THE DEMAND FOR CIGARETTES IN JAPAN: IMPACT OF INFORMATION DISSEMINATION ON CIGARETTE CONSUMPTION

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The authors present a theoretical derivation of cigarette demand and estimate the demand in Japan with prefecture-level data. By examining the impact of information dissemination regarding the health hazards of smoking, the authors argue that information dissemination is an effective instrument of public health policy, supplementary to cigarette taxation and antismoking ordinances. (*JEL* D12, H51, I18)

I. INTRODUCTION

This study of cigarette demand in Japan was motivated by two stylized facts. First, Japan has by far the highest per capita consumption of tobacco among industrialized countries according to the data published by the World Health Organization (WHO). (See Table 1 for details.) Second, despite massive warnings of the sharp rise in smoking-related costs in Japan, as reported, for example, in the *Economist* (November 4, 1995), studies of smoking-related issues conducted by economists in Japan are practically nonexistent. This paucity is documented by the reference search CD-ROM compiled by the Library of the Diet. Only one paper exists (Haden, 1990), and it is not concerned with the public health aspect of smoking. The first objective is, therefore, to break ground in this unexplored area.

The second objective is to estimate Japanese cigarette demand and to evaluate the postulation that information dissemination about the health hazards of smoking plays an important role in affecting per capita cigarette consumption, in addition to the effects of price and income. Instead of merely positing a regression equation, the article derives the cigarette demand function by explicitly introducing a household or personal production function into utility maximization à la Becker and Stigler (1977). This approach enables us to exclude the inexplicable differences in preferences among individuals living in different prefectures and to attribute all differences among prefectures to differences in price, income, and information dissemination.

Before engaging in the main body of the study, the article presents a brief and inexhaustive review of previous studies of smoking-related issues outside Japan.

Smoking-related issues have been of interest to economists for many decades. One such study dates back as early as Schoenberg (1933) who conducted a statistical analysis of cigarette consumption for the 1913–31 period and gave a brief history of cigarette consumption dating back to 1864 when the manufacture of cigarettes began in the United States. Research topics on smoking are varied. First, almost all studies cover the topic of price

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ABBREVIATIONS

JT: Japan Tobacco Inc.
NGO: Nongovernmental organization
OLS: Ordinary Least Squares
WHO: World Health Organization
WLS: Weighted Least Squares

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TABLE 1
Annual Per Capita Consumption of Manufactured Cigarettes and Smoking Rate (Major Industrialized Nations)

Country	1980–82	1990–92	Male (%)	Female (%)	Data Year
Austria	2,620	2,210	NA	NA	
Belgium	2,880	2,310	NA	NA	
Canada	3,800	2,540	31	29	1991
Denmark	2,020	1,919	NA	NA	
France	2,080	2,120	40	27	1993
Germany	2,420	2,360	37	21	1992
Japan	3,430	3,240	59	15	1994
Luxembourg	2,580	2,080	NA	NA	
Netherlands	3,290	2,820	36	29	1994
Norway	1,950	1,830	36	35	1994
Spain	2,440	2,670	48	25	1993
Sweden	1,840	1,550	22	24	1994
Switzerland	3,060	2,910	36	26	1992
United Kingdom	2,740	2,210	28	26	1994
United States	3,560	2,670	28	23	1989

The degree of male dominance of a country appears to be reflected in the degree of disparity in the smoking rate between men and women (i.e., the stronger the male dominance of a country, the higher the male smoking rate and the lower the female smoking rate, hence, the greater the disparity in the smoking rate between men and women). Although the United States addresses the smoking issue specifically to young people, those male-dominant countries must pay attention in the same vein to a rise in the smoking rate expected among women. This warning becomes even more alarming when we consider the addictive nature of smoking and the significance of the presence of "mothers" at home and in society.

Source: The consumption data are obtained from WHO, "Tobacco or Health: A Global Report," available online at www.cdc.gov/nccdphp/osh/who/. The figures are number of cigarettes consumed by people who are 15 years of age or older. The smoking rate data are obtained from WHO, www.who.int/psa/toh/Alert/apr96/.

elasticity of cigarette demand and have found that smokers are sensitive to price increases. These studies suggest that taxation is an effective instrument of public policy in that an increase in cigarette excise tax significantly reduces smoking. Chaloupka and Wechsler (1997) present a recent compact review on price elasticities of cigarette demand. For the Canadian experience, see Galbaith and Kaiserman (1997). Galbraith and Kaiserman (1997) and Lewit et al. (1982) deal with a slightly different but closely related topic, namely, price elasticities of smoking participation.

Another important issue to economists is whether price elasticities of cigarette demand differ among different age groups. Chaloupka and Wechsler (1997), for instance, find that young smokers are more sensitive to price increases than are adult smokers, though Chaloupka (1991) and Wasserman et al. (1991) earlier rejected this hypothesis.

A third research topic on smoking concerns the question of whether or not the "health scare" evoked by the 1964 U.S. Surgeon General's Report and antismoking commercials have had negative effects on cigarette consumption. Hamilton (1972), and Kao and Tremblay (1988) find evidence supporting the "health scare" hypothesis, whereas Bishop and Yoo (1985) find evidence otherwise.

The impact of cigarette advertising ban on smokers' behavior is another important research topic. Stewart (1993) using Organisation for Economic Co-operation and Development data and Duffy (1996) reviewing international studies of the impact of advertising on cigarette consumption reject the hypothesis that there exists a strong relationship between cigarette advertising and consumption. However, Tremblay and Tremblay (1997) counter the Stewart-Duffy argument by identifying two areas of advertising impact: one is directly on the demand

function and the other is on the quantity demanded through the producers' move to increase the price as a result of reduced competition caused by the advertising ban. Thus, they conclude that advertising bans reduced cigarette consumption. Eckard (1991), viewing the 1971 advertising ban as an experiment to test the related hypothesis that advertising bans reduce competition among producers, renders support to the Tremblay-Tremblay argument.

A fifth issue that economists have been trying to resolve is whether regulations and ordinances banning or restricting smoking in public places and private worksites reduce cigarette consumption and hence promote the health and welfare of people. In spite of using different data sources, Chaloupka (1991), Chaloupka and Wechsler (1997), Hsieh et al. (1996), and Keeler et al. (1993) all find supporting evidence that smoking bans in public places and private worksites reduce cigarette consumption. Further, Keeler et al. (1993) note that the introduction of a variable for antismoking regulations and ordinances cuts price elasticities of cigarette demand in half, but the other studies report no such findings.

Finally, research work has been conducted to examine whether smokers' behaviors conform to "rational addiction." The notion of rational addiction pivots on the concept of consumption capital (sometimes referred to as personal capital). It is postulated that current consumption depends in part on past consumption, which accumulates as consumption capital. Current consumption will contribute to the accumulation of future consumption capital on which future consumption in part will depend. Thus, past choice, current choice, and future choice are all interconnected via consumption capital. Therefore, a model of rational addiction is tantamount to maximization of the individual's lifetime utility subject to (1) the lifetime budget constraint and (2) the consumption capital accumulation process. The notion of rational addiction and that of consumption capital are introduced by Becker and Stigler (1977) and further developed by Becker and Murphy (1988) and Becker et al. (1991). The rational addiction models have been empirically tested in detail by Chaloupka (1991) and Becker et al. (1994), whereas many others have used models in which current consumption depends in part on the past consumption, ignoring the process of consumption capital accumulation.

Against this backdrop of extensive research work and ever-increasing public awareness of the smoking-related health hazards outside Japan, on the one hand, and widespread tobacco use and the lack of research on the smoking-related issues in Japan, on the other, the authors believe that it is time to break ground in studying this neglected area and motivate more researchers to look into smoking-related issues in Japan.

Following this introduction, section II describes the current situation besetting cigarette consumption and production in Japan that motivates this article. Section III develops a theoretical framework. Section IV discusses data used. Section V presents an empirical model and demand estimation. Section VI discusses the empirical results, and section VII provides concluding remarks.

II. BACKGROUND INFORMATION

Smoking may be one area where the United States and Japan can be indisputably posited at two opposite poles. The following anecdote should help highlight the contrast. In 1992, an American exchange student from the University of Washington arrived at Narita/Tokyo International Airport to spend a year at Aoyama Gakuin University in Tokyo. After going through the customs and immigration inspection procedures, the student proceeded to the gallery, where many air travelers are met by their friends and families. The American student fell unconscious in a shock resulting from sudden exposure to the massive cigarette smoke permeating the gallery. She was immediately taken to a nearby hospital by an ambulance. (This incident took place while one of the authors was teaching at Aoyama Gakuin Unviersity.)

The per capita tobacco consumption in Japan tops all other industrialized countries in recent years (see Table 1). Cigarette prices in general are relatively low in Japan. In 1993, the mainstream domestic brands retailed for approximately $1.69 per pack according to WHO. Retail prices of imports range between $1.92 and $2.15 per pack. Cigarette vending machines can be easily

spotted on almost any street corner. Levin (1996) puts the number of cigarette vending machines at 500,000, which is approximately 1 for every 250 people. The WHO statistics indicate that male smokers consumed an average of 25 cigarettes per day and females an average of 16 in 1990. The same data source shows that 59% of adult males and 14.8% of adult females were smoking in 1994.

On the production side, 27,300 hectares were used for tobacco in 1993, which was 0.7% of all arable land in Japan. In the same year 67,000 tons of unprocessed tobacco were produced, which was approximately 1% of the world total according to WHO. In 1994, 268,900 million cigarettes were manufactured in Japan, which accounted for about 4.6% of the world production. All the domestic brands are developed, manufactured, and distributed by Japan Tobacco Inc. (JT), a government-controlled monopoly in the market. Since 1985 when tobacco imports were "liberalized," JT's market share has been declining. It fell from 97.6% in 1985 to 77.6% in 1997 according to JT's own statistics. (JT's statistics should be interpreted with caution, for it is in their own interest to overstate the market share of foreign competitors.)

Japan is a haven for smokers and cigarette producers. Despite WHO's unequivocal and repeated warnings on the health hazards of smoking since 1970 and a massive amount of studies confirming the evidence of the smoking hazards, there has been no antismoking legislation enacted in Japan. *The 1997 Health and Welfare White Paper* published by the Japanese Ministry of Health and Welfare (1997), reports that all regulations in effect are of voluntary restraints. For example, the warning label printed on the cigarette package is a directive of the Ministry of Finance. It was first issued in 1972 and then modified in 1989. The 1972 version reads: "For the sake of your health, be careful not to smoke excessively." Note the peculiar absence of the smoking-related health hazards in the wording of this warning label. The 1989 version, which is used today, reads: "Because of possible adverse health consequences of smoking, be careful not to smoke excessively." Notice that the 1989 version of the warning label neither attributes lung cancer (and other types of cancer) to smoking, nor does it warn pregnant women of smoking as dangerous (see *Mainichi Shinbun Yuukan* [1989] and *Nikkei Ryuutsuu Shinbun* [1989]).

In contrast, in the United States, the Broadcasting Advertising Ban was enacted in 1971, and the state of Arizona legislated an indoor antismoking regulation in 1973 (see Tremblay and Tremblay [1997]). Many other states have followed suit.

The prevalence of tobacco use in Japan results in serious public health consequences. Those consequences are reported in *Tobacco or Health: A Global Status Report* by WHO (1997) as follows:

> Lung cancer became the leading cause of cancer deaths among Japanese deaths among Japanese men in 1993. In 1995, it is estimated that tobacco will cause 14% of all deaths (20% M; 8% F), a proportion that is still increasing among both males and females. It is also estimated that 21% of all cancer deaths will be caused by smoking in 1995 (29% among males and 8% among females).

Despite the rising mortality rate from tobacco use in Japan, efforts to control tobacco use have been scant. It was not until 1987 that the Ministry of Health and Welfare formally endorsed the notion of controlling the health hazards of tobacco, though nongovernmental organizations (NGOs) had been campaigning against tobacco use since the 1970s. There have been no coordinated actions at the national level, and most antismoking activities have been ad hoc. The WHO World No-Tobacco Day has been observed since 1991. To observe this day according to WHO, the Ministry of Health and Welfare turns off some of the cigarette vending machines in the ministry's building for the day. It needs to be noted that there has been a positive development of tobacco control in recent years. Since 1990, a few prefectural governments began to allocate a small amount of their budgets to tobacco controls.

In general, however, there is inertness on the part of the government in raising public awareness on the health hazards of smoking. This inertness appears to be rooted in the history and the system of tobacco production and sales. The tobacco production and sales had been the activities of a government monopoly until 1985 when the operation was "privatized" and its name was changed to Japan Tobacco Incorporated. However, despite the privatization, JT remains under the control of the Ministry of Finance and is governed by both the Tobacco Industry Law

(*Tabako Jigyou Hou*) and the JT Corporation Law (*Nippon Tabako Sangyou Kabushiki-gaisha Hou*). (See Japan Tobacco Incorporated [1998] for details.) Even as of 1997, the Ministry of Finance holds 1,338,110 shares (66.9%) of the total number of 2,000,000 outstanding shares. The number of shares authorized but yet to be issued for public offering remains 6,000,000. There seems to be no sign of a decrease in the ministry's holding. It is written in Article 18 of the by-law of the Japan Tobacco Corporation Law, which governs the activities of the corporation, that "the government shall continue to hold at least 2/3 of the shares issued for the time being in order to ensure the sound growth and development of the corporation" (see Japan Tobacco Incorporated [1998]). Further, according to Article 2 of the Japan Tobacco Corporation Law, "the government shall hold at least one half of the shares issued of the corporation in perpetuity" (Japan Tobacco Incorporated, 1998).

JT is an important tax revenue source to the government. In 1990 the total tobacco tax revenue collected, apart from the associated consumption tax, was slightly under 2 trillion yen, which was 3% of the government's regular budget (66.237 trillion yen) of that year. In 1995 the tobacco tax revenue was slightly over 2 trillion yen, which was 2.94% of the government regular budget of 70.987 trillion yen (see Japanese Ministry of Finance [1998]).[1] These legal, institutional, and financial ties between the government and JT indicate that the government has a vested interest in the welfare of JT and may effectively explain the "dead-silence" on the health hazards of smoking at all levels of governments.

The "dead-silent" policy has its consequences. The statistics (given in Table 1) contain several social implications: (1) a rise in the smoking-related toll in the future; (2) a need for a policy design to reduce the male smoking rate; (3) a need for a policy design to keep the female smoking rate low as women gain greater equality with men in social status; (4) a need for a policy design to cope with a rise in smoking-related social costs in the future; and (5) a need to *identify* cigarette substitutes and to keep cigarette consumption under control.

1. Tobacco tax revenues are split equally between the central government and the local municipalities (prefecture, city, and town governments). Thus, the central government collected only a half of the tax revenues quoted in the above paragraph. This tax revenue sharing may explain why local governments do not have incentives to launch antismoking campaigns, though they are not involved in cigarette production, as the central government is.

III. THEORETICAL FRAMEWORK [2]

The consumer is assumed to maximize

$$(1)\quad u = u(s, x) \quad \text{subject to} \quad s = h(c; I) \quad \text{and} \quad pc + qx = M,$$

where s stands for smoking appreciation, c cigarettes, x composite market good, I level of dissemination of information about the health hazards of smoking, p price of cigarettes, q price of composite good, M money income. The function u is a utility function, which applies commonly to the representative consumer across all prefectures. It is a function of "smoking appreciation" (not a function of cigarettes per se) and the composite market good, which includes all other market goods. It is postulated to be increasing and concave in s and x and twice continuously differentiable. The function h is a "household or personal production function" through which the consumer "produces" "smoking appreciation" with cigarettes and smoking-related health hazard information as inputs. The function h is postulated to be increasing and concave in c and twice continuously differentiable.

By substitution, the optimization model in (1) can be rewritten as

$$(2)\quad \underset{c,x}{\text{Maximize}}\ w(c, x; I) \quad \text{subject to} \quad pc + qx = M.$$

The corresponding Lagrangian function is

$$(3)\quad L(c, x, \lambda) = w(c, x; I) + \lambda(M - pc - qx).$$

Substituting $c = c^*(p, q, I, M)$, $x = x^*(p, q, I, M)$, and $\lambda = \lambda^*(p, q, I, M)$, the optimal solutions for (3) into the objective function

2. The detailed presentation of this section is available on request.

in (2) results in the following maximum value function

$$(4)\quad w^*(p,q,I,M) \equiv w(c^*(p,q,I,M), x^*(p,q,I,M); I).$$

Characterizing the cigarette demand function, $\partial c/\partial p < 0$ is deduced via the Slutsky equation and the envelope theorem with the assumption that cigarettes are a normal good, i.e., $\partial c/\partial M > 0$. Consider the following primal-dual objective function of the maximization problem:

$$(5)\quad \underset{I}{Maximize}\ F(c,x,I) \equiv w(c,x,I) - w^*(I).$$

Solving (5) results in

$$(6)\quad w_I = w_I^*.$$

In view of (4), (6) is rewritten as

$$(7)\quad w_I^*(I) \equiv w_I(c^*(I), x^*(I), I).$$

Note that $c^*(I)$ and $x^*(I)$ are the suppressed versions of the optimal solutions to (3) with the understanding that parameter I does not enter the constraint and that the values of c and x are chosen and held so as to satisfy the constraint.

Because, by construction, the primal-dual objective function (5) has a maximum value of zero, the sufficient second-order condition is

$$(8)\quad F_{II} < 0; \quad \text{that is, } w_{II} - w_{II}^* < 0.$$

Differentiating both sides of (7) with respect to I results in

$$(9)\quad w_{II}^* \equiv w_{Ic}(\partial c^*/\partial I) + w_{Ix}(\partial x^*/\partial I) + w_{II}.$$

Imposing the sufficient second-order condition on (9) and using Young's theorem yield

$$(10)\quad w_{II}^* - w_{II} \equiv w_{cI}(\partial c^*/\partial I) + w_{xI}(\partial x^*/\partial I) > 0$$

Assuming safely that $w_{xI} = 0$ (i.e., the dissemination of information on smoking-hazards does not affect the marginal utility of consuming noncigarette goods) and $w_{cI} < 0$ (i.e., the dissemination of information on smoking hazards reduces the marginal utility of cigarette consumption), the authors are able to conclude that

$$(11)\quad \partial c^*/\partial I < 0.$$

Thus, an increase in the level of dissemination of information on the health hazards of smoking will reduce cigarette consumption. Therefore, at least theoretically, the dissemination of information is an effective public health policy.

IV. DATA

Japan has 47 prefectures (known as *ken*, *fu*, or *dou* in Japanese), each being a geographical area under the administration of an elected governor. The raw data set includes prefecture-level data on population, income, tobacco tax revenues, regional price index, and national aggregate cigarette sales. Most prefecture-level data are obtained from *Chiiki Keizai Souran* (Regional Economic Survey; Toyou Keizai Shyukan [1992 and 1997]). The cigarette sales data are obtained from *Total Consumption of Cigarettes*, published by JT (available online at *www.jtnet.ad.jp/www/jt/jti/outlinetobacco/hanbaisuj.html*). The price information is obtained from the *Survey of Prefectural Budgets* published by Fiscal Bureau, Ministry of Autonomy, and *Chihou Zeisei Toukei Nenpou* (The Annual Report on Local Fiscal Statistics, various years) published by Japan Statistic Association (1992 and 1997).

V. EMPIRICAL MODEL AND DEMAND ESTIMATION

Based on the theoretical framework developed in section III, the limited data, as well as the unique market structure in Japan, a single-equation linear model is used to estimate the cigarette demand. Specifically, per capita annual cigarette consumption is regressed on cigarette price, per capita income, an information dissemination proxy, and a dummy variable as follows:

$$(12)\quad C = \beta_0 + \beta_P P + \beta_Y Y + \beta_T D_T + \beta_A D_A + \varepsilon,$$

where C is per capita annual cigarette consumption, Y per capita income, P cigarette price, D_T time dummy, D_A information dummy, and ε a random error term.

Prefecture-level consumption data are not readily available and, therefore, we compute the prefecture-level cigarette consumption by multiplying the total domestic tobacco sales by the shares of each prefecture's tobacco tax revenue in the national tax revenue. This approach is legitimate in that Japan has a unified tobacco excise tax rate across all pre-

fectures.[3] Therefore, the tobacco tax revenue share of a particular prefecture should largely reflect its cigarette consumption relative to other prefectures. Data on per capita income are taken directly from Regional Economic Survey. They are deflated with the consumer price index.

A unique and important characteristic of the Japanese cigarette market is that there are virtually no price differentials for any particular brand of cigarettes across prefectures. Specifically, JT, the monopolist, sets a uniform price (for each brand) across all areas of Japan and rarely makes price adjustments. A pack of Mild Seven, for instance, costs a consumer the same amount of yen in Tokyo as it does in a remote, small fishing village in Okinawa. All brands are readily available across the country, and JT does not appear to "price discriminate" consumers in different prefectures with different brands. This unique feature presents a problem. In particular, the actual price of any brand does not exhibit prefectural variations, which means that inferences about how cigarette demand responds to price changes across prefectures cannot be made on the basis of the actual (nominal) price data. On the other hand, the arbitrary uniform pricing practice simplifies the empirical analysis and frees the single-equation linear model from endogeneity problems.[4]

The average price of 22 major domestic brands in Japan for each sample period is used for the price variable. (The authors experimented with other price measures, all of which yielded similar results.) The price measure is a single nationwide uniform tobacco price (in current yen), which is then deflated by the consumer price index into constant yen (¥1990 = 100). "Relative cigarette prices" are used in capturing the potential price effects on the cigarette consumption. To obtain the relative cigarette prices for all the prefectures, the uniform cigarette price measure is "normalized" with respect to the prefectural price index. The prefectural price index is given in Regional Economic Survey. This is a legitimate approach because there exist considerable disparities in the cost of living among the prefectures, and these disparities make the real cost of a pack of cigarettes vary across the prefectures.

The authors' interest is in assessing how information dissemination about the health hazards of smoking would affect cigarette consumption. Ideally, health knowledge data similar to those survey data used by Hsieh et al. (1996) should be used for this purpose, but nothing of the sort is available in Japan. Due to data limitation, a prefecture-level antismoking budget dummy is used as a proxy for information dissemination.[5] This is based on the assumption that prefecture governments use the fund to improve citizens' awareness of the tobacco health hazards. As the theoretical priors suggest, health hazard knowledge increases the cost of tobacco consumption and hence discourages tobacco use; the cigarette consumption is therefore expected to be lower in the prefectures with an antismoking budget ceteris paribus. The data set covers two periods (1990 and 1995). There are two reasons for using these two periods. First, as mentioned in section II, certain tobacco control measures have been

3. Although there is a local tobacco tax levy in addition to the national tobacco tax, the local tax revenues are not included in the tax data we used. Because exclusion of local taxes does not affect the tax shares of the prefectures, our computation should mirror the relative shares of actual consumption among prefectures. For details, see *An Outline of Japanese Taxes* (1996).

4. A referee was concerned about potential endogeneity problems with the price variable in this single-equation linear model. To address this concern, we conducted a Hausman test in which the percentage of adult population was used as an instrumental variable for the price variable. We observe that the percentage of adult population is likely to be correlated with cigarette prices (the correlation coefficient being 0.73). All things being equal, the greater the adult population in a prefecture, the greater the aggregate cigarette demand in that prefecture, which translates into higher cigarette prices. In addition, it is reasonable to assume that the percentage of adult population is uncorrelated with the error term. Therefore, the percentage of adult population is a legitimate instrument. The resulting Chi-square statistics (with 5 degrees of freedom) were 0.3727 and 2.8330, respectively, for ordinary least squares and weighted least squares which suggest that the null hypothesis, $E[X\varepsilon] = 0$, cannot be rejected. Hence, we found no evidence of endogeneity problems.

5. The data were collected over the telephone by contacting the prefectural officials in charge of tobacco-related affairs. Even though we had the actual amount of the budget, we have to settle for a dichotomous dummy for two reasons. First, only a small number of prefectures have antismoking programs and budgets. Second, there were little variations in the antismoking budgets. In addition, we cannot adopt the time-series approach used by Hu et al. (1995) in defining our proxy for information dissemination because we have only two years of data, which hardly constitute a time-series.

TABLE 2
Descriptive Statistics

	Average	Maximum	Minimum	SD
Per capita consumption	414.32	573.11	341.75	43.39
Per capita income	2,648.42	4,458.00	1,961.00	407.96
Cigarette price	0.323	0.346	0.284	0.012
Antismoking budget	1,498.26	5,000.00	160.00	1,745.72

Note: There are 94 observations in the data set. Per capita consumption is in 20-pack, per capita income, cigarette price, and antismoking budget are all in thousand yen. Income, price, and antismoking budget data are in constant yen (¥1990 = 100). Cigarette price is the mean value of 22 major domestic brands. The prefectural variations in these price measures are obtained by "normalizing" by prefectural price index.

taken in Japan since 1991. For instance, an NGO, Council on Tobacco or Health, was established in 1991, followed by the Japan Medical and Dental Association for Smoking Control Promotion in 1992. Also, the WHO No-Tobacco Day has been observed in Japan since 1991. If these tobacco control measures were effective, they might have some cumulative effects on reducing the cigarette consumption in 1995. Second, these data happened to be available. A time dummy variable is used for the year 1995 in the hope that it may capture potential effects of these tobacco control measures on the cigarette consumption between these two periods. (This time dummy captures the influence of all the unobserved time-series determinants; therefore, its coefficient should be interpreted with caution.) If these tobacco control measures were effective, the coefficient of this dummy variable is expected to be negative ceteris paribus.[6]

The data indicate that among 47 prefectures, 14 had lower per capita cigarette consumption in 1995 than 1990. Over the same two periods, 13 prefectures experienced real per capita income decline whereas the relative (real) price of tobacco decreased across the board. In 1990, there were 5 prefectures with an antismoking budget, and this number increased to 15 in 1995. Table 2 presents descriptive statistics for per capita cigarette consumption, per capita income, cigarette price, and antismoking budget.

The model is first estimated by ordinary least squares (OLS). Various diagnostic tests indicate that the disturbances resulting from the OLS estimation may be heteroskedastic.[7] To account for the heteroskedasticity, a weighted least squares (WLS) procedure is applied to the model (weighted with smoking population). The WLS procedure yields very similar parameter estimates to those of OLS.[8] Both OLS and WLS estimation results are given in Table 3. A Hausman (1978) test is performed on both OLS and WLS to detect potential endogeneity problems. The test statistic is consistent with the authors' conjecture that the simple linear model does not suffer from endogeneity problems. TSP4.4 was used for estimation and testing.

VI. RESULTS AND DISCUSSION

The following discussion is based on the WLS estimation results. First, the effects of per capita income level on cigarette consumption are found to be positive and significant (at 5% level). The coefficient estimate

6. A reader of the previous draft suggested that cigarette advertising should be included in our demand function. We do not include it because empirical evidence found by previous studies indicates that prosmoking advertising does not have significant effect on aggregate demand.

7. Among the diagnostic tests, Lagrange multiplier test, Ramsey RESET test, and Jarque-Bera test yield significant test statistics, which suggest that the simple OLS model may suffer from heteroskedasticity or may be misspecified. We experimented with a few alternative specifications, all of which yielded similar test statistics. We suspect that the significant test statistics may be due to heteroskedasticity rather than misspecification.

8. Although WLS estimation yields similar results, none of those diagnostic tests applied to the OLS estimation yield significant test statistics when applied to WLS. Hence, we conclude that there is no evidence that the model is misspecified.

TABLE 3
Parameter Estimates

Parameter	OLS Estimates	WLS Estimates
Constant	1.7814**	1.7118**
	(0.5826)	(0.5928)
Income	0.2479**	0.2901**
	(0.0936)	(0.0933)
Price	−1.0013**	−0.9749*
	(0.4985)	(0.5043)
Budget	−0.0423*	−0.0455*
	(0.0243)	(0.0242)
Time	−0.0381	−0.0363
	(0.0323)	(0.0331)
R^2	0.3302	0.3980

Note: Estimates with ** are significant at 5% level, and * at 10% level. Standard errors are in parentheses.

is 0.2901. Based on this estimate, income elasticities of cigarette demand are computed (as $\eta_Y = \beta_Y * Y/C$) for all the 94 observations (see Table 4). The mean value of the estimated income elasticities is 0.2909. This result is consistent with previous findings. Haden (1990), for instance, found that the income elasticity of demand in Japan for Japanese cigarettes is 0.1607 and that for U.S. cigarettes is 0.5950. The small magnitudes of income elasticities (found in this article) suggest that cigarettes are a normal good and cigarette consumption is not very responsive to income changes.

The estimated coefficient for price is −0.9749 and significant (at 10% level). The corresponding price elasticities (computed as $\eta_P = \beta_P * P/C$) have a mean value of −0.9857 (see Table 4). Given the magnitude of the elasticities, the authors test the null hypothesis that price elasticities are unitary. The hypothesis tests indicate that the null hypothesis that price elasticities are unitary cannot be rejected at the mean value. Out of the 94 observations, 6 have price elasticities statistically less than unitary and 6 more than unitary. (They are all significant at 10% level.) Hence, 87% of the observations may have unitary price elasticities. This result is in general consistent with previous findings. Compared with price elasticities (centered on −0.4) estimated with U.S. data (see Chaloupka and Warner [1999]), the price elasticities of cigarette demand estimated in this article are approximately twice as large as those in the United States (in absolute values). However, they are very similar to that estimated by Haden (1990), which is −0.9483 for the own price elasticity of Japanese cigarettes. If the price elasticities are truly unitary (or close to being unitary), the Japanese tobacco users seem to be quite responsive to price changes, at least more so than what we expected, given the addictive nature of tobacco. A policy implication from this finding is that price increases by taxation or other means may be more effective in reducing cigarette consumption in Japan than in America.

TABLE 4
Income and Price Elasticities of Demand for Cigarettes

	Mean	SD	Minimum	Maximum
η_{Price}	−0.98573	0.11007	−1.22857	−0.63759
η_{Income}	0.29089	0.038043	0.20005	0.38327

Antismoking budget, the dummy variable used as proxy information on dissemination about tobacco health hazards, has a negative and significant (at 10%) coefficient. The parameter estimates are around −0.0455. Although the coefficient is small in magnitude, it does suggest that the prefectural antismoking spending has produced intended effects on reducing cigarette consumption. Specifically, per capita cigarette consumption is about 4.5% lower in those prefectures where there are antismoking programs and budgets than those without, ceteris paribus. According to the data used in demand estimation, an average smoker in Japan consumes about one pack (or 20 cigarettes) a day. Therefore, this reduction rate translates into approximately 18 packs fewer per smoker per year. If all smokers could reduce their cigarette consumption by 4.5% , there would be an aggregate annual reduction of about 700 million packs (based on the smoking population in 1995). Given the fact that none of the prefectures' antismoking budgets exceeded ¥5 million per year, the effects of the money spent on disseminating information on tobacco health hazards are nothing short of significant (in the practical as well as in the statistical sense).

The time dummy variable (1 for the year 1995) is intended to account for potential cumulative effects of a few nominal/

ceremonial tobacco control measures since 1991. The parameter estimate, although negative as expected, is not statistically significant. This finding is disappointing, but not surprising. Technically, this dummy variable captures the influence of all the unobserved time-series determinants, and the potential cumulative effects of those control measures may have been offset by other unobserved factors. However, until relevant data become available to help sort out all the unobserved factors, one may have to accept the evidence that those nominal/ceremonial tobacco control measures are ineffective in helping reduce cigarette consumption in Japan. Therefore, the authors contend that more substantial measures than merely celebrating WHO No-Tobacco Day and turning off a small number of vending machines for one day should be taken to improve public awareness of health hazards of tobacco and reduce cigarette consumption.

VII. CONCLUDING REMARKS

The authors present this study on the demand for cigarettes in Japan against a noteworthy backdrop: the lack of such studies in Japan, Japan's top ranking among industrialized countries in per capita cigarette consumption, the Japanese government's monopoly of the tobacco industry, the absence of antismoking ordinances and regulations, and the peculiar "dead-silent" policy on disseminating information about smoking-related health hazards in Japan. The article derives cigarette demand à la Becker and Stigler, estimates cigarette demand with Japanese prefecture-level data and evaluates the effects of information dissemination about the health hazards of smoking on cigarette consumption. It is found that cigarettes are a normal good, cigarette demand in Japan is unit elastic to price changes and inelastic to income changes. The findings suggest that price effects dominate the income effects on cigarette consumption. Therefore, price increases by taxation or other means may be an effective way to reduce cigarette consumption in Japan. Given the fact that the prices of cigarettes are low in Japan (in dollar terms and relative to other goods and services), policy makers could easily use the price mechanism to achieve their public health objective if they intend to reduce smoking-related health hazards.

The authors also find that prefectural antismoking programs and budgets are effective means of disseminating information about the health hazards of smoking, which helps reduce the cigarette consumption in Japan; nominal/ceremonial projects, however, do not seem to work. Although the data used are far from satisfactory, the findings do shed light on Japanese smoking behavior and yield meaningful policy implications with respect to reducing cigarette consumption in Japan. Note that Japanese smoking behavior attests to low levels of public awareness regarding smoking-related health hazards. Smoking is permissible almost anywhere in Japan. It is believed to be merely a matter of etiquette (not at all a matter of health) for a smoker to ask another person sitting next to him or her for permission to smoke, and it is believed to be polite to grant permission. The concurrence of the widespread cigarette consumption and of the shortage of information about smoking-related health hazards in Japan suggests that, without any in-depth knowledge about those health hazards, symbolic and ceremonial activities (such as observing a single "no smoking day" a year) may not have any impact on Japanese smoking behavior. As is stated in the development of the theoretical formulation, only when people learn of the health hazards of smoking, do they change their smoking behavior, for knowledge of smoking-related health hazards increases the costs of smoking (i.e., the knowledge reduces the marginal utility of cigarette consumption). Penalties stipulated in antismoking legislations and regulations and cigarette taxation would raise the "cost of smoking from without" (i.e., the nominal cost of smoking), and information dissemination regarding smoking-related health hazards would raise the "cost of smoking from within" (i.e., the imputed cost of smoking). Further, without elevating public awareness of the smoking-related health hazards, no antismoking legislation will ever be on the Japanese political agenda; hence, effective means to raise the cost of smoking from without are not likely to come about.

In light of these stylized facts and findings, the authors contend that information dissemination is an important instrument of public health policy, supplementary to cigarette

taxation and antismoking ordinances. Coordinated actions at the local, prefectural, and national levels are called for to raise public awareness of the health hazards of cigarette smoking. Information dissemination regarding the health hazards of smoking should and must be a prerequisite for the emergence of any social and legislative acts to reduce cigarette consumption in Japan.

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