Tobacco Taxes and Cigarette Demand in Japan: Could the Government Kill Two Birds with One Stone?[1)]

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1. Introduction

Smoking is prevalent in Japan, especially among male adults. The most recent data from the World Health Organization (WHO) indicate that Japan has the highest prevalence of male who smoke among all industrialized countries.[2)] (See Table 1 for details.) The extent of smoking in Japan has serious public health implications and consequences. According to the WHO statistics, smoking is a contributing factor in more than 78% of lung cancer deaths among males between age 35 and age 69, and 43% of lung cancer deaths among females of the same age group. The rate of smoking-related lung cancer deaths is even higher for those 70 and older. (See Table 2 for details.) The same WHO statistics indicate there were more than 112 thousand smoking-related deaths in Japan in the year 2000, and the number of such deaths has been on the rise. (See Figure1 for details.) Given this growing problem, controlling tobacco consumption has become an important public health issue to the central and prefectural governments. In fact, some local governments are already taking action against smoking in public places. For instance, three local municipalities recently made unprecedented moves to combat smoking in public. Chiyoda Ward in Tokyo, Shirakawa Town in Gifu Prefecture, and Nikkou City in Tochigi Prefecture have enacted ordinances to designate nonsmoking zones.[3)] The prevalence and the public health consequences of smoking appear to have, at long last, attracted the attention of some local politicians as well as citizens.

From a public health perspective, the seriousness of this issue dictates that government at all levels needs to take effective measures to reduce cigarette consumption.

1) The author thanks David Schneider for proof-reading and polishing the manuscript. All remaining errors are of the author's.

2) This information is available at the WHO's website (http://www.who.int/tobacco/en/).

3) See http://www1.sumoto.gr.jp/shinryou/kitsuen/kinen_supportcenter/news.html for details.

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Table 1. Smoking Prevalence: Selected Industrialized Countries

Country	Adult (20 Years & Older)		Youth (15-18 Years Old)	
	Male	Female	Male	Female
Australia	21.1	18.0	14.1	16.2
Belgium	28.0	20.0	9.0	8.0
Canada	23.9	19.6	16.2	20.9
Demark	32.0	29.0	31.0	32.0
Finland	27.0	20.0	41.0	38.0
France	33.0	21.0	28.0	20.0
Germany	38.9	30.6	29.0	N.A.
Italy	31.1	22.3	22.0	28.0
Japan	47.7	11.5	25.9	9.2
Netherlands	32.2	25.3	27.0	26.0
New Zealand	25.1	24.8	16.3	22.0
Norway	31.0	32.0	31.0	34.0
Spain	39.1	24.6	25.2	35.8
Sweden	17.4	20.4	26.0	25.0
Switzerland	26.9	24.0	25.0	25.0
UK	28.0	26.0	24.0	28.0
USA	25.7	21.0	26.0	20.1

Source: The World Health Organization

But the absence of action on the part of the central government in this regard suggests that it may have other concerns. From a public finance perspective, for instance, reducing cigarette consumption in Japan may have undesirable financial consequences. It is a well-known fact in Japan that the government has a considerable stake in cigarette consumption. Tobacco taxes constitute an important source of revenue to the treasury, especially when the government has serious budget deficit problems due to the prolonged economic recession. The prospect of a revenue shortfall resulting from reduced cigarette consumption would dissuade the government from attempting to reduce cigarette consumption.[4)]

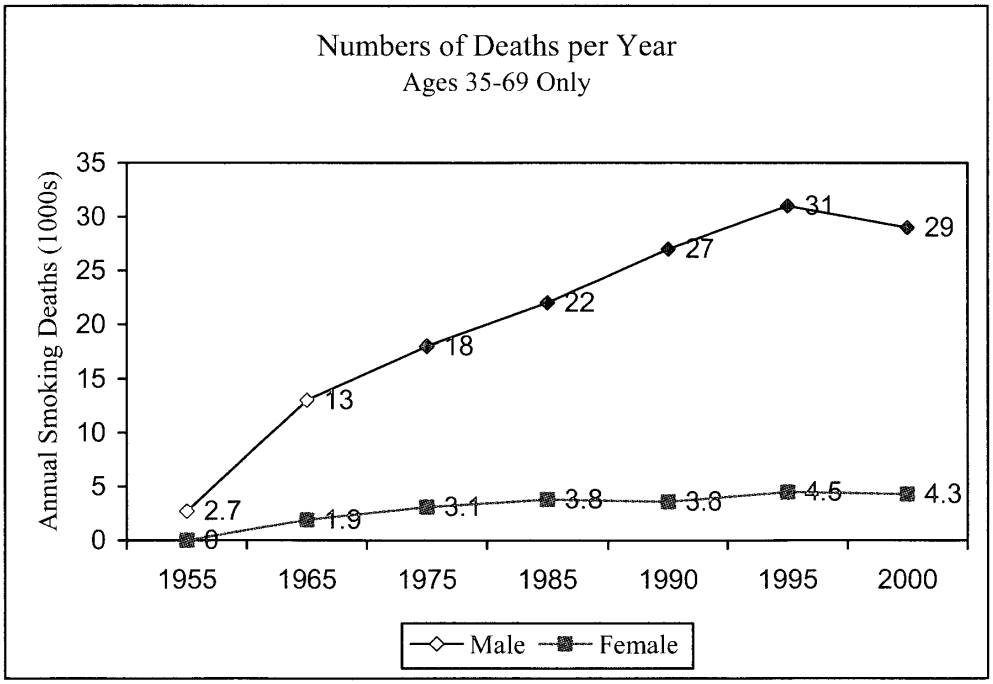
4) The fact that Japan is conspicuously absent from a long list of nations who signed the WHO Framework Convention on Tobacco Control is a convincing piece of evidence that the government is not yet interested in reducing cigarette consumption.

Table 2. Smoking-related Disease Impact in Japan

Cause	Males (by Age)			Females (by Age)		
	0-34	35-69	70+	0-34	35-69	70+
Lung Cancer	0.00%	78.57%	88.00%	0.00%	43.48%	63.00%
All Cancer	0.00%	23.68%	32.67%	0.00%	5.71%	10.68%
Vascular	0.00%	13.26%	10.00%	0.00%	5.00%	3.56%
Respiratory	0.00%	21.00%	20.00%	0.00%	9.76%	8.52%
All Other	0.00%	5.00%	7.21%	0.00%	2.38%	2.88%
All Causes	0.00%	15.76%	18.35%	0.00%	5.06%	5.54%

Source: The World Health Organization

Figure 1. Smoking-related Numbers of Deaths



Given the competing policy concerns of promoting public health on the one hand and preventing revenue shortfalls on the other, what policy instruments are available to the government? Would there be any way the government could effectively address one of these concerns without compromising the other? This is an issue that nobody appears to have addressed. The objective of this paper is to explore a politically plausible, financially beneficial, and socially responsible policy instrument, i.e., a tobacco tax increase, and its

potential impact on cigarette consumption and tax revenues in Japan.

The paper is organized as follows. Section 2 presents data sources and discusses variable constructions. Section 3 discusses an empirical model and estimation method. Section 4 offers empirical results and policy discussions. Section 5 presents concluding comments.

2. Data and Variable Constructions

The first step in investigating the issue is to estimate cigarette demand. This task requires data on cigarette consumption, cigarette prices, per capita income, tobacco tax collection, and other related information. The raw data used in the analysis were obtained from various sources covering all prefectures from 1989 to 1997. Prefecture-level data on population, income, and tobacco tax revenues were obtained from *Chiiki Keizai Souran* (Regional Economic Survey, 1990-1999) published by Touyou Keizai Shyukan. National aggregate cigarette sales data were obtained from the Tobacco Institute of Japan.[5] The prefectural price index (i.e., cost-of-living index) and related information were 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 the Japan Statistics Association.

Prefecture-level consumption data were not readily available. To obtain the rate of prefecture-level cigarette consumption, I multiplied the total domestic tobacco sales by the shares of each prefecture's tobacco tax revenue in the national tax revenue. This approach is appropriate in that Japan has a unified tobacco excise tax rate across all prefectures. The tobacco tax revenue share of a particular prefecture should largely reflect its cigarette consumption relative to other prefectures. Therefore, derived prefecture-level cigarette consumption should mirror actual cigarette consumption across prefectures. The original data were converted to 20-cigarette packs to facilitate interpretation of estimation results. Per capita annual cigarette consumption was obtained by dividing total prefecture-level cigarette consumption by smoking population.[6] Data on per capita income were taken directly from *Chiiki Keizai Souran* (Regional Economic Survey). They were deflated with the consumer price index (Year 1990 = 100).

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, Japan Tobacco Co (JT), the monopolist, sets a uniform price for each brand across all areas of Japan and rarely makes price adjustments over time. A pack of *Mild Seven,* for instance, costs the same amount of yen in Tokyo, the capital city of Japan, as

5) The data are available at its website (http://www.tioj.or.jp).

6) I obtain data on smoking population by applying the World Health Organization estimates of the percentage of male and female smokers to the adult population. See Table 1 for details.

it does in a remote small fishing village in Okinawa situated to the southwest of the main Japanese islands. All brand names are readily available across the country and JT does not appear to price discriminate against smokers in different prefectures by means of different brand names. This unique feature presents a problem in the variable construction of prefectural level cigarette prices. In particular, no brand price is subject to prefectural variation, 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.

To resolve this problem, I adopted the "relative prices" approach used by Yorozu and Zhou (2002). First, I took the average price of all major domestic brands in Japan for each sample period, which resulted in a single nationwide uniform cigarette price (in current yen). Then, I deflated this price by the consumer price index into constant yen. Finally, I computed "relative cigarette prices" for all the prefectures by normalizing the uniform cigarette price measure with the prefectural price index (cost-of-living index).[7] This approach is legitimate because there are considerable disparities in cost of living among prefectures, which make the real cost of cigarettes vary across prefectures.

3. Empirical Model and Demand Estimation

Based on economic theory and the unique market structure in Japan, I used a single-equation model to estimate cigarette demand.[8] The demand function is assumed to be a linear function of cigarette price and per capita income.[9] Per capita annual cigarette consumption was used as the dependent variable in the estimation.

Descriptive statistics (see Table 3) of the variables in the dataset suggest that there may be considerable heterogeneity in cigarette consumption across prefectures and over time. To account for potential heterogeneity exhibited in the dataset, I used a two-way fixed effects model in estimating the demand function. Thus, the estimated demand function takes the following form:

$$C = \beta_0 + \beta_P P + \beta_Y Y + \beta_{Pf} Pf + \beta_T T + \varepsilon$$

7) The prefectural price index is given in *Chiiki Keizai Souran* (Regional Economic Survey).

8) Despite the problem posed by the uniformity of the nominal cigarette prices across prefectures, JT's arbitrary uniform pricing practice considerably simplified my empirical analysis and made the single-equation linear model less vulnerable to potential endogeneity problems. Using the approach discussed in Yorozu and Zhou (2002), I conducted a Hausman test nevertheless and found no statistical evidence that the single-equation model suffered from endogeneity problems.

9) I also tested a few non-linear specifications and all were rejected on statistical grounds.

Table 3. Descriptive Statistics

Variable	Consumption[a]	Price[b]	Income[a]
Mean	412.8076	225.6957	2770886.5200
Std. Dev.	45.9087	8.7340	429027.3200
Minimum	242.9280	199.6019	1908000.0000
Maximum	589.0890	249.7279	4485000.0000
Skewness	1.4058	0.0280	1.0351
Kurtosis	3.4910	0.6889	2.3616
Median	403.0165	224.9896	2727000.0000

a. In packs.
b. In yen.
c. In 1000 yen.

where C is per capita annual cigarette consumption, P cigarette price, Y per capita income, Pf prefecture dummies, T time dummies, and ε a random error term.

The two-way fixed effects model appeared to fit the data quite well (with $R^2 = 0.968$). The F test for no fixed effects yields $F(54,365) = 135.81$, confirming the existence of prefecture-specific and time-specific effects in the data. I also performed the routine Hausman test in order to determine if the fixed effects model is appropriate versus a two-way random effects model. The Chi-square statistic resulting from the Hausman test with two degrees of freedom is $\chi^2(2) = 38.0432$, suggesting that the prefecture-specific and time-specific effects are correlated with other right-hand variables in the model and the fixed effects model is an appropriate choice.

4. Results and Discussions

The estimation results are generally consistent with previous studies (see Table 4). The effects of per capita income level on cigarette consumption are found to be positive and significant (at 1% level). The coefficient estimate is 0.000019, which implies that for a 100,000-yen (approximately $850) increase in per capita annual income, the average smoker would increase consumption by 19 cigarettes (i.e., approximately one pack) per year. Based on this estimate, income elasticities of cigarette demand are computed (as $\eta_Y = \beta_Y Y/C$) for all the 423 observations (see Table 5). The mean value of the estimated income elasticities is 0.1272. This result is similar to that of Haden (1990), where the income elasticity of demand in Japan for Japanese cigarettes is estimated to be 0.1607. The magnitude of the estimated income elasticity, however, is smaller than that estimated by

Table 4. Parameter Estimates[10)]

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
Per Capita Income	1.90E-5	7.06E-6	2.6800	0.0077
Price	-0.8160	0.3731	-2.1900	0.0294
SSE:	28450.7896			
DF:	366.0000			
R-Square:	0.9680			
F-Value:	135.8100			
P-Value:	<0.0001			

Note: SAS was used for estimation and testing.

Yorozu and Zhou (2002).[11)] The positive estimate of per capita income and small magnitudes of income elasticities suggest that cigarettes are a normal good, but cigarette consumption is not very responsive to income changes. Therefore, real income changes (in either direction) are unlikely to affect tobacco consumption.

Table 5. Descriptive Statistics of Estimated Elasticities

	Price Elasticities	Income Elasticities
Mean	-0.4524	0.1272
Std. Dev.	0.0555	0.0175
Minimum	-0.7476	0.0965
Maximum	-0.2774	0.1792
Skewness	0.1460	-0.6137
Kurtosis	3.0122	6.0683
Median	-0.4571	0.1251

Note: SAS was used for estimation.

10) Estimates of annual and prefecture dummies are omitted but available upon request.

11) The estimated income elasticity in Yorozu and Zhou (2002) was 0.2909, more than twice as large as that estimated in this paper. This difference may have resulted from the difference in the datasets and model specifications used. The current dataset has nine years of data whereas the one used in Yorozu and Zhou (2002) had only two years of data. Nevertheless, the difference does not materially change my conclusion that cigarette consumption is not responsive to income changes.

The estimated coefficient for price is -0.8160 and significant (at 5% level). That is, a 10-yen increase in cigarette price (per pack) would make an average smoker reduce consumption by 8.1 packs per annum.[12] The estimated price elasticities (computed as $\eta_P = \beta_P P/C$) range from -0.7476 to -0.2774 with a mean value of -0.4524 (see Table 5). This result is comparable to the price elasticities (centered on -0.4) estimated with U.S. data (Chaloupka and Warner, 1999). However, they are smaller in magnitude than those estimated by Haden (1990), and by Yorozu and Zhou (2002).[13] The price elasticity estimate suggests that cigarette demand in Japan is not responsive to price changes when prefecture-specific heterogeneity and time effects are controlled for. The price inelasticity of cigarette demand may be due to the addictive nature of tobacco products.

Table 6. Projected Impact of Tobacco Tax Increase

Price Change	5%	10%	15%	20%
New Price [a]	0.2625	0.2750	0.2875	0.3000
Tax Increase [b]	0.0125	0.0250	0.0375	0.0500
New Tax [c]	0.0298	0.0423	0.0548	0.0673
Consumption Chg [d]	-2.25%	-4.50%	-6.75%	-9.00%
New Consumption [e]	15.5882	15.2294	14.8708	14.5118
Revenue Chg [f]	188.6325	368.2948	538.9869	700.7089
New Revenue [g]	465.0725	644.7348	815.4269	977.1489

Note: The projection was made on the basis of average cigarette price, total cigarette consumption, and tobacco tax revenue in 1999, and the mean value of the estimated price elasticity of demand (-0.4524).

a. Hypothetical cigarette price after tax increase (in ¥1000).
b. Size of tax increase per pack (in ¥1000).
c. Amount of tax per pack after tax increase (in ¥1000).
d. Consumption change due to tax increase.
e. Projected consumption level after tax increase (in 1,000,000,000 packs).
f. Tax revenue change (in ¥1,000,000,000).
g. Projected tax revenue (in ¥1,000,000,000).

12) JP¥100 is approximately US$0.85.

13) The estimated price elasticity in Yorozu and Zhou (2002) was -0.9857. Two factors may have contributed to the difference, one being the control for heterogeneity across prefectures, and the other being the greater number of observations used in this paper.

What policy implications do these estimates yield with respect to reducing tobacco consumption and preventing revenue shortfalls? The answer to this question lies in the magnitude of price elasticity of cigarette demand. The estimated price elasticity of cigarette demand (-0.4524) says that for a 1% increase in cigarette prices per capita cigarette consumption per annum would reduce by 0.45% *ceteris paribus*. Based on the values of total cigarette sales in 1999, I estimated the potential impact of a range of tobacco tax increases on cigarette consumption and tobacco tax revenue. The results are presented in Table 6.

The estimation was based on the *ceteris paribus* assumption, i.e., assuming all other variables are held constant. In 1999 cigarette sales total in Japan was approximately 15.95 billion packs. This figure includes both domestically manufactured and imported cigarettes. The average nominal price of cigarettes in 1999 was about ¥250 per pack. The tobacco tax

Table 7. Projected Impact of Tobacco Tax Increase

Price Change	5%	10%	15%	20%
New Price [a]	0.2625	0.2750	0.2875	0.3000
Tax Increase [b]	0.0125	0.0250	0.0375	0.0500
New Tax [c]	0.0298	0.0423	0.0548	0.0673
Consumption Chg [d]	-3.75%	-7.50%	-11.25%	-15.00%
New Consumption [e]	15.3490	14.7510	14.1529	13.5549
Revenue Chg [f]	181.4958	348.0414	499.6366	636.2815
New Revenue [g]	457.9358	624.4814	776.0766	912.7215

Note: The projection was made on the basis of average cigarette price, total cigarette consumption, and tobacco tax revenue in 1999, and the minimum value of the estimated price elasticity of demand (-0.7476).

a. Hypothetical cigarette price after tax increase (in ¥1000).
b. Size of tax increase per pack (in ¥1000).
c. Amount of tax per pack after tax increase (in ¥1000).
d. Consumption change due to tax increase.
e. Projected consumption level after tax increase (in 1,000,000,000 packs).
f. Tax revenue change (in ¥1,000,000,000).
g. Projected tax revenue (in ¥1,000,000,000).

revenue collected by the central government in 1999 was more than ¥276 billion. Assuming that all this revenue came from cigarette sales, these figures translate into a little more than ¥17 per pack of cigarettes. The estimates in Table 6 imply that a ¥12.5-per-pa

ck tobacco tax increase would translate into a 5% price increase. The estimated price elasticity of demand implies that total cigarette consumption would drop by 2.25%. Tobacco tax revenue, however, would increase from ¥276 billion to ¥465 billion per year. That would be a whopping 68.5% increase.[14] Notice that the revenue increase was calculated based on reduced cigarette consumption.

One may argue that using the mean value of the estimated price elasticity of demand to estimate the potential impact of a tax increase on cigarette consumption and tax revenue may not be realistic since cigarette consumption across prefectures exhibit considerable heterogeneity. To account for this potential problem, I conducted the same analysis in a more conservative fashion. Specifically, I used the maximum estimate (in absolute value) of the price elasticity in computing the effects. The results are given in Table 7. These results do not differ much from those in Table 6. For instance, a ¥12.5 per pack tobacco tax increase (i.e., a 5% price increase) would reduce cigarette consumption by 3.75%. The tobacco tax revenue would increase ¥276 billion to ¥457 billion per year, which would still be a 65.5% increase. This is not surprising because the difference between the two elasticity estimates is not large enough to qualitatively alter the conclusion that cigarette demand in Japan is price inelastic. In fact, reduced cigarette consumption due to tobacco tax/price increases will not lead to tobacco tax revenue shortfall so long as demand is inelastic.

The analysis above indicates that if there were budget concerns on the part of the government with respect to reducing cigarette consumption in Japan, those concerns were clearly unjustified. An important policy implication of this analysis is that tobacco taxation can be a powerful policy instrument in addressing both the public health concerns caused by smoking and budget concerns (due to the prolonged economic recession but not due to reduced cigarette consumption). Although it requires a considerable tax increase to achieve a certain targeted reduction in cigarette consumption due to the price inelasticity of demand, it is a politically viable, financially beneficial, and socially responsible proposition for the government. Given that Japan has the lowest cigarette prices and higher costs of living among all industrialized nations, a 10% cigarette price increase as a result of a higher tobacco tax rate is unlikely to stir up a political storm. Financially, a ¥25-per-pack tax increase could generate ¥624 billion per annum in tobacco tax revenue, which is 2¼ times the amount collected by the central government in 1999.[15] With respect to cigarette

14) These were calculated assuming the market price of one pack of cigarette was ¥250 and using the tobacco tax revenue in 1999.

15) This estimate was calculated with the more conservative estimate of price elasticity.

consumption a 10% cigarette price increase could reduce cigarette consumption by 7.5% (using the conservative estimate of price elasticity of demand). The upshot of this analysis is that the government could indeed kill two birds (cigarette consumption reduction and budget improvement) with the stone of a tobacco tax increase.

6. Concluding Remarks

Against the backdrop of the growing public health problem caused by the prevalence of smoking in Japan, this paper was intended to explore the plausibility and effectiveness of using tobacco taxes as a policy instrument in reducing cigarette consumption. I estimated a cigarette demand function with the most recent prefectural level data available and found that cigarette demand in Japan is inelastic to both income and price changes. Based on these parameter estimates as well as the price, tax, and consumption data of 1999, I estimated the potential effects of hypothetical tobacco tax increases on cigarette consumption and tobacco tax revenue. My estimates indicated that, given the price inelasticity of cigarette demand in Japan, it would take a tobacco tax increase of considerable magnitude to reduce cigarette consumption to a meaningful extent. What policy makers may find more interesting in the analysis is that even a moderate tobacco tax hike (such as ¥12.5 per pack, which is equivalent to a 5% price increase) could generate over 60% more tobacco tax revenue than without the tax increase and in spite of reduced cigarette consumption. The substantial social and financial benefit mentioned above ought to be enough incentives for proactive Japanese government to combat smoking in Japan and its negative impact on public health.

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Abstract

This paper explores the plausibility and effectiveness of using tobacco taxes as a policy instrument in reducing cigarette consumption. I estimated a cigarette demand function with the most recent prefectural level data available and found that cigarette demand in Japan is inelastic to both income and price changes. Based on the estimated demand as well as the price, tax, and consumption data of 1999, I conclude that it would take a tobacco tax increase of considerable magnitude to reduce cigarette consumption to a meaningful extent and a sizeable tobacco tax increase is likely to generate substantial social and financial benefit.