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Discussion Paper 04-13-Rev.

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Responses of Consumers to the Mandatory Disclosure of Information: Evidence from Natural Experiments in Japanese Inter-brand Cigarette Demands*

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Abstract

I estimated inter-brand cigarette demands with nicotine, tar content and policy event information in Japan during 1950-84. The demand for all brands increased but the demand for plain (non-filter) brands decreased due to the dissemination of " A Note about Health Damage from Smoking " in 1964. The demand for all brands increased but the demand for high-nicotine brands decreased due to the disclosure of nicotine and tar content in 1967 and the labeling warnings in 1972, however consumers had still preferred high-nicotine brands after 1972. Contrastively, the demand for high-tar brands increased in 1967 but decreased in 1972, and consumers had switched to prefer low-tar brands after 1972. Disclosure did not reduce the intake of nicotine but reduced the intake of tar, accordingly disclosure may benefit consumers by reducing the health risk as tar causes cancers. In line with changes in inter-brand demands, the monopolistic firm discontinued old products with poorer quality (plain, high-tar) but provided new better ones (filter-tipped, low-tar).

JEL classification: I18, D12, D82

Keywords: disclosure, nicotine, tar, cigarette, inter-brand, panel estimation, difference in difference

1 Introduction

Whether there a need exists for mandatory information disclosure continues to be hotly debated. Many economists insist, by means of theoretical analyses, that mandatory disclosure is necessary, and much empirical evidence supports this view. However, some economists do not accept this claim, and strong evidence has recently undermined the idea that more information is better.[1] Thus, a clarification of which side of the debate is correct is needed, which has important implications for policy making and legislation.

In addition to clarifying the debate, this research sought to investigate the outcome of recent legislation and legal changes regarding worldwide information disclosure about tobacco products. The World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) was unanimously approved by all WHO members (192 countries) on 27 May 2003. Over 57 countries, including Japan, had already ratified this treaty by September 2005. The FCTC seeks to protect human health by reducing tobacco consumption, and has described in detail several methods for tobacco control. In particular, information disclosure and labeling are believed to be important tools. For example, Article 11 states,“ ... each unit packet and package of tobacco products and any outside packaging and labeling of such products shall, in addition to the warnings . . ., contain information on relevant constituents and emissions of tobacco products . . . . ” Such labeling and information disclosure regulations have been implemented in Japan since the 1960s and 1970s, respectively. By examining the effects of these policies in Japan, we can demonstrate directly the validity of Japanese policy, and also characterize the possible impacts of the FCTC on cigarette consumption in the world.

Therefore, it is crucial to empirically test how consumers react to the new

[1] See details in Dranove et al., (2003).

information releases mandated by Japanese policies. However, it is very difficult to measure the effects of information disclosure, for two main reasons. First, the abstract and general nature of information makes it difficult to quantify and define. Second, it is hard to separate the effects of information disclosure from the effects of other factors. For example, even if some information is presented and has a particular effect, the economy will always change for other reasons as well; thus, any impact of information is in combination with other factors. As a result of these problems, research on information disclosure is generally rare and has been virtually nonexistent in Japan.

Furthermore, one could arrive at the effect of information disclosure on non-addictive goods by testing its effect on addictive goods. It is commonly believed that consumer responses in the case of addictive goods are less sensitive to exogenous information shocks than in the case of general goods, as the consumer cannot easily give up addictive goods or find substitutes for them. Therefore, in the event of a statistically significant effect of information disclosure on the consumption of the addictive good tobacco, it would be reasonable to infer the existence of a similar, but stronger, effect on the consumption of general goods.

With these ideas in mind, this paper proposes a new method for verifying the effects of information disclosure by incorporating information on product contents into the demand equation. A difference-in-difference (DID) approach is provided for directly estimating those changes in inter-brand cigarette demands that result from policy changes and increased information awareness about nicotine and tar levels. Using cross-sectional time-series data, I examined consumer responses to public information announcements. Because consumers generally responded to the newly disclosed information, this implies that they previously had insufficient information. Moreover, results of this study provide new evidence that mandatory disclosure decreases tar intake and increases con-

sumer welfare while making monopolistic firms improve product quality, supply a greater number of new and better quality products, and discontinue their products of poorer quality.

The composition of the paper is as follows: section 2 reviews related research, section 3 describes policy events, section 4 presents the data, section 5 presents the model and estimation techniques, section 6 reports the estimation results, and section 7 provides the conclusion and discusses policy implications and issues relevant to future research.

2 Related Literature

2.1 Theoretical and empirical work

The most influential theoretical works on the topic of information disclosure have been those of Grossman (1981) and Milgrom (1981). When information disclosure is costless to the seller, when the buyer can costlessly confirm whether the disclosed information is true or false, and in the absence of moral hazards on the part of the buyer, Grossman (1981) found that the optimal strategy of the seller is to fully disclose all information and to provide the buyer with complete quality assurance. In such a case, mandatory disclosure is not necessary, because it is in the interests of the firm to disclose all information voluntarily. However, Verrecchia (1983) introduced a nonzero information disclosure cost into the standard model and then found that the seller instead chooses to disclose information only when the profits from such a decision exceed the costs. More recently, Fishman and Hagerty (2003) pointed out that in certain situations, mandatory disclosure may be worse than voluntary disclosure.[2] In short, no consensus has yet been reached in the theoretical literature as to whether

[2] Akita and Maeda (2005) also have made this argument

mandatory or voluntary disclosure is the better policy choice.

In contrast, much empirical work exists on the effects of information on consumption. Brown and Schrader (1990) demonstrated that the introduction of health information empirically helped to explain the phenomenon that egg consumption in the United States decreased despite a decline in the price of eggs. In their analysis, the accumulated yearly number of articles espousing either of two opposing viewpoints (that cholesterol is either good or bad for the health) published in medical magazines between 1955 and 1987 was indexed as a measure of information. Yen and Chern (1992) found that the consumption of animal oil was reduced, and that vegetable oil consumption significantly increased, as a result of the disclosure that cholesterol is bad for the health, using the cholesterol index of Brown and Schrader (1990) as a proxy for health information. Chern et al. (1995) then obtained further evidence that health information affected consumption by using the averages and variances of consumer beliefs as proxy variables for information measures in accordance with the Bayesian information model. Ippolito and Mathios (1995) also provided evidence that the dissemination of information on the negative effects of cholesterol had an effect on food consumption.

Mathios (2000) recently examined nutrition label information and supermarket scanner data from both before and after the introduction of the Nutrition Labeling and Education Act. He found that mandatory labeling did have an effect on consumer behavior and health. However, Dranove et al. (2003) provided evidence that the public disclosure of patient outcomes decreased patient and social welfare. Jin and Leslie (2003) used restaurant hygiene grade cards as a measure of information disclosure and provided evidence that these grade cards caused restaurants to make hygiene quality improvements, although they could not directly estimate the demand for restaurant food, due to a lack of

restaurant price information.

Using American survey data on cigarette consumption, Viscusi (1992) analyzed the effect on smoking behavior attributable to the disclosure that smoking is harmful to health. He found that the probability that an informed person smoked was lower than that for an uninformed one. Furthermore, the introduction of such information significantly decreased cigarette consumption. Yorozu and Zhou (2002) used Japanese prefectural cigarette sales data and a prefectural dummy based on whether there was a smoking and health advertising budget as measures of information dissemination. They found that cigarette consumption decreased significantly in the prefectures with a budget for such advertising. Along similar lines, Wan (2004) used monthly data and event dummies to analyze the effect of information on total cigarette consumption and concluded that information regarding the potential damage due to smoking reduced consumption significantly in Japan.

2.2 Departure from previous work

In previous research, advertisements, regulations, and opinion polls were used as measures of information. In contrast, this analysis uses not only policy information, such as regulation, but also the contents of goods, as measures of information. The measures of information discussed in this paper are reliable, and the measurement bias of this information is low. Furthermore, the estimation approach used here differs markedly from those used in previous research, in that inter-brand demands are used directly, by means of a DID method. Although much research related to cigarette consumption has been conducted using both macro and micro data, there has been no analysis conducted to date of the way in which nicotine and tar content information disclosure has affected inter-brand cigarette demand by causing consumers to switch products. This

inquiry is thus the first of its kind.

This paper also differs from that of Jin and Leslie (2003) in three main respects. First, the estimation approach adopted directly estimates demand by means of disclosed information rather than by means of estimated revenue. Second, this paper focuses on an addictive good (cigarettes), while Jin and Leslie (2003) did not. Third, this paper focuses on the response behavior of a monopolistic firm faced with mandatory information disclosure, whereas Jin and Leslie (2003) focused on relatively competitive firms (restaurants) under both mandatory and voluntary disclosure.

3 Main Policy Events Concerning Smoking Information in Japan

The Japan Tobacco and Salt Public Corporation (JT) is the only cigarette maker in Japan. It is a matter of established fact that JT is, and has generally been, unwilling to voluntarily disclose complete information about the quality of its products. This fact is consistent with the prediction of the standard theory of information disclosure. Large costs associated with information disclosure arise for both JT (in measuring cigarette contents and convincing the smoker that the disclosed information is true) and the cigarette consumer (in verifying that the information disclosed by JT is true), if there is no government regulation. Therefore, because of these enormous costs of information disclosure and verification, the government must legislate information disclosure and establish organizations that verify information, such as various governmental inspection agencies. In addition, a substantial tax should be charged to cover these costs. The Japanese government has enacted such legislation, and has forced JT to disclose cigarette content information in accordance with related laws.

For the purpose of conducting the analysis reported in this paper, three main policy events pertinent to information about smoking in Japan were used to measure information effects quantitatively. The first occurred on 6 February 1964, when the Ministry of Health and Welfare of Japan disseminated“ A Notice about Health Damage from Smoking ”to prefectural governors and to the mayors of several designated cities following the release of the U.S.“ Smoking and Health Report, ” which was published in 1964. One may consider this publication as a completely exogenous shock to the consumer, as this was the first time that the government officially informed consumers about the negative health effects of smoking.

The second information disclosure event in Japan concerned the nicotine and tar content of cigarettes. In 1967, the amounts of nicotine and tar per cigarette were published in the newspapers, as mandated by the Ministry of Finance. One may also consider this event as constituting a completely exogenous information shock, for the following reason. Before this disclosure, neither consumers nor JT possessed information about nicotine and tar levels; nicotine and tar levels were first measured in 1967. Before 1967, both demand and supply sides had no data concerning nicotine and tar levels. As information regarding the levels of nicotine and tar had not yet been disclosed, even as late as 1966, it can be assumed that consumer knowledge of nicotine and tar levels did not affect the consumption of cigarettes. After 1967, however, it can be inferred that consumer behavior was influenced by the new information.

The third information disclosure event occurred on 20 April 1972, when the Japanese Ministry of Finance issued a directive put a warning label on cigarette packs. Specifically, manufacturers were required to add the label,“ Smoking too much may be bad for your health. ” This warning had to be displayed on the packs of all brands produced after April 1972, and this mandatory disclosure

continues today.

Tax revenues were necessary to enforce these policies and to cover the related costs. Therefore, one may think of part of the cigarette tax revenues as the costs associated with information disclosure, e.g., verification costs. According to Wan (in press), the price of cigarettes today is completely controlled by the Japanese government, and special laws are frequently passed to enact cigarette tax changes. In fact, seven cigarette tax increases have been passed, not because of fluctuations in the demand for cigarettes, but because of a large public deficit. Thus, the price of cigarettes is an exogenous variable for the Japanese cigarette consumer. Therefore, the prices of all brands were included in the estimation equation, not only to control for effects other than those of information about nicotine and tar, but also to obtain the variations in price across all brands.

4 Data

The time-series sales data used for each brand came from the " National Budget " and the " History of the Japanese Cigarette Monopoly. "[3] In particular, the data included information for the period 1950-1984 on the consumption of 55 brands that had more than 95 percent of the total market share after 1960. In addition, the data included each brand's price and respective levels of nicotine and tar. The nicotine and tar-level data were announced officially in the " Asahi Shimbun " and the " Mainichi Shimbun. "[4]

Policy dummies were used to indicate whether disclosure of information occurred, i.e., they were assigned a value of " 0 " before an event occurred and designated as " 1 " after the event. A time trend and its square were also used. Furthermore, macroeconomic factors, such as income and population,

[3] In Japanese, the " National Budget " is " Kuni No Yosan, " and the " History of the Japanese Cigarette Monopoly " is " Nihon Tabako Senbaishi. "

[4] The " Asahi Shimbun " and the " Mainichi Shimbun " are the main newspapers in Japan. The information on nicotine and tar content was obtained from these two newspapers.

were taken into consideration. The time transitions of nicotine and tar levels per cigarette are presented in Figure 1. This graph shows that cigarette nicotine and tar content decreased after 1967, and that the decrease in nicotine levels was slightly more sudden than that of tar. Figure 2 presents the time transition of annual per capita cigarette consumption versus annual consumption per smoker. Cigarette consumption per capita increased until the mid-1970s and then leveled off. However, cigarette consumption per smoker has been increasing until the present time.[5] The total intake of nicotine and tar per capita is presented in Figure 3. Nicotine consumption exhibited an upward trend until 1967 but declined thereafter. This trend then turned upward again until 1972, shifting to another downward trend thereafter. Tar consumption, however, increased slowly after 1967 and declined from 1972. The total intakes of nicotine and tar per smoker are presented in Figure 4. The pattern of nicotine consumption exhibited similar tendencies to that of tar; this trend increased until 1963 but then shifted to a downward trend from 1964. However, it is noteworthy that in 1972, nicotine consumption moved in the opposite direction to that of tar consumption.

To help assess the subjective changes in consumer consciousness that occurred with the dissemination of new information, I investigated the number of newspaper articles with headlines containing relevant keywords.[6] The number of articles with titles related to the harmful effects of smoking, or to not smoking, suddenly increased after 1964. There were a few more articles with titles including the keyword " nicotine " than there were titles including " tar " around 1967, although the number of articles with titles containing " tar " increased from 1972. It appears that these changes in consumer consciousness correspond to the changes in the consumption patterns presented in Figure 1, and to the

[5] Calculation details were presented by Wan (in press).

[6] I searched keywords in the Asahi Shimbun Database. The data obtained and a graph are available upon request.

changes in the total intake of nicotine and tar shown in Figure 4.

5 Specification and Estimation Methods

5.1 Modeling the effects of the policy events in 1964, 1967, and 1972

The response of consumers to the 1964 policy event was likely represented by the adjustment in total cigarette consumption and inter-brand switching that occurred. Ideally, consumers should have restricted their consumption of plain cigarettes, if they only had information regarding plain and filtered cigarettes. Therefore, plain-cigarette consumers may be taken as a treatment group, with filtered-cigarette consumers used as a control group.

Similarly, the response of consumers in 1967 to the disclosure of information about nicotine and tar content levels can be represented by switches among brands or an adjustment of total consumption following the disclosure of this information. Once consumers became aware that nicotine and tar were bad for their health, the demand for brands with a high-nicotine or tar content should have decreased, while the demand for low-nicotine brands characterizing the control group should have increased.

Finally, the consumer response to the 1972 warning label on cigarette packs that " Smoking too much may be bad for your health " can similarly be used to characterize the market response to the disclosure of nicotine and tar information in 1967.

5.2 Econometric model

As noted by Wan (2004), consumer consumption of cigarettes is based not only on cigarette prices, but also on the available information concerning the dam-

aging effects of smoking. If one ignores the aspect of addiction, a simple model for cigarette brand demand can be described as follows: demand for brand$_{it}$ = f (the attributes of the brand$_{it}$, policy information, etc.). The attributes of the brand and relevant policy information can be used as proxies for the extent of consumer knowledge about the harmful effects of smoking.

$$\begin{aligned} D_{it} = \beta_0 + \beta_1 * time + \beta_2 * time^2 + \beta_3 * price_{it} + \beta_4 * income_t + \beta_5 * after64 \\ + \beta_6 * plain_i + \beta_7 * after64 * plain_i + \beta_8 * after67 + \beta_9 * nicotine_{it} \\ + \beta_{10} * after67 * nicotine_{it} + \beta_{11} * after72 \\ + \beta_{12} * after72 * nicotine_{it} + a_i + u_{it}. \quad (1) \end{aligned}$$

Two assumptions may also be made:

$$\begin{aligned} Assumption\ 1: \ E(u_{it}|x_{itj}, a_i) &= 0, \\ Assumption\ 2: \ Cov(x_{itj}, a_i) &= 0, \end{aligned}$$

where the x are explanatory variables and j = 1, 2, ..., 12, is the number of explanatory variables; i = 1, 2, ..., 55; t = 1, 2, ..., 35. The two assumptions presented above are consistent with the characteristics of the sample. It can easily be verified that Assumptions 1 and 2 are satisfied by the sample used, as the explanatory variables are the attributes of brands and policy information.

The variables used in the estimation were constructed as follows. " D " denotes the annual demand for each brand, divided by the Japanese population; " time " is a time trend for the years 1950, 1951, ..., 1984; " time^2 " is the square of " time " divided by 100; " price " is the nominal price of each brand divided by the consumer price index (CPI); " income " is Japanese per capita disposable income divided by the CPI; " after64 " is a time dummy, which equals 1 for the period after 1964 and 0 otherwise; " plain " is a dummy for plain brands, which

equals 1 if the brand was plain and 0 otherwise; " after64*plain " is a term for the intersection of after64 and plain; " after67 " is a time dummy, which equals 1 for the period after 1967 and 0 otherwise; " tar " is the tar content of each brand as disclosed in the newspapers; " after67*tar " is a term for the intersection of after67 and tar; " nicotine " is the nicotine content of each brand as disclosed in the newspapers; " after67*nicotine " is a term for the intersection of after67 and nicotine; " after72 " is a time dummy, which equals 1 for the period after 1972 and 0 otherwise; " after72*tar " is a term for the intersection of after72 and tar; and " after72*nicotine " is a term for the intersection of after72 and nicotine. The number of observations, maximum value, minimum value, average, standard error, and so on, for each variable, are summarized in Table 1.

5.3 Information on nicotine and tar content before 1967

In 1967, the nicotine and tar content of only existing brands was tested. Thus, information on nicotine and tar content before 1967 is lacking. Therefore, the assumption was made that the nicotine and tar content prior to 1967 was equal to the value disclosed in 1967. Given that nicotine and tar levels are the primary characteristics of a cigarette brand, JT may have chosen to produce new brands, rather than change the content of its old brands; JT would have incurred large costs in changing the components of an existing brand.[7]

Accordingly, consumers could not "see" information about nicotine and tar content before 1967, but it would be reasonable that they might estimate the content of their favorite brands to some degree by their taste sensations. To capture this effect, I use information about nicotine and tar content in 1967 as a proxy for the one prior to 1967.

[7] See the " History of the Japanese Cigarette Monopoly " (Tabako Senbaishi in Japanese) for details.

5.4 High correlation between nicotine and tar

It is reasonable that cigarette consumers should generally choose brands based on their information about nicotine and tar content. As high-nicotine brands always have a higher tar content, tar content is strongly and positively correlated with nicotine content. In fact, the coefficient of correlation in this case is 0.9261. Therefore, the possibility of multicollinearity arises when nicotine and tar are both included in a regression equation. In consequence, either nicotine or tar was dropped from the model to control for this potential problem.

However, the coefficient of correlaton is not equal to 1, it also makes sense that the estimation is performed including both nicotine and tar. If eithor nicotine or tar is dropped from the model, the issue of an omitted variable may arise. Thus, I make three estimations and then compare their results to control for these issues.

5.5 Data unavailable after 1984

Data from 1985 are not available, because JT has not disclosed its inter-brand cigarette sales information since its privatization in 1985. If the information disclosure events considered in this paper were unrelated to JT's privatization, then the obtained estimators should be consistent.[8] It is reasonable that these events should have been independent, because JT's privatization was mainly caused by trade conflicts and the trade-liberalization talks that took place between Japan and the United States in the 1980s.[9] Partially relevant information is also available from the following Web address. http://www.kantei.go.jp/jp/gyokaku/1006kiki2-besi.html

[8] See Chapter 17 of Wooldridge (2002) for details.

[9] See the " History of the Japanese Cigarette Monopoly " (Tabako Senbaishi in Japanese) for details.

5.6 Unobserved (potentially existing) samples

The observed sample is unbalanced because new brands were introduced and some old brands were withdrawn from the market at different times. The demand for discontinued brands or those that had not yet been introduced could not be observed. This observation indicates a typical selection bias problem, assuming that the introduction and discontinuation of brands was a choice made by JT. Under the assumption that JT 's strategy for the introduction and discontinuation of brands was based on the observed information x in equation (1) and the unobserved time-invariant a_i, a relevant fixed-effects estimator should be unbiased.[10]

If JT's strategy for the selection of brands were based not only on the information in equation (1), but also on the unobserved time-variant growth rate of demand, the following random growth model would be more suitable.

$$\begin{aligned} ln(D_{it}) = \gamma_0 + \gamma_1 * time + \gamma_2 * time^2 + \gamma_3 * ln(price_{it}) + \gamma_4 * ln(income_t) \\ +\gamma_5 * after64 + \gamma_6 * plain_i + \gamma_7 * after64 * plain_i + \gamma_8 * after67 \\ +\gamma_9 * ln(nicotine_{it}) + \gamma_{10} * after67 * ln(nicotine_{it}) \\ +\gamma_{11} * after72 + \gamma_{12} * after72 * ln(nicotine_{it}) \\ +g_i * time + a_i + u_{it}. \quad (2) \end{aligned}$$

Here, " ln " denotes the natural logarithm, and g_i is the potential growth rate of brand i. An estimation of this specification was also performed.

5.7 Estimation methods

For the purpose of estimating equation (1), fixed-effects (FE, where Assumption 2 is not required) and random-effects (RE) panel estimation techniques

[10] See Chapter 17 of Wooldridge (2002) for details.

were used. A Hausman-Wu test was used to identify which specification was superior.[11]

In the estimation of equation (2), the a_i were removed via first-differencing; this differenced equation was then estimated using FE (with the g_i removed) and RE methods. In this process, the variables *time* and $time^2$ in equation (2) became constant, as did *time* in the differenced equation.

5.8 The monopolistic firm's strategy for the selection of brands

Pooled ordinary least squares (POLS) estimation was used to determine how JT selected new and discontinued brands in response to the mandatory disclosure of nicotine and tar content information. A new brand dummy (*new_brand*), which equals 1 at the time of the first observation of a new brand and 0 otherwise, was constructed, in addition to a discontinued brand dummy (*discontinued_brand*), which equals 1 when a brand was observed for the last time and 0 otherwise. The dependent variable was taken to be either nicotine or tar, while the independent variables included time, the square of time, after67, after72, the new brand dummy, and the discontinued brand dummy, which characterized JT's strategy of brand selection. These estimations were essentially difference tests for the nicotine and tar content of discontinued brands, as well as those of new and existing brands, both before and after 1967 and 1972, that were performed to verify whether there were significant differences.

[11] Even though FE estimators are sometimes accepted by the Hausman-Wu test, RE estimation results may also be robust in this context because nicotine and tar levels are nearly time invariant.

6 Results and Their Explanation

6.1 Panel estimation with level data

Table 2 presents the results of the panel regressions using level data. The first and second columns contain results regarding nicotine, while the third and fourth columns contain results concerning tar. The Hausman-Wu test for the estimation with nicotine accepted the RE formulation. Note that the coefficients for " after64, "" after67, " and " after72 " for this case are significantly positive, as indicated in the first column.[12] Similarly, the Hausman-Wu test for the estimation with tar fit the FE formulation, and the coefficients for " after64 " and " after72 " presented in the fourth column are significantly positive. These results imply that the policy events of 1964 and 1972 both increased cigarette sales. However, the coefficient for " after67 " in the fourth column is significantly negative and is opposite in sign to the coefficient in the case of nicotine, implying that the coefficient for " after67 " is sensitive to whether nicotine or tar was considered, and that the variable " after67 " may have been highly correlated with nicotine and tar content itself. Thus, it is not clear whether the sale of cigarettes truly increased after the policy event of 1967.

In the first column of the same table, the coefficients for " price " and " income " are not significant. The coefficient for " plain " is significantly positive, but the coefficient for " after64*plain " is significantly negative. The sum of the estimated coefficients for " plain " and " after64*plain " is significantly neg-

[12] Due to the event in 1964, consumers significantly switched to filter-tipped cigarettes. The filter-tipped cigarette would be felt ' light ' compared with the plain brands when the other factors were the same, thus smokers would smoke ' more ' to keep the ' smoking or nicotine stock ' in their bodies. The other reason might be the consumers ' illusion, that is, the ' filter-tipped ' were considered ' safer ', thus the smoker could smoke more ' safer ' (filter-tipped) cigarettes under the same health risk. Even though consumers still preferred high-nicotine brands after 1972, but coefficients on' after67*nicotine 'and' after72*nicotine 'are significantly negative, respectively. These results implied that consumers switched to lower-nicotine brands after these policy changes. Those consumers had to consume more lower-nicotine cigarettes to keep or smooth the intake of nicotine as shown in Figure 4.

ative (“ plain ” + “ after64*plain ” = 123.194, standard error = 63.004, p = 0.051), which suggests that the sales of plain cigarettes decreased significantly and implies that smokers started to buy filtered cigarettes after the policy event of 1964. The coefficient for “ nicotine ” is significantly positive, but the coefficients for “ after67*nicotine ” and “ after72*nicotine ” are significantly negative. The sum of the coefficients for “ nicotine ” and “ after67*nicotine ” is significantly positive (“ nicotine ” + “ after67*nicotine ” = 143.294, standard error = 26.569, p = 0.000), which suggests that the demand for high-nicotine cigarettes increased significantly after the policy event of 1967. The sum of the three coefficients for “ nicotine, ” “ after67*nicotine, ” and “ after72*nicotine ” is also significantly positive (“ nicotine ” + “ after67*nicotine ” + “ after72*nicotine ” = 57.521, standard error = 25.952, p = 0.027), which suggests that the demand for high-nicotine cigarettes increased significantly, even after the policy event of 1972. These results indicate that the sales of high-nicotine brands decreased significantly compared to those of low-nicotine brands, after the introduction of the information disclosure regulations in 1967 and in 1972; however, consumers generally still preferred high-nicotine brands.

In the fourth column, the coefficient for“ price ”is negatively significant. The coefficient for “ income ” is not significant. The coefficient for “ after64*plain ” is significantly negative and implies that the sales of plain cigarettes decreased significantly after the policy event of 1964. The coefficient for “ tar ” is positive but not significant. The coefficient for “ after67*tar ” is significantly positive, but the coefficient for “ after72*tar ” is significantly negative. The sum of the coefficients for “ tar ” and “ after67*tar ” is significantly positive (“ tar ” + “ after67*tar ” = 13.631, standard error = 3.510, p = 0.000), which suggests that the demand for high-tar cigarettes increased significantly after the policy event of 1967. The sum of the three coefficients for “ tar, ” “ after67*tar, ”

and " after72*tar " is positive but not significant (" tar " + " after67*tar " + " after72*tar " = 4.333, standard error = 3.651, p = 0.236), which suggests that the demand for high-tar cigarettes did not increase significantly after the policy event of 1972. These results indicate that the sales of high-tar brands increased significantly after the introduction of the information disclosure regulations in 1967 but decreased significantly after 1972 compared to those of low-nicotine brands. The increased availability of tar information decreased sales of high-tar brands following the warning-label legislation of 1972; in fact, consumers have not significantly preferred high-tar brands since 1972.

The fifth and the sixth column present the result when both nicotine and tar are simultaneously included in the estimation. RE and FE estimation are performed, but the FE result is accepted by the Hausman-Wu test. The obtained related coefficient sums are " nicotine " + " after67*nicotine " = 108.747 (p = 0.019); " nicotine " + " after67*nicotine " + " after72*nicotine " = 122.305 (p = 0.002);" tar " + " after67*tar " = 2.793 (p = 0.609) and " tar " + " after67*tar " + " after72*tar " = - 10.80214 (p = 0.024). These results imply that the consumers prefer high nicotine and low tar brands after 1972. It is nearly consistent with the results in the first and the fourth column.

I sum up above findings here. Due to information disclosure, smokers switched to prefer brands with lower nicotine and lower tar, and they increased cigarette cosumption; as a result, smokers smoothed or kept their intakes of nicotine, just as shown in Figure 4. As smoking rate decreased, total intake of nicotine and tar per capita decreased after information disclosure as shown in Figure 3. By contrast, total intake of nicotine per smoker almost did not decreased, and total intake of tar per smoker only decreased slightly. The consumers' intake of nicotine is consistent with the addictive nature of nicotine.[13]

[13]Rational addiction hypothesis is empirically supported by cigarette consumption in Japan. See Wan (2005) for details.

6.2 Panel estimation with growth rate data

Table 3 presents the results for the panel regressions of equation (2) using growth data. The first and second columns present the results of the estimations including nicotine, while the third and fourth columns contain the results from the estimations including tar. The Hausman-Wu test accepted the RE estimations (second and fourth columns). The estimated coefficients for " Δln(price) " and " Δln(income) " are significantly negative and positive, respectively, which means that the inter-brand price elasticity for cigarettes was -0.474 and the corresponding income elasticity fell between 2.343 and 2.409. The " constant " has a significantly positive sign and corresponds to the time trend of equation (2), thus implying that cigarette sales exhibited a significant growth trend. The estimated coefficient for " time " is significantly negative and corresponds to the square of the time trend in equation (2), implying that the trend of the sales growth was nonlinear. The coefficient for " Δafter64 " is significantly negative, and this implies that the growth rate of cigarette sales significantly decreased after 1964. The coefficients for " Δafter67, "" Δafter72, " and " Δafter64*plain " are not significant.

In the second column (FE estimation with nicotine), the coefficients for " Δln(nicotine), "" Δafter67, " and " Δafter67*ln(nicotine) " are not significant. However, the coefficient for " Δafter72*ln(nicotine) " is negatively significant, and this implies that the growth rate of the cigarette sales of high-nicotine brands did not significantly change in 1967 but significantly decreased after 1972.

In the fourth column (FE estimation with tar), the coefficients for " Δln(tar), " " Δafter67, " and " Δafter67*ln(tar) " are not significant. However, the coefficient for " Δafter72*ln(tar) " is negatively significant, which implies that the growth rate of the cigarette sales of high-tar brands did not change sig-

nificantly in 1967 but significantly decreased after 1972. In the sixth column (FE estimation with nicotine and tar), the coefficients on“ time, ” “ Δln(price), ” “ Δln(income) ” and “ constant ” are significant and close to the ones in the second and the fourth columns. The other coefficients are not significant. It may be caused by the multicollinearity or by too many parametors.

From the information in Table 3, one may conclude that the policy events of 1964 and 1967 did not have significant effects on the growth of inter-brand cigarette demand, while the growth rate of the demand for high-nicotine and high-tar brands decreased due to the policy event of 1972. Since a consumer's choice of brand requires information regarding nicotine and tar levels, one may infer that the effect in 1972 was ancillary to that of the 1967 information disclosure. The consumer could not have chosen a brand based on nicotine and tar contents if such content information had not been released in 1967.

6.3 Impacts on the monopolistic firm

During the period of voluntary disclosure (before 1967), JT did not disclose content information. In contrast, JT disclosed all information regarding nicotine and tar content during the period of mandatory disclosure (after 1967). It is noteworthy that the number of brands on sale increased continuously throughout both periods, and that the rate of increase became greater after the mid-1960s. Furthermore, the annual average sales of each brand decreased continuously. In other words, JT supplied more brands after the introduction of mandatory disclosure. Moreover, changes also occurred in the composition of consumer demand for plain versus filtered cigarettes. Before 1964, 3 plain brands were introduced, but after 1964, there were no new plain brands. Only 2 filtered brands were introduced before 1964, but after 1964, 47 filtered brands were introduced. Thus, JT supplied more filtered brands and fewer plain brands

after the policy event of 1964. In addition, graphs of the time transitions for the number of discontinued and new brands indicate that remarkably large numbers of new brands were introduced in 1964, 1967, and 1972.[14] No brands were discontinued before 1972, but many were discontinued thereafter. These facts imply that JT introduced many new brands in response to the events of 1964, 1967, and 1972 and discontinued many brands in response to the policy event of 1972. Finally, the average nicotine and tar content of both discontinued and new brands indicates that a transition occurred in favor of low tar and nicotine. In particular, the average nicotine content of the discontinued brands was higher than that of the new brands, implying that JT discontinued many high-nicotine brands and introduced many low-nicotine brands. Similarly, the amount of tar in the discontinued brands was on average higher than that of the new brands, implying that JT discontinued many high-tar brands and introduced many low-tar brands.

After 1967, 20 brands were discontinued, while 39 new ones were introduced; only 13 brands had been introduced before 1967. Using a difference test, it was possible to determine that the nicotine and tar content of the cigarettes that were discontinued after 1967 was higher than that of the newer brands. Moreover, it was likewise determined that the nicotine and tar content of brands introduced before 1967 was much higher.

To formally test the above implications, four estimations were performed using POLS. The results of these estimations are summarized in Table 4. The first and second columns contain the results for the nicotine content of new and discontinued brands, while the third and fourth columns present the results for tar content. In the third column, the coefficients for " after67, " " after72, " and " new_brand " are significantly negative, but the coefficient for " discontinued_brand " is significantly positive. These results imply that JT

[14]The graphs are available upon request.

supplied more lower-nicotine brands and discontinued higher-nicotine brands. In the fourth column, the results are very similar to those in the second column and imply that JT supplied more lower-tar brands and discontinued higher-tar brands.

It seems contradictory that consumers still preferred high-nicotine brands, and that JT nonetheless discontinued brands of this type and instead supplied low-nicotine brands.[15] However, this may actually be a rational response by JT: firstly, high-nicotine brands also tend to be high in tar, and consumers dislike high-tar brands. In fact, the growth rate of high-nicotine brands was significantly lower than that of other cigarettes. Secondly, if consumers switch to consume low nicotine brands, they have to consume more cigarettes to smooth the intake of nicotine because of nicotine's addictive nature; Thus, JT may sell more cigarettes and get much larger profit. This strategy of brand selection would be consistent with JT's profit maximiziton.

7 Conclusion and Policy Implications

By incorporating information on product contents into the demand equation, this paper has presented a new way to test the effects of information disclosure on consumption. Moreover, this new methodology was used to test the effects of mandatory information disclosure regulations on Japanese inter-brand cigarette demand. The main findings are as follows.

In 1964, the demand for all cigarette brands increased, and the demand for plain cigarettes decreased, due to the dissemination of " A Notice about Health Damage from Smoking. "The growth rate of the demand for all brands decreased from 1964. Compared with that for low-nicotine brands before the information disclosure, the demand for high-nicotine brands decreased due to the mandatory

[15]This point was first argued by Takeo Hoshi.

disclosure of 1967, and also decreased due to labeling warnings that were implemented in 1972. However, consumers greatly preferred high-nicotine brands before the information disclosure; in fact, consumers still preferred high-nicotine brands even after the events of 1967 and 1972. The growth rate of high-nicotine brands did not change significantly in 1967 but did decrease significantly after 1972. Compared to that for low-tar brands before the information disclosure, the demand for high-tar brands increased due to the mandatory disclosure in 1967 but decreased due to the labeling warnings in 1972. The total effect was that consumers generally did not prefer high-tar brand cigarettes after 1972. The growth rate of high-tar brands did not significantly change in 1967 but significantly decreased after 1972.

In harmony with the change in consumer preferences caused by the disclosure of information about the health effects of smoking, JT also supplied more and better-quality products and discontinued products of poorer quality by supplying more filter-tipped, low-tar (nicotine) brands and discontinuing plain and high-tar (nicotine) brands.[16] This JT's strategy is consistent with its profit maximiziton because if consumers switch to consume low nicotine brands, they have to smoke more cigarettes to keep the intake of nicotine and then JT may sell more cigarettes.

These results are consistent with the time transitions that occurred in the average nicotine and tar per cigarette, total nicotine intake, and the tar per capita and per smoker. This suggests that the cigarette consumer had an insufficient amount of information before the disclosure events took place, as the mandatory disclosure of information resulted in a decreased intake of tar per capita and per smoker.

The policy implications of this paper are as follows. The mandatory disclo-

[16]Medical research has corroborated that low-tar cigarettes are of " better quality " than high-tar brands, as tar is a cause of cancer; thus, filtered cigarettes are better than those without filters because filters remove some of the tar and other harmful ingredients.

sure of information about smoking is likely to decrease the incidence of cancer caused by tar intake and increase consumer welfare, if consumers always choose their favorite cigarettes. Thus, mandatory information disclosure is both important and indispensable. These regulations are of great importance to the consumer in light of the current lack of information provided to consumers, and they should also force monopolistic firms to improve the quality of their products by shifting consumer demand.

In closing, there are two major issues that were not been addressed in this study. The first is that the addictive nature of smoking was not considered in the estimated model. It would be interesting to introduce the effect of information disclosure into the framework of Becker et al. (1994) or Wan (in press). The second issue is that the approach of Yen and Chern (1992) should have been used to estimate information effects. However, when this approach was used, data limitations became a major problem, because the data set has too many brands, too many missing values,[17] and a very short time-series.

[17]This is also a typical attrition issue. See Kawaguchi and Neumark (2004) for details.

References

Akita, M., and Y. Maeda (2005) Bank's Disclosure and Efficiency of Allocation, *Discussion Paper*, Keio University, Japan, 2005, No.005.

Becker, G.S., M. Grossman, and K.M. Murphy (1994) An Empirical Analysis of Cigarette Addiction, *American Economic Review*, 72, 548-555.

Brown, D. J., and L. F. Schrader (1990) Cholesterol Information and Shell Egg Consumption, *American Journal of Agricultural Economics*, 74(3), 689-697.

Chaloupka, F. J., and K. E. Warner (1999) Economics of Smoking, *NBER Working Paper*, 7047.

Chern, W. S., E. T. Loehman, and S. T. Yen (1995) Information, Health Risk Beliefs, and the Demand for Fats and Oils, *Review of Economics and Statistics*, 77(3), 555-564.

Dranove, D., D. Kessler, M. McClellan, and M. Satterthwaite (2003) Is More Information Better? The Effects of" Report Cards "on Health Care Providers, *Journal of Political Economy*, 111(3), 555-587.

Economic Planning Agency, Government of Japan, *Report on National Accounts*, various years.

Fishman, M. J., and K. M. Hagerty (2003) Mandatory versus Voluntary Disclosure in Markets with Informed and Uninformed Customers, *Journal of Law, Economics, & Organization*, 19(1), 45-63.

Grossman, S. J. (1981) The Informational Role of Warranties and Private Disclosure about Product Quality, *Journal of Law and Economics*, 24, 461-483.

Ippolito, P. M., and A. D. Mathios (1995) Information and Advertising: The

Case of Fat Consumption in the United States, *American Economic Review*, 85(2), 91-95.

Japan Tobacco and Salt Corporation. Tabako Senbaishi (in English, The History of Japanese Tobacco Monopoly), Vol.1-6, 1963-1990.

Jin, G. Z., and P. Leslie (2003) The Effect of Information on Product Quality: Evidence from Restaurant Hygiene Grade Cards, *Quarterly Journal of Economics*, 118(2), 409-451.

Kawaguchi, D., and D. Neumark (2004) Attrition Bias in Economic Relationships Estimated with Matched CPS Files, *Journal of Economic and Social Measurement*, 29(4), 445-472.

Mathios, A. D. (2000) The Impact of Mandatory Disclosure Laws on Product Choices: An Analysis of the Salad Dressing Market, *Journal of Law and Economics*, 651-677.

Milgrom, P. (1981) Good News and Bad News: Representation Theorems and Applications, *Bell Journal of Economics*, 12, 380-391.

Ministry of Health and Welfare of Japan, *Report on Smoking and Health*, 1st edition, 1987; 2nd edition, 1993.

Ministry of Health and Welfare of Japan, *Tobacco and Health*, http://www.health-net.or.jp/tobacco/front.html.

Statistics Bureau and Statistics Center, Government of Japan, *Consumer Price Index*, 1951-1999.

Verrecchia, R. (1983) Discretionary Disclosure, *Journal of Accounting and Economics*, 5, 179-194.

Viscusi, K. W. (1992) *Smoking: Making the Risky Decision*, New York, NY, USA, Oxford University Press.

Wan, J. (2004) Response to Health Information: Evidence from Cigarette Consumption and Intake of Nicotine and Tar in Japan, *Discussion Papers* of the Graduate School of Economics and Osaka School of International Public Policy, Osaka University, June 2004, No. 04-12.

Wan, J. (2005) Rational Addiction with Optimal Inventories: Theory and Evidence from Cigarette Purchases in Japan, *Discussion Papers* of The Institute of Social and Economic Research, Osaka University, August 2005, No. 641.

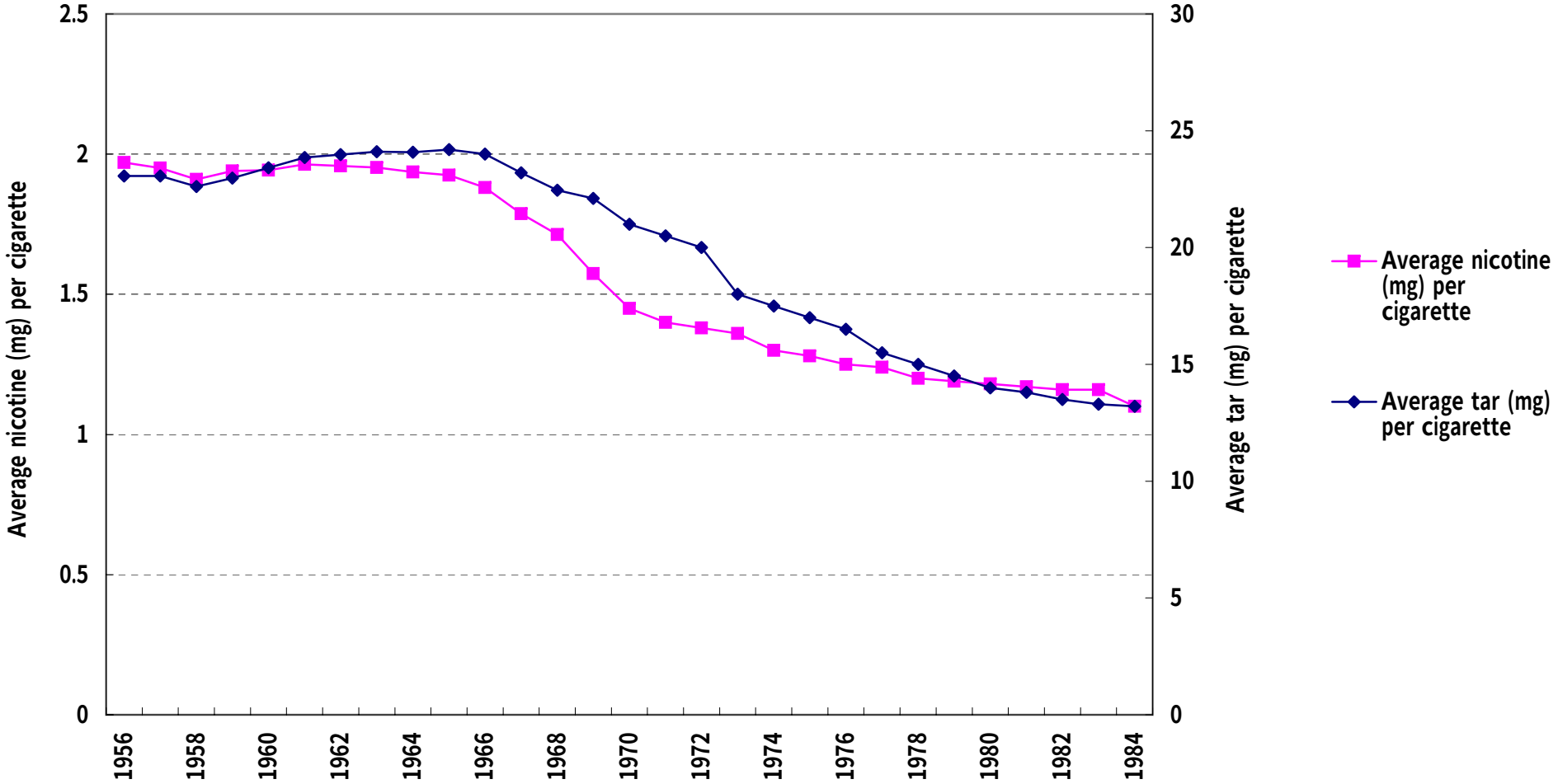
Wan, J. (in press) Cigarette Tax Revenues and Tobacco Control in Japan, *Applied Economics*, in press.

Wooldridge, J. M. (2002) *Econometric Analysis of Cross Section and Panel Data*, Cambridge, MA, USA, MIT Press.

Yen, S. T., and W. S. Chern (1992) Flexible Demand Systems with Serially Correlated Errors: Fat and Oil Consumption in the United States, *American Journal of Agricultural Economics*, 74(3), 689-697.

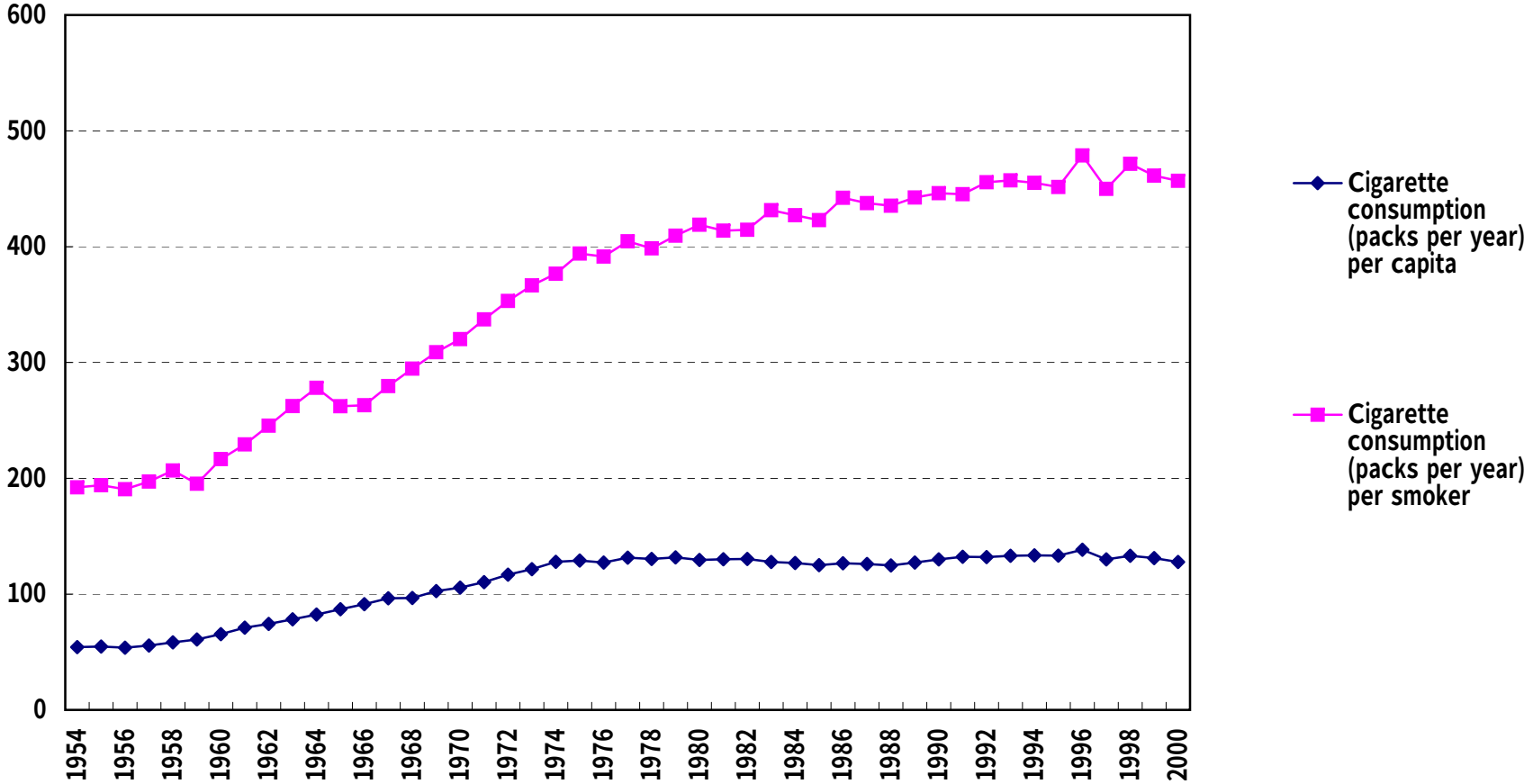
Yorozu, I., and Y. Zhou (2002) The Demand for Cigarettes in Japan: Impact of Information Dissemination on Cigarette Consumption, *Contemporary Economic Policy*, 20(1), 72-82.

Figure 1. Average nicotine and tar content per cigarette



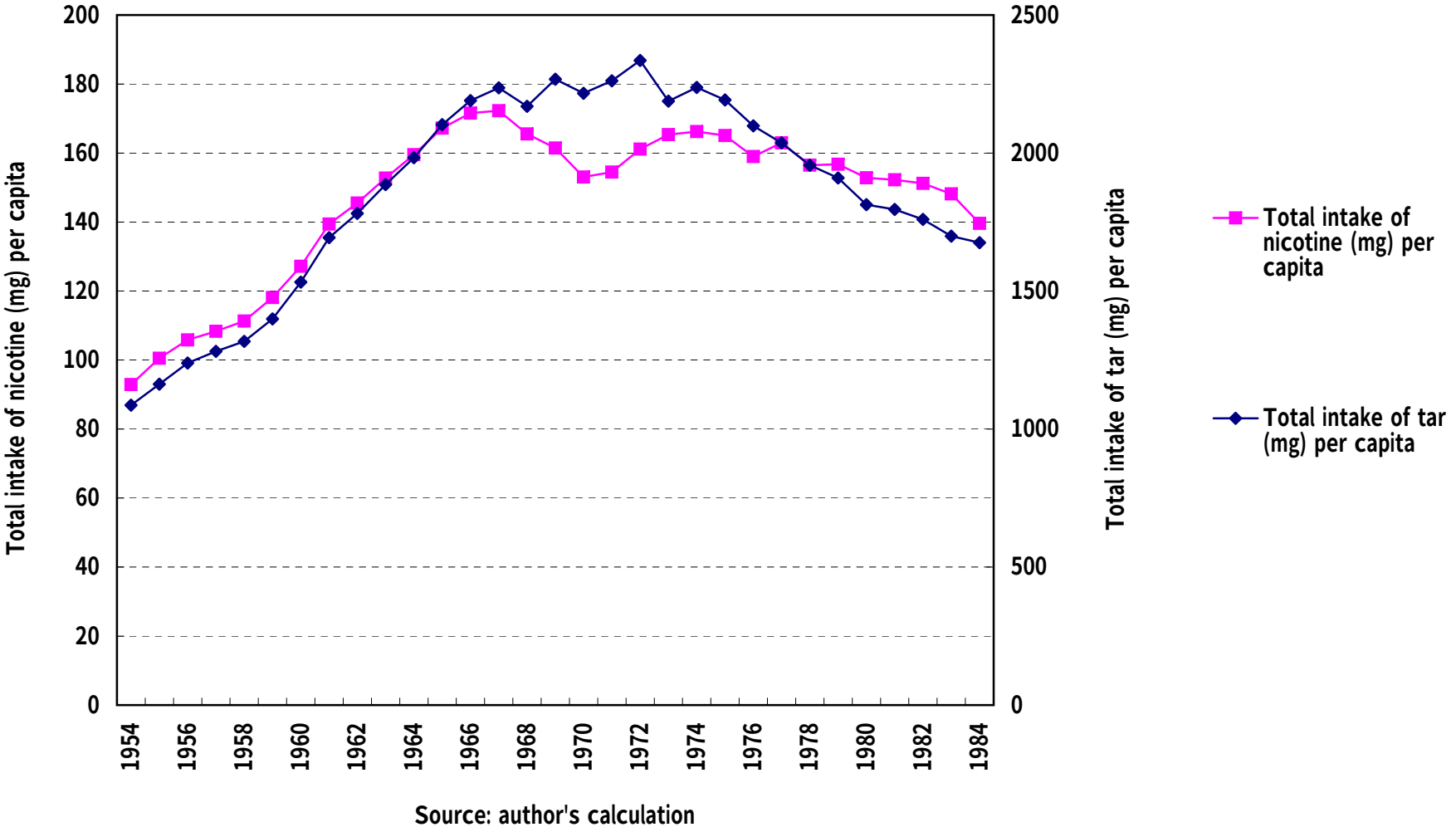
Source: author's calculation

Figure 2. Cigarette consumption per capita and per smoker



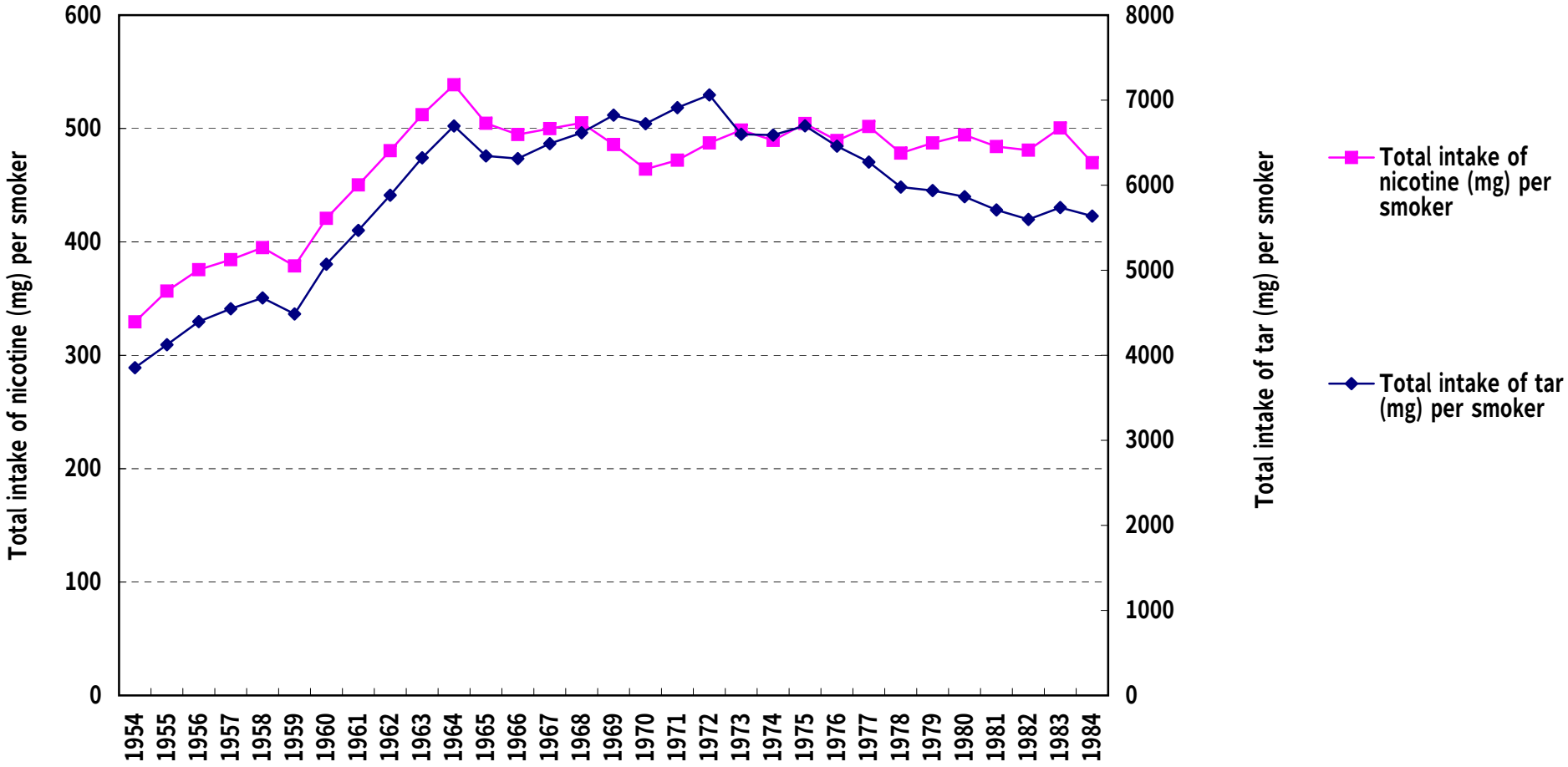
Source: author's calculation

Figure 3. Total intake of nicotine and tar per capita



Source: author's calculation

Figure 4. Total intake of nicotine and tar per smoker



Source: author's calculation

Table 1
Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
id	688	21.84	14.08	1	55
year	688	1973.59	7.84	1950	1984
price	688	0.09	0.04	0.02	0.28
demand_per	688	90.56	177.00	0.0006	1114.09
income	688	11.79	3.63	2.10	15.37
demand	688	9610.63	19203.04	0.06	132234.20
nicotine	688	1.41	0.48	0.30	2.76
tar	688	19.68	4.98	6	32
nominal_price	688	6.14	3.06	1.5	13.32
disposable_income	688	104854.70	67176.35	2820.41	207215
population	688	109251	9153.82	83200	120235
cpi	688	69.10	30.87	16.14	112.10
after64	688	0.88	0.32	0	1
after67	688	0.82	0.38	0	1
after72	688	0.67	0.47	0	1
plain	688	0.26	0.44	0	1
after64*plain	688	0.16	0.36	0	1
after67*nicotine	688	1.05	0.62	0	2.76
after67*tar	688	15.04	8	0	32
after72*nicotine	688	0.79	0.63	0	2.2
after72*tar	688	11.57	8.70	0	27
time	688	24.59	7.84	1	35
time_square/100	688	6.66	3.42	0.01	12.25
Δ ln(demand)	633	-0.05	0.74	-7.82	4.16
Δ ln(income)	633	0.04	0.04	-0.01	0.11
Δ after64	633	0.01	0.12	0	1
Δ after64*plain	633	0.01	0.10	0	1
Δ after67	633	0.03	0.16	0	1
Δ ln(nicotine)	633	-0.01	0.05	-0.42	0.36
Δ after67*ln(nicotine)	633	0.01	0.11	-0.42	1.02
Δ after72	633	0.04	0.19	0	1
Δ after72*ln(nicotine)	633	0.01	0.10	-0.51	0.79
Δ ln(price)	633	-0.02	0.10	-0.22	0.32
Δ ln(tar)	633	-0.01	0.04	-0.47	0.23
Δ after67*ln(tar)	633	0.07	0.51	-0.47	3.45
Δ after72*ln(tar)	633	0.11	0.57	-0.47	3.30

Table 2
Effect of disclosure of nicotine and tar content on inter-brand cigarette demand
(panel estimation with level data)

	Dependent variable = demand_per					
	nicotine		tar		nicotine and tar	
	RE	FE	RE	FE	RE	FE
time	1.627	2.575	-3.898	-3.931	4.784	5.378
	(5.663)	(5.700)	(5.819)	(5.847)	(5.679)	(5.725)
time_square/100	-8.798	-10.479	-1.850	-2.111	-15.473	-16.731
	(7.761)	(7.838)	(7.946)	(8.010)	(7.808)**	(7.904)**
price	-515.349	-352.848	-1,236.581	-1,216.566	-107.354	41.101
	(321.121)	(354.587)	(311.190)***	(343.490)***	(332.645)	(366.156)
income	-3.315	-2.676	-1.429	-0.397	-1.906	-0.633
	(10.326)	(10.324)	(10.839)	(10.888)	(10.425)	(10.477)
after64	238.845	247.177	279.594	282.023	271.527	276.460
	(34.954)***	(34.996)***	(36.892)***	(36.939)***	(35.504)***	(35.588)***
plain	181.562		263.517		283.470	
	(71.076)**		(76.180)***		(75.287)***	
after64*plain	-304.756	-312.580	-389.269	-391.782	-350.657	-355.045
	(37.287)***	(37.315)***	(40.062)***	(40.098)***	(38.892)***	(38.951)***
after67	205.345	178.972	-204.053	-207.325	-61.273	-76.812
	(89.929)**	(90.970)**	(113.254)*	(113.903)*	(113.008)	(113.718)
nicotine	254.232	260.170			358.687	360.230
	(42.211)***	(42.590)***			(51.002)***	(51.937)***
after67*nicotine	-110.939	-97.694			-253.497	-251.483
	(46.516)**	(47.024)**			(63.391)***	(64.168)***
after72	144.234	145.358	201.381	194.781	268.199	275.151
	(44.379)***	(44.724)***	(62.340)***	(63.530)***	(64.286)***	(65.645)***
after72*nicotine	-85.772	-84.318			10.002	13.558
	(26.117)***	(26.456)***			(52.863)	(53.217)
tar			2.983	4.961	-20.079	-18.822
			(4.586)	(4.720)	(5.407)***	(5.580)***
after67*tar			8.516	8.670	21.178	21.614
			(4.405)*	(4.425)*	(6.004)***	(6.042)***
after72*tar			-9.705	-9.298	-13.104	-13.595
			(2.913)***	(2.983)***	(5.740)**	(5.809)**
constant	-469.642	-446.987	18.111	53.059	-316.083	-284.756
	(121.296)***	(124.167)***	(124.871)	(133.414)	(129.911)**	(137.061)**
Observations	688	688	688	688	688	688
Number of groups	55	55	55	55	55	55
R-sq: within	0.32	0.33	0.28	0.28	0.34	0.35
between	0.00	0.01	0.00	0.00	0.00	0.00
overall	0.08	0.02	0.06	0.01	0.09	0.01
sigma_u	149.47	168.67	149.64	175.89	150.49	179.62
sigma_e	84.55	84.55	87.31	87.31	80.51	83.51
rho(fraction of variance due to u_i)	0.76	0.80	0.75	0.80	0.77	0.82
Hausman-Wu test statistics	6.23		82.09		20.52	

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3
Effect of disclosure of nicotine and tar content on growth of inter-brand cigarette demand (panel estimation with data on growth rates)

	Dependent variable = Δ ln(demand)					
	nicotine		tar		nicotine and tar	
	RE	FE	RE	FE	RE	FE
time	-0.016 (0.006)***	-0.026 (0.006)***	-0.016 (0.006)***	-0.026 (0.006)***	-0.016 (0.006)***	-0.026 (0.006)***
Δ ln(price)	-0.441 (0.285)	-0.474 (0.280)*	-0.443 (0.286)	-0.474 (0.280)*	-0.440 (0.287)	-0.474 (0.281)*
Δ ln(income)	1.498 (1.268)	2.409 (1.256)*	1.479 (1.267)	2.343 (1.254)*	1.433 (1.276)	2.362 (1.262)*
Δ after64	-0.078 (0.496)	-0.207 (0.486)	-0.075 (0.497)	-0.208 (0.487)	-0.070 (0.499)	-0.207 (0.487)
Δ after64*plain	0.106 (0.561)	0.277 (0.550)	0.098 (0.562)	0.277 (0.551)	0.096 (0.563)	0.283 (0.552)
Δ ln(nicotine)	0.927 (1.130)	-0.065 (1.136)			10.94 (1.814)	0.635 (1.799)
Δ after67	0.540 (0.596)	0.162 (0.595)	2.230 (3.988)	-0.923 (3.964)	0.526 (6.109)	-0.1.831 (5.991)
Δ after67*ln(nicotine)	-0.569 (0.928)	0.148 (0.929)			-0.609 (1.603)	-0.287 (1.583)
Δ after72	0.087 (0.209)	0.086 (0.208)	4.518 (2.273)**	3.711 (2.264)	1.302 (3.782)	-0.266 (3.723)
Δ after72*ln(nicotine)	-0.944 (0.411)**	-0.908 (0.410)**			-0.768 (0.719)	-0.970 (0.708)
Δ ln(tar)			1.082 (1.520)	-0.230 (1.514)	0.334 (2.481)	-1.356 (2.441)
Δ after67*ln(tar)			-0.635 (1.242)	0.368 (1.235)	0.012 (2.144)	0.706 (2.102)
Δ after72*ln(tar)			-1.589 (0.756)**	-1.315 (0.752)*	-0.428 (1.327)	0.122 (1.306)
constant	0.288 (0.200)	0.487 (0.191)**	0.285 (0.199)	0.494 (0.192)**	0.278 (0.200)	0.491 (0.192)**
Observations	633	633	633	633	633	633
Number of groups	55	55	55	55	55	55
R-sq: within	0.10	0.11	0.10	0.11	0.10	0.11
between	0.22	0.23	0.21	0.22	0.21	0.22
overall	0.02	0.02	0.02	0.02	0.03	0.02
sigma_u	0.30	0.58	0.29	0.57	0.28	0.58
sigma_e	0.67	0.67	0.67	0.67	0.67	0.67
rho(fraction of variance due to u_i)	0.16	0.42	0.16	0.42	0.15	0.42
Hausman-Wu test statistics	78.44		33.21		22.66	

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4
Nicotine and tar contents among new, existing and exiting brands
(pooled OLS estimation)

	Dependent variable=nicotine		Dependent variable=tar	
time	-0.029	-0.019	-0.334	-0.103
	(0.009)***	(0.015)	(0.089)***	(0.151)
time_square/100	-0.035	-0.028	-0.327	-0.442
	(0.021)*	(0.029)	(0.206)	(0.287)
after64		0.062		0.311
		(0.090)		(0.885)
after67		-0.119		-1.880
		(0.068)*		(0.669)***
after72		-0.199		-2.216
		(0.053)***		(0.523)***
new_brand	-0.294	-0.289	-2.694	-2.621
	(0.051)***	(0.051)***	(0.506)***	(0.498)***
exiting_brand	0.119	0.141	1.182	1.434
	(0.080)	(0.079)*	(0.792)	(0.778)*
constant	2.367	2.240	30.182	28.014
	(0.091)***	(0.122)***	(0.902)***	(1.200)***
Observations	652	652	652	652
R-squared	0.47	0.49	0.51	0.54

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%