#13	Banan	cefpodoximine proxecil
#14	Panimycin	dibekacin sulfate
#15	Halospor	cefotiam hydorochloride
#16	Pansporin	cefotiam hydorochloride
#17	Biklin	amikacin
#18	Firstcin	cefozopran hydrochloride
#19	Farom	faropenem sodium
#20	Flumark	Enoxacin
#21	Flomox	cefacpene pivoxil hydrochloride
#22	Bestcall	cefmenoxime hemihydrochloride
#23	Penglobe	bacampicillin hydrochloride
#24	Pentcillin	piperacillin sodium
#25	Fosmicin	Fosfomycin
#26	Miocamycin	midecamycin acetate
#27	Minostacin	minocycline hydrochloride
#28	Minomycin	minocycline hydrochloride
#29	Meiact	cefditoren pivoxil
#30	Megalocin	fleroxacin
#31	Meropen	meropenem trihydrate
#32	Modacin	ceftazidime
#33	Unacin	sultamicillin
#34	Rasenazolin	cefazolin sodium
#35	Ricamycin	rokitamycin
#36	Rulid	roxithromycin

(資料2)

Geographical Variance and Convergence of Medical Cost in Japan

(Presentation Summary)

Presented at the 5-th World Congress of the International Health Economics Association

論文口頭発表用資料

Anegawa Tomfoumi

July 2007

1. Motivation

a. existing literature

Cutler David and Louise Sheiner (1999) "The Geography and Medicare" *Federal Reserve Board Working paper.*

Wennberg, John E. Elliott S. Fisher, and Jonathan S. Skinner (2002) "Geography and the Debate Over Medicare Reform,", *Health Affairs, Web Exclusive* reappeared in *Health Affairs* "Variations Revisited" in 2004.

Tokita Tadahiko, Tetsuro Chino, and Hedeaki Kitaki, "Health Care Expenditure and the Major Determinants in Japan," *Hitotsubashi Journal of Economics,* 41(1), 1-16, 2000

b. Why do we study Japanese case?

- Wide geographical variations
- Japanese government's political agenda

The government is currently investigating the method to contain medical expenditure which is expected to grow rapidly due to the increase in the aged population. Currently share of medical cost is 8 percent of GDP, which level is expected to grow due to aging of the population.

National Health Insurance plan (NHI) has long provided universal medical service for Japanese with 20 to 30 percent co-payment.

This NHI is no longer sustained without the increase of insurance premiums and co-payment.

The government is planning to contain medical expenditure.

The government finds the wide variation of medical expenditure Japan, while there are no similar variations of life expectance or quality of life (QOL).

c. Background of Japanese Medical Expenditure

Figure Japanese medical expenditure

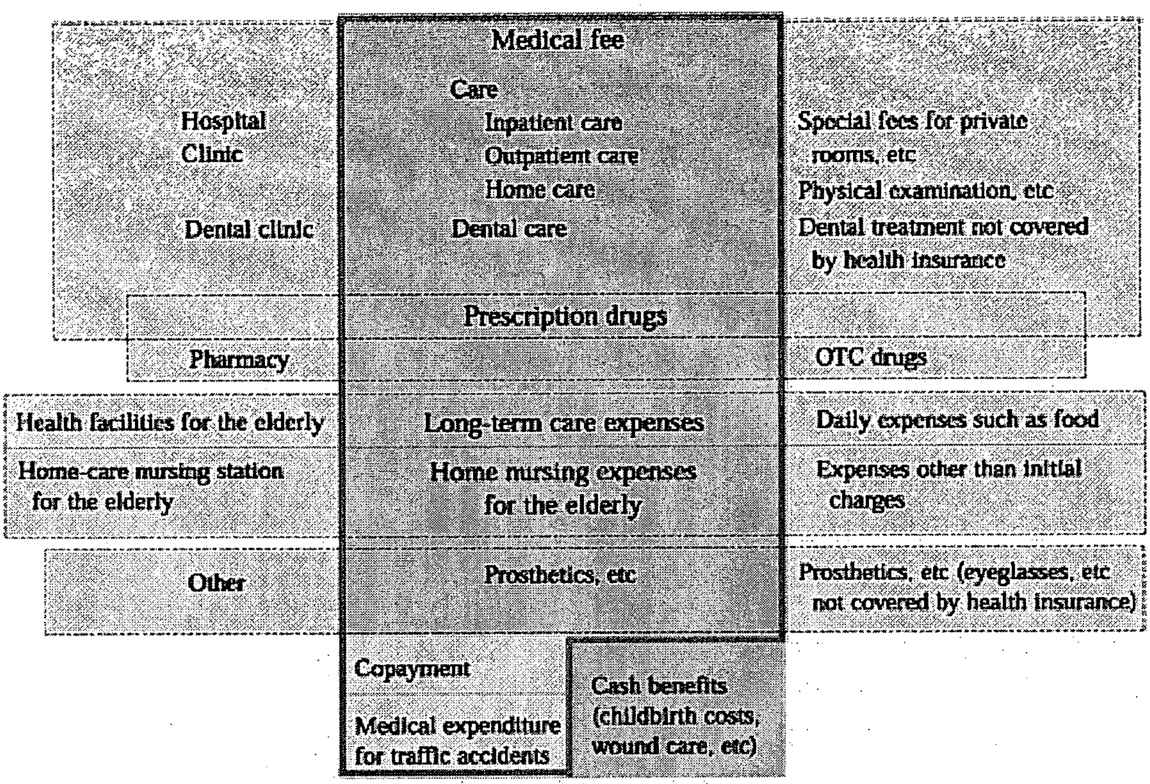

Figure 2. National medical expenditure (▭) and major items covered by insurance (░).

Source: web of the Japan Pharmaceutical Manufacturers Association(JPMA).

Figure 2. Japanese Medical Expenditure

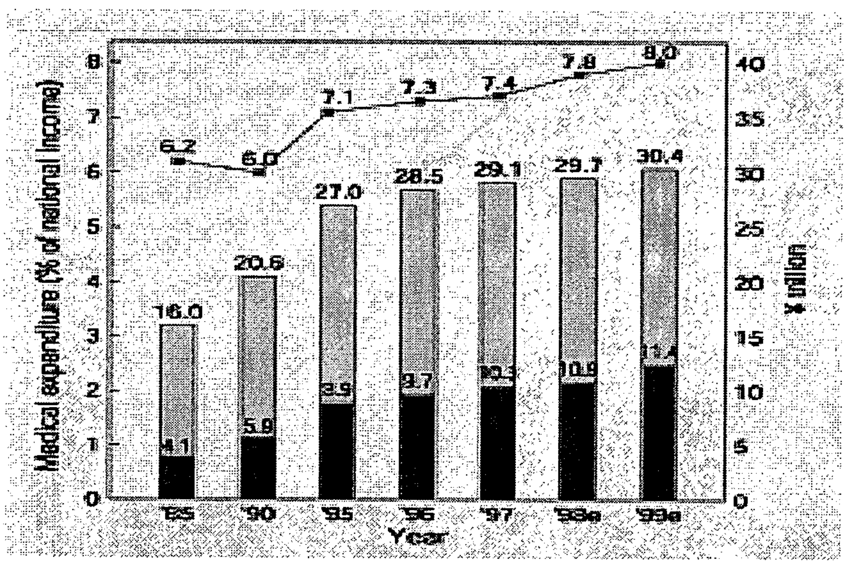

Figure 3. Trends in national medical expenditure. — Medical expenditure as a percentage of national income; ▒ total medical expenditure (¥ trillion); ▓ medical expenditure for the elderly (¥ trillion); e, estimate.

Source: web of the Japan Pharmaceutical Manufacturers Association(Japan Pharmaceutical Manufacturer's Association).

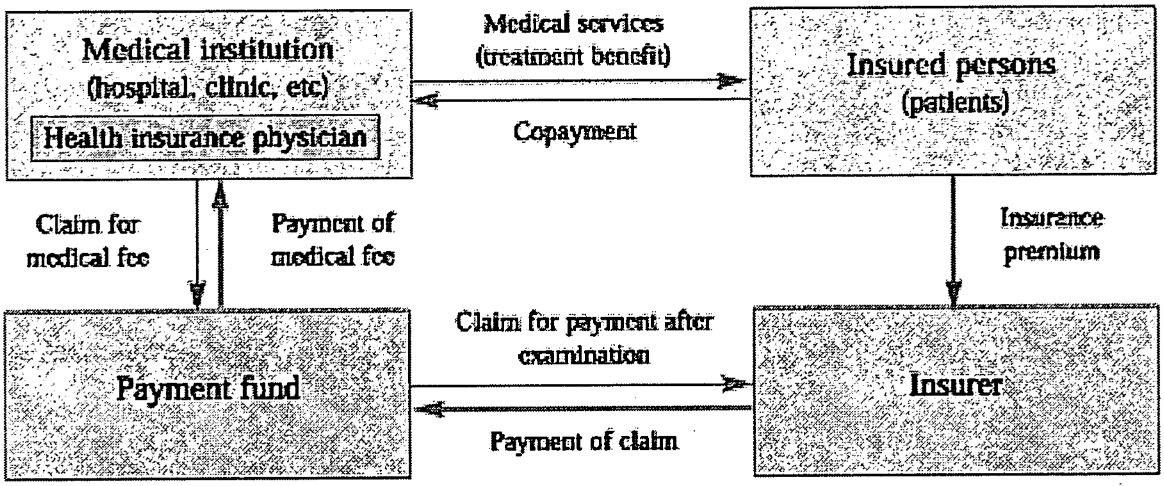

Figure 1. Outline of health insurance payment system.

Source: web of the Japan Pharmaceutical Manufacturers Association(JPMA).