KEIO/KYOTO JOINT
GLOBAL CENTER OF EXCELLENCE PROGRAM
Raising Market Quality-Integrated Design of "Market Infrastructure"

KEIO/KYOTO GLOBAL COE DISCUSSION PAPER SERIES

DP2011-035

Effectiveness of cigarette tax in Japan

Kazuki Kamimura*

Abstract

In this paper, we estimate the relationship between cigarette tax (price) and smoking behavior in Japan. We breaks smoking behavior into participation part and conditional demand part. With Keio Household Panel Survey (KHPS), we can identify the effect of cigarette price depending on intertempporal variation of cigarette price. Main results are as follows.

First, effect of cigarette price is considerable and negative as expected. Particularly in case of male, cigarette price work on both participation and consumption. Thus cigarette tax increase is possible policy alternative to lower the smoking prevalence rate in Japan though decrease of tax revenue is not negligible.

Second, effect of large tax increase in October 2010 is not as expected based on past performance. With various specification, effect of large tax increase in October 2010 is smaller than that of modest tax increase in July 2006 in estimates. This result implies accumulated effect of repeating modest cigarette tax increase is larger than effect of large cigarette tax increase even if total increment of cigarette price is the same.

Third, there is considerable gender difference of sensitivity to cigarette price. While estimates in participation equation seems almost the same, elasticity differs a lot. In addition, consumption elasticities of male is by far larger than those of female. Thus for most of female, alternatives are smoking as in the past or quit smoking when confronting the cigarette tax increase.

Fourth, there is strong evidence for recent anti-smoking trend in Japan. Though our proxy is how many years have passed since the enforcement of Health Promotion Law and thus somehow inaccurate, including the variable considerable change the estimates of cigarette price and is itself significant. Therefore, to explore how cigarette tax works in recent Japan, how to control the anti-smoking trend is unavoidable issue.

Additionally we seek to obtain more reliable elasticities with various specifications. When we use dataset consists of who has ever smoked in recent years, elasticities seem most trustworthy.

*Kazuki Kamimura
Graduate School of Economics, Keio University

KEIO/KYOTO JOINT GLOBAL COE PROGRAM

Raising Market Quality-Integrated Design of "Market Infrastructure"

Graduate School of Economics and Graduate School of Business and Commerce,
Keio University
2-15-45 Mita, Minato-ku, Tokyo 108-8345, Japan

Institute of Economic Research,
Kyoto University
Yoshida-honmachi, Sakyo-ku, Kyoto 606-8501, Japan

Effectiveness of cigarette tax in Japan *

Kazuki Kamimura†

Abstract

In this paper, we estimate the relationship between cigarette tax (price) and smoking behavior in Japan. We breaks smoking behavior into participation part and conditional demand part. With Keio Household Panel Survey (KHPS), we can identify the effect of cigarette price depending on intertempporal variation of cigarette price. Main results are as follows.

First, effect of cigarette price is considerable and negative as expected. Particularly in case of male, cigarette price work on both participation and consumption. Thus cigarette tax increase is possible policy alternative to lower the smoking prevalence rate in Japan though decrease of tax revenue is not negligible.

Second, effect of large tax increase in October 2010 is not as expected based on past performance. With various specification, effect of large tax increase in October 2010 is smaller than that of modest tax increase in July 2006 in estimates. This result implies accumulated effect of repeating modest cigarette tax increase is larger than effect of large cigarette tax increase even if total increment of cigarette price is the same.

Third, there is considerable gender difference of sensitivity to cigarette price. While estimates in participation equation seems almost the same, elasticity differs a lot. In addition, consumption elasticities of male is by far larger than those of female. Thus for most of female, alternatives are smoking as in the past or quit smoking when confronting the cigarette tax increase.

Fourth, there is strong evidence for recent anti-smoking trend in Japan. Though our proxy is how many years have passed since the enforcement of Health Promotion Law and thus somehow inaccurate, including the variable considerable change the estimates of cigarette price and is itself significant. Therefore, to explore how cigarette tax works in recent Japan, how to control the anti-smoking trend is unavoidable issue.

Additionally we seek to obtain more reliable elasticities with various specifications. When we use dataset consists of who has ever smoked in recent years, elasticities seem most trustworthy.

JEL classification numbers: I12, I18
Keywords: Cigarette tax, elasticity of smoking cessation, elasticity of conditional cigarette demand

*We would like to thank Kohei Komamura, Colin McKenzie, Akihiko Noda, Atsuhiro Yamada for their helpful comments.

†Corresponding author: Graduate School of Economics, Keio University, 2-15-45 Mita, Minato-ku, Tokyo, 108-8345, Japan (E-mail: k_kamimura@2010.jukuin.keio.ac.jp).

1 Introduction

In Japan, despite variety of approaches including cigarette tax increase, smoking prevalence rate remains high. Table1 shows the fact dramatically. Prevalence rate in Japan is about 24% and this is the twelfth highest in OECD countries, However, table2 shows different aspect of Japanese smoking behavior. In Japan, prevalence rate has gradually declined. Both graphs indicate smoking prevalence rate in Japan is still high and there is a large possibility additional approaches will lower the prevalence rate further.

From the aspect of public health in Japan, downward trend of the prevalence rate is evidently desirable. The lower the smoking prevalence rate in Japan is, the healthier Japanese people become (at least on average). If this is the whole thing, more and more increasing of cigarette tax is perhaps the best alternative. Unfortunately, cigarette tax has the other aspect.

Developed countries more or less rely on the tax revenue from cigarette tax. For example, in Japan, about 5% of national budget is the tax revenue from cigarette tax. Therefore, if the tax revenue from cigarette tax declines as a consequence of cigarette tax increase, the government must compensate the decrease in some way. This issue raises an unavoidable question. What is important is not whether the cigarette tax increase works but how it works.

If the effect of price is too strong, reduction of tax revenue may cancel out the benefit from reduction of prevalence rate. Even if being countered is a too pessimistic scenario, reduction of tax revenue somewhat decreases total welfare. Without quantitative evaluation in this regard, the argument about cigarette tax is inadequate.

Estimating the effect of cigarette is an essential part of a policy argument, above all, as to cigarette tax policy. In many developed countries therefore many researchers have somehow estimated the elasticity. In the U.S, variation of cigarette price between states is considerably wide and thus vast amount of previous studies are there (Chaloupka and Warner (2000)). In other countries, there are also large amount of studies.

In Japan, the situation seems quite different. Some feature of Japanese cigarette market prevents researchers from estimating the effect of cigarette price. As referred to for details later, in Japan, there is almost no regional variation of the cigarette price. In addition, other problems also prevent us from estimating the effect. There are only a few studies estimate effect of cigarette price in some way[1]. Cigarette tax policy has been one of central issues in Japanese health policy and therefore, accumulation of studies as to effectiveness of cigarette tax policy is necessary.

Table2 implies an additional issue. While smoking prevalence rate deceased even in years without cigarette tax increase, effect of cigarette tax increase seems not as much. There is a possibility effect of marginal cigarette tax increase has gradually declined. Verifying the issue is helpful for policy debate. In addition, sequential (not intermittent) decline of smoking prevalence rate may be result of anti-smoking sentiment. This issue is also worth while examining.

Another striking feature of Japanese smoking behavior table1 shows is prevalence rate of male is about two and a half times higher than those of female. Among the countries in table1, difference of prevalence rate between male and female is quite large. In addition, even if we look at the smokers only, average quantity of cigarettes male smokers smoke is

[1]Examples are Sato and Okusa (2003), Kadota et al. (2005), Ishii and Kawai (2006), and Goto et al. (2007). However, these studies are with some problems. We will refer to the issue later.

larger than those of female smokers as we will refer to later. This possibly leads to the gender difference of sensitivity to cigarette price.

From above argument, we examine the following issues. First, though it seems there is some effect of cigarette price increase as table2 shows, characteristics of smokers must be controlled when drawing a conclusion. Thus we estimate whether there is in fact some statistically significant effect of cigarette price increase. Second issue is as to quantitative effect. Above argument indicates effect of cigarette price increase has gradually declined. We also examine the issue. Thirdly, whether there is anti-smoking sentiment in a statistical sense is also an important issue. And at last, gender difference of sensitivity to cigarette price is interesting itself and useful for policy.

This paper is organized as follows. In the next section, we briefly summarize the background of this study. In the third section, we set up the hypothesis. Then we provide empirical framework in the fourth section and the fifth section is a summary of empirical results. At last, the last section is our conclusion.

2 Back ground and hypothesis

2.1 Back ground

Since the latter half of the past century, cigarette smoking has been one of social concerns in many countries. Both the aim of the studies and the ground the scientists stand on is various and consequently the approach they adopt is also various.

Among variety of issues, effect of price is main concern for policymakers. The reason why the effect of price is of concern for them is government can easily control the cigarette price through cigarette tax. In economic studies, what the study implies for policy is of importance and thus the effect of price is the principal issue in economic studies as to smoking behavior.

For those who are not economists or policy makers, the relationship between the cigarette price and smoking behavior is also the big concern. For epidemiologists and who consider cigarette as harmful, for example, the cigarette price is deterrent against smoking behavior. Thus it is no wonder there are many empirical studies from various points of view.

In what follows, we briefly summarize the earlier studies concerning the effect of the cigarette price on smoking behavior. Firstly, we summarize existing literature other than studies of Japanese smoking behavior. Next,we sum up what is already known and what is not known yet as to relationship between cigarette price and smoking behavior of Japanese.

There are already large amount of studies as to the effect of the cigarette price on smoking behavior. Most of them use the data of the U.S. Empirical studies in the U.S. until the twenty first century is summarized in Chaloupka and Warner (2000).

They point out economists view smoking behavior as irrational and thus economic study has not examined the smoking behavior in detail. Such a view has gradually changed and many empirical studies are already there at the time of Chaloupka and Warner (2000). According to them, the price elasticity of demand in the studies using U.S state level data are centered on -0.4. Individual level studies reveal the inverse relationship between price sensitivity and age. The study also points out the possibility of gender difference of price sensitivity.

Gallet and List (2003) is a meta-analysis of the price elasticity of cigarette demand.

Authors regress the elasticity in each study on the variables indicating specification of each study. As expected, the type of elasticity (short run or long run), demand specification (myopic, rational addiction and so on), data (time series, cross sectional, and so on), and estimation method (OLS, 2SLS, and so on) have all significant effect on the price elasticity acquired in each empirical study. Thus it is fair to say there is no definitive approach to estimate the cigarette price elasticity.

In more recent studies, there are indications interest of scholars has gradually moved into how to estimate the more relevant elasticities. There are two types of such studies. The first type is econometric oriented. And the second type is political oriented. At last, the third type is epidemiological oriented.

The first type of studies focus on how they obtain accurate estimate as possible. The second type of studies aim at providing more useful policy implication through estimating the separate elasticity for each gender, ethnic, and socioeconomic group. The third type of studies seek to reveal the relationship between cigarette smoking and other symptom including other addictions.

Liu (2010) is an example of the first type and extended standard econometric approach to estimate the relationship between cigarette price and smoking. He estimate not only the decision to start, but to relapse and to quit smoking. Surprising result in Liu (2010) is there is no evidence cigarette tax increase can prevent the onset of youth smoking. On the contrary, more elder people are sensitive to cigarette price. His result indicates there has not been conclusion yet as to debate about the cigarette price elasticity.

Siahpush et al. (2009) and Nonnemaker and Farrelly (2011) are examples of the second type. Siahpush et al. (2009) is an Australian study and assess the impact of the price of cigarettes on smoking prevalence across three income groups. They find low income group is more price sensitive than other groups. On the basis of the estimation result, they point out increasing the cigarette tax may provide a means of reducing social disparities in smoking. Nonnemaker and Farrelly (2011) points out few studies have considered the possibility that the impact of cigarette taxes and prices might differ by gender or race/ethnicity. They empirically examine the issue and find blacks are more price sensitive than other groups.

Ong et al. (2010) is an example of the third type. The author's research interest is to explore the relationship between cigarette smoking and comorbid alcohol, drug, or mental disorders. Estimation result indicates cigarette tax is an effective tool to reduce smoking participation even in case of people with alcohol addiction, drug addiction, and mental disorders. We must take substitutability into account between cigarette and alcohol and/or drug when interpreting this hopeful result.

Number of the studies outside the U.S has also gradually increased in recent years. In chronological order, Gallus et al. (2006), Bishop et al. (2007), John (2008), Chang and Chiang (2009), Sen and Wirjanto (2010), Hidayat and Thabrany (2010), and Chen and Xing (2011) are very recent examples of those studies. Gallus et al. (2006) use aggregate data of each European countries and estimate the cigarette price elasticity of demand. The others estimate the price elasticity in China, India, China, Canada, Indonesia and Taiwan, respectively.

Above examples indicates there exists large amount of empirical studies estimating the price elasticity of cigarette in variety of countries. Thus the price elasticity of cigarette is already world wide concern. Estimating the elasticity is an indispensable part of the tobacco control policy and how to obtain more elaborate estimate is of great concern.

In Japan, the situation somewhat differs. As far as authors concern, there is little

empirical studies which estimate the relationship between the cigarette price in Japan and smoking behavior of Japanese. Moreover, for the reasons we will refer to later, most of them examine effect on participation (cessation) only.

Sato and Okusa (2003) estimates the price elasticity using retrospective data from the survey they conduct. Their research interest is very wide and they examine determinants of both smoking and drinking. They employ survival analysis to estimate the price elasticity of smoking cessation. Using the retrospective data, the price elasticity of smoking cessation is over one and a half for male and not significant in most cases for female. The problem is, because of the attribute of survival analysis, who has once stopped smoking never comes into the sample again even if they restart smoking.

Kadota et al. (2005) estimate the price elasticity using retrospective data and usual panel data. Their data also comes from the questionnaire survey they conduct. Their analysis consists of three parts. The first part is determinants of adolescent smoking behavior. Estimate from the cross sectional data suggests the price elasticity is not significant, however, as we will refer to later, the result suffer from the mechanism of cigarette price in Japan. The second part is survival analysis as to adolescent smoking initiation. The elasticity is about 0.6 and this seems plausible. The third part is analysis as to why some smokers quit smoking while others not. The price elasticity of quit smoking is about 0.6 for male and 0.5 for female.

Ishii and Kawai (2006) estimate the relationship between the cigarette price and smoking behavior. Using Keio Household Panel Survey (KHPS), they estimate the effect of cigarette price on the timing of quit smoking. Results from the survival analysis indicates the price elasticity of quit smoking is about one for both gender. This seems a little different to other studies. Why no gender difference is detected is not examined in the study.

Goto et al. (2007) is an example of conjoint analysis. They conduct original survey which ask respondents their smoking behavior in detail. Striking feature of the study is dividing smokers into three groups depends on Fagerstrom Test for Nicotine Dependence (Heatherton et al. (1991)). The first group is those whom degree of addiction is modest. And the second and the third group are those whom degree of addiction is medium and severe, respectively. Their analysis employing random effect probit indicates the price elasticity of smoking cessation in about 0.93 for the first group, 1.45 for the second group, and 1.61 for the third group. While they find the price elasticity depends on the degree of addiction, how number of cigarette they smoke change facing the cigarette price increase is not within the scope of the study.

The reason why the earlier studies in Japan has not fully examined the issue can be summarized as follows. Firstly, the cigarette price is not the "price" in the sense economists usually mean. Secondly, the method to solve the first problem is not available until very recent years. Thirdly, due to the first and the second reasons, estimating the elasticity which can be directly compared to the elasticity in other countries is a hard task. Below are more detailed explanation of each reason.

The first issue we must resolve is as to the cigarette price. In Japan, cigarette is almost exclusively sold by Japan Tobacco, Inc (JT). What the word "almost" means is we cannot entirely rule out the possibility of smuggling. However, in Japan, no official statistics as to the smuggling is there and the effect of the smuggling is supposedly negligible. If we ignore the smuggling, the price of cigarette in Japan is, at least officially, completely determined by JT.

Even if the cigarette price is entirely determined by JT, zone price is sufficient condition to estimate the price elasticity in the usual sense. JT, however, has not adapt the zone

price until now. Therefore in Japan, there is almost no regional price difference. Other goods is sold at different price in different area and thus with not the nominal price but relative price, we can estimate the elasticity in anyway. Regional difference of consumer price index in each prefecture is at most 10%. and this variation seems too little to obtain reliable estimate.

Because of the pricing mechanism as described above, at least either of longitudinal data, retrospective data, contingent valuation method is necessary when estimating the elasticity in an appropriate way. All of these method have advantages but are not free from disadvantages. We subsequently make a comparative review of three methods.

With longitudinal data, intertemporal variation of cigarette price is a key factor. Fortunately, in Japan, there is some intertemporal variation of cigarette price through recent years. And moreover, few representative longitudinal surveys as The Japanese Panel Survey of Consumers and KHPS already started more than five years ago. Thus using longitudinal data is a promising method in the context of Japan.

Longitudinal data has a few additional advantages. Firstly, we can explicitly control unobserved heterogeneity with longitudinal data. And secondly, the answer of longitudinal data is more reliable than retrospective data in that the interval between when actual smoking behavior occured and when the survey was carried out is shorter. The third advantage is the answer from longitudinal data is more realistic at least than those of contingent data.

Main drawback is inextricably linked to the advantages. We rely on intertemporal variation of cigarette price when estimating the price elasticity with longitudinal data. This consequently means variation of cigarette price is same with the case of discrete variable. Dividing nominal cigarette price by regional consumer price index is possible solution though this seems only a little useful.

Another point about longitudinal data is worth while to note here Longitudinal data can be sorted into retrospective data in the sense we cannot ask smoking behavior point by point. However high frequency of the survey is, there must be some time lag when actual smoking behavior take place and when the survey is conducted. According to the view, there is a possibility reliability may be not an advantage of the longitudinal data.

When we rely on retrospective data, we easily obtain long-term data of each respondent. In some cases, retrospective study provides smoking behavior through all their lives. With the longer term data, the larger intertemporal variation is there. Consequently, it is no longer necessary to get anxious about estimation. Longer term data is suited for survival analysis is an another advantage.

However, as is already noted, there is also a serious problem with retrospective data. In short, memory of human being is too inaccurate. In case of whether they smoke or not at the given point, this problem is moderate. On the other hand, in case of number of cigarettes they smoke, the problem is severe. Who exactly remember how many cigarettes they smoke at the given point is out of common. Thus retrospective data usually does not provide us about how many cigarettes people smoked in many years ago.

Contingent valuation method is attractive in terms of flexible survey design. With both of longitudinal data and retrospective data, we can analyze the effect of what has already occured. Examples are the effect of the policy already enforced, the effect of the recent cigarette tax increase and so on. This constraint severely matters if our purpose is to analyze what has not occured yet. In Japan, there is no regional variation of nominal cigarette price but with contingent analysis, it is no longer the problem.

The drawback of contingent valuation method is clear. The information we acquire

through contingent valuation method is not the data as to actual behavior. Even if we elaborately implement the survey, the answer to the hypothetical question and what they actually do when they confront the same situation as the hypothetical situation often differ[2].

As refereed to above, all the methods have pros and cons. Thus not sticking around one method, we should use appropriate method according to the purpose of the analysis. In this study, one of main purpose is to quantitatively assess the impact of large cigarette tax increase in October 2010. To assess the actual policy, hypothetical data is of no use. And more importantly, retrospective data is not suitable for estimating the conditional demand elasticity. Thus our only possible choice is using longitudinal data.

3 hypothesis

Aim of this paper is to empirically examine the effectiveness of Japanese cigarette tax policy as already noted. More precisely, our main purpose are to test hypothesis as follows. Firstly, whether there is an inverse relationship between cigarette price and smoking. Secondly, how people's reaction to cigarette price depend on whether the change is large or not. Thirdly, existence or degree of gender difference between cigarette price sensitivity. And last, whether Japanese anti-smoking trend is detectable. We consequently explain each hypothesis in detail.

3.1 Effect of price

The first hypothesis is straightforward. The price elasticity of cigarette is negative. Many earlier studies in various countries confirm the price elasticity of cigarette is in fact negative. In Japan, despite several problems, some studies already find negative cigarette price elasticity. Thus this hypothesis seems trivial at first sight.

However, some issues are worth while to note. In a few existing literature, the price elasticity of cigarette is not significant (Liu (2010)). The reason elasticity is not significant depends on the empirical framework and/or countries they examine. In the context of Japan, the following reason could lead to insignificant estimates. Gradual reduction of smoking prevalence rate in Japan means who smoke even now are heavy addicts of cigarette. As heavy addicts are more price insensitive (Goto et al. (2007)), there is some possibility elasticities are not significant in some cases.

3.2 Inconsistent reaction to price

The second hypothesis is as to the quantitative effect of cigarette price. Cigarette price elasticity crucially depends on contexts (Gallet and List (2003)). In this study, variety of factors have considerable effect on elasticities. According to the study, it is no wonder reaction to small cigarette tax increase and to large increase are inconsistent.

What the word "inconsistent" means in the context of this study is as follows. Suppose cigarette price in a given year is 200 Japanese yen. Two year later, the price increase and become 300 Japanese yen. And then, four year later, cigarette price become 500 Japanese yen. In the case, two cigarette price increase take place in the end. In the context of this

[2]How effective is hypothetical question itself is an active research area. Chang et al. (2009) is an recent example.

study, if there is a nonnegligible difference between reaction to both changes, we call this inconsistent reaction. There is variety of reasons the net effect in the first increase is not just a half of the second increase.

The first reason is severity of addiction. Prevalence rate in Japan has gradually declined even in recent years and therefore, smoker's average severity of addiction has risen in recent years. In addition, Goto et al. (2007) finds heavy addicts are more insensitive to price. This implies there is a large possibility effect of moderate increase in July 2006 and large increase in October 2010 is inconsistent.

The second reason is look-ahead behavior of current and potential smokers. In Japan, anti-smoking trend has grown and the speed of cigarette tax increase tends to accelerate. Under such circumstance, smokers may perceive the news of cigarette tax increase as a sign environment around them will be more adverse. If this is the case, smoker's react to tax increase to some degree depends on the news of cigarette tax increase itself regardless of the markup rate. This leads to inconsistent reaction in the sense refereed to above.

The third reason is related to research field in behavioral economics. Individual preference as subjective discount rate and measure of subjective risk aversion have large effect on smoking behavior. According to the studies, the shortsighted and risk lovers have difficulty in quit smoking and the shortsighted and risk lovers are possibly insensitive to cigarette price. These implies year by year, smoker's average degree of shortsighted has risen and risk aversion declined.

Above argument indicates existence of inconsistent reaction to price is rather trivial. However, this issue has not been examined in Japan yet and is helpful for policy discussion. Effectiveness of cigarette tax policy in the future depends on existence and degree of inconsistent reaction in the above meaning. Thus verifying the inconsistency is indispensable process of study as to effect of the cigarette price.

As a robustness check, we use four data sets for each gender to examine the hypothesis. The first data set is from 2004 to 2011. This is a largest datasets. The second data set is from 2004 to 2010. We exclude the data after the large cigarette tax increase in October 2010 to explore the second hypothesis. The third data is from 2006 to 2007, the fourth data is 2010 to 2011, respectively. Aim of these datasets are to extract as pure as possible effect of cigarette tax increase by shortening the sample period as possible. With two these datasets, short-term but direct effect of cigarette tax increase can be detected.

3.3 gender difference

As already noted, smoking behavior of Japanese male and female considerably differ. Such a difference may lead to gender difference in sensitivity to cigarette price. As pointed out in Chaloupka and Warner (2000), there is no clear conclusion as to which gender is more sensitive. Why each gender can be more sensitive to price is as follows.

The reason why male smokers and potential smokers are more sensitive is mainly higher prevalence rate and higher cigarette demand (both conditional and not conditional). Higher prevalence rate and demand means there is enough room for lowering them. The explanation seems plausible at least intuitively.

On the contrary, lower prevalence rate of female is partly result of some invisible cultural or social norm which prevents female from smoking. With such norm, female smokers can more easily quit smoking even if they do so reluctantly. Harmful effect of cigarette to mother's body is widely known is another reason why female are more sensitive to price.

As referred to in detail later, cigarette price elasticity of individual consists of two parts. Thus mixed result such as participation elasticity is higher for male and conditional demand elasticity is higher for female is possible. This possibility make a priori prediction as to which gender is more sensitive to price much difficult.

3.4 anti-smoking sentiment

In recent years, strong anti-smoking trend has been there. At least, in developed countries, it seems no exception is there. DeCicca et al. (2008) develop direct measure of it employing factor analysis and to examine how controlling this measure affect estimation result as to effect of cigarette price on youth smoking behavior. They indeed confirm directly controlling anti-smoking sentiment changes estimation results.

In Japan, evidence of anti-smoking trend is found in everywhere. Various action has already taken place by both central and local government In August 2002, the government has enacted the Health Promotion Law (Kenko Zoshin Hou). This law is epoch-making in that it clearly states curbing passive smoking is an obligation to make effort. The law is the driving force of recent anti-smoking sentiment.

An example of policy implemented by local government is by Yokohama city, which is famous for the second biggest city in Japan. Yokohama city enacted the "Ordinance for banning smoking in the street (Rojyo Kitsuen Boshi Jyorei)" in April 2010. Before and after the enforcement, many city/town/village/ have enacted the same type of ordinance.

The problem here is how we consider the trend. Apparently the best alternative is to use measure developed in DeCicca et al. (2008) or some kind of similar measure. However, Japan is behind many developed countries as US and UK in collecting reliable national wide statistics. This holds true for statistics as to anti-smoking sentiment and therefore, following DeCicca et al. (2008) is not feasible.

Confronting the difficulty as above, what we can do at best is roughly estimating the existence of anti-smoking trend. What practically matters is how we quantify the trend. As described above, the Health Promotion Law perhaps have nonnegligible impact on anti-smoking trend. We thus use variable indicating how long years have passed since the enforcement of the Health Promotion Law.

Use of this variable leaves us another problem. As cigarette price has monotonically increased in recent Japan, there is possible multicollinearity. Using relativized cigarette price is possible solution, however, this may be not enough. With trend dummy, there is a large possibility too large part of cigarette price effect is absorbed. Thus we estimate the specification with and without trend dummy and consider estimate from the latter as upper limit and the former as lower limit of the effect of cigarette price, respectively.

At last, additional problem is there. When we use data sets consisting of just the before and after year of cigarette tax increasing, such a trend dummy cannot be included in the analysis. It may problematic though effect of anti-smoking trend may negligible as only one year has passed through the sample period.

4 Empirical Framework

4.1 Elasticity

In economics, as long as if price is available, most studies analyzing the consumption behavior provide elasticity. The reason why elasticity has been central issue in economic studies is it provides us the effect of price in the ways not depending on the magnitude of price and/or amount of consumption.

Cigarettes is not an exemption of course. From the early studies to the latest studies, estimating the price elasticity has been, at least in the field of economics, an indispensable part of studies concerning smoking behavior(Chaloupka and Warner (2000)). Other than economic studies, many studies also estimate the elasticity while some not.

However, in case of cigarettes, estimating the elasticity is a somewhat complicated process. In case of most goods such as vegetable, rice, and pencil, almost everyone purchases some amount of those goods. Under such circumstance, we simply estimate the elasticity employing some kind of linear least square method. Cigarettes is not that type of goods. As table1 shows, smoking prevalence rate are from 10% to 50%. Thus too many observation of zero is an unavoidable problem using individual data.

As for cigarette smoking, most of previous studies using individual data accordingly break elasticity into two parts. The former is so called participation, initiation or cessation elasticity. This measure how smoking prevalence rate changes with cigarette price change. The latter measure conditional demand elasticity. When the researchers estimate the price elasticity, most of them estimate the above two elasticities separately and provide sum of them as total cigarette price elasticity.

A few issues to be resolved before we move into empirical analysis. The first issue is of whom elasticity is our main concern. The second issue is problem stems from using longitudinal data but depending on intertemporal variation of cigarette price to identify the effect. Below, we describe both issue in turn.

We break elasticity into two part as most empirical studies using individual data. Elasticity with probit model or logit model is, by definition, depends on whom we focus on. Most of studies provide elasticity at means as participation elasticity and thus providing elasticity at means make some sense. However, other possibility is also there. Advantage and drawback of each type of elasticity is as follows.

The advantage of elasticity at means is apparently clarity of its meaning. Additional advantage is comparability. As most of studies provide elasticity at means, direct comparability is the big appeal. The disadvantage is also clear. We already exhibit how high smoking prevalence rate in Japanese people. The prevalence rate in Japan is far below 50% and therefore elasticity at mean supposedly make no sense for policy debates.

We can provide the elasticity at some meaningful point other than at means. Estimating the elasticity of marginal people who may or may not smoke is possibly a dominant alternative. By definition, the elasticity of marginal people tell us well as to how cigarette price works for smoking cessation. Especially for female, as prevalence rate in Japan is at most 20%, elasticity of marginal people tell us a lot about how additional cigarette tax increase work.

Elasticity at any point has some advantages and/or disadvantages. Thus no best alternative is there and which is the better alternative depends on aim of the analysis. In this paper, our aim is how cigarette price contributes to depress prevalence rate of smoking in Japan. In such a case, elasticity at means is not necessarily the best alternative. We

accordingly estimate variety of elasticities.

Firstly, we estimate elasticity at means. The purpose is mainly comparability with existing literature. Secondly, we estimate elasticity at marginal people who may or may not smoke. With fitted value from the probit or logit analysis, we can detect whose tendency to be a smoker is at marginal. Thirdly, we estimate the elasticity at means using dataset consisting of who has ever smoked at once only. At last, we estimate the elasticity at means using dataset consisting of who has ever smoked at once since 2004 only.

The second issue is unavoidable in the framework of this paper. We use longitudinal data but mostly depending on intertemporal price elasticity. In such case, cigarette price is nearly equal to discrete variable. As variation of price is not an ideal form, there is a afraid of overestimation. If estimate is overestimated, elasticity is also. Degree of comparability of elasticity in this paper and in existing literature is clearly low.

No other identification strategy is available and thus we have no choice but to rely on intertemporal variation and afraid of overestimation is unavoidable. Although estimation in this study is not free from some problems, providing evidence regarding the effectiveness of cigarette tax policy in Japan is helpful for both Japan and the other countries. For other countries, consequence of authorized price serve as a useful reference as a case study.

4.2 Empirical Model

In this paper, we estimate the two types of elasticity and consider the sum of both elasticities as total elasticity. In what follows, we explain how we estimate the both elasticities in turn.

The first part of elasticity is so called participation, cessation, or quitting elasticity. In this paper, our attention is how many smokers quit smoking as a consequence of increasing cigarette tax. Therefore except some exceptions, we call this part of elasticity cessation elasticity in what follows. Sometimes we call this participation elasticity if relevant.

Whether they smoke or not is a binary variable and thus many previous studies employ probit and/or logit model to estimate the cessation elasticity. In economic studies, probit model is more frequently used in this type of analysis and thus we also employ probit model. Our data is longitudinal and to make full use of it, we employ random effect probit model. Random effect probit model is described as follows.

$$y^*_{p,i,t} = \mathbf{x}'_{p,i,t}\boldsymbol{\beta}_p + \delta_{p,i} + \epsilon_{p,i,t}, \quad i = 1, \cdots, n, \quad t = 1, \cdots, t,$$

$$y_{p,i,t} = \begin{cases} 1 & if \quad y^*_{p,i,t} > 0 \\ 0 & if \quad y_{p,i,t} \leq 0 \end{cases}$$

In the above equation, subscription p, i, t denote participation, individual, and time, respectively.

When we estimate the participation equation, we use all available samples in principle. Thus sample size is relatively large and problem of identification or convergence is no relevant.

The second part of the elasticity is so called conditional demand equation or merely demand equation. What we estimate in this case is how demand of cigarettes of each smoker changes in confront of the cigarette tax increase conditional on smoking participation. We employ random effect model to standardize the estimation method with participation equation. Random effect model is described as follows.

$$y_{d,i,t} = \mathbf{x}'_{d,i,t}\boldsymbol{\beta}_d + \delta_{d,i} + \epsilon_{d,i,t}, \quad i = 1, \cdots, n, \quad t = 1, \cdots, t,$$

In the above equation, subscription d, i, t denote demand, individual, and time, respectively.

Above equation is to estimate the conditional demand. As table2 indicates, smoking prevalence rate in Japan is not so high. Particularly for female, this may leads to severe small sample problem. Thus whatever result we obtain, it is reserved. As we will refer to later, when sample size is small, we should particularly keep this in mind.

4.3 Data

We use the first (2004) to the eighth (2011) waves of the Keio Household Panel Survey (KHPS). KHPS is conducted first by Keio University in January 2004 and conducted in January of subsequent years. Advantage of using this data are as below.

The first and most critical advantage is KHPS is a longitudinal survey. As already referred to above, in Japan, estimating the effect of cigarette price (tax) is too hard a task without longitudinal data. Longitudinal characteristic of KHPS offers us another advantage. With longitudinal data, we explicitly control the unobserved heterogeneity of individuals. Considering the characteristic of smoking behavior, accounting heterogeneity is an indispensable part of the analysis.

The second advantage is KHPS asks respondents about their smoking behavior in every year. And moreover, it asks them both whether they smoke and how many cigarettes they smoke a day. This advantage allows us to break the elasticity into two parts. Particularly, smoking behavior of respondents are asked as twofolds. First, respondents are asked as follows.

"Do you smoke?"
1.Everyday
2.Sometimes
3.Previously smoked but don't smoke
4.have never smoked

Consequently, who take the first or second alternative are continuously asked as below.

"How many cigarettes do you smoke a day?"

If respondents take the latter two alternative, number of cigarettes they smoke a day is obviously zero. KHPS provides us both smoking status and smoking quantity in this way.

The third advantage is KHPS provides variety of characteristics of surveyed households. For example, economic situation, family structure, education, employment history, health condition, living environment and so on are asked in KHPS.

Several drawbacks are also there. First, smokers may change cigarette brand they smoke confronting the cigarette tax increase. Even if number of cigarettes they smoke remains the same as before, in some cases expenditure to cigarette decreases. In the proper meaning

of the demand elasticity, in this case, elasticity is negative. In KHPS, no questionary item as to cigarette brand is there and thus we have no choice but to ignore the issue.

Second, individual's detailed smoking history is not included in the survey. Information about when they started to smoke and when they quitted smoking are there, however, reliability of the information is doubtful. Moreover, the information tell us nothing about (conditional) cigarette demand. Estimating the participation elasticity only is inadequate and we do not use the retrospective information in the analysis.

Next issue is what variable we should include in the analysis. We provide what variable we use and definition of each variable in table 3.

(Table 3 around here)

In what follows we provide more detailed definition of some variables. Most important explanatory variable in this study is cigarette price. In Japan, no official statistic is there about market share of each cigarette brand. Information about cigarette brand each respondent smokes is also not there. Statistical Research of Retail Price (Kouri Bukka Tokei Cyousa, in Japanese) provide monthly price of some representative cigarette brand. Thus we use average of representative cigarette price as proxy variable for cigarette price.

What also seems to require an explanation is pregnancy dummy. KHPS unfortunately dose not ask respondents accurate birthday of their children. We can use the information as to birth month only. Construction of the variable is as follows. Firstly, we compare a respondent's data in a given year to next year's data. This process brings out who delivered the child in the given year. Next, average duration of the pregnancy is about ten months and thus only if new children was born until the ten month has passed since the last survey, she was supposed to pregnant at the time of the last survey. In case of male, pregnancy dummy indicates whether they have a pregnant spouse.

At last, summary statistics of dataset we use are in from table4 to table7. As described above, we use four data set for each gender. The data sets are KHPS from 2004 to 2011, 2004 to 2010, 2006 to 2007, and 2010 to 2011, respectively.

(Table 4, 5, 6 and 7 around here)

5 Empirical Results

We estimate with many specification and it is helpful to sort out here. Firstly, each estimation is by gender. Next, we use four data set. And with all data set, we use nominal cigarette price and relative price. With two longer data set, both the specification with and without trend dummy is there. Empirical results are provided in table8 to table13. Estimation consists of participation part and conditional demand part. In all, 48 equations are estimated. In each columns, we clearly write result of which specification is in the column.

Organization of this section is as follows. Firstly, we discuss the detailed result by gender and mainly focus on the effect of cigarette price. Next, we discuss gender difference. At last, elasticities from various specification are provided and we also provide possible explanation of the relationship between elasticities and specification.

5.1 Male

5.1.1 Smoking Participation

Firstly, empirical results as to smoking cessation (participation) are in the columns noted "Smoker". Comparing all tables, conclusions about the hypothesis described above are as follows.

First, cigarette tax seem effective. In the all columns noted Smoker, estimates of cigarette price are negative and significant. This is itself trivial but actually confirming the issue is one step forward for research about cigarette tax policy in Japan.

Second, as expected, effect of the tax increase in October 2010 are not as large as expected the predicted value based on the effect of the past tax increase. This conclusion is drawn as follows. First, comparing table8 and table10, estimates are by far larger in the latter case. And next, we comparing table12 and table13, estimates are by far larger in the former case. These results imply estimates are by far smaller when we control the large cigarette tax increase.

Third, There are indeed anti-smoking sentiment. Comparing the estimates with trend dummy and without trend dummy, the former are larger in absolute value. Estimates of trend dummy are significant and negative in all cases. As already noted, estimates without trend are upper limit of the effect of cigarette tax increase and with trend are lower limit.

As for other control variables, below results are of importance. Firstly, effect of age seems u-shaped. And next, income effect seems not significant. Effect of education is strong but almost limited to university graduates. Having a spouse or pregnant spouse have no effect. And last, there is little evidence health affects the smoking participation.

5.1.2 Conditional Cigarette Demand

We turn into empirical results as to conditional cigarette demand. The columns noted "Demand" are relevant. Comparing all tables, conclusions about the hypothesis described above are as follows.

Firstly, and most fundamentally, there is strong evidence cigarette demand of smokers are sensitive to cigarette price. In most columns noted Demand, estimates are significantly negative. This is a result from estimating not demand but conditional demand. Thus cigarette price have twofold effect for Japanese male.

Second issue is effect of the tax increase in October 2010. As with the case of smoking participation, estimates are by far larger in table10 and table12. As compared to the markup rate, large cigarette tax increase in 2010 have only modest effect. In columns noted Demand, estimates are elasticities at the same time. Elasticity is at most less than one and in the worst case not significant.

Evidence for existence of anti-smoking trend is also strong. Comparing the estimates with trend dummy and without trend dummy again, the former are larger in absolute value. In table10, most striking result is there. With trend dummy, estimates are not significant. On the contrary, without trend dummy, estimates are significant. In case of estimation in table10, cigarette price are nearly binary variable. Thus including monotone increasing trend dummy have larger effect than the case of estimations is table8.

Effect of other variables are almost the same as case of smoking participation.

5.2 Female

5.2.1 Smoking Participation

Firstly, empirical results as to smoking cessation (participation) are in the columns noted "Smoker". Comparing all tables, conclusions about the hypothesis described above are as follows.

First, cigarette tax seem effective also for females. In the most columns noted Smoker, estiamtes of cigarette price are negative and significant. Thus cigarette tax increase encourage female to quit smoking as expected.

Second, also as expected, effect of the tax increase in October 2010 are not as large as expected the predicted value based on the effect of the past tax increase. This conclusion is drawn as follows. First, comparing table9 and table11, estimates are by far larger in the latter case except a partial exception. And next, we comparing table12 and table13, estimates are by far larger in the former case. These results imply estimates are by far smaller when we control the large cigarette tax increase for both gender.

Third, There are some evidence for anti-smoking sentiment. Trend dummy is significantly negative as expected, however, comparing the estimates with trend dummy and without trend dummy, we can not draw a clear-cut conclusion. In some cases, estimates turn into positive with trend dummy. As table2 shows, trend of smoking prevalence rate is ambiguous. Thus with trend dummy, some confounding effect leads to unstable results. Consequently whether we should consider estimates without trend are upper limit of the effect of cigarette tax increase and with trend are lower limit is also ambiguous.

As for other control variables, below results are of importance. Firstly, effect of age seems u-shaped. And next, income effect seems not significant. Effect of education is strong and not limited to university graduates. Gender difference as to this point may stem from gender difference of relative socioeconomic status of technical college or junior college graduates. Having a spouse or being pregnant have considerable effect. The reason female tend to quit smoking and reduce cigarette demand is probably care for children. And last, there is seemingly-contradictory effect of health. Whether this is causal or not depends on the possibility of reverse causality.

5.2.2 Cigarette Demand

We turn into empirical results as to conditional cigarette demand. The columns noted "Demand" are relevant. Comparing all tables, conclusions about the hypothesis described above are as follows.

Firstly, there is mixed evidence cigarette demand of smokers are sensitive to cigarette price. While in some cases estimates are significant, others not. Thus for female, effect of cigarette tax increase mainly works on smoking cessation and have only a little effect on conditional demand. We should keep one issue in mind. Reflecting low prevalence rate for female, sample size may be too small.

Second issue is effect of the tax increase in October 2010. As with the case of smoking participation, in some cases estimates are by far larger in table11 and table12. In this case small sample size may also impede acquiring stable estimation results.

Evidence for existence of anti-smoking trend is fair. Comparing the estimates with trend dummy and without trend dummy again, the former are larger in absolute value. Moreover, with trend dummy, estimates are sometimes positive though not significant. This result is somewhat problematic. As already noted, complicated anti-smoking trend

for female are cause of the result. In sum, anti-smoking trend is evidently there but more elaborate formulation is necessary to draw a clear-cut conclusion.

Effect of other variables are almost the same as case of smoking participation. A little difference is also there. Living in own house dummy and having spouse dummy is significant only in case of participation equation. This result implies even if care for others is reason for changing smoking behavior, they quit smoking and gradual change of smoking behavior is not their option.

5.3 Gender Difference

We examine the gender difference in this section. Table8 and table9, table10 and table11, right half and left half of the table12, and right half and left half of the table13 are pairs, respectively. In all cases, the former are results of male and the latter are of female.

At first sight, it is not clear which gender is more sensitive to cigarette price. Firstly, as for participation, there are mixed results and no conclusion can be drawn. Thus gender difference of prevalence rate remains stable with additional cigarette tax increase. On the contrary, as for conditional demand, there is some evidence male are more sensitive to cigarette price. Thus gender difference of average conditional demand will gradually shrink.

As total effect is the sum of the effect on participation and effect on conditional demand, net effect of cigarette price is stronger for male. What the result implies is female smokers are more stronger addicts than male smokers while as to decision to quit smoking, there is no gender difference.

Possible explanation for this seemingly puzzling result is as follows. First explanation is unobserved external factor. There is a possibility while male and female are equally sensitive to cigarette price, there is gender difference as to what affects conditional demand. For example, effect of friends and work environment are candidates. Second explanation is small sample problem. Smoking prevalence rate for female is by far smaller than for male. Thus sample size when estimating the conditional demand of female may be to small. To explore both issues, additional data is necessary.

Next issue is inconsistent reaction to price as referred to above. There is almost no gender difference in this regard and indeed, effect of large cigarette tax increase in October 2010 not seems as much as a priori prediction. Possible explanations are as follows.

The first explanation is strength of addiction. In Japan, smoking prevalence rate has gradually declined. Thus who smoke even now are on average stronger addicts than who were smoker and are not smoker now. Some earlier studies show if one's addiction is strong, him or her price elasticity is low.

Other explanation is politically relevant. There is no guarantee if tax increase is two times larger, effect of tax increase is also exactly two times larger. This issue is also related to how rationally people decide whether they smoke or not. To explore the issue more, there is no choice in Japan but employing hypothetical data.

Not depending on whether explanation are more relevant, this result implies how policy makers should decide as to the cigarette tax policy. If their primary objective is to reduce the smoking prevalence rate, increasing cigarette tax little by little seems better. On the contrary, if their purpose is to keep or increase tax revenue, increasing cigarette tax at once is better alternative. Effect of intermediate approach may also be intermediate.

5.4 More on Cessation Elasticities

As we note in the last subsection, elasticities in from table8 to table13 is not directly comparable to the elasticities in existing literature in other than Japan. Elasticities in table8 to table13 indicates our anticipation is to-the-point. While elasticities of smoking quantity are not surprisingly large, elasticities of smoking cessation are terribly large. Notable findings are as follows.

Most striking result is gender difference of participation elasticity. Though estimates of the price are seems not so different, elasticities are considerably higher in case of female. This seemingly-contradictory result is in fact a natural result.

The key point is twofold. First, elasticities in table8 to table13 are elasticity at means. This implies elasticity depends on characteristics of people whose smoking tendency is on average. And second, smoking prevalence rate of female in Japan are much smaller than that of male. This implies there is considerable gender difference in typical characteristics of whose smoking tendency is on average. Consequently, it is no wonder elasticity at means of female are larger than that of male.

The second point is, as referred to above, our proxy variable of cigarette price is not the price in the usual sense economists use. In recent Japan, cigarette price has not changed without cigarette tax increase. Thus cigarette price in this paper is nearly discrete even if we relativize them with regional consumer price index. This may leads to overestimate of estimates and elasticities.

The second point is unavoidable in this paper and probably the subsequent study which estimate the effect of cigarette price in Japan. Meanwhile, there is some solution to the first point. We try to elicit more implicative elasticity with some other specifications. Next issues is relationship between specification and elasticity. In the subsequent estimation, we provide cigarette price elasticity only and omit detailed results for avoiding cumbersome tables.

Other than elasticities in table8 to table13, we estimate three types of elasticities. The first type is elasticities at marginal people who may or may not smoke. The second type is elasticity of people who has ever smoked at once. The third type is elasticity of people who has ever habitually smoked since 2004. In total, number of estimation is four times larger as already shown. Providing all detailed results is too cumbersome and therefore we provide elasticities only in table14.

5.4.1 Elasticities at marginal people

Those whom tendency to be a smoker is on average is not average people in recent Japan. Thus to estimate the elasticity useful for policy debate, some additional device is in need. Here we estimate the elasticity who are thought to be able to be either of a smoker and a non-smoker. In what follows, we call such people "marginal smoker".

Relevant columns are third and fourth columns of table14. At first glance, the elasticity are by large smaller than the elasticities in the first and second columns of table14 as expected. The reason is as already explained. What matters here is the elasticities of marginal smokers are more suggestive for policy makers.

Comparing the first to second columns and the third to fourth columns, gender difference of the elasticity is drastically smaller in the latter case. In Japan, the smoking prevalence rate of male is much larger than female. Thus the difference between the elasticity of marginal smokers and whose tendency to be a smoker is on average is more prominent

in case of female. Consequently the difference between the third last row and the fourth last row is larger in female.

This in turn means surprisingly high elasticity for female in table9, and table11, table12 and table13 can be at least partly attributed to difference between average female and average female smoker. The same argument holds true for male, though degree of problem seems more modest.

5.4.2 Elasticities with who has ever smoked

We hitherto estimate the elasticity taking account of as many people as possible. When our primarily interest is to understand adolescent smoking behavior, this make sense. However, in our dataset, most of the respondents are equal or over thirty. Smoking initiation after the adolescent years is not a frequent case and therefore estimating the elasticity of smoking cessation taking who has ever smoked only into account make some sense.

The fifth and sixth columns of table14 is elasticity as described above. At first sight, elasticities are a few times smaller than those of the first and second columns. However, elasticities are surprisingly large yet and by far larger than those of the third and fourth columns. This implies considering all Japanese and considering only who has ever smoked is not considerably different.

Possible explanation is difference between habitual smoking and experience of smoking. KHPS asks respondents whether they have ever smoked at least once. How respondents interpret the sentence depends on their cognitive ability but at least some answers yes even if their lifetime number of cigarette they have ever smoked is only a few. Thus this method does not seem working well.

5.4.3 Elasticities with who has smoked at least once since 2004

Next, we estimate the elasticity using dataset consists of people only who have ever smoked habitually since 2004. This type of elasticity is almost the same as quitting or cessation elasticity. This elasticity is perhaps most relevant for policy debate as only habitual smokers are counted as smokers and who has never smoked since 2004 will not smoke even if they have smoked habitually before 2003.

Last two columns of table14 are relevant. This type of elasticity is most small is expected result, however, elasticities seem too small. However, considering how many Japanese actually quitted smoking during this period, at least elasticities in from first to fourth rows and from seventh to tenth rows are not implausible. Moreover, these elasticities are more relevant for policies.

The reason why elasticities in the fifth, sixth, and last two columns is as follows. Elasticity depends on the value of probability density function and cumulative frequency function at means. In these cases, we consider who has ever smoked since 2004 and only two years. Number of smokers who quitted smoking through the investigation period is too small and thus probability density function take too small value and cumulative frequency function take too large value. As a result, elasticities become too small.

6 Conclusion

This paper studies how large cigarette tax increase in 2010 works on Japanese people's smoking behavior. More concretely, we empirically estimate the cessation elasticity and

conditional demand elasticity.

This paper's most notable feature is this is the first study which empirically estimates both elasticities in Japan with longitudinal data. Thus this paper contributes to the debate of cigarette tax policy in Japan. And moreover, in Japan, cigarette price is uniquely determined by JT. Thus if some countries consider the introduction of similar cigarette pricing policy, results in this paper is helpful. Empirical results in this paper are summarized as follows.

First, the price elasticity of quantity are under one and variance of the price elasticity of cessation is large. These estimates are larger than the estimates in almost of previous studies other than Japan. However, estimates in a few Japanese previous studies are almost the same with ours. Thus the price elasticity of smoking in Japan is larger than that of other countries.

Second, there are considerable risk for overestimating the price elasticity of smoking if our available information is limited. More particularly, if we consider the effect of large cigarette tax hike in October 2010, estimated elasticities are much smaller than the otherwise case. This result implies several non negligible points.

The first point is directly from the results. Our result implies if our prediction of the effect of cigarette tax increase in 2010 was based on the past performance only, we were supposed to overestimate the effect. In the not-so-distant future, more cigarette tax increase will be implemented. Conclusion with respect to both whether tax increase should be implemented and how large tax hike is desirable crucially depends on prediction. However, our result implies there is a risk for overestimating the effect of cigarette tax increase. Whether our result is specific or general is an open question.

The second point is related to the first but somewhat different. If policy makers intend to implement cigarette tax increase of five hundred yen by five years later, roughly speaking, two alternatives are at hand. The first alternative is increase of five hundred yen at one time. By contrast, the second alternative is increase in several batches. Our result implies two alternatives exert not the same effect. The second alternative will eventually exert stronger influence on the smoking behavior of Japan. For policy debates, whether our result is general or specific seriously matters.

Third, there are considerable gender difference between their price elasticities. In total, male are more elastic. The difference mainly stems from the elasticity of conditional demand. In some cases, the conditional demand elasticity is not significant for female. This result implies when female smokers confront the cigarette tax increase, their choice is either of keep smoking as usual or quit smoking. This result is desirable for whom priority is public health and not unwelcome for whom priority is tax revenue.

Except policy debate, gender difference between elasticities implies what is behind smoking behavior in Japan. The following explanation is possible. First explanation is unobserved external factor. There is a possibility while male and female are equally sensitive to cigarette price, there is gender difference as to what affects conditional demand. For example, effect of friends and work environment are candidates. Second explanation is small sample problem. Smoking prevalence rate for female is by far smaller than for male. Thus sample size when estimating the conditional demand of female may be to small. To explore both issues, additional data is necessary.

At last, there are strong evidence for recent anti-smoking trend in Japan. In most cases, estimates with trend variable which indicates how many years have passed since the enforcement of the Health Promotion Law are larger in absolute value than estimates without the trend variable. However, without more elaborate measure, we cannot provide

useful policy implication.

There are several issues to be resolved in the future researches. Firstly, our identification strategy crucially depends on time series variation of cigarette price. This in turn means there is a possibility variation of price is insufficient. As already noted, this insufficiency matters because too small variance of explanatory variable leads to too large estimates. As long as cigarette pricing mechanism in Japan remains unchanged, future research are also not free from this problem.

Secondly, in this paper, data limitation prevents us from exactly identifying the effect of recent anti-smoking trend. We include a variable which indicates the trend, however, there is a positive correlation between such a trend variable and the cigarette price. If there is enough regional variation of the cigarette price, this does not matter. Alternatively, cigarette price reduction can be a solution.

Thirdly, more longer panel data tells us a lot about how robust our results, above all, elasticities are. In this paper, as already noted, several important findings are confirmed or reconfirmed. However, how our results are robust cannot be fully examined in this paper. Data limitation is the main reason and thus with more longer-running panel data, we can easily perform the robustness check.

At last, we cannot exclude the possibility smokers does not reduce the number of cigarette they smoke but change the cigarette brand to keep their expenditure as low as possible. As there is a positive correlation between cigarette price and nicotine content, even if it seems smoker's behavior remain unchanged, there nicotine intake may decrease. If this is the case, cigarette tax increase may work more effectively in terms of public health than result in this and other paper indicates. To appropriately control cigarette smoking behavior, those issue is necessary to be examined in the subsequent studies.

References

Bishop, J.A., H. Liu, and Q. Meng, "Are Chinese Smokers Sensitive to Price?," *China Economic Review*, 2007, *18* (2), 113–121.

Chaloupka, F.J. and K.E. Warner, "The Economics of Smoking," in A.J. Culyer and J.P. Newhouse, eds., *Handbook of Health Economics*, Elsevier, 2000, pp. 1539–1627.

Chang, H.H. and T. Chiang, "Depressive Symptoms, Smoking, and Cigarette Price Elasticity: Results from a Population-Based Survey in Taiwan," *International Journal of Public Health*, 2009, *54* (6), 421–426.

Chang, J.B., J.L. Lusk, and F.B. Norwood, "How Closely Do Hypothetical Surveys and Laboratory Experiments Predict Field Behavior?," *American Journal of Agricultural Economics*, 2009, *91* (2), 518–534.

Chen, Y. and W. Xing, "Quantity, Quality, and Regional Price Variation of Cigarettes: Demand Analysis Based on a Household Survey in China," *China Economic Review*, 2011, *22* (2), 221–232.

DeCicca, P., D. Kenkel, A. Mathios, Y.J. Shin, and J.Y. Lim, "Youth Smoking, Cigarette Prices, and Anti-Smoking Sentiment," *Health Economics*, 2008, *17* (6), 733–749.

Gallet, C.A. and J.A. List, "Cigarette Demand: A Meta-Analysis of Elasticities," *Health Economics*, 2003, *12* (10), 821–835.

Gallus, S., A. Schiaffino, C. La Vecchia, J. Townsend, and E. Fernandez, "Price and Cigarette Consumption in Europe," *Tobacco control*, 2006, *15* (2), 114–119.

Goto, R., S. Nishimura, and T. Ida, "Conjoint Analysis of Willingness to Quit Smoking (in Japanese)," *Index of Welfare*, 2007, *54* (10), 38–43.

Heatherton, T.F., L.T. Kozlowski, R.C. Frecker, and K.O. FAGERSTROM, "The Fagerström Test for Nicotine Dependence: A Revision of the Fagerstrom Tolerance Questionnaire," *British journal of addiction*, 1991, *86* (9), 1119–1127.

Hidayat, B. and H. Thabrany, "Cigarette Smoking in Indonesia: Examination of a Myopic Model of Addictive Behaviour," *International Journal of Environmental Research and Public Health*, 2010, *7* (6), 2473–2485.

Ishii, K. and H. Kawai, "How Effective is Cigarette Tax Increasing and Health Promotion Act? (in Japanese)," in Y. Higuchi, ed., *Dynamism of Household Behavior in Japan*, Keio Gijyuku Syuppan, 2006, pp. 211–236.

John, R.M., "Price Elasticity Estimates for Tobacco Products in India," *Health policy and planning*, 2008, *23* (3), 200–209.

Kadota, T., S. Ogura, and W. Suzuki, "Econometric Analysis of Generational Chain of Smoking Behavior (in Japanese)," in E. Tajika and M. Sato, eds., *Intergenerational Inequality of Health Care and Long Term Care -Actual Status and Reform-*, Toyo Keizai Shinpousya, 2005, pp. 241–260.

Liu, F., "Cutting through the Smoke: Separating the Effect of Price on Smoking Initiation, Relapse and Cessation," *Applied Economics*, 2010, *42* (23), 2921–2939.

Nonnemaker, J.M. and M.C. Farrelly, "Smoking Initiation among Youth: The Role of Cigarette Excise Taxes and Prices by Race/Ethnicity and Gender," *Journal of Health Economics*, 2011, *30* (3), 560–567.

Ong, M.K., Q. Zhou, and H.Y. Sung, "Sensitivity to Cigarette Prices among Individuals with Alcohol, Drug, or Mental Disorders," *American journal of public health*, 2010, *100* (7), 1243–1245.

Sato, M. and Y. Okusa, "Economic Analysis of Smoking and Drinking (in Japanese)," in Y. Okusa, ed., *Health Ecocomics*, Toyo Keizai Shinpousya, 2003, pp. 33–56.

Sen, A. and T. Wirjanto, "Estimating the Impacts of Cigarette Taxes on Youth Smoking Participation, Initiation, and Persistence: Empirical Evidence from Canada," *Health economics*, 2010, *19* (11), 1264–1280.

Siahpush, M., M.A. Wakefield, M.J. Spittal, S.J. Durkin, and M.M. Scollo, "Taxation Reduces Social Disparities in Adult Smoking Prevalence," *American Journal of Preventive Medicine*, 2009, *36* (4), 285–291.

Table 1: Smoking Prevalence Rate in OECD Countries

Country	male	female	total	survey year
Australia	18.0	15.2	16.6	2007
Austria	27.3	19.4	23.2	2006
Belgium	23.6	17.7	20.5	2008
Canada	18.2	14.2	16.2	2009
Chile	33.0	26.0	29.8	2009
Czech Republic	30.0	19.4	24.6	2008
Denmark	20.0	20.0	20.0	2010
Estonia	38.6	17.1	26.2	2008
Finland	21.9	16.0	18.6	2009
France	30.6	22.3	26.2	2008
Germany	26.4	17.6	21.9	2009
Greece	46.3	33.5	39.7	2008
Hungary	31.9	21.7	26.5	2009
Iceland	14.5	14.1	14.3	2010
Ireland	31.0	27.0	29.0	2007
Israel	28.4	12.6	20.3	2009
Italy	29.6	17.1	23.1	2010
Japan	36.6	12.1	23.9	2010
Korea	44.3	7.0	25.6	2009
Luxembourg	21.0	16.0	18.0	2010
Mexico	21.6	6.5	13.3	2006
Netherlands	23.1	18.8	20.9	2010
New Zealand	19.3	17.0	18.1	2007
Norway	19.0	19.0	19.0	2010
Poland	33.5	21.0	27.0	2009
Portugal	27.2	11.0	18.6	2006
Slovak Republic	26.9	12.4	19.4	2009
Slovenia	22.4	15.5	18.9	2007
Spain	31.2	21.3	26.2	2009
Sweden	13.5	15.0	14.3	2009
Switzerland	23.4	17.6	20.4	2007
Turkey	43.8	11.6	27.4	2008
United Kingdom	22.3	20.7	21.5	2009
United States	17.9	14.4	16.1	2009

Table 2: Trantition of Smoking Prevalence Rate in Japan (by gender)

	Smoking Prevalence Rate Survey			National Health and Nutrition Survey			
	male	female	Month	male	female	Month	CPI (cigarette)
2002	49.1	14.0	August	43.3	10.2	November	92.3
2003	48.3	13.6	August	46.8	11.3	November	100.0
2004	46.9	13.2	June	43.3	12	November	100.0
2005	45.8	13.8	June	39.3	11.3	November	100.0
2006	41.3	12.4	August	39.9	10	November	109.2
2007	40.2	12.7	May	39.4	11	November	109.2
2008	39.5	12.7	May	36.8	9.1	November	109.2
2009	38.9	11.9	May	38.2	10.9	November	109.2
2010	36.6	12.1	May	N.A	N.A	November	109.2
2011	33.7	10.6	August	N.A	N.A	November	151.3

Table 3: Definition of Variables

Variable Name	Definition
PRICE	Average cigarette price of famous brands in each year (Japanese yen)
RELATIVE PRICE	Deviding PRICE by each prefecture's total consumer price index
AGE	Age of respondent (at Feburary 1)
AGESQ	Square of age
log(INCOME)	Logarithm of annual household income (Ten thousand Japanese yen)
UNIV	Indicates respondent is university or college graduates
COLL	Indicates respondent is junior college or technical college graduates
PRIG	Indicates respondent (female) or his spouse (male) is pregnant
MYHOME	Live in own house
HEALTH2	Health Condition is good
HEALTH3	Health Condition is fair
HEALTH4	Health Condition is bad
HEALTH5	Health Condition is very bad
TREND	How many years has passed since implement of Health Promotin Law

Table 4: Descriptive Statistics(2004-2011)

Gender	Male								Female							
Equation	Participation				Demand				Participation				Demand			
	Mean	Stdv	Max	Min	Mean	Stdv	Max	Min	Mean	Stdv	Max	Min	Mean	Stdv	Max	Min
Variable Name																
Smoking	0.4230	0.4941	0	1					0.1486	0.3557	0	1				
logCigarette					2.8514	0.5880	0	4.3820					2.4568	0.6427	0	4.0943
AGE	49.3200	13.3737	20	77	47.0786	12.6071	20	76	48.0672	13.3928	20	76	43.2556	11.9556	20	74
AGESQ	2611.3020	1308.8610	400	5929	2375.3020	1190.5220	400	5776	2489.8100	1293.4760	400	5776	2013.9020	1080.6670	400	5476
log(INCOME)	6.2507	1.2431	-11.5129	7.6401	6.2178	1.1981	-11.5129	7.6256	6.1743	1.3243	-11.5129	7.6387	6.0186	1.4427	-11.5129	7.6387
UNIV	0.3490	0.4767	0	1	0.2827	0.4504	0	1	0.1247	0.3304	0	1	0.0748	0.2631	0	1
COLL	0.0637	0.2442	0	1	0.0734	0.2608	0	1	0.2066	0.4049	0	1	0.1652	0.3714	0	1
SPOUSE	0.7914	0.4063	0	1	0.7752	0.4175	0	1	0.7560	0.4295	0	1	0.6456	0.4785	0	1
PRIG	0.0191	0.1369	0	1	0.0235	0.1514	0	1	0.0188	0.1357	0	1	0.0167	0.1283	0	1
MYHOME	0.7879	0.4088	0	1	0.7381	0.4397	0	1	0.7937	0.4046	0	1	0.6484	0.4776	0	1
HEALTH2	0.2630	0.4403	0	1	0.2573	0.4372	0	1	0.2569	0.4369	0	1	0.2439	0.4295	0	1
HEALTH3	0.3782	0.4850	0	1	0.3986	0.4897	0	1	0.3990	0.4897	0	1	0.4196	0.4936	0	1
HEALTH45	0.1053	0.3070	0	1	0.0942	0.2922	0	1	0.1047	0.3062	0	1	0.1144	0.3184	0	1
PRICE	319.6628	46.5913	269.3600	474.6520	5.7463	0.1196	5.5960	6.1626	320.0836	47.0762	269.3600	474.6520	5.7516	0.1220	5.5960	6.1626
RELATIVE PRICE	307.2110	43.1351	280.0000	428.0000	5.7082	0.1133	5.6348	6.0591	308.1994	43.6737	280.0000	428.0000	5.7118	0.1152	5.6348	6.0591
TREND	4.3564	2.2751	1.0000	8.0000	4.1151	2.2452	1.0000	8.0000	4.4367	2.2628	1.0000	8.0000	4.2182	2.2372	1.0000	8.0000
Sample Size	11828				4987				12154				1792			

Table 5: Descriptive Statistics (2004-2010)

Gender	Male								Female							
Equation	Participation				Demand				Participation				Demand			
	Mean	Stdv	Max	Min	Mean	Stdv	Max	Min	Mean	Stdv	Max	Min	Mean	Stdv	Max	Min
Variable Name																
Smoking	0.4332	0.4955	0	1					0.1520	0.3590	0	1				
logCigarette					2.8647	0.5827	0	4.3820					2.4529	0.6495	0	4.0943
AGE	48.9140	13.3608	20	76	46.8239	12.6077	20	75	47.6701	13.3939	20	75	42.8644	11.9934	20	73
AGESQ	2571.0720	1295.6980	400	5776	2351.3980	1182.8410	400	5625	2451.8170	1282.7430	400	5625	1981.1120	1077.8340	400	5329
log(INCOME)	6.2411	1.2883	-11.5129	7.6285	6.2109	1.2387	-11.5129	7.6256	6.1603	1.3867	-11.5129	7.6387	6.0077	1.4968	-11.5129	7.6387
UNIV	0.3484	0.4765	0	1	0.2822	0.4501	0	1	0.1243	0.3299	0	1	0.0767	0.2662	0	1
COLL	0.0637	0.2443	0	1	0.0739	0.2616	0	1	0.2056	0.4042	0	1	0.1669	0.3730	0	1
SPOUSE	0.7885	0.4084	0	1	0.7746	0.4179	0	1	0.7540	0.4307	0	1	0.6436	0.4791	0	1
PRIG	0.0214	0.1447	0	1	0.0257	0.1581	0	1	0.0211	0.1438	0	1	0.0184	0.1345	0	1
MYHOME	0.7858	0.4103	0	1	0.7366	0.4405	0	1	0.7908	0.4068	0	1	0.6466	0.4782	0	1
HEALTH2	0.2597	0.4385	0	1	0.2559	0.4364	0	1	0.2507	0.4334	0	1	0.2411	0.4279	0	1
HEALTH3	0.3712	0.4831	0	1	0.3901	0.4878	0	1	0.3956	0.4890	0	1	0.4098	0.4920	0	1
HEALTH45	0.0995	0.2994	0	1	0.0904	0.2867	0	1	0.1008	0.3010	0	1	0.1123	0.3158	0	1
PRICE	304.5161	16.1660	269.3600	334.9180	5.7134	0.0531	5.5960	5.8139	304.4139	16.1213	269.3600	334.9180	5.7170	0.0545	5.5960	5.8139
RELATIVE PRICE	292.6816	10.8712	280.0000	302.0000	5.6753	0.0377	5.6348	5.7104	293.1425	10.7898	280.0000	302.0000	5.6772	0.0375	5.6348	5.7104
TREND	3.9182	2.0024	1.0000	7.0000	3.7513	1.9918	1.0000	7.0000	3.9889	1.9918	1.0000	7.0000	3.8423	1.9847	1.0000	7.0000
Sample Size	10558				4560				10797				1630			

Table 6: Descriptive Statistics (2006-2007)

Gender	Male								Female							
Equation	Participation				Demand				Participation				Demand			
	Mean	Stdv	Max	Min	Mean	Stdv	Max	Min	Mean	Stdv	Max	Min	Mean	Stdv	Max	Min
Variable Name																
Smoking	0.4392	0.4964	0	1					0.1562	0.3631	0	1				
logCigarette					2.8986	0.5673	0	4.3820					2.4478	0.6666	0	3.8067
AGE	48.7529	13.2060	20	73	47.0730	12.5890	20	72	47.2678	13.3141	20	73	42.6305	11.7459	20	71
AGESQ	2551.1880	1275.0870	400	5329	2374.2250	1183.4880	400	5184	2411.4470	1265.6140	400	5329	1955.0350	1057.1720	400	5041
log(INCOME)	6.2427	1.3697	-11.5129	7.6256	6.2077	1.3419	-11.5129	7.6256	6.1420	1.5376	-11.5129	7.6256	6.0342	1.3237	-11.5129	7.6256
UNIV	0.3506	0.4773	0	1	0.2842	0.4512	0	1	0.1235	0.3291	0	1	0.0793	0.2705	0	1
COLL	0.0646	0.2459	0	1	0.0722	0.2589	0	1	0.2052	0.4039	0	1	0.1775	0.3825	0	1
SPOUSE	0.7899	0.4075	0	1	0.7766	0.4167	0	1	0.7569	0.4290	0	1	0.6409	0.4802	0	1
PRIG	0.0216	0.1455	0	1	0.0228	0.1493	0	1	0.0237	0.1520	0	1	0.0209	0.1431	0	1
MYHOME	0.7842	0.4114	0	1	0.7325	0.4428	0	1	0.7919	0.4060	0	1	0.6472	0.4783	0	1
HEALTH2	0.2721	0.4451	0	1	0.2705	0.4444	0	1	0.2629	0.4403	0	1	0.2693	0.4441	0	1
HEALTH3	0.3923	0.4883	0	1	0.4164	0.4932	0	1	0.3994	0.4898	0	1	0.4134	0.4930	0	1
HEALTH45	0.0949	0.2931	0	1	0.0919	0.2891	0	1	0.0998	0.2998	0	1	0.1023	0.3034	0	1
PRICE	304.4519	16.2288	269.3600	334.9180	5.7146	0.0532	5.5960	5.8139	304.3050	16.0899	269.3600	334.9180	5.7168	0.0550	5.5960	5.8139
RELATIVE PRICE	292.5348	10.8942	280.0000	302.0000	5.6761	0.0377	5.6348	5.7104	292.9718	10.8236	280.0000	302.0000	5.6771	0.0376	5.6348	5.7104
Sample Size	3003				1316				3085				479			

Table 7: Descriptive Statistics (2010-2011)

Gender	Male								Female							
Equation	Participation				Demand				Participation				Demand			
	Mean	Stdv	Max	Min	Mean	Stdv	Max	Min	Mean	Stdv	Max	Min	Mean	Stdv	Max	Min
Variable Name																
Smoking	0.3585	0.4797	0	1					0.1292	0.3354	0	1				
logCigarette					2.7382	0.6310	0	4.0943					2.4764	0.5792	0	3.6889
AGE	52.1705	13.0600	23	77	49.3493	12.3607	23	76	50.8844	12.9336	23	76	47.0616	10.9273	23	74
AGESQ	2892.2620	1359.5280	529	5929	2587.9730	1234.8600	529	5776	2756.4440	1324.0880	529	5776	2333.8680	1063.1140	529	5476
log(INCOME)	6.3013	0.9753	-11.5129	7.6401	6.2416	1.0118	-11.5129	7.6123	6.2488	0.8748	-11.5129	7.6387	6.1186	0.7410	2.8332	7.6387
UNIV	0.3540	0.4783	0	1	0.2919	0.4549	0	1	0.1281	0.3342	0	1	0.0588	0.2356	0	1
COLL	0.0630	0.2431	0	1	0.0743	0.2624	0	1	0.2143	0.4104	0	1	0.1569	0.3642	0	1
SPOUSE	0.8162	0.3874	0	1	0.7845	0.4114	0	1	0.7692	0.4214	0	1	0.6583	0.4750	0	1
PRIG	0.0087	0.0931	0	1	0.0117	0.1075	0	1	0.0100	0.0996	0	1	0.0028	0.0529	0	1
MYHOME	0.8029	0.3979	0	1	0.7601	0.4273	0	1	0.8147	0.3886	0	1	0.6667	0.4721	0	1
HEALTH2	0.2993	0.4580	0	1	0.2898	0.4539	0	1	0.2894	0.4536	0	1	0.2689	0.4440	0	1
HEALTH3	0.4064	0.4913	0	1	0.4448	0.4972	0	1	0.4290	0.4950	0	1	0.4678	0.4997	0	1
HEALTH45	0.1443	0.3515	0	1	0.1306	0.3371	0	1	0.1335	0.3401	0	1	0.1457	0.3533	0	1
PRICE	377.6787	67.1065	290.5240	474.6520	5.9076	0.1776	5.6717	6.1626	377.4145	67.0039	290.5240	474.6520	5.9100	0.1775	5.6717	6.1626
RELATIVE PRICE	362.7748	62.9727	302.0000	428.0000	5.8685	0.1737	5.7104	6.0591	363.1742	62.9848	302.0000	428.0000	5.8687	0.1738	5.7104	6.0591
Sample Size	2633				942				2795				357			

Table 8: Male (All samples)

Cigarette Price	Relative				Nominal			
Trend Dummy	○		×		○		×	
Equation	Demand	Smoker	Demand	Smoker	Demand	Smoker	Demand	Smoker
PRICE		-0.0037***		-0.0056***		-0.0038***		-0.0058***
		[0.0009]		[0.0007]		[0.0009]		[0.0007]
log(PRICE)	-0.1916***		-0.4086***		-0.1958***		-0.4136***	
	[0.0553]		[0.0426]		[0.0558]		[0.043]	
AGE	0.0332***	0.2455***	0.0318***	0.2975***	0.0331***	0.2451***	0.0317***	0.2974***
	[0.0058]	[-0.0179]	[0.0066]	[0.0401]	[0.0065]	[0.0385]	[0.0066]	[0.0401]
AGESQ	-0.0003***	-0.0033***	-0.0003***	-0.0043***	-0.0003***	-0.0033***	-0.0003***	-0.0043***
	[0.0001]	[0.0004]	[0.0001]	[0.0004]	[0.0001]	[0.0004]	[0.0001]	[0.0004]
log(INCOME)	0.0058	-0.0179	0.006	-0.0195	0.0057	-0.0181	0.0058	-0.0199
	[0.005]	[0.0303]	[0.005]	[0.0321]	[0.005]	[0.0303]	[0.005]	[0.0321]
UNIV	-0.1539***	-1.6279***	-0.1606***	-3.0223***	-0.1569***	-1.6311***	-0.1671***	-3.0633***
	[0.0615]	[0.4351]	[0.0356]	[0.2055]	[0.0353]	[0.1897]	[0.0355]	[0.2058]
COLL	-0.1147*	0.0788	-0.133**	0.188	-0.1168*	0.0639	-0.1371**	0.1555
	[0.0318]	[0.2241]	[0.0619]	[0.3702]	[0.0615]	[0.4321]	[0.0618]	[0.3682]
SPOUSE	-0.047	-0.1535	-0.0361	-0.1225	-0.0472	-0.1527	-0.0367	-0.1191
	[0.0294]	[0.1769]	[0.0295]	[0.175]	[0.0294]	[0.1759]	[0.0294]	[0.175]
PRIG	0.0398	0.0651	0.0412	0.0859	0.0396	0.0658	0.0408	0.0867
	[0.0318]	[0.2241]	[0.0318]	[0.2222]	[0.0318]	[0.2241]	[0.0318]	[0.2223]
MYHOME	0.0353	-0.134	0.0297	-0.0899	0.0355	-0.1332	0.0303	-0.0895
	[0.0236]	[0.15]	[0.0237]	[0.1506]	[0.0236]	[0.1495]	[0.0237]	[0.1506]
HEALTH2	-0.0066	0.0154	-0.0225	-0.04	-0.0067	0.0163	-0.0225	-0.0409
	[0.0151]	[0.0973]	[0.0149]	[0.0969]	[0.0151]	[0.0973]	[0.0149]	[0.0969]
HEALTH3	0.0087	-0.0327	-0.0073	-0.0961	0.0087	-0.0314	-0.0072	-0.0965
	[0.0153]	[0.1005]	[0.0151]	[0.1003]	[0.0153]	[0.1004]	[0.0151]	[0.1003]
HEALTH45	-0.0144	-0.3132**	-0.0385	-0.3931***	-0.0144	-0.3111**	-0.0381	-0.3927***
	[0.0243]	[0.1434]	[0.0241]	[0.1454]	[0.0244]	[0.1432]	[0.0241]	[0.1455]
TREND	-0.021***	-0.1035***			-0.0209***	-0.1058***		
	[0.0034]	[0.0205]			[0.0034]	[0.0205]		
CONSTANT	3.1868***	-2.6196***	4.4623***	-1.5527*	3.2059***	-2.6437***	4.48***	-1.5621*
	[0.3443]	[0.9254]	[0.2754]	[0.8717]	[0.3456]	[0.9218]	[0.2761]	[0.8722]
Elasticity	-0.1916	-2.6516965	-0.1916	-3.123803	-0.1958	-2.5915129	-0.1958	-3.1179317
Total Elasticity	-2.843296511		-3.315403011		-2.787312912		-3.313731732	
Sample Size	4987	11828	4987	11828	4987	11828	4987	11828

Table 9: Female (All samples)

Cigarette Price	Relative				Nominal			
Trend Dummy	○		×		○		×	
Equation	Demand	Smoker	Demand	Smoker	Demand	Smoker	Demand	Smoker
PRICE		-0.0036***		-0.005***		-0.0038***		-0.0054***
		[0.0013]		[0.001]		[0.0013]		[0.0011]
log(PRICE)	-0.0511		-0.1874***		-0.074		-0.2023***	
	[0.0875]		[0.0688]		[0.0879]		[0.0689]	
AGE	0.0461***	0.1213**	0.0421***	0.0931*	0.046***	0.1167**	0.0423***	0.0869*
	[0.0029]	[0.0451]	[0.0025]	[0.0392]	[0.0114]	[0.0513]	[0.0113]	[0.0508]
AGESQ	-0.0005***	-0.0021***	-0.0005***	-0.0019***	-0.0005***	-0.0021***	-0.0005***	-0.0019***
	[0.0001]	[0.0006]	[0.0001]	[0.0006]	[0.0001]	[0.0006]	[0.0001]	[0.0006]
log(INCOME)	0.0029	0.0451	0.0025	0.0392	0.003	0.0436	0.0027	0.0395
	[0.0064]	[0.0334]	[0.0064]	[0.0327]	[0.0064]	[0.0333]	[0.0064]	[0.0327]
UNIV	-0.2509**	-2.186***	-0.2512**	-2.5389***	-0.2518**	-2.1614***	-0.2543**	-2.4095***
	[0.0805]	[0.2878]	[0.0807]	[0.2888]	[0.1105]	[0.419]	[0.1109]	[0.4178]
COLL	-0.222***	-1.5437***	-0.2295***	-1.6559***	-0.2228***	-1.5558***	-0.2315***	-1.6346***
	[0.063]	[0.2681]	[0.063]	[0.2664]	[0.0808]	[0.2851]	[0.081]	[0.2953]
SPOUSE	-0.0047	-1.3637***	0.0056	-1.3662***	-0.0048	-1.2802***	0.0046	-1.2809***
	[0.0406]	[0.1919]	[0.0404]	[0.1869]	[0.0406]	[0.1972]	[0.0404]	[0.1995]
PRIG	-0.2511***	-0.6555**	-0.2477***	-0.6501**	-0.2508***	-0.6291**	-0.2475***	-0.6363**
	[0.063]	[0.2681]	[0.063]	[0.2664]	[0.0629]	[0.2634]	[0.0629]	[0.2641]
MYHOME	-0.0311	-0.4269**	-0.0324	-0.5229***	-0.0307	-0.3942**	-0.0313	-0.4841***
	[0.0395]	[0.169]	[0.0396]	[0.1656]	[0.0396]	[0.1713]	[0.0396]	[0.1741]
HEALTH2	0.0533**	0.2334*	0.0442*	0.1959	0.0531**	0.2238*	0.0446*	0.1948
	[0.0252]	[0.1365]	[0.025]	[0.1341]	[0.0252]	[0.1352]	[0.0249]	[0.1337]
HEALTH3	0.0484**	0.3304**	0.0409*	0.2799**	0.0485**	0.3139**	0.0415*	0.2847**
	[0.0245]	[0.1323]	[0.0244]	[0.1304]	[0.0245]	[0.131]	[0.0243]	[0.13]
HEALTH45	0.084**	0.2415	0.0706**	0.1717	0.0835**	0.1863	0.0712**	0.1637
	[0.0356]	[0.2049]	[0.0352]	[0.201]	[0.0355]	[0.2067]	[0.0352]	[0.2047]
TREND	-0.0146**	-0.0587**			-0.0136**	-0.0552**		
	[0.0058]	[0.0276]			[0.0058]	[0.0275]		
CONSTANT	1.7357***	-7.471***	2.6095***	-6.043***	1.8625***	-7.3911***	2.6797***	-5.5073***
	[0.557]	[1.1307]	[0.4363]	[1.1155]	[0.5563]	[1.1487]	[0.4344]	[1.0881]
Elasticity	0	-11.555285	-0.1874	-15.662647	0	-11.692139	-0.2023	-15.2961
Total Elasticity	-11.55528527		-15.85004741		-11.6921394		-15.49839162	
Sample Size	1792	12154	1792	12154	1792	12154	1792	12154

Table 10: Male (2004-2010)

Cigarette Price	Relative				Nominal			
Trend Dummy	○		×		○		×	
Equation	Demand	Smoker	Demand	Smoker	Demand	Smoker	Demand	Smoker
PRICE		-0.0115***		-0.0206***		-0.0131***		-0.0218***
		[0.0033]		[0.0025]		[0.0049]		[0.0029]
log(PRICE)	-0.0637		-0.8318***		-0.0738		-0.9325***	
	[0.2057]		[0.1367]		[0.2374]		[0.1459]	
AGE	0.0323***	0.263***	0.0316***	0.2818***	0.0323***	0.2603***	0.0314***	0.2651***
	[0.006]	[-0.0128]	[0.0064]	[-0.0127]	[0.0069]	[0.031]	[0.007]	[0.0319]
AGESQ	-0.0003***	-0.0033***	-0.0003***	-0.0036***	-0.0003***	-0.0032***	-0.0003***	-0.0033***
	[0.0001]	[0.0003]	[0.0001]	[0.0004]	[0.0001]	[0.0003]	[0.0001]	[0.0003]
log(INCOME)	0.006	-0.0128	0.0064	-0.0127	0.006	-0.0139	0.0061	-0.0146
	[0.0049]	[0.0267]	[0.005]	[0.0283]	[0.005]	[0.0264]	[0.005]	[0.0268]
UNIV	-0.1576***	-1.122***	-0.1515***	-1.1998***	-0.1586***	-1.1633***	-0.1638***	-1.2021***
	[0.0619]	[0.1956]	[0.0624]	[0.2229]	[0.0354]	[0.1148]	[0.0357]	[0.1204]
COLL	-0.1255**	0.1111	-0.1302**	0.0972	-0.1262**	0.0638	-0.1372**	0.0404
	[0.0312]	[0.1905]	[0.0313]	[0.1967]	[0.0617]	[0.1931]	[0.0622]	[0.2]
SPOUSE	-0.0366	-0.1914	-0.028	-0.1904	-0.0364	-0.1874	-0.0302	-0.1838
	[0.0309]	[0.1209]	[0.031]	[0.1345]	[0.0308]	[0.1192]	[0.031]	[0.1229]
PRIG	0.0213	0.1195	0.0235	0.1385	0.0213	0.121	0.0229	0.1314
	[0.0312]	[0.1905]	[0.0313]	[0.1967]	[0.0313]	[0.1899]	[0.0313]	[0.1916]
MYHOME	0.0127	-0.2277**	0.01	-0.2157*	0.0129	-0.2243**	0.0119	-0.2143*
	[0.0241]	[0.1096]	[0.0242]	[0.1208]	[0.0241]	[0.1081]	[0.0242]	[0.1111]
HEALTH2	-0.0136	0.0499	-0.0246	0.0186	-0.0135	0.0461	-0.0238	0.0179
	[0.0152]	[0.0855]	[0.015]	[0.0887]	[0.0152]	[0.0851]	[0.015]	[0.0854]
HEALTH3	0.0058	0.0437	-0.0057	0.008	0.0059	0.0456	-0.0045	0.0178
	[0.0153]	[0.0854]	[0.0151]	[0.0892]	[0.0153]	[0.0849]	[0.0152]	[0.0857]
HEALTH45	-0.0118	-0.1788	-0.0279	-0.2261*	-0.0116	-0.1742	-0.0253	-0.2103*
	[0.0249]	[0.1272]	[0.0248]	[0.1332]	[0.0249]	[0.1262]	[0.0248]	[0.1276]
TREND	-0.0218***	-0.0645***			-0.0217***	-0.0592**	0***	0***
	[0.0044]	[0.0218]			[0.0047]	[0.0266]	[0]	[0]
CONSTANT	2.4878**	-0.5407	6.8568***	1.8314*	2.5423*	-0.1481	7.3991***	2.1903**
	[1.1715]	[1.1515]	[0.7806]	[1.0209]	[1.3439]	[1.4817]	[0.8278]	[1.0246]
Elasticity	0	-4.571409	-0.8318	-8.523475	0	-5.014761	-0.9325	-8.38466
Total Elasticity	-4.571408983		-9.355275325		-5.014760818		-9.317159544	
Sample Size	4560	10558	4560	10558	4560	10558	4560	10558

Table 11: Female (2004-2010)

Cigarette Price	Relative				Nominal			
Trend Dummy	○		×		○		×	
Equation	Demand	Smoker	Demand	Smoker	Demand	Smoker	Demand	Smoker
PRICE		-0.0081		-0.0124***		-0.0148*		-0.0164***
		[0.0056]		[0.0038]		[0.0077]		[0.0045]
log(PRICE)	0.504		-0.2319		0.1919		-0.4386*	
	[0.3525]		[0.242]		[0.3953]		[0.253]	
AGE	0.041***	0.0876	0.0384***	0.0781	0.0413***	0.1391**	0.0398***	0.126**
	[0.0048]	[0.0444]	[0.0041]	[0.0429]	[0.0124]	[0.058]	[0.0124]	[0.0582]
AGESQ	-0.0004***	-0.0018***	-0.0004***	-0.0018***	-0.0004***	-0.0023***	-0.0004***	-0.0022***
	[0.0001]	[0.0006]	[0.0001]	[0.0006]	[0.0001]	[0.0006]	[0.0001]	[0.0006]
log(INCOME)	0.0048	0.0444	0.0041	0.0429	0.0045	0.0464	0.0044	0.0477
	[0.0064]	[0.0348]	[0.0064]	[0.035]	[0.0064]	[0.0346]	[0.0064]	[0.0343]
UNIV	-0.267**	-2.3772***	-0.2563**	-2.5618***	-0.2585**	-2.1612***	-0.2597**	-2.3023***
	[0.0809]	[0.29]	[0.0812]	[0.3068]	[0.1111]	[0.4312]	[0.1112]	[0.435]
COLL	-0.2258***	-1.5784***	-0.2251***	-1.7195***	-0.2199***	-1.5172***	-0.2259***	-1.5702***
	[0.0631]	[0.2728]	[0.0632]	[0.2712]	[0.0812]	[0.3102]	[0.0812]	[0.3024]
SPOUSE	-0.0038	-1.2028***	0.0073	-1.2543***	-0.0028	-1.2936***	0.0041	-1.3036***
	[0.0423]	[0.2015]	[0.0422]	[0.2097]	[0.0423]	[0.2052]	[0.0422]	[0.2048]
PRIG	-0.2553***	-0.7114***	-0.256***	-0.6777**	-0.257***	-0.6857**	-0.2575***	-0.6711**
	[0.0631]	[0.2728]	[0.0632]	[0.2712]	[0.0631]	[0.2771]	[0.0631]	[0.2749]
MYHOME	-0.0212	-0.4656***	-0.0279	-0.5972***	-0.0245	-0.4307**	-0.0269	-0.5436***
	[0.041]	[0.1744]	[0.041]	[0.1783]	[0.041]	[0.1832]	[0.041]	[0.1805]
HEALTH2	0.0426	0.2619*	0.0333	0.2521*	0.0424	0.2663*	0.0355	0.2621*
	[0.0262]	[0.1435]	[0.0261]	[0.1429]	[0.0262]	[0.1452]	[0.026]	[0.1439]
HEALTH3	0.0404	0.3169**	0.0313	0.3123**	0.0394	0.3152**	0.0327	0.3198**
	[0.0253]	[0.1387]	[0.0251]	[0.1382]	[0.0253]	[0.1412]	[0.0251]	[0.1394]
HEALTH45	0.0743**	0.2691	0.0594	0.2124	0.0728*	0.2336	0.0624*	0.2528
	[0.0374]	[0.2225]	[0.0371]	[0.2257]	[0.0373]	[0.2309]	[0.037]	[0.2252]
TREND	-0.0214***	-0.0393			-0.0166**	-0.0154	0***	0***
	[0.0075]	[0.037]			[0.008]	[0.0435]	[0]	[0]
CONSTANT	-1.314	-5.522***	2.9253**	-3.3857**	0.4533	-4.4727*	2.1903**	-3.513**
	[2.005]	[1.965]	[1.356]	[1.5231]	[2.2287]	[2.4833]	[1.0246]	[1.6519]
Elasticity	0	-25.87126	0	-37.75158	0	-43.07043	-0.4386	-47.57859
Total Elasticity	-25.87125528		-37.75158111		-43.07043392		-48.01719133	
Sample Size	1630	10797	1630	10797	1630	10797	1630	10797

Table 12: 2006-2007

Gender	Male				Female			
Cigarette Price	Relative		Nominal		Relative		Nominal	
Equation	Demand	Smoker	Demand	Smoker	Demand	Smoker	Demand	Smoker
PRICE		-0.0219***		-0.0284***		-0.0284***		-0.0269***
		[0.006]		[0.0072]		[0.0072]		[0.0095]
log(PRICE)	-0.4689***		-0.4912**		-0.4912**		-0.348	
	[0.1794]		[0.1925]		[0.1925]		[0.4327]	
AGE	0.0312***	0.1711*	0.0314***	0.1735**	0.0728***	0.3688***	0.0738***	0.4307***
	[0.0116]	[0.0899]	[0.0116]	[0.0819]	[0.0224]	[0.1354]	[0.0224]	[0.1115]
AGESQ	-0.0003**	-0.0022**	-0.0003**	-0.0022***	-0.0008***	-0.0046***	-0.0008***	-0.0056***
	[0.0001]	[0.0009]	[0.0001]	[0.0008]	[0.0002]	[0.0015]	[0.0002]	[0.0012]
log(INCOME)	0.0164	-0.0471	0.0159	-0.0566	0.0108	-0.1065	0.0113	-0.018
	[0.0104]	[0.0807]	[0.0104]	[0.0778]	[0.0159]	[0.071]	[0.0159]	[0.0777]
UNIV	-0.138***	-1.2374***	-0.146***	-1.2806***	-0.1582	-1.9362***	-0.1593	-5.0425***
	[0.0434]	[0.3392]	[0.0432]	[0.2947]	[0.1431]	[0.6852]	[0.1429]	[0.7023]
COLL	-0.0706	2.2825***	-0.0757	2.3798***	-0.1955**	-1.3766**	-0.1968**	-2.9637***
	[0.0749]	[0.7931]	[0.0748]	[0.7092]	[0.0993]	[0.5794]	[0.0991]	[0.5524]
SPOUSE	0.0437	-0.4189	0.0429	-0.3681	-0.0792	-1.7894***	-0.0819	-3.6016***
	[0.0473]	[0.4102]	[0.0473]	[0.3692]	[0.0722]	[0.6079]	[0.0722]	[0.4713]
PRIG	-0.0352	-0.2644	-0.0343	-0.2959	-0.0309	-0.0156	-0.0376	-0.1334
	[0.0693]	[0.6687]	[0.0693]	[0.6732]	[0.1569]	[0.6747]	[0.1566]	[0.7572]
MYHOME	0.0371	-3.2484***	0.0387	-3.3398***	-0.1536**	-1.4148**	-0.154**	-4.9332***
	[0.0422]	[0.4159]	[0.0422]	[0.3712]	[0.074]	[0.5926]	[0.0739]	[0.7736]
HEALTH2	-0.0023	0.4744	-0.0028	0.4657	0.1147*	0.2223	0.1124*	0.4371
	[0.0322]	[0.294]	[0.0322]	[0.2859]	[0.0679]	[0.3602]	[0.0678]	[0.3342]
HEALTH3	-0.0242	0.4307	-0.0241	0.4327	0.0592	0.1988	0.0544	0.4315
	[0.0329]	[0.2816]	[0.033]	[0.272]	[0.0664]	[0.3501]	[0.0665]	[0.3458]
HEALTH45	-0.0755	-0.0553	-0.0742	-0.0234	0.1176	-0.0151	0.116	0.4892
	[0.0521]	[0.4228]	[0.0521]	[0.411]	[0.0972]	[0.5163]	[0.0971]	[0.453]
TREND	-0.4689***	-0.0219***	-0.4912**	-0.0284***	-0.0553	-0.0174*	-0.348	-0.0269***
	[0.1794]	[0.006]	[0.1925]	[0.0072]	[0.3936]	[0.0094]	[0.4327]	[0.0095]
CONSTANT	4.7361***	5.3198**	4.8421***	6.9074**	1.2501	-7.6037*	2.889	-2.7726
	[1.058]	[2.5978]	[1.1226]	[2.7443]	[2.2628]	[3.9708]	[2.4707]	[3.4559]
Elasticity	-0.4689	-15.1388	-0.4912	-19.0664	-0.4912	-56.7834	0	-95.7341
Total Elasticity	-15.60774301		-19.55755032		-57.27459698		-95.73405995	
Sample Size	1316	3003	3085	479	1316	3003	3085	479

Table 13: 2010-2011

Gender	Male				Female			
Cigarette Price	Relative		Nominal		Relative		Nominal	
Equation	Demand	Smoker	Demand	Smoker	Demand	Smoker	Demand	Smoker
PRICE		-0.006***		-0.0063***		-0.0047***		-0.005***
		[0.0011]		[0.0012]		[0.0015]		[0.0016]
log(PRICE)	-0.2013***		-0.2058***		-0.0866		-0.0955	
	[0.0603]		[0.0606]		[0.0936]		[0.0934]	
AGE	0.0232	0.0728	0.023	0.0728	0.0473*	0.4058***	0.0471*	0.414***
	[0.0163]	[0.0774]	[0.0163]	[0.0771]	[0.0277]	[0.0916]	[0.0277]	[0.0909]
AGESQ	-0.0002	-0.0013*	-0.0002	-0.0013*	-0.0005*	-0.0046***	-0.0005*	-0.0047***
	[0.0002]	[0.0007]	[0.0002]	[0.0007]	[0.0003]	[0.0009]	[0.0003]	[0.0009]
log(INCOME)	0.0312*	-0.1567	0.0311*	-0.1621	0.0265	-0.0132	0.0263	-0.0154
	[0.0177]	[0.1541]	[0.0177]	[0.163]	[0.0542]	[0.2129]	[0.0542]	[0.1897]
UNIV	-0.2065***	-1.1538***	-0.2099***	-1.1824***	-0.2088	-1.7466***	-0.2118	-1.7655***
	[0.0578]	[0.2591]	[0.0578]	[0.2596]	[0.1633]	[0.4779]	[0.1634]	[0.4696]
COLL	-0.1029	0.4214	-0.1053	0.3889	-0.186*	-1.2776***	-0.1862*	-1.2971***
	[0.0983]	[0.5277]	[0.0983]	[0.5247]	[0.1076]	[0.3634]	[0.1077]	[0.3551]
SPOUSE	-0.0947	-0.1855	-0.0961	-0.1783	-0.0502	-1.3715***	-0.0499	-1.4264***
	[0.0628]	[0.3252]	[0.0628]	[0.3243]	[0.091]	[0.3385]	[0.091]	[0.3326]
PRIG	0.4423***	0.1256	0.442***	0.1279	-0.3999	-1.2465	-0.4025	-1.2848
	[0.1221]	[0.9423]	[0.122]	[0.9388]	[0.3775]	[1.3749]	[0.3769]	[1.3718]
MYHOME	0.1221**	-0.8176**	0.1232**	-0.8073**	-0.0522	-1.3301***	-0.0515	-1.3866***
	[0.0615]	[0.3366]	[0.0615]	[0.3372]	[0.0889]	[0.3475]	[0.0889]	[0.3415]
HEALTH2	0.0683	0.2815	0.0687	0.2819	0.1287	-0.2625	0.1295	-0.2459
	[0.0517]	[0.2829]	[0.0517]	[0.2826]	[0.0822]	[0.357]	[0.0821]	[0.3531]
HEALTH3	0.0677	0.6784**	0.0687	0.6824**	0.0226	-0.1673	0.0241	-0.1422
	[0.0546]	[0.3009]	[0.0546]	[0.3006]	[0.0806]	[0.3381]	[0.0805]	[0.3347]
HEALTH45	0.1102	-0.1513	0.1111	-0.1385	0.1204	-0.2394	0.1218	-0.2232
	[0.0693]	[0.3738]	[0.0693]	[0.3742]	[0.1006]	[0.4451]	[0.1006]	[0.4402]
TREND	-0.2013***	-0.006***	-0.2058***	-0.0063***	-0.0866	-0.0047***	-0.0955	-0.005***
	[0.0603]	[0.0011]	[0.0606]	[0.0012]	[0.0936]	[0.0015]	[0.0934]	[0.0016]
CONSTANT	3.0705***	0.7978	3.0925***	0.8273	1.7539**	-11.9818***	1.807**	-11.9019***
	[0.5118]	[2.1439]	[0.512]	[2.1595]	[0.8459]	[2.4209]	[0.8492]	[2.349]
Elasticity	-0.2013	-6.62932	-0.2058	-6.70156	0	-13.0373	0	-13.2402
Total Elasticity	-6.830619256		-6.90736391		-13.03731269		-13.24023849	
Sample Size	1942	2633	357	2795	1942	2633	357	2795

Table 14: Participation elasticities with various specifications

			At Means		Marginal		Smoke_Ever		Smoke_2004	
Cigarette Price	Trend Dummy	Dataset	Male	Female	Male	Female	Male	Female	Male	Female
Relative	◯	2004-2011	2.651697	11.55529	0.776026	0.30421	1.486499	6.528938	0.042167	0.103514
Relative	×	2004-2011	3.123803	15.66265	1.172139	0.419117	1.523521	3.679298	0.136334	0.3061
Relative	◯	2004-2010	4.571409	25.87126	2.446667	0.690345	3.88275	10.1448	0.055578	0.041313
Relative	×	2004-2010	8.523475	37.75158	4.402774	1.056525	3.212238	8.832439	0.293723	0.717324
Relative	×	2006-2007	15.13884	56.7834	4.738695	1.519065	0.525314	0.638955	0.001179	0.001386
Relative	×	2010-2011	6.629319	13.03731	1.074563	0.347498	1.830296	1.121938	0.054441	0.031224
Nominal	◯	2004-2011	2.591513	11.69214	0.788906	0.322012	1.466805	6.764565	0.043597	0.124315
Nominal	×	2004-2011	3.117932	15.29609	1.209485	0.44839	1.491079	3.823807	0.140409	0.325048
Nominal	◯	2004-2010	5.014761	43.07043	2.806156	1.261501	4.242615	26.00252	0.146488	0.607171
Nominal	×	2004-2010	8.38466	47.57859	4.662329	1.402709	2.370297	7.729401	0.436478	1.234328
Nominal	×	2006-2007	19.06635	95.73406	6.145107	2.345698	0.616335	0.692879	0.001829	5.05×10^{-5}
Nominal	×	2010-2011	6.701564	13.24024	1.126655	0.370491	1.842349	1.147229	0.056795	0.039412