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Abstract

The hypotheses of non-addiction, myopia and rational addiction are tested using annual, quarterly and monthly data. Changes in the prices of Japanese cigarettes can be viewed as exogenous from the point of view of consumer behavior, because the Japanese government controls cigarette prices. The empirical results of this paper support the addiction hypothesis. The short-run and long-run price elasticities range from -0.338 to -0.421, and from -0.679 to -0.686, respectively; thus, increases in tax revenues in the long-run are likely to be smaller than those in the short-run. As a result, tax increases would be an effective means of curbing smoking and reducing its social cost. Furthermore, the debt compensation programs for the Japan Railway and the National Forestry will not go according to plan, unless revenues are increased in the future.

JEL classification: D12, E21, H29

Keywords: smoking, rational addiction, tax revenues

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1 Introduction

Because smoking is harmful to human health, many countries have instituted various anti-smoking policies. For example, the 192 members of the World Health Organization (WHO) unanimously adopted the Framework Convention on Tobacco Control (FCTC), aimed at curbing tobacco-related deaths and disease, on May 21, 2003. This was the first international treaty negotiated under the auspices of the WHO. In Japan, smoking has also become a hot topic in the mass media and the Diet. The Health Enhancement Act (HEA; in Japanese, Ken Kou Zou Shin Ho) was implemented on May 1, 2003, and consisted, primarily, of anti-smoking legislation. Many policies and tools were mentioned in the FCTC and HEA, and an increase in cigarette taxes was clearly an important and common goal of the two acts. Thus, a clarification of the effect that tax increases are likely to have on cigarette consumption is important.

Cigarette consumption and the prevalence of smoking in Japan have been much higher than comparable rates in other developed countries. The WHO has pointed out that the provisions of the Japanese anti-smoking policy have been very lax, as compared to those of other developed countries. This observation raises the question of whether Japanese anti-smoking policies, and especially tax increases, will actually reduce cigarette consumption.

In order to eliminate some of the enormous debts of the Japan Railway and the National Forestry, the Japanese Government raised the cigarette tax rate after 1998 by introducing the 'Tobacco Special Tax'; this tax is an earmarked tax. The increase in tax revenues accruing to the Japanese government from the 'Tobacco Special Tax' is anticipated to be 260 to 280 trillion yen (about 2.413 to 2.598 trillion dollars in 2000 dollars) during the period 2000-2059. However, it is not clear that these revenues will be realized according to plan, or what the effects of this tax will be on overall tax revenues from cigarette taxation and on the social cost of smoking.

In addition, a new tobacco tax, called the 'Tobacco Health Tax,' was introduced on July 1, 2003. Based on the HEA, this tax was intended to decrease cigarette consumption and to increase tax revenue, thereby decreasing the deficit of the annual budget, a budget that had been reduced, due to gloomy economy prospects. However, the amount of revenue that the tax will actually generate, as well as the effects that the new tax[1] will have on smoking behavior, remain unclear.

Since the social cost of smoking is very high, tobacco control is necessary; thus, an important issue in this respect is the question of which tobacco control policy will be most effective for Japan.

Chaloupka (1991), Becker, Grossman and Murphy (BGM, 1994), Bardsley and Olekalns (1999), Escario and Molina (2001), and many other authors[2] have provided empirical results in support of the rational addiction model. The effect of anti-smoking policies, e.g., a workplace smoking ban, has been analyzed by Evans et al (1999) and by Bardsley and Olekalns (1999); their results support the view that workplace smoking bans reduce smoking. It is not yet clear, however, which hypothesis best characterizes the behavior of Japanese cigarette consumers. Specifically, is their behavior non-addictive, myopic, or rationally addictive?

This paper analyzes cigarette consumption in Japan during the period 1955-2003 from the point of view of addictive behavior[3]. Models of non-addiction, myopia, and rational addiction are tested respectively. The results support the rational addiction model, but reject the non-addiction and mypic addiction model. The long-run price elasticity is larger than that in the short-run. Thus,

[1] According to Merriman (2001) and Goel (2004), higher tobacco tax rate may cause cigarette smuggling. The cigarette smuggling in Japan is not analyzed here.

[2] Bask and Melkersson (2004) analyze two addictive goods, alcohol and cigarette. Here, only one addictive goods, cigarette smoking is analyzed.

[3] The price elasticity of demand for Japanese cigarettes was estimated by Saito (1991). In the book, *National Accounts*, Saito estimated the price elasticity of demand for cigarettes to be −0.46, using data from the Japanese Household Consumption Expenditure survey. However, some aspects of his analysis left room for improvement, such as parts of the model and the sample, among other things. First, the analytic model used was static, because cigarettes were considered to be non-addictive goods. If smoking addiction were to be considered, the analytic model would have to be dynamic. Second, the sample included only worker households, not all households. Furthermore, the time-series data were for the period from 1954 to 1984; thus, cigarette consumption after 1985 was not analyzed.

increases in tax revenues in the long-run are likely to be smaller than those in the short-run.

The models employed in this paper do not address the effects of advertising, public knowledge about the health hazards of smoking[4], demography, and other issues, because data on these variables are not currently available.

This paper is organized as follows. Smoking in Japan is described in Section 2. Rational, myopic, and non-addiction models are outlined in Section 3. The data and estimation techniques are presented in Section 4, and the empirical results are reported in Section 5. Japanese tobacco policy is analyzed in Section 6. Section 7 concludes the study.

2 Tobacco in Japan

2.1 Aggregate and per capita consumption

We have the cigarette consumption data in Japan from 1955 to 2002. Aggregate consumption (in packs) grew continuously, with growth accelerating until 1977 and decelerating after 1978. While cigarette consumption per capita increased greatly until 1977, it was relatively static, experiencing only a slight decrease, after 1978.

2.2 Smoking prevalence

There are data on the prevalence of smoking among Japanese adults from 1958 to 2000. There was a downward trend in smoking for males, but a stable trend for females. Figure illustrates the prevalence of smoking among Japanese adult males by generation. All generations exhibited downward trends. Figure 2 illustrates the smoking prevalence for all generations of Japanese adult females. The younger generations exhibited an upward trend, while the older generations exhibited downward trends.

[4] For example, Hsieh (1998) analyzes this point.

2.3 Cigarette industry and imports

The Japan Tobacco and Salt Corporation was started in 1949 and run by the Japanese government. It was then reorganized into Japan Tobacco Inc. in 1985, in accordance with Japan's Tobacco Industry Law (in place from 1985). The Ministry of Finance owned all Japan Tobacco Inc. stock until 1994, at which time one-third of the stock was sold to various private companies. At present, the Ministry of Finance continues to own two-thirds of the stock. It is indicating that the Japanese government has maintained a monopoly over the Japanese cigarette industry.

The ratio of imported cigarettes to total cigarettes consumed continued to rise, and increased remarkably in 1987, due to the removal of the import tax.

2.4 Tobacco taxes and pricing

The tobacco tax was set by the 'Tobacco Tax Law' and the 'Local Tax Law.' In May of 1999, the national tobacco tax rate was 2,716 yen per 1,000 cigarettes. In addition, the rate of the 'Tobacco Special Tax' was 820 yen per 1,000 cigarettes, and the rate of the 'District Tobacco Tax' was 3,536 yen per 1,000 cigarettes, of which 868 yen was to be distributed to prefectures, and 2,668 yen of that sum was to go to cities, towns and villages.

Nominal cigarette prices rose seven times as a consequence of successive cigarette excise tax increases during the period 1955-2003. The real price of cigarettes greatly declined during the period 1955-1974 because of an increasing consumer price index (CPI). After 1974, real prices experienced a slight increase due to a surge in nominal prices (Figure 3).

2.5 Tax revenues

Each year, when the annual budget is formulated in the Diet, the Japanese government decides the target figure for tobacco tax revenues for the following year. The total revenue from tobacco taxes in the 1999 fiscal year was

2,322,100 million yen (about 21,547 million dollars in 2000 dollars), whereas revenue from the national tobacco tax was 905 billion yen (about 8.398 billion dollars in 2000 dollars). The 'Tobacco Special Tax' was 273,600 million yen (about 2,538.799 million dollars in 2000 dollars), of which the tobacco tax to prefectures was 276,400 million yen (about 2.564.781 million dollars in 2000 dollars), and the tobacco tax to cities, towns and villages was 867,100 million yen (about 8,046.026 million dollars in 2000 dollars) from that sum.

Figure 4 illustrates the real cigarette tax revenues collected and real cigarette prices from 1955 to 2002. Real tax revenues exhibited an upward trend from 1955 until the end of the 1970s, while they exhibited a downward trend from 1980 to 2002. Conversely, real prices of cigarettes declined from 1955 to the end of the 1970s, while they increased slightly from 1980 to 2002. Thus, real cigarette tax revenues moved in a direction opposite to that of real cigarette prices.

2.6 Social cost

According to 'Tobacco control measures in the 21st century,' a report issued by the Ministry of Health and Welfare in Japan, the extra medical expenses incurred as a result of smoking were 1.2 trillion yen (about 11.13 billion dollars in 1993 dollars) in 1993, which was just equal to the national tax revenue from cigarettes.

As indicated by Goto (1996), the total social cost to the Japanese of having a cigarette industry was 5.6 trillion yen (about 39.64 billion dollars in 1993 dollars), while the total economic benefit was 2.8 trillion yen (about 19.82 billion dollars in 1990 dollars) in 1990. Thus, the total social loss due to smoking was 2.8 trillion yen (about 19.82 billion dollars in 1990 dollars).

Therefore, from the economic point of view, tobacco control is necessary.

2.7 Tobacco control

The Statistics of Tobacco Control Country Profiles (WHO Reports 2001) reported that the national tobacco control provisions in Japan were much less restrictive than those in other industrialized countries. For example, provisions in the following four areas were voluntary and not nationally legislated or regulated:

(1) Advertising and Sponsorship: advertising bans (cinema, internet, radio and television) and sponsorship restrictions; (2) Health Promotion and Education: institution of health education curricula or programs and public information initiatives; (3) Sales and Distribution Restrictions: the prohibition of free products or samples, the restriction of tobacco sales to certain locations, and the prohibition of the sale of smokeless tobacco; (4) Smoke-Free Indoor Air Restrictions: prohibition in air crafts, educational facilities, government worksites, health care facilities, workplaces, etc.

The prevalence of smoking among Japanese adults and youth has also been very high. Japan has been regarded as a 'smokers' heaven,' largely as a result of the lack of tobacco controls and the high prevalence of smoking.

3 Analytical Models

3.1 Rational addiction

The theoretical model employed here follows BGM (1994). Consumers are assumed to be infinitely-lived and to maximize their lifetime utility, which is discounted at the rate r. The consumer's problem can be stated as

$$\max \sum_{t=1}^{\infty} \beta^{t-1} U(C_t, C_{t-1}, Y_t, e_t). \tag{1}$$

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

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

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 taken as the numeraire, so the price of cigarettes in period t is denoted by P_t. The rate of interest is assumed to equal the rate of time preference. β is the time discount factor. A^0 is the present value of wealth.

The associated first-order conditions are

$$U_y(C_t, C_{t-1}, Y_t, e_t) = \lambda, \tag{2}$$

$$U_1(C_t, C_{t-1}, Y_t, e_t) + \beta U_2(C_{t+1}, C_t, Y_{t+1}, e_{t+1}) = \lambda P_t. \tag{3}$$

The utility function considered is quadratic in Y_t, C_t, and e_t. By solving the first-order condition for Y_t and C_t, a linear difference equation can be derived,

$$C_t = \alpha + \theta C_{t-1} \ + \ \beta\theta C_{t+1} \ + \ \theta_1 P_t \ + \ \theta_2 e_t \ + \ \theta_3 e_{t+1}, \tag{4}$$

where [5]

$$\begin{aligned}
\alpha &= -\lambda(u_{y1} + \beta u_{y2}) \\
\theta &= \frac{-(u_{12}u_{yy} - u_{1y}u_{2y})}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)} \\
\theta_1 &= \frac{u_{yy}\lambda}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)} \\
\theta_2 &= \frac{-(u_{yy}u_{1e} - u_{1y}u_{ey})}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)} \\
\theta_3 &= \frac{-\beta(u_{yy}u_{2e} - u_{2y}u_{ey})}{(u_{11}u_{yy} - u_{1y}^2) + \beta(u_{22}u_{yy} - u_{2y}^2)}.
\end{aligned}$$

A good is addictive if $\theta > 0$ and the degree of addiction increases with θ.

The roots of the difference equation (4) are

$$\phi_1 = \frac{1 - (1 - 4\theta^2\beta)^{1/2}}{2\theta}, \ \phi_2 = \frac{1 + (1 - 4\theta^2\beta)^{1/2}}{2\theta}, \tag{5}$$

[5] There seems to be a misprint in BGM (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 $u_{2y}u_{2e}$.

and the stability conditions are

$$4\theta^2\beta < 1,\ \phi_1 < 1,\ \phi_2 > 1. \tag{6}$$

Given these roots, the temporary current, past, and future price effects are

$$\frac{dC_t}{dP_t} = \frac{\theta_1}{\theta\phi_2} \tag{7}$$

$$\frac{dC_t}{dP_{t-1}} = \frac{\theta_1}{\theta(\phi_2)^2} \tag{8}$$

$$\frac{dC_t}{dP_{t+1}} = \frac{\theta_1\phi_1}{\theta\phi_2}. \tag{9}$$

All roots are negative, since θ_1 is negative.

The short-run price effect is

$$\frac{dC_t}{dP^*} = \frac{\theta_1}{\theta(1-\phi_1)\phi_2} \tag{10}$$

and is defined as the impact of a reduction in current and all future prices on current consumption, with past consumption held constant.

The long-run price effect is

$$\frac{dC_\infty}{dP} = \frac{\theta_1}{\theta(1-\phi_1)(\phi_2-1)} \tag{11}$$

and is defined as the effect of a permanent reduction in prices in all periods.[6]

3.2 Myopic addiction

Following BGM (1994), the myopic consumer is assumed to fail to consider the impact of current consumption on future utility and future consumption. Future price and consumption changes have no impact on the current consumption of a myopic addict. Under the scenario detailed in Fenn et al. (2001), the myopic

[6]See BGM (1994) for details.

consumer faces a one-period problem:

$$\max U(C_t, C_{t-1}, Y_t, e_t). \tag{12}$$
$$s.t. \;\; Y_t + P_t C_t = A_t,$$

where A_t is period t income. The solution is

$$C_t = \eta + \gamma C_{t-1} \;\; + \gamma_1 P_t \;\; + \;\; \gamma_2 e_t, \tag{13}$$

where

$$\begin{aligned}
\eta &= -\lambda u_{y1} \\
\gamma &= \frac{-(u_{12}u_{yy} - u_{1y}u_{2y})}{(u_{11}u_{yy} - u_{1y}^2)} \\
\gamma_1 &= \frac{u_{yy}\lambda}{(u_{11}u_{yy} - u_{1y}^2)} \\
\gamma_2 &= \frac{-(u_{yy}u_{1e} - u_{1y}u_{ey})}{(u_{11}u_{yy} - u_{1y}^2)}.
\end{aligned}$$

The demand equation of a myopic addict is entirely backward-looking, and current consumption depends only on current price, lagged consumption, the consumer's marginal utility of wealth, and current events. Current consumption is independent of both future consumption, C_{t+1}, and future events, e_{t+1}.

3.3 Non-addiction model

The 'non-addiction' model addresses the case in which γ equals 0 in equation (13). Here, current consumption depends only on current prices. This is a very common model of consumption demand and can be found in a standard textbook.

4 Data and Estimation Techniques

4.1 Data

The data consist of yearly, quarterly and monthly time-series for the period from January 1955 to September 2003, where the yearly data are based on the Japanese fiscal year. The quarterly and monthly data are adjusted by X-12 ARIMA.

C_t denotes cigarette consumption in packs per capita. These data are taken from the 'Japan Tobacco Association' and 'Public Finance Statistics'; the data consist of total sales data of cigarettes, and are divided into three subsets, according to the age of smokers: the smoking population aged ten and over, the smoking population aged fifteen and over, and the total population of smokers.

P_t denotes the average real retail cigarette price per pack, which is equal to the Tobacco Price Index divided by the CPI. These data come from the 'Annual Report on the Consumer Price Index' and the 'Monthly Report on the Retail Price Survey.'

Y_t corresponds to real household disposable income per capita and is equal to total disposable income divided by the total population and the CPI. These yearly and quarterly data come from the 'Report on National Accounts.' Similarly, the monthly data come from the 'worker household disposable income' section of the 'Annual Report of Family Income and Expenditure' and, likewise, represent total disposable income per family divided by the total population. ΔY_t is the first difference of Y_t.

Tax_t denotes real cigarette tax revenue per capita in a given fiscal year, and is equal to total national tobacco tax revenue divided by the CPI and the total population. These data come from the 'Public Finance Statistics.'

Table 1 presents the means, standard deviations, and other indicators for the primary variables in the data set.

4.2 Unit root tests

If any of the variables were revealed to be nonstationary, then some problems would arise in the statistical inference using Ordinary least-squares (OLS) and two-stage least-squares (2SLS). Therefore, I test whether each variable is stationary. The ADF test and Phillips-Perron test (1988) are used for this purpose, and the results are presented in Table 2.

The hypotheses of unit roots for C_t, P_t and ΔY_t are rejected at the 10% significance level, so these variables are considered to be either stationary or time-trend stationary. Since the unit root hypotheses for the quarterly and monthly Y_t cannot be rejected at any conventional significance level, I conclude that Y_t is not stationary. If Y_t were used in OLS and 2SLS, a bias might arise; therefore, I use ΔY_t.

4.3 Estimation techniques

OLS and 2SLS are used to obtain parameter estimates. The OLS estimates may not be consistent because of the endogeneity of past and future consumption, and also because of the possibility of serial correlation of the residuals. Therefore, to insure that consistent estimates are obtained, I also use 2SLS methods.

The 2SLS estimates are consistent under the instrumental variables approach[7]. The cigarette price is totally controlled by the Japanese government. There was a special law for every increase of cigarette tax. The seven times of cigarette tax increase were done by Japanese government not because of the situation of cigarette demand but because of the heavy deficit of public finance[8]. Thus the tax (or changes in cigarette prices) is an exogenous variable for the cigarette consumer. Furthermore, price is strongly correlated with cigarette consumption; thus, it is thought to be a good instrument for cigarette consumption. Price lags are used as the instrumental variables for past cigarette consump-

[7] Auld and Grootendorst (2004) point that aggregate data tend to yield spurious evidence in favor of the rational addiction hypothesis. But it is also pointed in the 9th page of their paper that instrumental variable estimates of the coefficients on the lag and lead of consumption are consistent if prices are exogenous.

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

tion, while price leads are used as the instrumental variables for future cigarette consumption. Finally, the Wu test is used to determine whether OLS estimates are consistent.

5 Empirical results

5.1 Non-addiction and myopic addiction

The estimated values for the myopic and non-addiction models are reported in Table 3 [9](C_t is divided by the population aged 15 and over). The 'non-addiction' column presents the parameter estimates for the non-addiction model. The 'basic' column presents the parameter estimates for the basic myopic addiction model. All coefficients from the OLS and 2SLS regressions are significant at the 1% level. In the Wu test, the hypothesis that the OLS estimates are consistent cannot be rejected at the 5% level; therefore, the OLS estimates can be considered efficient when compared to those from the 2SLS procedure.

The 'non-addiction' model corresponds to the case in which $\gamma = 0$ in equation (13). The OLS coefficient of C_{t-1} in the 'basic' model is significant at the 1% level. Thus, the 'non-addiction' model is not supported.

The 'expanded' column presents the parameter estimates for the expanded myopic addiction model. When the one-period lead price is added to the basic myopic addiction model, its OLS coefficient is significant at the 5% level, and its 2SLS coefficient is significant at the 1% level. These results suggest that current consumption depends on future prices. Thus it rejects myopic addiction model but is consistent with a rational addiction hypothesis. In a rational addiction model, a reduction in future prices brings about higher expected future consumption, which, in turn, raises current consumption. Hence, these results challenge the validity of the myopic addiction model. The hypothesis in the Wu test, that the OLS estimates are consistent, cannot be rejected at the 5% level.

[9]The results based on yearly data are reported here. Other results, which are based on quarterly and monthly data, are very similar to those derived from the yearly data and are thus not reported here. The omitted results are available upon request from the author.

5.2 Rational addiction

5.2.1 C_t divided by the smoking population aged 15 and over

The estimated parameter values for the rational addiction model are reported in Table 4 (C_t is divided by the smoking population aged 15 and over). The 'yearly,' 'quarterly,' and 'monthly' columns present the estimates for the rational addiction model using yearly data, quarterly data,[10] and monthly data[11]. The three results are very similar.

The hypothesis in the Wu test that the OLS estimates are consistent cannot be rejected at the 5% level. Thus, the OLS estimates are considered consistent and efficient. The OLS and 2SLS coefficients on C_{t-1}, C_{t+1} and P_t are significant, and these results provide sound support for the rational addiction model.

The OLS and 2SLS coefficients on Y_t in the 'yearly' column are positive but are not significant at any conventional level. These results suggest that current consumption does not depend on real disposable household income. The coefficient on ΔY_t in the 'quarterly' column is also not significant. The coefficient on ΔY_t in the 'monthly' OLS column is significantly negative.

The estimated values satisfy the stability conditions given in equation (6). The rational addiction hypothesis is strongly supported by all three results. Using these coefficients and the sample means from Table 1, I estimate the short-run and long-run price elasticities, which are shown in the rows labeled 'short-run ϵ' and 'long-run ϵ.' The long-run price elasticity is about two times as large as that for the short-run.

According to the results derived from the yearly data, a 10-percent permanent increase in the price of cigarettes should reduce current consumption by 3.38 percent in the short-run, and by 6.59 percent in the long-run.

[10] Following another paper of the author's, the rates of tax increase are used as proxies for inventory in the estimated equation. The estimates of the coefficients on the proxies are not reported here, though there is a large inventory effect. The omitted results are available upon request from the author.

[11] Following another paper of the author's, dummies are used as proxies for inventory in the estimated equation. The coefficient estimates for the proxies are not reported here but are available upon request. The inventory effect is large.

5.2.2 C_t divided by the total population of smokers

In this case, the coefficient on price is not significant, and the stability condition is not satisfied. The rational addiction model is not supported, while the myopic addiction model is supported, possibly because consumers are not given the choice to quit smoking in the latter model. This result is not contradictory to the sense of the rational addiction model, because, in that model, the consumer has the option to quit.

5.2.3 Comparison with the U.S.

According to BGM (1994), the short-run price elasticity (taken from annual U.S. data) ranged from -0.355 to -0.407, and the long-run price elasticity ranged from -0.734 to -0.788. The short-run and long-run price elasticities in Japan were -0.338 and -0.659. Thus, the absolute values of the short-run and long-run price elasticities in Japan are near to those in the U.S.

6 Policy analysis

6.1 Debt compensation and the reduction of pure social cost

Because of the Japanese government's monopoly of the tobacco industry, cigarette prices are entirely controlled via adjustments in cigarette tax rates. High tax rates increase cigarette prices for consumers.

The cigarette tax rate was raised in 1998. According to the 'Tobacco Special Tax,' an extra tax of 820 yen per thousand cigarettes was imposed.

A new tax called the 'Tobacco Health Tax' was introduced on July 1, 2003. The total increase in tax revenues resulting from the 'Tobacco Health Tax' is anticipated to be about 240 trillion yen.

The increase in tax revenues accruing to the Japanese government as a result of the 'Tobacco Special Tax' is anticipated at 260 to 280 trillion yen. Because the long-run price elasticity is about two times as large as the short-run price elasticity, the long-run increase in tax revenues will be much smaller than that in the short-run. According to my calculations (Table 5), the increase in tax revenues will be less than 260 billion yen after 2003, because of the 'Tobacco Health Tax'. Therefore, the debt compensation programs will not go according to plan.

According to Goto (1996), the pure social cost of smoking was 173.913 yen per pack in 1990. The reduction of pure social cost resulting from the 'Tobacco Special Tax' and from the 'Tobacco Health Tax' is estimated in Table 5, in which I also assume that all other conditions are unchanged. The reduction of the pure social cost of smoking should become greater with time and should be much greater than the reduction that accrues in the increased tax revenue.

6.2 Better policy for tax revenue

The smoking rate for Japanese males has declined. One can infer from the trend of smoking rate (or the minus coefficient of time in the Table 4) that consumers will probably reduce cigarette consumption gradually in the future, because of a greater awareness of health hazards, among other reasons. Thus, total cigarette consumption should decrease in the long-run. Although the current policy for total tax revenue maximization in the long-run is a lower tax rate in an unchanged smoking environment, a better policy for raising tax revenue would be to increase the current tax rate, if the government expects consumers to reduce their cigarette consumption in the future. Therefore, increases in the 'Tobacco Special Tax' and the 'Tobacco Health Tax' should be considered as better policies for raising tax revenue. In addition, the absolute value of the long-run price elasticity is smaller than one, and thus tax increases should increase total tax revenues.

6.3 Tobacco control

Due to the enormous social cost of smoking, the WHO and many other groups have proposed tobacco control policies. The Japanese government has also introduced many tobacco control provisions, most of which have been voluntary. Because price increases tend to have a negative effect on consumption, an increase in the cigarette tax would be an effective means of further tobacco control. Furthermore, such increases would be most effective in the long-term, since consumers are more sensitive to events taking place in the long-run than they are to those that occur in the short-run.

7 Conclusion

Japanese cigarette consumption has been analyzed in this study using non-addiction, myopic and rational addiction models. This analysis obtains some evidences that are not consistent with the non-addiction and myopic addiction hypotheses but consistent with the rational addiction hypothesis. The real cigarette price has a negative effect on consumption, while the effect of real household disposable income on consumption is not significant. The long-run price elasticity is about two times as large as the short-run elasticity. Thus, any long-run increase in tax revenues resulting from higher tax rates is likely to be much smaller than that in the short-run. The debt compensation programs of the Japan Railway and the National Forestry will not proceed according to plan, as the 'Tobacco Health Tax' was imposed on July 1, 2003. On the other hand, these price increases should reduce the total social cost resulting from smoking and should constitute a good anti-smoking policy, bearing in mind the current state of regulations that are otherwise lax in Japan.

In this paper, the models do not treat the effects of advertising, public knowledge about the health hazards of smoking, education, and demography, etc. In fact, data for these variables are not currently available. However, it is hoped that these issues will be addressed in the future.

Appendix: Data

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Nominal Tax Revenues, Ministry of Finance, Government of Japan. *Public Finance Statistics*, 1955-2003.

Nominal Cigarette Prices, Nominal Retail Cigarette Prices (2000) times the consumer price index of cigarettes divided by the index (2000).

Per Capita Cigarette Consumption, Total cigarette consumption divided by the Japanese population.

Population, Statistics Bureau and Statistics Center, Government of Japan. *Population estimates series*, 1955-2003.

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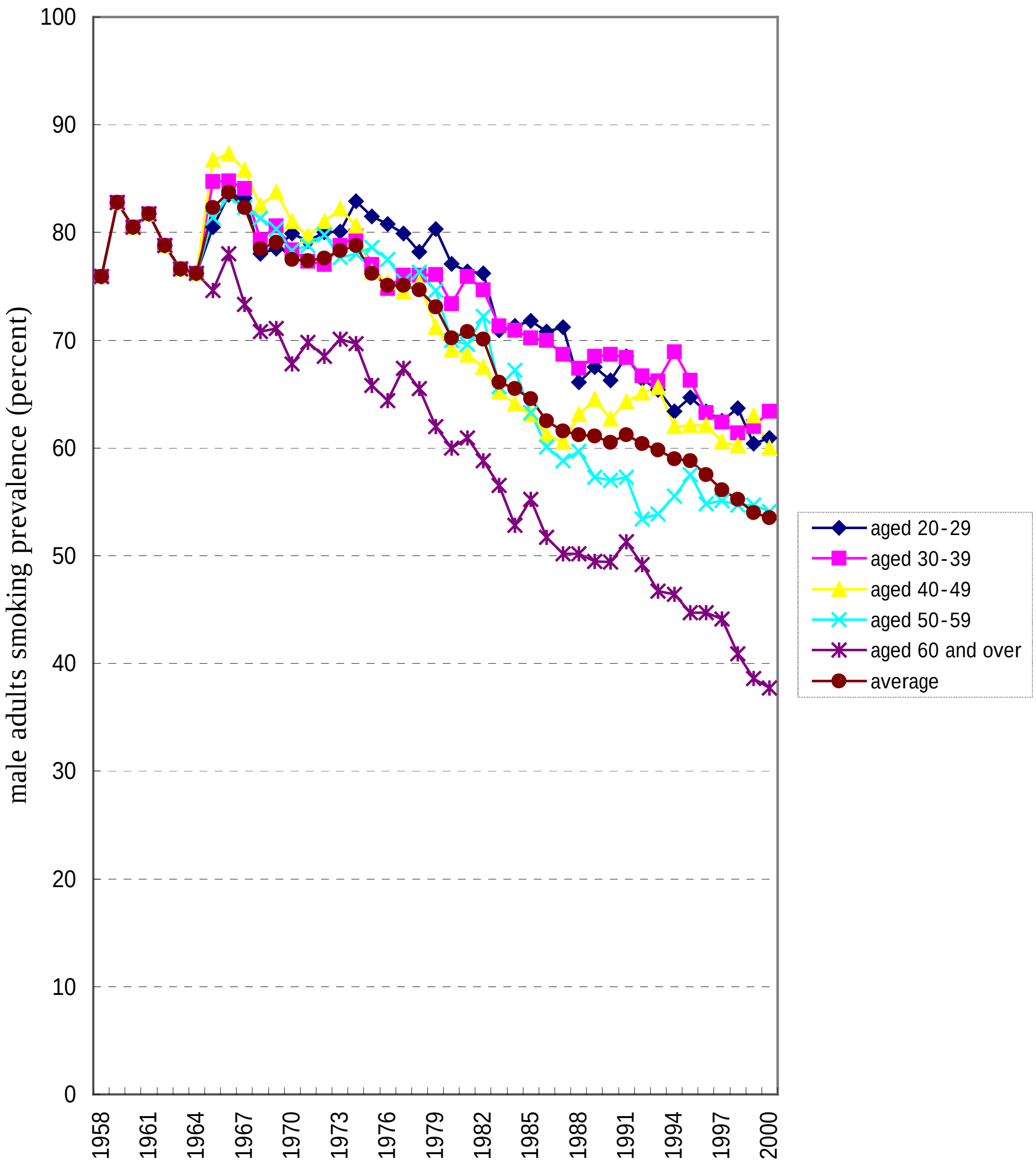
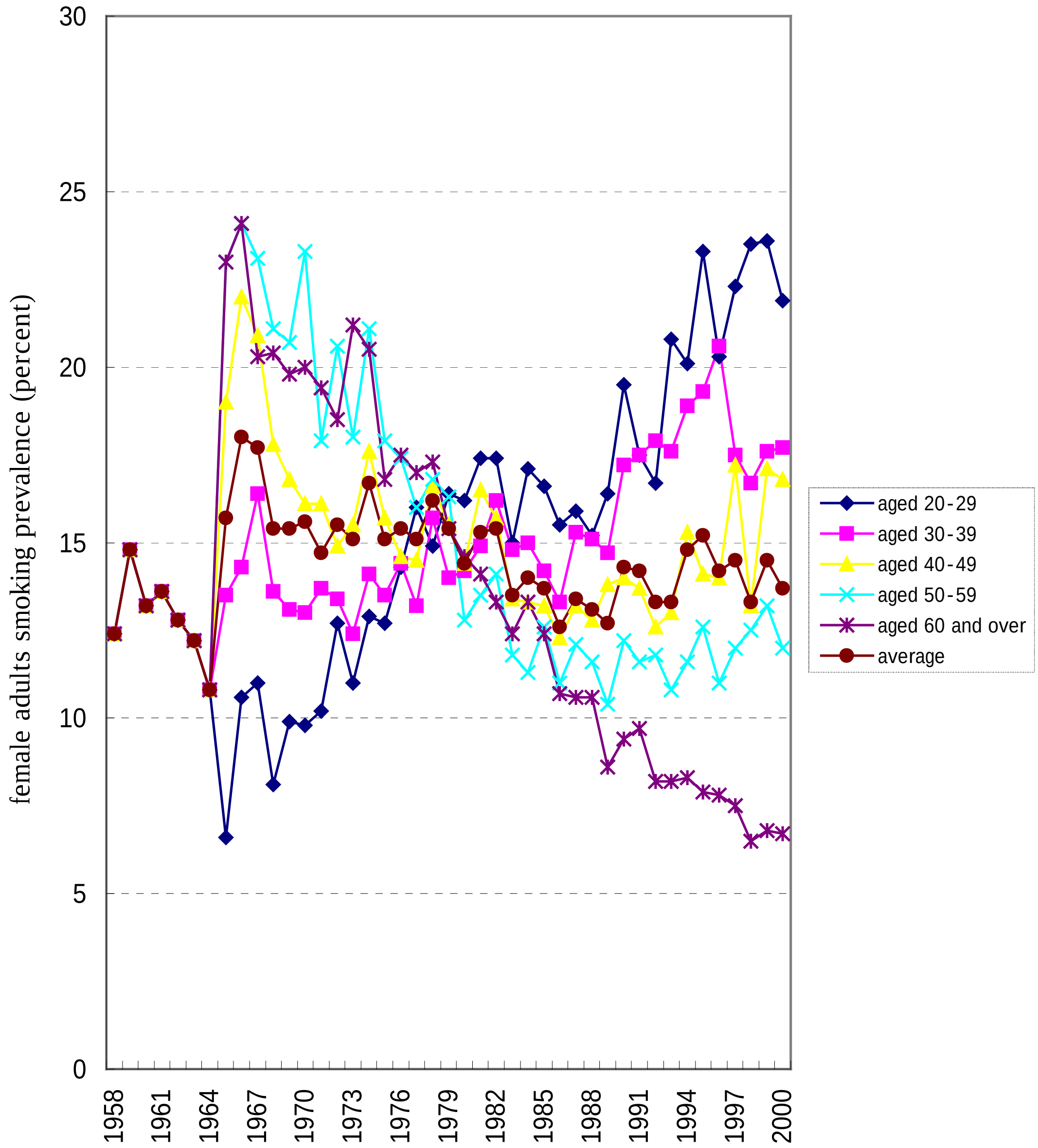
Figure 1: Smoking prevalence of Japanese male adults 1958-2000



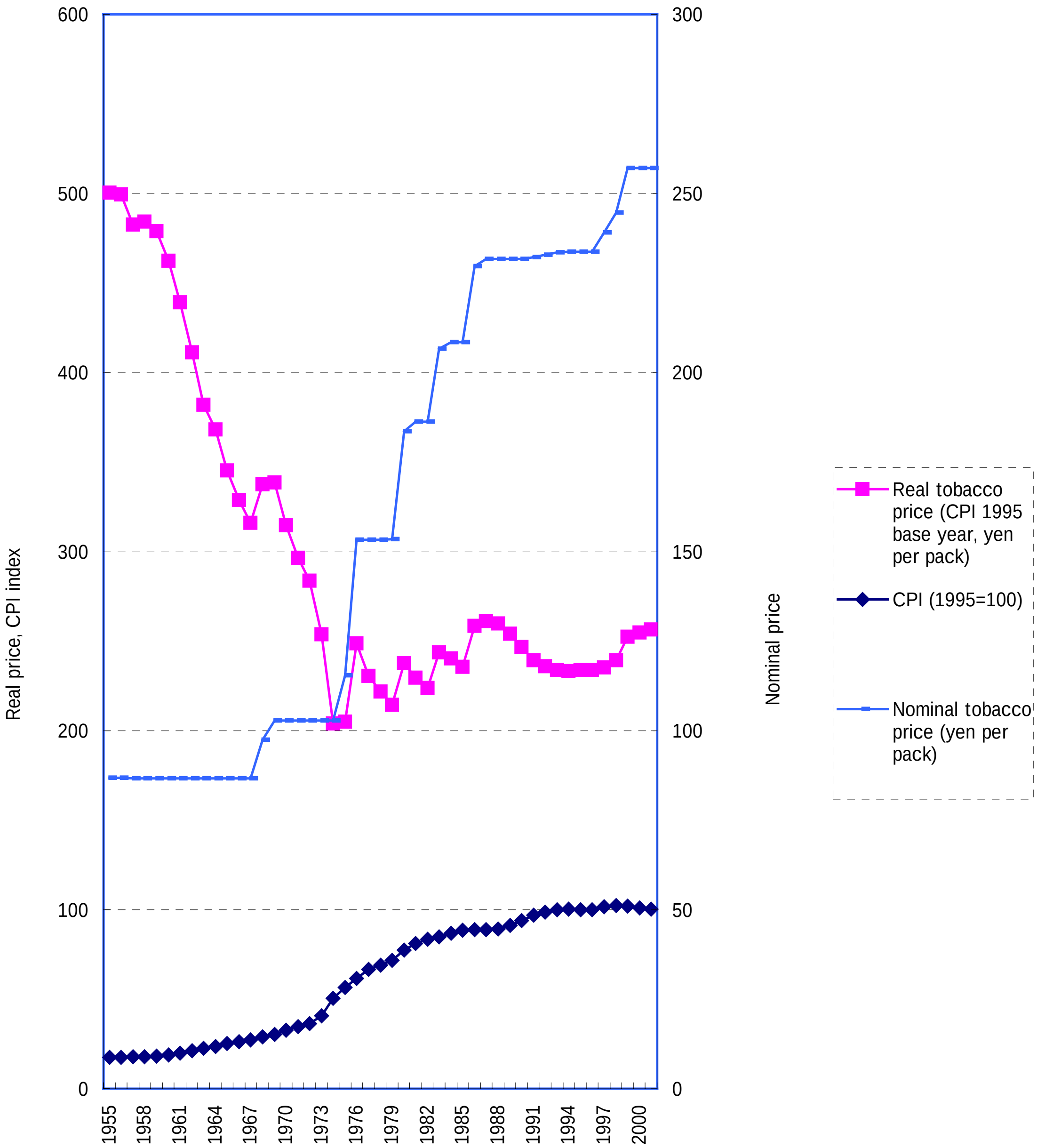
Source: Japan Tobacco Association

Figure 2: Smoking prevalence of Japanese female adults 1958-2000



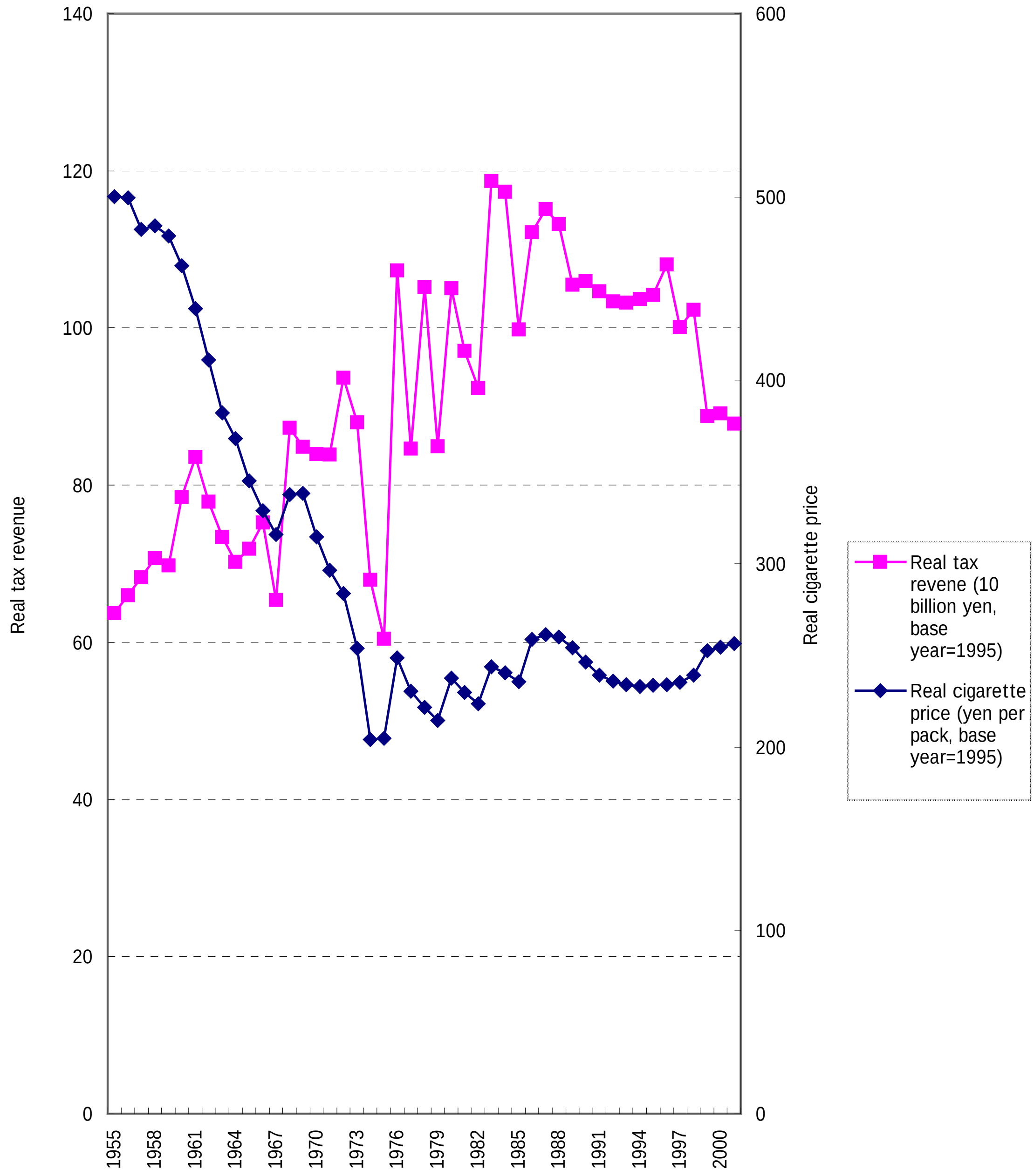
Source: Japan Tobacco Association

Figure 3: Real and nominal cigarette price 1955-2002



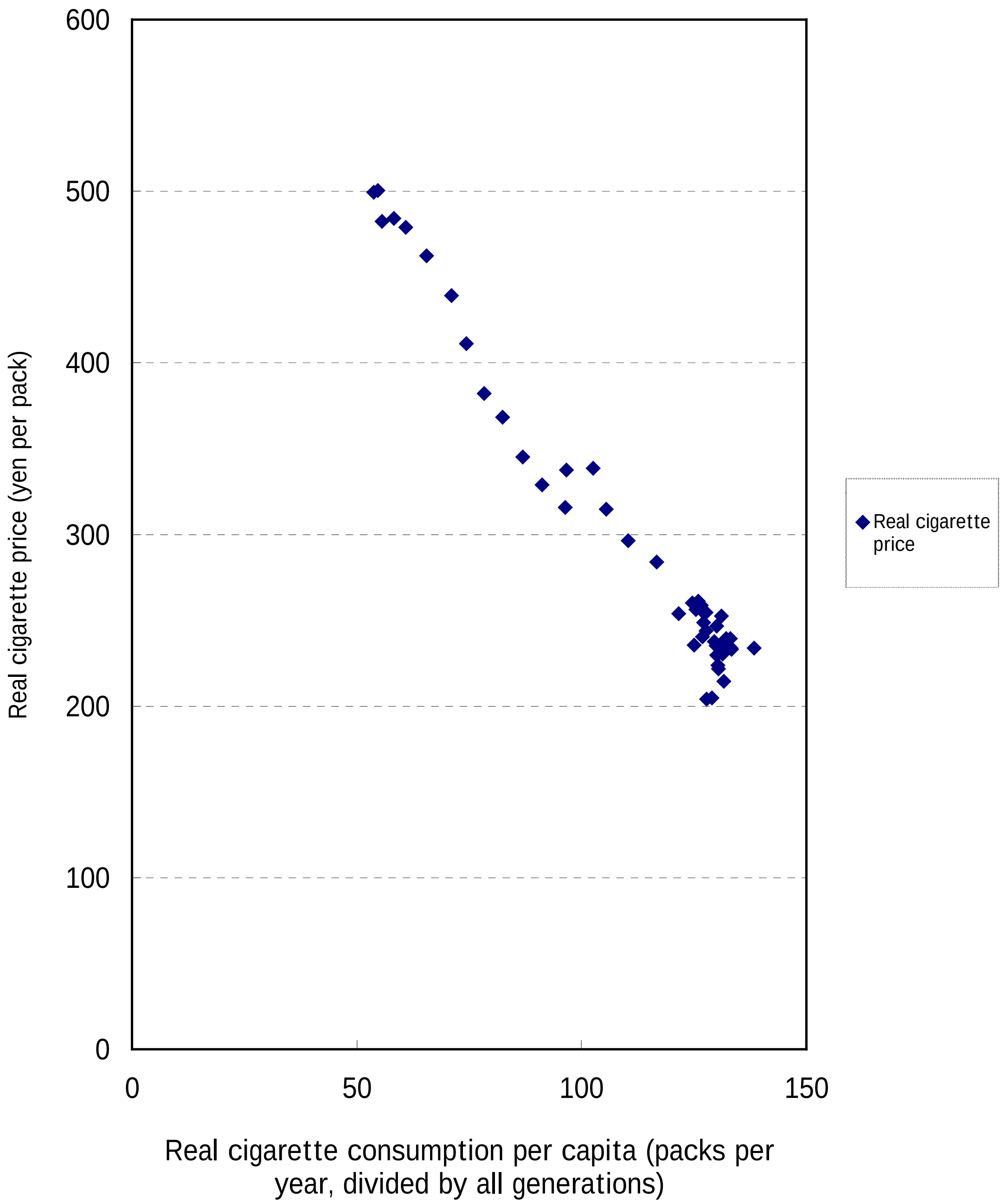
Source: Annual Report on the Consumer Price Index, Monthly Report on the Retail Price Survey

Figure 4: Real cigarette tax revenue and real cigarette price 1955-2002



Source: Public Finance Statistics

Figure 5: Real cigarette consumption and real cigarette price 1955-2002



Source: author's calculation based on the processed data

Table 1. Summary statistics: 1955–2003

Period	Variable	Mean	Std.Dev.	Max.	Min.
Yearly (1955–2002)	C_t	142.900	29.079	174.850	80.000
	P_t	29.677	8.902	50.035	20.406
	Y_t	16.777	6.817	24.448	4.092
Quarterly (1955.01–2003.03)	C_t	35.672	7.183	49.719	19.407
	P_t	28.726	8.642	49.114	17.192
	Y_t	3.179	2.278	6.280	0.154
	ΔY_t	0.028	0.065	0.344	−0.183
Monthly (1955.01–2003.09)	C_t	11.896	2.552	23.430	5.902
	P_t	28.734	8.626	49.591	17.153
	Y_t	0.712	0.497	1.448	0.050
	ΔY_t	0.002	0.022	0.099	−0.136

Note: Max means maximum value; Min means minimum value; C_t is divided by the population of aged 15 and over.

Table 2. Tests of unit roots (ADF test and Phillips–Perron test): 1955–2003

	Variable	ADF test				Phillips–Perron test			
		constant	time	lags	test statistics	constant	time	lags	test statistics
Yearly	C_t	yes	no	2	-2.823^{*}	yes	no	1	-2.667^{*}
	P_t	yes	no	2	-2.856^{*}	yes	no	2	-2.797^{*}
	Y_t	yes	no	2	-2.764^{*}	yes	no	2	-2.909^{*}
Quarterly	C_t	yes	no	5	-2.670^{*}	yes	no	1	-2.506
	P_t	yes	no	4	-2.711^{*}	yes	no	2	-2.584^{*}
	Y_t	yes	yes	2	0.878	yes	yes	2	1.179
	ΔY_t	yes	yes	2	-4.940^{***}	yes	yes	2	-15.381^{***}
Monthly	C_t	yes	yes	2	-3.278^{***}	yes	yes	2	-8.922^{***}
	P_t	yes	no	2	-2.610^{*}	no	no	2	-2.276^{**}
	Y_t	yes	yes	2	-0.068	yes	yes	2	-0.889
	ΔY_t	yes	yes	2	-20.081^{***}	yes	yes	2	-52.633^{***}

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

Table 3. Estimates of Myopic and Non-addiction Models, Dependent Variable=Ct, yearly data

Independent variable	OLS			2SLS	
	non-addiction	basic	expanded	basic	expanded
Constant	237.759***	63.983***	79.976***	130.608**	139.943***
	(77.364)	(2.864)	(3.797)	(2.696)	(3.440)
C_{t-1}		0.721***	0.665***	0.445**	0.419**
		(7.847)	(7.721)	(2.241)	(2.508)
P_t	−3.196***	−0.782**	−0.010	−1.707**	−0.724
	(−32.197)	(−2.452)	(−0.024)	(−2.469)	(−1.182)
P_{t+1}			−1.057***		−1.191***
			(−2.844)		(−2.883)
Adjusted R^2	0.956	0.980	0.984	0.973	0.982
Wu ratio	−	−	−	3.295	2.971
Observations	48	47	46	46	45

Note: *** means significant at the 1% level; ** means significant at the 5% level; * means significant at the 10% level; The instruments of `basic' 2SLS column: the second lag of price and other exogenous variables. The critical 5% value for Chi-Square distribution with 3 degrees of freedom is 7.815; The instruments of `expanded' 2SLS column: the first lag and the first lead of price and other exogenous variables; The critical 5% value for Chi-Square distribution with 4 degrees of freedom is 9.488.

Table 4. Estimates of Rational Addiction Models, Dependent Variable=Ct, yearly, quarterly and monthly data

Independent variable	Yearly		Quarterly		Monthly	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
Constant	48.1926**	43.712*	26.642***	20.312*	10.595***	7.588*
	(2.469)	(1.656)	(5.489)	(1.777)	(15.487)	(1.929)
C_{t-1}	0.394***	0.441***	0.388***	0.376**	0.364***	0.342***
	(4.681)	(3.103)	(5.098)	(2.549)	(13.301)	(4.065)
C_{t+1}	0.392***	0.366**	0.184**	0.290**	0.114***	0.277*
	(4.001)	(2.12)	(2.603)	(2.272)	(4.826)	(1.675)
P_t	−0.679**	−0.609*	−0.364***	−0.281*	−0.147***	−0.104*
	(−2.540)	(−1.740)	(−5.211)	(−1.731)	(−14.440)	(−1.854)
Y_t	0.523	0.49				
	(0.844)	(0.62)				
ΔY_t			1.485	1.455	−2.230**	−2.480**
			(0.807)	(0.793)	(−2.316)	(−2.356)
Time	−0.256	−0.253	−0.005	−0.004	−0.001***	−0.000
	(−1.062)	(−0.781)	(−1.415)	(−0.930)	(−2.876)	(−0.767)
$4\theta^2\beta<1$	(−2.486)	(−1.491)	(−7.455)	(−2.340)	(−24.516)	(−2.528)
$\phi_1<1$	(−3.497)	(−2.068)	(−9.786)	(−3.957)	(−34.015)	(−3.280)
$\phi_2>1$	(2.005)	(1.264)	(2.904)	(1.255)	(8.025)	(2.121)
short-run ε	−0.338***	−0.293**	−0.397***	−0.387***	−0.421***	−0.406***
	(−3.439)	(−1.999)	(−6.255)	(−2.717)	(−18.124)	(−4.679)
long-run ε	−0.659***	−0.655***	−0.686***	−0.680***	−0.679***	−0.658***
	(−4.064)	(−3.023)	(−16.265)	(−11.871)	(−36.825)	(−15.526)
Adjusted R^2	0.991	0.990	0.956	0.973	0.962	0.955
Wu ratio	−	0.219	−	2.398	−	1.076
Observations	46	45	193	187	583	576

Note: *** means significant at the 1% level; ** means significant at the 5% level; * means significant at the 10% level; The instruments of `yearly' 2SLS column: the second and the first lag of price, the lead of price, the lag of $Y_t$, tax rate and other exogenous variables. The critical 5% value for Chi-Square distribution with 6 degrees of freedom is 12.592; The instruments of `quarterly' 2SLS column: three lags and two leads of price, the lag of ΔY_t, five leads and two lags of tax rate and other exogenous variables. The critical 5% value for Chi-Square distribution with 8 degrees of freedom is 15.507; The instruments of `monthly'

2SLS column: three lags and the lead of price, seven lags of ΔY_t, and other exogenous variables, where twenty dummies for inventory are included in the exogenous variables. The critical 5% value for Chi-Square distribution with 26 degrees of freedom is 38.885.

Table 5. Estimates of tax revenue and reduction of pure social cost (unit: billion yen per fiscal year)

year	1999	2000	2001	2002	2003	2004	…
estimates	26.651	26.323	26.199	26.146	25.196	24.844	…
realized	27.36	26.44	26.59	26.021	25.196	24.844	…
reduction	100.769	135.461	148.683	154.314	255.083	292.398	…

Note: estimates: estimated tax revenue from the `Tobacco Special Tax'; realized: realized tax revenue from the `Tobacco Special Tax'; reduction: estimated reduction of pure social cost from the `Tobacco Special Tax' and `Tobacco Health Tax'.