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Discussion Paper 04-12-Rev.

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Abstract

Japan has implemented a number of anti-smoking policies; these include information disclosures, taxation, and smoking bans. These measures have increased the information available to consumers, as well as tax rates on tobacco products. First, this paper shows, theoretically, the association between a lack of information and over-consumption of cigarettes, and then examines the effects of smoking policies using monthly data from 1951 to 1999. Long-term policies have had greater effects than short-term policies. Taxation has reduced consumption, but income differences have had no significant effect. Following health disclosures in 1964 and 1967, many consumers switched to filtered cigarettes and low-nicotine and low-tar products, respectively. The move to lower tar and nicotine products was further accelerated by the " harmful to health "label applied to cigarettes in 1972, although many smokers then raised the number of cigarettes they smoked to keep up their intake of nicotine. Other policies have decreased cigarette, nicotine, and tar consumption since 1972.

JEL classification: I18; D11; D12

Keywords: anti-smoking, health information, nicotine-tar, compensative behavior, rational addiction

1 Introduction

1.1 Purpose and findings

Smoking is a complicated behavior. Price, income, and past and future cigarette consumption influence smoking behaviors, as do factors such as health information and regulations related to this unhealthy and addictive behavior. It is thus important to understand how cigarette consumers respond to health information and regulations. Here, I incorporate health information into a rational addiction (RA) model. The model indicates that consumers over-consume cigarettes due to a lack of information on related health hazards, and that more and new information reduces consumption. Because smoking is addictive and detrimental to health, to protect human health and reduce the social costs of smoking, the Japanese government has implemented anti-smoking policies that include health information disclosures, taxation, and smoking bans. This paper examines the effects of these policies on cigarette consumption, and on nicotine and tar intake, within a framework of rational addiction and non-addiction using generalized methods of moments (GMM), ordinary least-squares (OLS) techniques, and monthly data from Japan from 1951 to 1999.

The analyses showed that anti-smoking policies have had a significant impact on consumer behavior. Long-term policies have had as much as twice the impact of short-term policies, and long-term policies, such as health hazard information campaigns and tax increases, have become more developed over time. Consumers have responded by changing their cigarette type or by reducing or quitting smoking. The share of filtered cigarette sales has been increasing since the 1960s, following the first official information disclosure on cigarette risks in Japan. Consumers have also switched to low-nicotine

and low-tar cigarettes, following the release of data on nicotine and tar consumption in 1967. The printing of " smoking is harmful to health " on every cigarette package since 1972 has further increased the move to lower tar and nicotine products, although consumers have compensatively raised their total consumption of low-nicotine/tar brands to maintain a consistent intake of nicotine, owing to the addictiveness of cigarettes. However, other control policies implemented since 1972, such as workplace smoking bans, smoking science research, health warnings, nicotine labeling, and official reports on smoking, have helped reduce the consumption of cigarettes, nicotine, and tar overall.

1.2 Japanese smoking issues and international regulations

Smoking is a serious social and economic problem in Japan, with lung cancer ranking as the most dangerous cancer in the country since 1996. In 2000, the adjusted mortality rate in Japan from lung cancer was as much as 2.5 times greater than the average rates in the U.S., Germany, Italy, France, Sweden, and the Netherlands.[1] The smoking rate in Japan is very high compared to rates in other developed countries.[2] Scientific research has shown that smoking causes many kinds of cancer, especially lung cancer. Even without accounting for the loss of human life caused by smoking, the social costs of smoking are immense.[3]

To reduce and prevent smoking worldwide, the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) was unan-

[1]The number of deaths caused by lung cancer was reported as 39,053 males and 14,671 females in 2000. See Ikeda and Kamimura (1998) and Ikeda et al. (2004) for details.

[2]According to a survey by Japan Tobacco Inc., 45.8% of adult males and 13.8% adult females smoked in 2005.

[3]Social cost = medical costs, etc. - (tax revenue + benefit of tobacco industry, etc.). Japan 's national health insurance system may actually be one cause of the high smoking rate because smokers do not have to pay additional insurance premiums under the system. See Wan (forthcoming) for details.

imously approved by all WHO members (192 countries) on 27 May 2003. Japan also ratified this treaty and instituted its principles on 27 February 2005. The treaty focuses on information dissemination concerning the health effects of smoking, taxation on tobacco products, and smoking bans. Japan has instituted numerous policies similar to those recommended by the FCTC. Japan 's anti-smoking policies will be detailed in Section 2.2.

1.3 Related literature and departure from previous studies

Many previous papers have analyzed the consumption of hazardous goods such as cigarettes. Ippolito (1981) developed a theoretical model to analyze consumer reactions to new health information. Ippolito and Ippolito (1984) provided empirical evidence to show that new health information reduces cigarette consumption. Goldbaum (2000) showed that an endogenous desire to quit smoking can result from a rational consumption path chosen as the consumer begins smoking. Viscusi (1992) and Hu et al. (1995) also reported that health hazard information has a strong effect on consumer behavior. Clark and Etile (2002), based on British data, found that smokers who develop health problems from smoking are likely to smoke less or quit in the future. The effects of anti-smoking policies such as workplace smoking bans were analyzed by Evans et al. (1999) and Bardsley and Olekalns (1999), whose results indicate that such bans reduce smoking. Here, a testable RA model incorporating health information and regulations was constructed and tested using Japanese policy events and monthly data on cigarette, nicotine, and tar consumption.

Although several studies have examined Japanese cigarette consumption, their focus and methods differed from those of this paper. For example, Haden (1990) was not concerned with addiction and health hazard infor-

mation. Without considering the addictive aspect, Yorozu and Zhou (2002) found that“ information ”reduces smoking, using cross-sectional, prefecture-level data; however, the information measure in this instance was prefectural anti-smoking budget dummy data collected by telephone conversations with prefectural officials.[4] Using panel data on inter-brand cigarettes, Wan (June 2004) found that the mandatory information disclosure of nicotine and tar content has decreased the demand for high-tar (nicotine) brands, but that consumers have compensatively increased total consumption to keep their nicotine intake steady.

1.4 Structure of the paper

The remainder of this paper is organized as follows. Section 2 examines knowledge and beliefs in relation to smoking and the main anti-smoking policies in Japan. Section 3 describes the conceptual and empirical specifications, while section 4 presents the data and empirical strategy, and section 5 reports the estimation results. The conclusion and policy implications are discussed in section 6.

[4]Two other issues must also be addressed. First, Yorozu and Zhou (2002, p. 79) listed per capita consumption as 414.32 packs (20 cigarettes per pack) per year, but the“ Public Finance Statistics ” publication edited by the Ministry of Finance of Japan, and Wan (forthcoming), show per capita consumption in 1990 and 1995 as 130.03 (20 cigarettes per pack) and 133.25 packs, respectively; therefore, the consumption data may have been overestimated by as much as three times by the former study. Second, the effect of the anti-smoking budget may have arisen from the discretionary estimation method (pooled OLS of a 2-year panel) and prefectural fixed effects. Additionally, an anti-smoking budget may be used not only for information dissemination but also for other purposes, such as the construction of smoking areas (because of smoking bans in other areas).

2 Knowledge, Beliefs, and Anti-smoking Policies

2.1 Knowledge and beliefs in relation to smoking in Japan

A number of surveys have examined smoking and health in Japan.[5] Two surveys have collected information on the harmful effects of smoking.[6] Table 1a lists the percentages of respondents who knew about the negative health impacts of smoking. In this table, the values in the " difference " column indicate the increase in the proportion reporting to know about the damage from smoking.[7] All the values were positive and significant, indicating that information on smoking damage has increased over time.

Smokers ' reasons for reducing or quitting smoking are shown in Table 1b.[8] The most important reason given for every year is that smoking is " harmful to health. " The change in the importance of health reasons from 1981 to 1988 was larger than that from 1988 to 1999. This implies that there was a sharp increase in the amount of information regarding smoking hazards from 1981 to 1988. The second most important reason changed over time. Cost was relatively unimportant and increased little in importance from 1981 to 1988 due to the relatively low real price of cigarettes and the bubble economy. In contrast, the effect of cost increased sharply in importance from 1988 to 1999 due to the relatively high real price of cigarettes that resulted from a tax increase and Japan 's depressed economy.

[5] See Appendix for details.

[6] The questions used almost the same wording to describe the health damage from smoking, even though these two surveys were conducted by two different institutions, and at different times.

[7] The samples of the surveys were assumed to have binomial distributions. Difference tests were used to test whether there were differences in information between earlier and later surveys, and among smokers, former smokers, and non-smokers.

[8] Former smokers ' reasons for quitting or reducing smoking are not shown here. The reasons are very similar to those of smokers who want to quit.

2.2 Anti-smoking policies in Japan

Governmental policies are considered a main contributor to the changes in consumer attitudes described in section 2.1. Following the " Report on Smoking and Health " by the Ministry of Health, Labor, and Welfare of Japan (MHLWJ), the government has implemented a number of tobacco-control policies. There were ten main tobacco-control policies instituted between 1951 and 1999, as well as six rises in cigarette tax hikes. These policies can be roughly divided into three parts: information disclosure, cigarette taxes, and smoking bans.

The MHLWJ first issued information on the detrimental health effects of smoking on 6 February 1964 in a report entitled " A Notice about Health Damage from Smoking. " The report was given to prefectural governors and to the mayors of several designated cities, and followed the release of the U.S. " Smoking and Health Report, "published in 1964. In April 1967, information on nicotine and tar content was released in newspapers, as mandated by the Ministry of Finance. Beginning August 1972, cigarette manufacturers were required to include the following warning on all cigarette packages, " Let 's be careful about smoking too much for health reasons. " In October 1987, the first edition of the " Report on Smoking and Health, " edited by the MHLWJ, was released. In January 1990, cigarette manufactures were required to include the following warning on cigarette packages, " Let 's be careful about smoking too much because there is a possibility that it will ruin your health, "and to print the nicotine and tar contents on the package. The MHLWJ released the second edition of the " Report on Smoking and Health " in May 1993. In the analysis, dummies were used to examine the effects of information dissemination.

Taxes on tobacco products increased six times from 1951 to 1999, as

summarized by Wan (2001). The first proposed cigarette tax increase was passed in the House of Representatives on 12 April 1968 and enforced on 1 May 1968. The second, and additional increases up to the sixth, were passed on 25 October 1975, 7 February 1980, 1 February 1983, 8 May 1986, and 6 October 1998, respectively, and enforced on 18 December 1975, 22 April 1980, 1 May 1983, 1 May 1986, and 1 December 1998, respectively. Thus, consumers can expect future tax and price variations.[9]

Other policies also aimed to control tobacco use. In April 1978, the MHLWJ issued an edict requiring national hospitals and sanitariums under its jurisdiction to restrict smoking to certain areas. In June 1978, domestic airlines instituted non-smoking areas, while in July 1978, ferries connected with Japan Railway instituted non-smoking sections. The Japanese government also established the Smoking Research Foundation in April 1986 to scientifically examine the health effects of smoking.

3 Conceptual and Empirical Specifications

A model was required to identify the effects of the anti-smoking policies described in Section 2.2. The anti-smoking policies have mainly focused on health information, taxation, and workplace smoking bans. The workplace smoking ban, to some extent, constitutes an extension of the information dissemination policies because smoking bans aim to protect human health and to reduce consumption, both directly and indirectly, by serving as reminders of the danger of smoking. Thus, in this study, health information was incorporated into the framework adopted from Becker et al. (1994).

As Stigler and Becker (1977) have noted, " A consumer may indirectly receive utility from a market good, yet the utility depends not only the

[9]Source: the Asahi Shimbun, a main newspaper in Japan, 1951-1999.

quantity of the good, but also the consumer 's knowledge of its true or alleged properties. If he does not know whether the berries are poisonous, they are not food, if he does not know that they contain vitamin C, they are not consumed to prevent scurvy. " The consumer derives utility from a good based on his or her limited knowledge about it. This knowledge is produced by scientific research and is thus exogenous to the consumer. Cigarette demand as a function of health hazard information was therefore derived, as follows.

Consumers were assumed to have infinite lives and to maximize lifetime utility discounted at the rate r. Utility was composed of two parts: euphoria from smoking and disutility from knowing the health hazards of smoking. Consumption euphoria and the disutility of the health hazard were assumed to be separable.[10] The consumer 's utility is bounded by his or her limited information.

$$V(C_t, C_{t-1}, Y_t, e_t; I_t) = U(C_t, C_{t-1}, Y_t, e_t) - \alpha(I_t)C_t. \tag{1}$$

[10]For simplicity, I assumed that the disutility of the health hazard is separable from the consumption utility. I examined the case for which the disutility from the health hazard was non-separable from the consumption utility as $V(C_t, C_{t-1}, Y_t, e_t; I_t) = [\gamma(I_t)C_t]U(C_t, C_{t-1}, Y_t, e_t)$. The calculation was complicated, but in the simplest case, $V(C_t, C_{t-1}, Y_t, e_t; I_t) = \gamma(I_t)U(C_t, C_{t-1}, Y_t, e_t)$; the demand equation was almost the same as equation (3), where $\eta(I_t) = 0$ and the coefficient of C_{t+1} was not $\beta\theta$ but $[\gamma(I_{t+1})/\gamma(I_t)]\beta\theta$. If negative information shock (or bad news) means that $\gamma(I_{t+1})/\gamma(I_t)$ becomes smaller, this (negative) information shock may increase consumption because the consumer becomes less forward looking, and increases current consumption, increasing the absolute values of short- and long-run price elasticities. The amount of information on the health hazards of smoking has increased with time; thus, $\gamma(I_{t+1})/\gamma(I_t)$ may have decreased with time. This decreasing $\gamma(I_{t+1})/\gamma(I_t)$ may explain why estimates of β have been too small in the literature, e.g., in Becker et al. (1994), and in this paper. The detailed proof is available upon request.

The consumer 's problem is

$$\max \sum_{t=1}^{\infty} \beta^{t-1} \Big[U(C_t, C_{t-1}, Y_t, e_t) - \alpha(I_t) C_t \Big]. \tag{2}$$

$$s.t. \ \sum_{t=1}^{\infty} \beta^{t-1} (Y_t + P_t C_t) = A^0$$

$$\beta = 1/(1+r)$$

Here C_t, C_{t-1} are the quantities of cigarettes consumed in periods t and t-1, respectively. Y_t is the consumption of the composite commodity in period t, and e_t reflects the impact of unmeasured life-cycle variables on utility. The composite commodity, Y, is the numeraire, and thus the price of cigarettes in period t is denoted by P_t. The rate of interest was assumed to equal the rate of time preference. β is the time discount factor. Any effect of C on earnings and on the present value of wealth (A^0) were ignored. The same applies to the effect of C on other types of uncertainty. The initial condition for the consumer in period 1, C^0, measures the level of cigarette consumption in the period prior to the one under consideration.

$\alpha(I_t)$ is the consumer 's disutility factor, which is the consumer 's subjective belief that smoking is truly harmful to his or her health. This subjective belief was assumed to increase with " information I_t " by a Bayesian learning framework; thus, $\frac{d\alpha(I_t)}{dI_t} > 0$. New beliefs will be formed when new health hazard information is announced.

The associated first-order conditions are

$$\begin{aligned} U_y(C_t, C_{t-1}, Y_t, e_t) &= \lambda, \\ U_1(C_t, C_{t-1}, Y_t, e_t) + \beta U_2(C_{t+1}, C_t, Y_{t+1}, e_{t+1}) - \alpha(I_t) &= \lambda P_t. \end{aligned}$$

A consumption euphoria function that is quadratic in Y_t, C_t, and e_t was

considered. By solving the first-order condition for Y_t and substituting it into the first-order condition for C_t, a linear difference equation can be derived:

$$C_t = \theta_0 \ + \ \theta C_{t-1} \ + \ \beta\theta C_{t+1} \ + \ \theta_1 P_t \ + \ \eta(I_t) + \ \theta_2 e_t \ + \ \theta_3 e_{t+1} \qquad (3)$$

where,[11]

$$\eta(I_t) = \frac{u_{yy}\alpha(I_t)}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)}. \qquad (4)$$

Health hazard information cannot be anticipated by the consumer. If the consumer obtains new health hazard information at time t, the short-run effect of health hazard information is

$$\frac{dC_t}{dI^*} = \frac{1}{\theta(1-\phi_1)\phi_2}\frac{d\eta(I_t)}{dI_t} < 0, \qquad (5)$$

which is defined as the impact of an increase in current and all future information on current consumption, with past consumption being held constant. If there is no information depreciation, the long-run effect of health hazard information is

$$\frac{dC_\infty}{dI} = \frac{1}{\theta(1-\phi_1)(\phi_2-1)}\frac{d\eta(I_t)}{dI_t} < 0, \qquad (6)$$

which is defined as the effect of a permanent increase in information, in all

[11] This model setting and equation (3) have also been presented by Wan (2001, Dec. 2004). There appears to be a misprint in the publication by Becker et al. (1994). According to my calculations, the last multiplicative term in the numerator of the formula for θ_3 should be $u_{2y}u_{ey}$ instead of $u_{2y}u_{2e}$.

$\theta_0 = -\lambda(u_{y1} + \beta u_{y2})$, $\theta = \frac{-(u_{12}u_{yy} - u_{1y}u_{2y})}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)}$, $\theta_1 = \frac{u_{yy}\lambda}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)}$, $\theta_2 = \frac{-(u_{yy}u_{1e} - u_{1y}u_{ey})}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)}$, $\theta_3 = \frac{-\beta(u_{yy}u_{2e} - u_{2y}u_{ey})}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)}$. A good is considered addictive if $\theta > 0$; the degree of addiction increases with θ. The roots of the difference equation are $\phi_1 = \frac{1-(1-4\theta^2\beta)^{1/2}}{2\theta}$, $\phi_2 = \frac{1+(1-4\theta^2\beta)^{1/2}}{2\theta}$, and the stability conditions are $4\theta^2\beta < 1$, $\phi_1 < 1$, $\phi_2 > 1$. The short- and long-run price effects are $\frac{dC_t}{dP^*} = \frac{\theta_1}{\theta(1-\phi_1)\phi_2}$, $\frac{dC_\infty}{dP} = \frac{\theta_1}{\theta(1-\phi_1)(\phi_2-1)}$. See Becker et al. (1994) for details.

periods. $|\frac{dC_\infty}{dI}| > |\frac{dC_t}{dI^*}|$, meaning that the absolute value of the long-run effect is larger than that of the short-run effect.

4 Dataset and Estimation Strategy

4.1 Dataset and variable creation

The data were comprised of monthly time series data from Jan. 1951 to Oct. 1999. Table 2a presents the means, standard deviations, and other descriptive statistics for the variables, following seasonal adjustments.

Cigarette purchases by Japanese worker households (C_t) refers to cigarette purchases in packs (20 cigarettes per pack) per capita, per month, per family, divided by the number of family members.[12] Purchase data were obtained from the " Annual Report of Family Income and Expenditure Survey (FIES). "[13] Hoarding and stock dummies were taken into account. The data were seasonally adjusted using X-12 ARIMA, a seasonal adjustment program.

Nicotine intake$_t$ is the monthly intake of nicotine in minigrams per capita. The data were created by multiplying cigarette purchases by nicotine content per cigarette. The data were then seasonally adjusted using X-12 ARIMA.

Tar intake$_t$ is the monthly intake of tar in minigrams per capita. The data were made by multiplying cigarette purchases by the tar content per cigarette and seasonally adjusted using X-12 ARIMA.

Price (P_t) is the real average retail cigarette price per pack for each

[12] In the FIES, the respondents were divided into two groups: worker and non-worker households. A non-worker household has no labor income. In this study, only information on worker households was used because a labor income variable was available for this group.

[13] The trend of per capita cigarette purchase is similar to the statistical data shown in Wan (forthcoming), though the mean here is smaller than the statistical one.

month and is equal to the Tobacco Price Index divided by the Consumer Price Index (CPI).[14] The data were acquired from the " Annual Report on the Consumer Price Index " and the " Monthly Report on the Retail Price Survey. " These data were also seasonally adjusted using X-12 ARIMA.

Disposable income (Y_t) is real per capita disposable income per month for salaried worker households. These data were from the " Annual Report of Family Income and Expenditure Survey " and calculated by dividing the average household disposable income by the average number of household members per household and the CPI. The data were seasonally adjusted using X-12 ARIMA.

Tax Rate (Tax_t) is the rate of tax increase based on data from the " Public Finance Statistics. "

US Report is a dummy variable for the release of" Smoking and Health: Report of the Advisory Committee to the Surgeon General of the Public Health Service " in 1964 in the U.S. The Japanese government first officially disseminated" A Notice about Health Damage from Smoking "to prefectural governors and the mayors of several cities following the U.S. Report. This variable had a value of 0 from Jan. 1951 to Dec. 1963, and 1 from Jan. 1964 to Oct. 1999.

Nicotine-tar release is a dummy variable relating to the release of nicotine and tar information in main newspapers in Japan. The variable had a value of 0 from Jan. 1951 to Mar. 1967, and 1 from Apr. 1967 to Oct. 1999.

Warning1 is a dummy variable relating to the warning " Let 's be careful about smoking too much for health reasons " printed on cigarette

[14] As shown in Merriman (2002), cigarette smuggling may exist if the domestic price is different from the foreign one, but the smuggling seems not a big issue in Japan. It may be because of geography (island nation).

packages. The variable had a value of 0 from Jan. 1951 to Jul. 1971, and 1 from Aug. 1971 to Oct. 1999.

Dummy7504 is a dummy variable for the period from Apr. 1975 to July 1975, with a value of 1 from Apr. 1975 to July 1975, and 0 in all other periods. The tax increase proposal was passed by the Finance Committee on 24 Apr. 1975, but it was voted down by the Lower House on 4 Jul. 1975.

Dummy7509 is a dummy variable for the period Sept. 1975 to Nov. 1975, with a value of 1 from Sept. 1975 to Nov. 1975, and 0 in all other periods. The tax increase proposal was submitted to the Diet again on 20 Sept. 1975 and was enforced on 18 Dec. 1975.

Workplace ban is a dummy variable for smoking bans. It had a value of 0 from Jan. 1951 to Mar. 1978, and 1 from Apr. 1978 when the smoking ban in facilities such as hospitals was mandated to Oct. 1999.

Research is a dummy variable for smoking research.[15] It had a value of 0 from Jan. 1951 to Mar. 1986, and a value of 1 from Apr. 1986, when the Smoking Research Foundation was established, until Oct. 1999.

Report1 is a dummy variable for the 1st edition of the " Report on Smoking and Health. " This variable had a value of 0 from Jan. 1951 to Sept. 1987, and a value of 1 from Oct. 1987, when the report was released, until Oct. 1999.

Warning2 is a dummy variable relating to the warning " Let 's be careful about smoking too much because there is a possibility it will ruin your health. " This variable had a value of 0 from Jan. 1951 to Dec. 1989, and a value of 1 from Jan. 1990, when the warning was mandated, until

[15]After this event (April 1986 founding of the Smoking Research Foundation), many scientific articles on smoking damage have been reported from this foundation in every year since that time. The funding volume is huge, and the number of articles is averagely about 140 every year during 1986-2001. The research pursuers are averagely about 450 persons every year. The yearly funding is about 330 million yen. The detail is in the Appendix A (A2) of Wan (2001).

Oct. 1999.

Report2 is a dummy variable for the 2nd edition of" Report on Smoking and Health. " It had a value of 0 from Jan. 1951 to May 1993, and a value of 1 from Jun. 1993, when the report was released, until Oct. 1999.

Hoarding is a dummy variable for the months just before cigarette tax increases. According to Wan (2005), the lead of Tax_t is a valid proxy for $Hoarding$.

Stock is a dummy variable for the months immediately after cigarette tax increases. According to Wan (2005), Tax_t is a valid proxy for $Stock$.

4.2 Unit root tests

If any of these variables were not stationary, some problems of statistical inference would arise if GMM or OLS were used. Therefore, each variable was tested for stationarity using the augmented Dickey-Fuller (ADF) test and Phllips-Perron test (1988) (see Table 2b).

The null hypothesis that C_t, $Nicotine\ intake_t$, $Tar\ intake_t$, P_t, ΔY_t and Tax_t have unit roots was rejected at the 1% significance level; these variables were thus considered to be stationary. Because the null hypothesis that Y_t had a unit root could not be rejected at any conventional significance level, Y_t was not considered stationary. Including Y_t while using GMM and OLS could have created a bias. Therefore, ΔY_t was used in the estimation.

4.3 Estimation technique

GMM and OLS methods were used to obtain parameter estimates. For the addiction model, OLS estimates may not be consistent because of the endogeneity of past and future consumption and because of the possibility that the use of leads and lags gave rise to serial correlation in the residuals.

To obtain consistent estimates, GMM was used.[16] OLS was used for the non-addiction model.

The GMM estimates will be consistent if suitable instrument variables are used. As discussed in Wan (forthcoming), the cigarette price and tax is exogenous in Japan from the viewpoint of consumers because the government controls the price and new law is needed for a tax increase. The nominal cigarette price cannot be changed, except for a change in the cigarette tax. Six cigarette tax increases were passed by the Japanese government from 1951 to 1999, not because of fluctuations in cigarette demands, but mainly because of a large deficit in public funds.[17] The consumer can perfectly anticipate the tax increase because there are several months (three to six months) between the enactment and implementation of a new cigarette tax law. Furthermore, because prices are strongly correlated with consumption, they are thought to be good instrument variables for consumption. The lagged cigarette price was used as an instrument variable for past cigarette consumption, while the lead of price was used as an instrument variable for future cigarette consumption. The leads and lags of the rate of the tobacco tax increase were also included as additional instruments.[18]

Hansen 's (1982) J test for over-identifying restrictions implied by the instruments was used as a specification test of the model. To obtain consistent estimates, the hoarding and stock proxies (current and lead of tax rate) were used to distinguish purchases from consumption following the method

[16]The time trend would be a good proxy for capturing the effect caused by policy change. However, GMM instruments need stationary variables; thus, only dummy variables were used here.

[17]See The History of the Japanese Tobacco Monopoly (in Japanese, Nihon Tabako Senbaishi).

[18]Auld and Grootendorst (2004, p. 1125, ln. 1-3) have noted that the estimable RA model tends to yield spurious evidence when aggregate data are used; if, however, prices are exogenous, instrumental variable estimates of the coefficients on the lag and lead of consumption will be consistent. Cigarette consumption in Japan would be an exceptional case.

of Wan (2005).

5 Empirical Results

5.1 Cigarette consumption

The parameter estimates of RA and non-addiction models are reported in Table 3. The RA models (models 1 and 2) were estimated by the GMM. The non-addiction model (Model 3) was estimated by OLS to test whether the effects of anti-smoking policies were changed by the model selection. The results of these three models showed little difference, except for the addictiveness.

In the columns for models 1 and 2, the coefficients of C_{t-1} and C_{t+1} were positive and significant. The coefficient of P_t was significantly negative. The estimated values satisfied the stability conditions. Thus, these results are consistent with the RA model. The coefficient of ΔY_t was not significant in Model 1 or in Model 2.[19] The coefficient of *US Report* was positive but not significant.

The coefficients of *Nicotine-tar release* and $Warning1$ were positive and significant. It appears that consumers shifted to low nicotine/tar and filter types of cigarettes after information on nicotine and tar had been disclosed, as shown in figures 1 and 2; however, consumers maintained or increased consumption of cigarettes to maintain their intake of nicotine.[20] The coefficient of $Workplace$ was negative and significant, implying that the smoking ban policy was effective. The coefficient of *Research* was negative and significant. Thus, cigarette research has a negative effect on cigarette

[19] $\Delta Y_t/Y_t$ was also used to capture the income effect. The estimated coefficient of income was not significant, and the coefficients of other variables were almost unchanged.

[20] Consumers also maintained their intake of tar because low-nicotine brands always have low tar.

consumption, as expected. The coefficients of $Report1$ and $Warning2$ were negative and significant. The coefficient of $Report2$ was negative but not significant. This result can be interpreted as follows: consumers decreased consumption in response to disclosures of health damage information. According to Figure 2, average nicotine and tar per cigarette declined only slightly and was quite stable after the 1980s. The consumer had to reduce consumption to adjust the stock of nicotine and tar gradually, in response to new health hazard information. This behavior is consistent with the RA prediction.

The coefficient of $Dummy7504$ was significantly positive, implying that consumers hoarded cigarettes when tax increase proposals were passed. The coefficient of $Dummy7509$ was not significant. The coefficient of $Hoarding$ was positive, significant, and large, while the coefficient of $Stock$ was negative, significant, and large. Thus, consumers took future price information into account and hoarded cigarettes just before the price increase. This result is similar to results found by Wan (2005).

Robust test using the non-addiction model

By the RA model, current consumption depended on past and future consumption. Thus, consumption changed only gradually. It is possible that the RA model makes it difficult for the consumers to respond in a timely manner to health information and regulations. A standard model (Model 3) was also applied, but results were very close to those of the RA model. Consumer responses to information on price and health suggest that smoking behavior is consistent with the RA prediction regarding the effects of health information.

Robust test for small β

The value of β implied by the results in Table 3 was too small.[21] Estimating β precisely for a specific good is considered difficult.[22] Here, a discount factor was imposed a priori to estimate the RA model (Model 2) again. Table 4a lists the long-run price elasticities. Long-run price elasticities were stable when β was changed from 0.4 to 0.95 and were very close to those of Model 2 shown in Table 3.

Elasticity and rate of contribution of each factor

The estimated coefficients and sample means in Table 2a were used to estimate the short- and long-run price elasticities,[23] which are shown in the rows labeled " short-run ϵ " and " long-run ϵ. " The long-run price elasticity was approximately 2.055 times as large as the short-run price elasticity, and close to the estimate based on annual data.[24]

The elasticities of all variables based on Model 1 are summarized in columns 3 and 4 of Table 4b. Using the mean and the relative change of each variable, the contribution rate of each factor was calculated based on the long-run elasticity. The results are summarized in columns 5-8 of Table 4b. Here, $\Delta C/\bar{C} = (C_{Oct.1999} - C_{Jan.1951})/\bar{C} = 0.397$, $\Delta P/\bar{P} = (P_{Oct.1999} - P_{Jan.1951})/\bar{P} = -1.441$. When t = six periods, the absolute

[21] Becker et al. (1994) found similar results for the time discount parameter from this sort of test.

[22] As shown in Footnote 10, the information effect may cause this small β. here I do not make this test but I plan to do it in a new research.

[23] The results differed from those by Haden (1990). Haden estimated the price and income elasticities of Japanese cigarette consumption using annual data for 1964-1983. Income elasticity was estimated to be 0.161 and the price elasticity to be -0.948. Thus, cigarettes are a normal good. The results presented in this paper also differ from those by Yorozu and Zhou (2002), who estimated the income and price elasticities of demand for cigarettes to be 0.291 and -0.986, respectively. According to Gruber and Köszegi (2001), the long-run price elasticity in the U.S. (based on monthly data) is -0.8, while here the long-run price elasticity in Japan was estimated to be -0.524. Thus, the absolute value of the long-run price elasticity was somewhat smaller in Japan than in the U.S.

[24] The long-run elasticity was approximately -0.67, see Wan (forthcoming).

value of elasticity was larger than that for 90% of the long-run elasticity.

The contribution rates of " tax related, " " information related, " and " control policy related "were approximately 166.24%, 45.89%, and −66.37%, respectively. The summation of the contribution rate of" information related " and " control policy related "was −20.48%. This means that anti-smoking policies have reduced consumption, but the decreasing price has increased consumption.

5.2 Nicotine and tar intake

Data on nicotine and tar price were unavailable; thus, cigarette price was used as a proxy for the price of nicotine. The intake of nicotine and tar was estimated with the RA model by GMM. Three lags and three leads of cigarette price, two lags and two leads of cigarette tax rate, and other explanatory variables were used as instruments. The results are reported in Table 5.[25]

In the column for nicotine intake, the coefficient of P_t was significantly negative and the short- and long-run price elasticities were -0.377 and -0.863, respectively. The stability conditions were satisfied. The coefficient of hoarding was significantly positive, and the coefficient of stock was significantly negative. The coefficients of C_{t-1}, C_{t+1} were significantly positive. Thus, these results are consistent with the RA model. The coefficient of *Nicotine-tar release* was significantly positive, implying that the release of nicotine and tar content significantly increased the intake of nicotine. The other variables, $Warning1$, $Workplace\ ban$, $Research$, $Report1$, $Warning2$, and $Report2$ had a significantly negative impact on nicotine intake.

The column for tar intake shows that the coefficient of P_t was signif-

[25] $\Delta Y_t/Y_t$ was also used to capture the income effect. The estimated coefficient of income was not significant, and the coefficients of other variables were almost unchanged.

icantly negative and the short- and long-run price elasticities were -0.401 and -0.844, respectively. The stability conditions were satisfied. The coefficient of hoarding was significantly positive, and the coefficient of stock was significantly negative. The coefficients of C_{t-1} and C_{t+1} were positive and significant. Thus, these results are consistent with the RA model. The coefficients of *US_Report* and *Nicotine-tar release* were significantly positive, implying that the *US_Report* and the release of nicotine and tar content information significantly increased the intake of tar. The other variables, $Warning1$, *Workplace ban*, *Research*, $Report1$, $Warning2$, and $Report2$ had significantly negative impacts on tar intake.

Note that the sign of the coefficient of $Warning1$ was inverse to that for cigarette consumption, as shown in Table 3. Consumption increased in 1972, but the intake of nicotine and tar decreased. This implies that the consumer switched to low nicotine and tar brands but consumed more cigarettes to keep up the intake of nicotine and tar. This compensative behavior is consistent with nicotine 's addictive nature. From figures 1, 2, and 3, it is clear that structural changes in nicotine and tar intake took place in the mid-1960s, when the U.S. report and release of nicotine and tar content were implemented.[26] These results are consistent with those for cigarette consumption and also with those of inter-brand cigarette demands found by Wan (2004).

6 Conclusions and Policy Implications

The Japanese government has implemented a number of anti-smoking policies, including the dissemination of information on the negative health im-

[26] A Chow test was also performed and confirmed this structural change. The estimation results are available upon request.

pacts of smoking, taxation of cigarettes, and smoking bans. Such anti-smoking measures have increased over time. To assess these policy effects, this study theoretically and empirically examined smoking behavior, simultaneously, by first considering addictiveness, health information, taxation, and regulations, such as smoking bans. Theoretically, the consumer over-consumes cigarettes because of a shortage of health information and reduces consumption when new information is announced. The estimation results based on monthly consumption data on cigarettes, nicotine, and tar by Japanese salaried worker households and several policy events were basically consistent with the predictions of the RA model for health information and also consistent with the results of Japan 's national smoking surveys.

Consumers responded to increased health information by changing their cigarette type and reducing or quitting smoking. The share of filtered cigarettes has been increasing since the 1960s, following the first official information disclosure on cigarettes and health in Japan. More consumers have also switched to low-nicotine and low-tar cigarettes since newspaper releases of data on nicotine and tar in 1967; however, nicotine addiction has led consumers to raise their consumption of cigarettes to maintain nicotine intake. The printing of " smoking is harmful to health " on cigarette packaging since 1972 has strengthened the consumer switch to lower tar/nicotine cigarettes but has compensatively raised total consumption to maintain nicotine intake. Other tobacco control policies since 1972, including workplace smoking bans, smoking science research, health warnings, nicotine labeling, and reports on smoking, have been effective in reducing nicotine and tar intake.[27] Anti-smoking policies have reduced consumption, but price de-

[27]The 1967 information release has implicitly had a negative impact on nicotine and tar intake since 1972 because the consumer could not choose his or her preferred brands based on nicotine and tar information if the tar contents in 1967 had not been released.

creases have increased consumption. The contribution rate of anti-smoking policies to the reduction of cigarette consumption from 1951 to 1999 was -20.48%.

These analyses have shown that health information, tax increases, and smoking bans are all effective for tobacco control. Long-run policies have had as much as double the effect of short-run policies. Compared to residents of other Westernized countries, the Japanese have less knowledge about how smoking affects heart disease and other health problems.[28] It appears that people in Japan generally have inadequate knowledge of the health hazards of smoking. The cigarette tax rate in Japan is also still rather low. Hence, the Japanese government should continue its anti-smoking policies and, in particular, strengthen information dissemination and taxation programs. Other smoking bans are also considered to be useful. Additionally, broad and comprehensive implementation of FCTC policies in Japan should have a considerable positive impact.

This study used several dummies as proxies for anti-smoking events. Other approaches such as an updating process based on Bayesian mean and variance methods would be a good measure of transition in consumer belief.[29] The consumer may be hyperbolic, as proposed by Gruber and Kőszegi (2001). The welfare change arising from health information and taxation was not analyzed here in detail.[30] These issues are topics for future research.

[28] As shown in Viscusi (1992), 81% in 1977 and 83% in 1981 of all respondents knew " smoking is one cause of lung cancer, " and 68% in 1977 and 74% in 1981 responded that " smoking is one cause of heart disease " in the U.S.

[29] See Chern (1995) for details.

[30] There are a number of studies, such as that by Ikeda and Gombi (2003), that have analyzed the change in consumer welfare within the framework of rational habit formation.

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Appendix: Surveys

1978 Survey on Smoking

An opinion poll on smoking was conducted by the Mainichi Shimbun Corporation (Mainichi Newspaper) in April 1978. The 2,176 pollees were randomly chosen from among persons aged 20 and over in Japan and were interviewed by the polltakers. The response rate was 73%. The smoking rate of adult males was 75% and that of adult females was 13%. These results are broadly consistent with the results of the Japan Tobacco, Inc. survey, in which the male smoking rate was 74.7% and the female rate was 16.2%. Respondents were asked the following question: " What do you regard as the harmful effects of smoking? " There were 12 items from which to choose and more than one item could be chosen.

1981 National Survey on Smoking

This survey (in Japanese, Kitsuen ni Kansuru Zenkoku Ishiki Chosa) was conducted by Tadao Shimao, the chief researcher at the Research Institute of Tuberculosis, Japan Anti-Tuberculosis Association, in 1981. The survey encompassed 5,394 adult persons, who were family members or friends of members of the 47 branches of the Japan Anti-Tuberculosis Association in all prefectures of Japan. The survey was conducted from Feb. 1981 to Mar. 1981 using a self-registering paper questionnaire method. There were 2,933 male respondents (54.3% of the total) and 2,461 female respondents (45.6% of the total). The male and female shares in the total population were 49.2% and 50.8%, respectively, in Oct. 1980.

1988 Survey on Smoking and Health

This survey (in Japanese, Kitsuen to Kenkou ni Kansuru Yoron Chosa) was conducted by the Public Relations Office of the Prime Minister 's Office, Japan, from 27 October to 6 November 1988. The survey targeted 2,339 persons, aged 20 and over. Survey recipients were selected from throughout Japan using a two-stage stratified random sampling method. The response rate for the direct-interview survey was 78.0%.

1999 National Survey on Smoking and Health

This survey was conducted by the Ministry of Health, Labor, and Welfare of Japan from February 17 to March 2, 1999 and targeted 12,858 persons aged 15 and over. Recipients were randomly selected from the sample used for the 1998 Basic Survey on National Life in fiscal year 1998. The response rate was 91.9%, and respondents were interviewed directly. The smoking rate was 52.8% for adult males and 13.4% for adult females. These results are very close to those of the Japan Tobacco Inc. survey, in which rates were 55.2% for males and 13.3% for females. Respondents were asked the following question: " What do you regard as the harmful effects of smoking? " There were eight answers from which to choose and more than one could be chosen.

Table 1a The proportions of those who know about the damage from smoking
(Asymptotic t statistics in parentheses)

all respondents	survey 1978	survey 1999	difference (test statistics)
Lung cancer	66%	84.5%	22.5% (17.38)***
Bronchitis	45%	65.5%	20.5% (17.39)***
Heart disease	16%	40.5%	24.5% (27.31)***
Influence on pregnacy	20%	79.6%	59.6% (64.21)***
Tobacco dependence	44%	51.8%	7.8% (6.77)***
smokers			
Lung cancer	65%	75%	10% (5.90)***
Bronchitis	45%	50%	5% (2.77)***
Heart disease	18%	37%	19% (12.92)***
Influence on pregnacy	10%	72%	62% (51.02)***
Tobacco dependence	43%	55%	12% (6.69)***
non-smokers			
Lung cancer	67%	89.6%	22.6% (16.23)***
Bronchitis	46%	69.2%	23.2% (15.22)***
Heart disease	15%	42.5%	27.5% (23.47)***
Influence on pregnacy	28%	85.4%	57.4% (42.54)***
Tobacco dependence	46%	50.3%	4.3% (2.791)***

Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level.

Table 1b Results of ``Why do you want to reduce or quit smoking?''
(Asymptotic t statistics in parentheses)

smokers	survey1981	survey1988	survey1999	D1	D2
harmful to health	55.7%	78.6%	85.5%	22.9% (12.61)***	6.9% (4.30)***
costs a lot	6.2%	9.0%	39.2%	2.8% (2.42)***	30.2% (22.98)***
people around me do not want me to smoke	6.1%	20.3%	29.3%	14.2% (9.16)***	9.0% (5.47)***
advised by family members, etc.	6.2%	12.6%	14.5%	6.4% (4.88)***	1.9% (1.42)**
advised by doctors	4.5%	na	10.5%	na	na
smoking ban in public areas	na	11.5%	13.1%	na	1.6% (1.24)
prohibition at one's workplace	na	na	2.4%	na	na

Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level; `D1': the gap between the figures for the 1981 and 1988 surveys; `D2': the gap between the figures for the 1988 and 1989 surveys; `na' means `not available' or `no data.'

Table 2a Summary statistics, Jan. 1951- Oct. 1999

Variable	Mean	Std.Div.	Max.	Min.
C_t	1.447	1.074	5.225	0.688
Nicotine intake$_t$	37.549	13.555	136.363	13.599
Tar intake$_t$	483.872	187.1416	1789.434	160.218
P_t	3.104	1.097	6.942	1.72
Y_t	8.724	3.658	14.428	1.924
ΔY_t	0.02	0.231	1.135	-1.375
Tax_t	0.002	0.025	0.491	0

Note: `Max.' and `Min.' are maximum value and mimimum value, respectively; C_t is denominated in number of packs; P_t is denominated in units of 100 yen per pack; Tax_t is the rate of tax increase, which is not seasonally adjusted.

Table 2b Unit root tests (ADF and Phillips-Perron), Jan. 1951- Oct. 1999

Variable	ADF test		Phillips-Perron test	
	Lag length	(Test statistics)	Lag length	(Test statistics)
C_t	1	$(-4.094)^{***}$	5	$(-5.692)^{***}$
Nicotine intake$_t$	1	$(-3.498)^{***}$	5	$(-4.704)^{***}$
Tar intake$_t$	1	$(-3.381)^{**}$	5	$(-4.447)^{***}$
P_t	2	$(-1.040)^{***}$	5	$(-4.967)^{***}$
Y_t	5	(-2.249)	5	(-1.677)
ΔY_t	5	$(-14.667)^{***}$	5	$(-57.119)^{***}$
Tax_t	4	$(-10.956)_{***}$	5	$(-24.318)^{***}$

Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level; The tests of ADF and Phillips-Perron for unit roots are in levels; No trend but an intercept is included in the test equations.

Table 3 Estimates of rational addiction and non-addiction model with health information and other tobacco control policies, Dependent Variable = C_t, with distinction between purchase and consumption. (Asymptotic t statistics in parentheses) Jan. 1951- Oct. 1999

(Event Time)	Independent Variable	Model 1 coef. (t-stat.)	Model 2 coef. (t-stat.)	Model 3 coef. (t-stat.)
	Constant	0.870 (7.871)***	0.959 (9.597)***	2.515 (16.126)***
	C_{t-1}	0.517 (18.357)***	0.508 (16.870)***	
	C_{t+1}	0.024 (1.966)**	0.022 (1.694)*	
	P_t	-0.098 (-5.115)***	-0.115 (-7.060)***	-0.347 (-10.287)***
	ΔY_t	0.000 (-0.024)	0.000 (0.038)	0.001 (0.148)
(Jan. 1964)	US_Report	0.026 (1.289)		-0.038 (-0.693)
(Apr. 1975)	Dummy7504	0.215 (12.505)***	0.210 (12.573)***	0.569 (10.428)***
(Sept. 1975)	Dummy7509	0.04 (1.944)*	0.033 (1.692)*	0.094 (1.516)
(Apr. 1967)	Nicotine-tar release	0.142 (6.369)***	0.148 (6.723)***	0.161 (3.170)***
(Aug. 1971)	Warning1	0.147 (4.660)***	0.138 (4.762)***	0.159 (3.180)***
(Apr. 1978)	Workplace ban	-0.068 (-3.370)***	-0.069 (-3.414)***	-0.101 (-2.455)**
(Apr. 1986)	Research	-0.107 (-3.536)***	-0.104 (-3.410)***	-0.135 (-2.566)**
(Oct. 1987)	Report1	-0.095 (-2.713)***	-0.1 (-2.793)***	-0.192 (-3.430)***
(Jan. 1990)	Warning2	-0.075 (-3.336)***	-0.079 (-3.371)***	-0.193 (-3.673)***
(Jun. 1993)	Report2	-0.024 (-1.500)	-0.025 (-1.505)	-0.061 (-1.304)
	Hoarding	6.011 (33.187)***	5.946 (32.051)***	6.207 (49.756)***
	Stock	-5.585 (-29.948)***	-5.514 (-28.693)***	-1.618 (-14.194)***
	$4\theta^2\beta-1<0$	(-35.742)***	(-34.670)***	
	$\phi_1-1<0$	(-77.741)***	(-74.721)***	
	$\phi_2-1>0$	(8.163)***	(7.659)***	
	short-run ε	-0.218 (-5.296)***	-0.255 (-7.540)***	-0.745 (-10.286)***
	long-run ε	-0.458 (-6.379)***	-0.524 (-10.520)***	-0.745 (-10.286)***
	Adjust R^2	0.978	0.978	0.978
	D-W Stat.	1.982	1.984	2.296
	J-Stat.	0.01	0.009	
	Obs.	580	580	583

Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level; The instruments of Models 1 and 2: three lags and three leads of price, two lags and two leads of tax rate, other explanatory variables; the p-value for the J-test of Models 1 and 2 is 1, respectively.

Table 4a Robustness test, impose β a priori (Model 2)

β	0.950	0.900	0.800	0.700	0.600	0.500	0.400
long-run ε	0.564	0.572	0.557	0.548	0.556	0.550	0.551

Note: Long-run ε calculated by GMM estimates.

Table 4b Short- and long-run elasticity, rate of contribution of each factor Jan. 1951 - Oct. 1999

	X (variable)	short-run e	long-run e	ΔX/X	long-run e ×ΔX/X	contribution rate of X	total effect (sumation of contribution rate)
Tax related	P	-0.218	-0.458	-1.441	0.660	166.24%	166.24%
Information related	US_report	0.019	0.039	1	0.039	9.86%	45.89%
	Release of nicotine and tar	0.102	0.214	1	0.214	53.85%	
	Warning1	0.105	0.221	1	0.221	55.75%	
	Report1	-0.068	-0.143	1	-0.143	-36.03%	
	Warning2	-0.054	-0.113	1	-0.113	-28.44%	
	Report2	-0.017	-0.036	1	-0.036	-9.10%	
Control policy related	Workplace ban	-0.049	-0.102	1	-0.102	-25.79%	-66.37%
	Research	-0.077	-0.161	1	-0.161	-40.58%	
	Other factors				-0.182	-45.76%	-45.76%
	Total				0.397	100%	100%

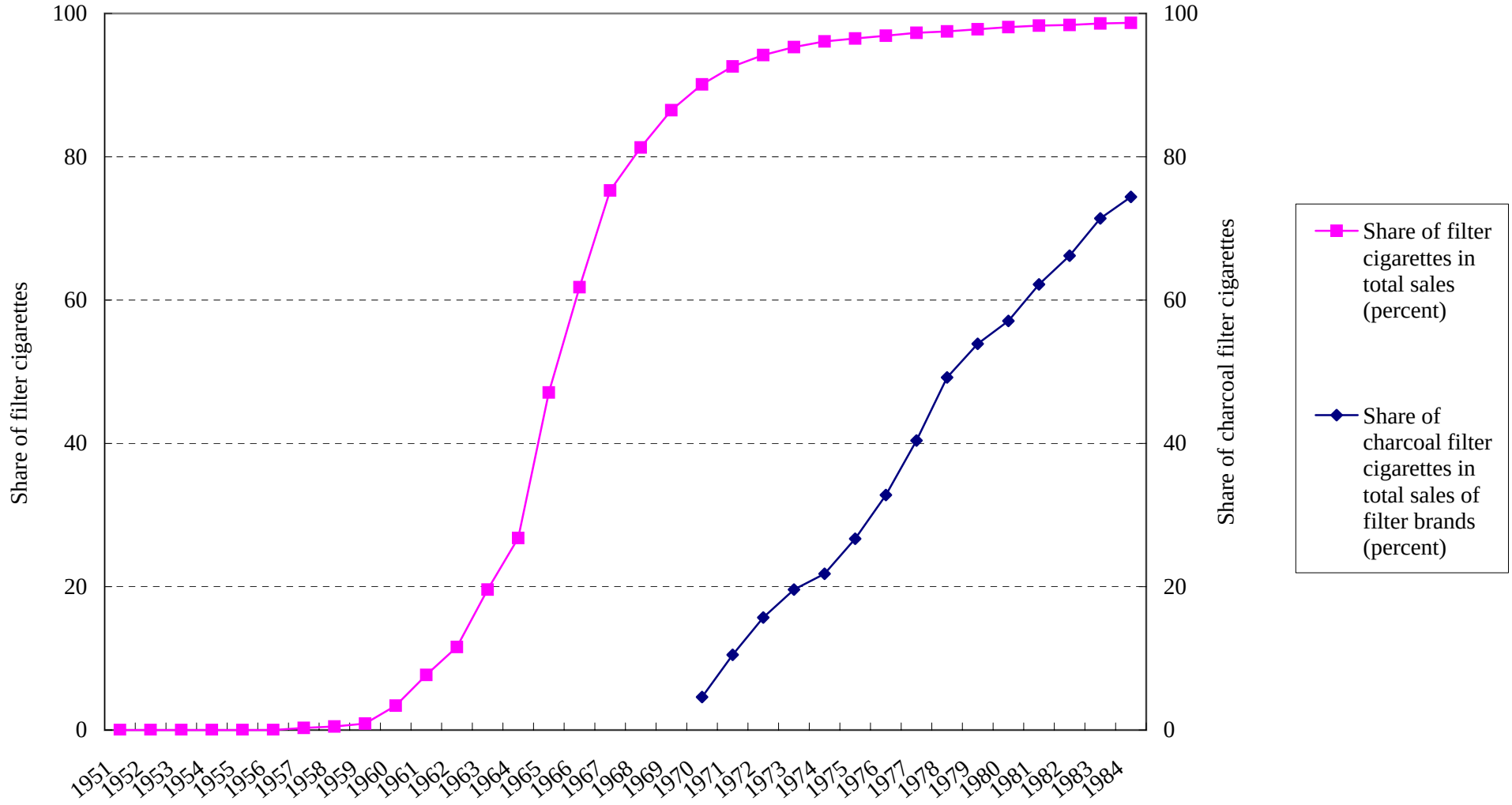
Note: Author's calculation by estimated coefficients of Model 1 in Table 3. Here, $\Delta C / C = (C_{1999} - C_{1951}) /$ mean of C = 0.397, $\Delta P / P = (P_{1999} - P_{1951}) /$ mean of P = -1.441. When t = six periods, the absolute value of elasticity is larger than the one of 90% of long-run elasticity.

Table 5 Estimates of intake of nicotine and tar with health information and other tobacco control policies, Dependent Variable = nicotine intake, tar intake, rational addiction model with distinction between purchase and consumption.
(Asymptotic t statistics in parentheses) Jan. 1951- Oct. 1999

(Event Time)	Independent Variable	Dep. var. = nicotine intake coef.	(t-stat.)	Dep. var. = tar intake coef.	(t-stat.)
	Constant	33.875	(8.899)***	456.565	(8.164)***
	C_{t-1}	0.552	(13.125)***	0.516	(10.041)***
	C_{t+1}	0.034	(2.090)**	0.031	(1.897)*
	P_t	-4.314	(-8.001)***	-59.477	(-7.443)***
	ΔY_t	0.136	(0.464)	1.706	(0.707)
(Jan. 1964)	US_Report	0.214	(0.472)	11.663	(1.670)*
(Apr. 1975)	Dummy7504	3.662	(1.753)*	56.201	(2.129)**
(Sept. 1975)	Dummy7509	-1.326	(1.598)	-10.986	(-1.003)
(Apr. 1967)	Nicotine-tar release	1.278	(3.350)***	19.698	(2.853)***
(Aug. 1971)	Warning1	-1.850	(-2.810)***	-19.901	(-2.701)***
(Apr. 1978)	Workplace ban	-7.472	(-7.882)***	-66.915	(-6.383)***
(Apr. 1986)	Research	-1.933	(-3.222)***	-46.238	(-4.527)***
(Oct. 1987)	Report1	-1.407	(-2.675)***	-37.637	(-3.593)***
(Jan. 1990)	Warning2	-2.279	(-4.864)***	-42.678	(-4.3.371)***
(Jun. 1993)	Report2	-2.454	(-5.497)***	-32.294	(-4.845)***
	Hoarding	148.863	(32.026)***	2003.402	(40.823)***
	Stock	-148.271	(-17.899)***	-1876.310	(-16.222)***
	$4\theta^2\beta-1<0$		(-25.827)***		(-27.594)***
	$\phi_1-1<0$		(-56.932)***		(-56.726)***
	$\phi_2-1>0$		(5.662)***		(4.724)***
	short-run ε	-0.377	(-8.451)***	-0.401	(-7.745)***
	long-run ε	-0.863	(-14.910)***	-0.844	(-14.298)***
	Adjust R^2	0.979		0.982	
	D-W Stat.	1.845		1.671	
	J-Stat.	0.014		0.011	
	Obs.	580		580	

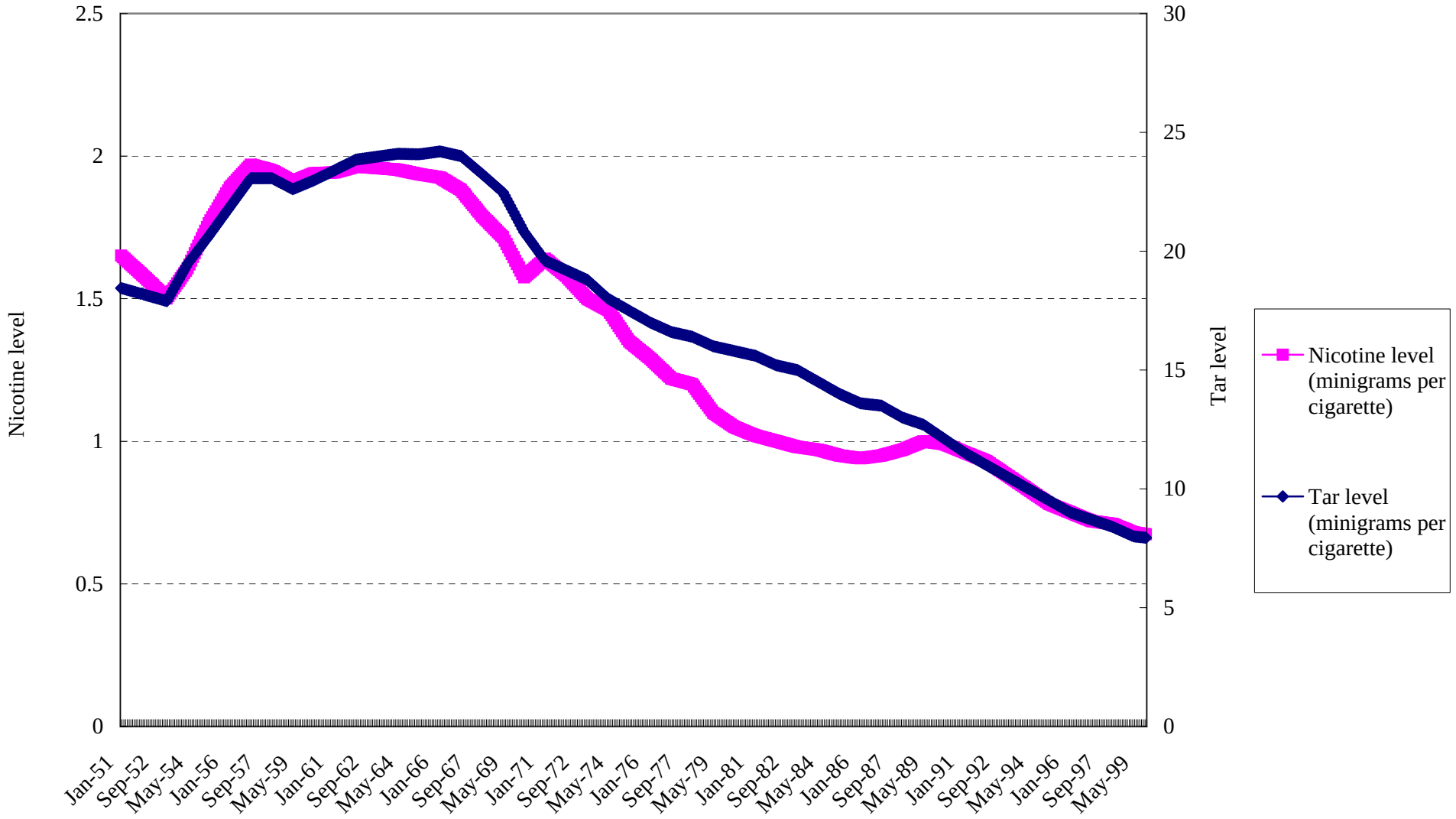
Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level; The instruments of columns 3 and 4: three lags and three leads of price, two lags and two leads of tax rate, other explanatory variables; the p-value for the J-test of columns 3 and 4 is 1, respectively.

Figure 1 The share of filter cigarettes in total sales 1951-84 and charcoal filter cigarettes in total sales of filter brands 1970-84



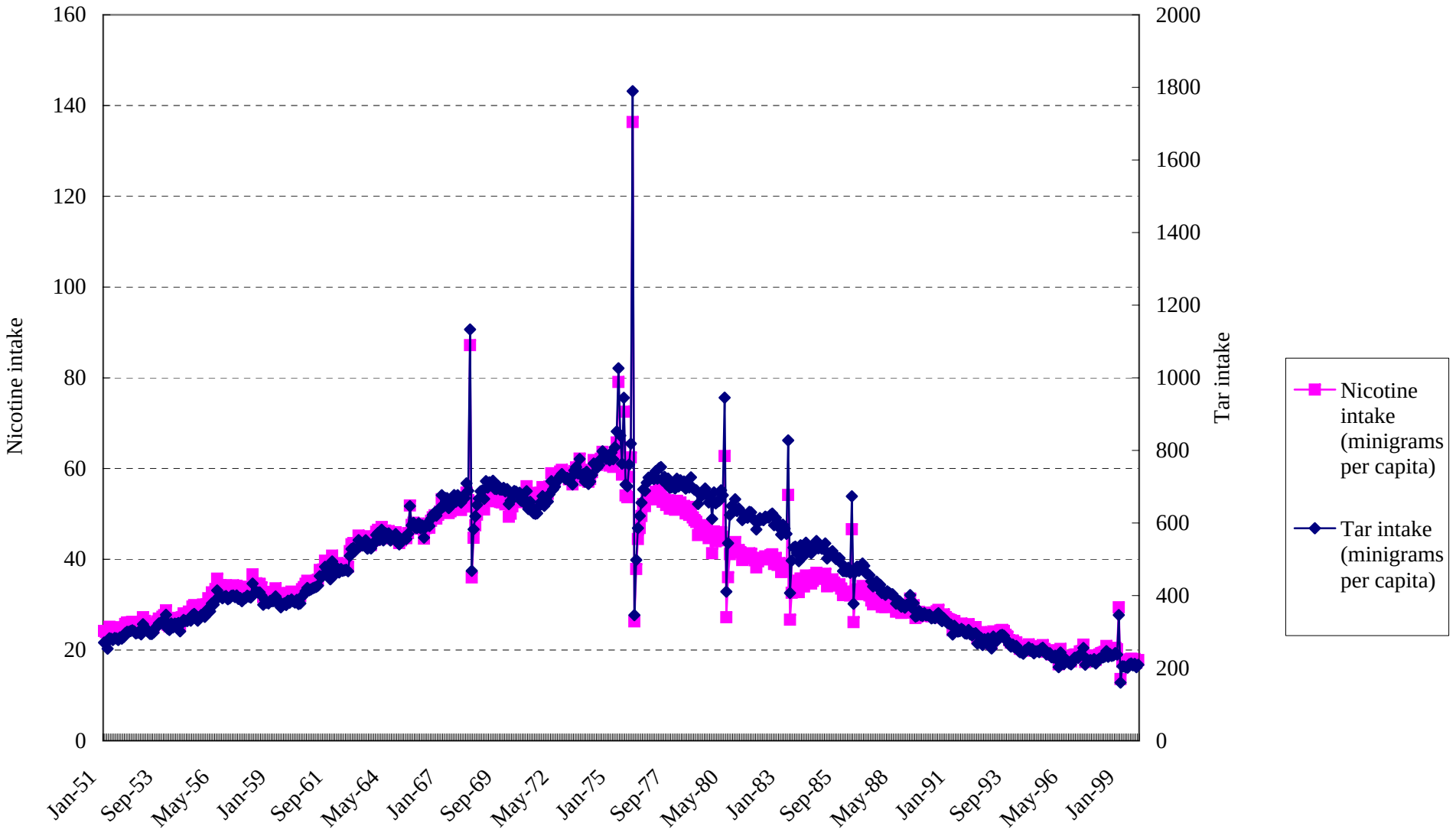
Source: The History of Tobacco Monopoly, The Budget of a Country and Author's calculation

Figure 2 The nicotine and tar level 1951-1999



Source: The History of Tobacco Monopoly, The Japanese Tobacco Association and Author's calculation

Figure 3 The nicotine and tar intake level 1951-1999



Source: The History of Tobacco Monopoly, Japanese Tobacco Association and Author's calculation