ENDOGENOUS TIME PREFERENCE AND ADDICTION

by

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ABSTRACT

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Both theoretical and empirical analyses were implemented so as to verify the relationship between endogenous time preference and addictive behavior. With simple 2 periods inter-temporal utility maximization model with choice variables of time preference factor, non-addictive and addictive goods, time preference factor is turned out to be one of most important determinants of consumer's addictive behavior. Especially, the theoretical implications show that once a person is addicted, he discounts the future more heavily, and in turn, becomes more addicted. Also, those who discount the future

heavily tend to show high sensitivity to cigarette price and those with high time preference rate respond less sensitively to price change.

Using the BRFSS data from 1984 to 2000, cigarette consumption and smoking participation equations with non-addictive, myopic and rational addiction models were estimated. Empirical results suggested that smoking participation in full sample is strongly addictive, but price insensitive, while the intensity of smoking is less addictive, but price sensitive. Especially, education has significant negative effect on cigarette consumption of smokers, but not on smoking participation. For different time preference groups, while the relationships between time preference and the amount of cigarette consumption of smokers are ambiguous, those with low rate of time preference are more addictive in smoking participation and more sensitive to cigarette price compared to the counterpart.

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Introduction

For past several decades, there have been a lot of studies about addictive behavior, such as demand for cigarettes, alcohol, and illegal drugs. Especially, Becker and Murphy (1988) explained the addictive behavior as a rational one, in the sense that when the addicted makes a decision on current consumption, he (or she) knows the interdependence of past, current and future consumption, and the consequences of the current consumption. Under the rationality condition, Becker, Grossman and Murphy (1990, 1994), Chaloupka (1991) implemented empirical research regarding smoking behavior based on rational addiction hypothesis. These studies found that past and future cigarette consumptions are closely and positively related with current consumption which is supporting the rational addiction hypothesis. However, Gruber and Koszegi (2001) pointed out that the hypothesis of rationality of addictive behavior is implicitly based on assumption of time consistent preference and if rational addiction model changes to incorporate time inconsistent preference, policy implications on cigarette consumption differ radically.

Regarding individual's time preference[1], there are two approaches according to Chaloupka (1991). Some regard time preference as constant over life cycle, the others as endogenous. The latter argues that the taste of the addicted is affected by past consumption. As Fuchs (2000) pointed out, the endogeneity of time preference is getting more attentions from numerous studies. Among them, Becker and Mulligan (1997) established a theoretical model of patience formation. Patience formation is primarily based on individual's recognition of positive or negative consequences of current behavior on future utility. Since every current economic activity of consumer may affect future's available resources, individual consumer has to decide whether he or she be patient or not at current economic choice. For example, a cigarette smoker knows that his current smoking behavior can have negative effect on future health and decides how much to smoke now. If he seriously worries about his health in the future, he will try to be abstinent in cigarette smoking. Under the assumption of same wealth and income, some consumers waste much more money now than others, because they do not care about the consequence of their behavior in the future while others try to save more today for the future's sake. Becker and Mulligan (1997) considered the four observations about

[1] For consistency of arguments, I define the rate of time preference as $\beta = 1/(1 + \delta)$ where δ is discount rate.

individual's time preference in building a model. According to their argument, (1) people are not all equally patient, (2) patience seems to be associated with income, development, and education, (3) heavy discounting of the future is viewed by many people to be inappropriate, undesirable, or even 'irrational', and (4) people are often aware of their weaknesses and may spend resources to overcome them. Becker and Mulligan provided several implications from the model such as complementary relationship between time preference and future utility, and positive correlation between time preference and wealth. Also, they implied implicitly that people with high discount rate are more likely to become addicted. A.L. Bretteville-Jenson (1999) showed the empirical evidences of the relationship between addiction and time preference by using survey data on illegal intoxicants. He found that active infectors of heroin and amphetamine have higher discount rates than those reporting that they have never used the substances.

Becker (1996) argued that the past casts a long shadow on the present through its influence on the formation of present preferences and choices. Therefore, considering individual's behavior is quite different from person to person, the analysis of habitual or addictive behavior can't be done without taking into account the formation of individual's preference on time. One of the main determinants of time preference may be education

(Fuchs, 1982). Using pilot survey data, Fuchs found that there is positive correlation between schooling and time preference. Also, Becker and Mulligan (1997) argued that wealth leads to patience, and income, development and education seem to be associated with patience, too. Individuals of different ages are often assumed to have different time preference (Chaloupka, 1991), but the direction of relationship between age and time preference is controversial. Generally, the aged are regarded to be more future oriented and the young behave myopically, but some economists do not agree with this direction (for example, Trostel and Taylor, 2001). However, numerous empirical studies support the positive direction of relationship between age and time preference in relation with young age smokers' smoking behaviors. The prediction is that young smokers are likely more addicted and price responsive. Lewit and Coate (1982) found that the price effect on smoking behavior end up with major impact on the decision to smoke rather than on the quantity demanded by smokers. Also, they found the price effect was greater for young adults than old smokers, and young male smokers showed sensitive response to price variation while women's smoking behavior were almost unaffected by price changes.

Also, Lewit, Coate, and Grossman (1981) estimate cigarette demand equations for youth smokers as well as smoking decision equations for all youth. They found a strong impact of price on smoking decision rather than on average cigarette consumption, as same as Lewit and Coate's findings. But, in terms of the price elasticity of demand for cigarette, Lewit, Coate, and Grossman's estimates were much higher than Lewit and Coat's results among youth and young adults.

Using rationality hypothesis of addiction, Chaloupka (1991) estimated the price elasticity of demand for cigarette for youths and young adults under the hypothesis that those discount future more heavily (low rate of time preference) tend to be more addicted. His finding was that the increase of cigarette price reduces consumption significantly, and without considering addiction, the impact might be understated. He also found that younger or less educated individuals behave more myopically, while older and more educated individuals show more farsighted behavior. Other researches such as Chaloupka and Saffer (1992), Chaloupka and Wechsler (1995), Evans and Farrely (1995), and Chaloupka and Grossman (1996) also found the evidence related with price effect on cigarette consumption among youth consistent with the studies of Lewit and his colleagues.

Contrary to these studies, Wasserman, Manning, Newhouse and Winkler (1991)'s price elasticity estimates were relatively low and they concluded that youth are less responsive to price than adults in cigarette consumption. But, Grossman (1991) pointed out that the results of Wasserman et al. can't be definitive because the inclusion of the regulation index that is highly correlated with cigarette price can lower the estimates.

With a constant rate of time preference, Becker and Murphy (1988) showed consumption of a harmful C is larger when time preference rate is lower (discount future utility more heavily) from the first order condition of consumer's inter-temporal utility maximization. Also, they argued that since the full cost of an addictive good depends on the degree of time preference, if the degree of addiction is sufficiently strong, a lower time preference is likely to raise the growth over time in consumption of the addictive good. Their arguments are persuasive implicitly in the sense that different levels of time preference given exogenously can affect consumption of addictive goods through different routes. Becker, Grossman and Murphy (1991) also showed that those who discount future utility more heavily are more price sensitive than those with high time preference rate. Nevertheless, they did not show explicitly how individual's rate of time preference is determined in context with consumer's inter-temporal utility maximization.

Becker and Mulligan showed how time preference is determined endogenously. They said, "the complementarity between future utilities and discount rates helps gain insights between addiction and time preference in that increased consumption of harmfully addictive goods tends to raise present utility at the expense of lowering future utility, and in turn, a decline in future utility reduces the benefits from an lower discount on future utilities, and therefore, greater consumption of harmful goods would lead to lower rates of time preference by discouraging investments in lowering these rates, assuming that such consumption does not lower the marginal cost of these investments".

The objective of this paper is to verify the relationship between time preference and addictive behavior under the hypothesis of endogeneity of time preference. Since time preference has been argued as being closely related with addictive behavior, the factors that affect time preference may eventually be important determinants for addictive behavior. To verify the relationship between endogenous time preference and addictive behavior, I setup simple 2-period inter-temporal utility maximization model including choice variables of time preference, non-addictive good and addictive good. Unlike other studies except one by Becker and Mulligan, time preference is determined endogenously within the system and affects consumer's evaluation on future utility. Consumer is assumed to decide how much resources allocate between time preference factor and other non-addictive or addictive goods in period 1 so as to maximize total utility of 2 periods.

Also, I derived marginal utility of wealth-constant demand functions for time preference factor, non-addictive and addictive goods. Using the derived demand functions, I found that increase in time preference rate by investing more in patience formation factor tends to reduce the sensitivity of response to price change both in non-addictive and addictive goods. As for the degree of addiction, those who discount future heavily tend to be more addicted than people with high time preference rate, and in turn, those addicted heavily whose tolerance effects are relatively high discount future more heavily than those addicted lightly.

With these theoretical implications, I implemented empirical analyses for addictive behavior, especially cigarette consumption and smoking participation. With the BRFSS data from 1984 to 2000, I estimated cigarette demand functions of smokers, per-capita cigarette demand function of full sample, and smoking participation function with non-addictive, myopically addictive and rationally addictive model using two stage least squares method as well as OLS. By grouping sample with different time preferences, I compared addictive behaviors of different time preference groups. The results present long-run and short-run price elasticities as well as the degree of addiction which is defined as the elasticity of past consumption on current consumption.

Theoretical model

As Becker and Mulligan (1997) pointed out, people decide to invest how much resources to overcome their defective recognition of future utilities, and therefore, time preference can vary among individuals or across time. Nevertheless, almost all studies estimating the demand function for cigarette consumption assume that time preference is exogenous or discount rate on future utility is the same as market interest rate. Since individual's decision on harmful behavior like cigarette smoking seems to be closely related with his attitude toward the future consequence of his current behavior, we cannot talk about individual's decision on smoking and the amount of cigarette consumption without taking into account time preference. In this context, time preference is no longer exogenous or given as was treated in major studies until recently. In following sections, relationship between normal (addictive) good and time preference is examined.

Endogenous time preference and inter-temporal consumption of non-addictive good

Let's start with simple model of two period time horizon with consumption of non-addictive goods. Unlike other studies, time preference is defined as a function of S, say patience formation factor, rather than given exogenously. Therefore, time preference function or patience formation function can be defined as below,

$$\beta = \beta(S), \text{ where } \beta'(S) > 0,\ \beta''(S) < 0$$

These notations are analogous with those appeared in Becker and Mulligan (1997). With this time preference function or patience formation function, we can think of two-period utility maximization problem with choice variables of normal good Y_t and patience formation factor S.

$$\text{Max. } V = U^1(Y_1) + \beta(S)U^2(Y_2)$$

$$\text{s.t. } P_{Y1} \cdot Y_1 + P_S \cdot S + (P_{Y2} \cdot Y_2)/(1+r) = W_0$$

where U^1 and U^2 represent current and future utility respectively, and Y_t means normal commodity consumed in period 1 and 2, and S is resource which is used for the sake of patience formation only in period 1. P_{Yt} is price of commodity in each period. W_0 is an initial asset and consumer is assumed to have no income in each period and exhaust the initial asset in two periods.

We can think of the meaning of S invested in period 1 as follows. Assume that a consumer lives only for two periods, "young" and "old". In youth, he has to make a choice between two goods, Y_1 for current pleasure and S for future's sake. If he chooses S a lot in period 1, then his future's well-being might be promising while current pleasure might be miserable. S can be the resources used in reading books, exercise, study, saving, etc., something productive for future, and Y_1 can be the resources consumed for current pleasure only. These two alter egos conflict each other choosing between current pleasure and investment for future. In this sense, his time preference is determined endogenously.

Under the assumption of concavity of utility function, the first derivatives with respect to Y is positive, $U_{Yt} > 0$, and negative in the second derivatives, $U_{YtYt} < 0$.

Using Lagrangian multiplier,

$$L = U^1(Y_1) + \beta(S)\, U^2(Y_2) + \lambda \{A_0 - [P_{Y1} \cdot Y_1 + S \cdot P_S + (P_{Y2} \cdot Y_1)/(1+r)]\}$$

First order conditions with respect to choice variables are,

$$\delta L/\delta Y_1 = U^1_{Y1}(Y_1) - \lambda \cdot P_{Y1} = 0 \quad (1)$$

$$\delta L/\delta Y_2 = \beta(S) \cdot U^2_{Y2}(Y_2) - \lambda \cdot P_{Y2}/(1+r) = 0 \quad (2)$$

$$\delta L/\delta S = \beta'(S) \cdot U^2(Y_2) - \lambda \cdot P_S = 0 \quad (3)$$

If the second order sufficient conditions are satisfied, there exist optimal solutions, Y_1^*, Y_2^*, and S^* which satisfy all these conditions. Equation (1) means consumer decides how much to consume in period 1 based on the condition that monetary value of marginal utility of consumption in period 1 is equal to marginal utility of wealth. As we can see in the equation, the consumption of current period is not affected by patience formation factor S, while the consumption of future period is affected by S through original, first derivative and second derivative of time preference function. Unlike probable intuition of consumer's choice between Y_1 and S in current period, S is determined in relation with Y_2 not with Y_1. Consumer determines how much to consume in current period based on the first order condition (1), and then, decides the amounts of Y_2 and S based on equation (2) and (3). This phenomenon is caused by not including S in the utility function of current period. Once S is included in the utility function of current period, Y_1 and S become substitutes each other.

Equation (2) means the monetary value of marginal utility of consumption in period 2, discounted appropriately, is equal to marginal utility of wealth. Equation (3) means that marginal utility of wealth is equal to increment of future utility caused by marginal increase of patience formation factor. Typically, $\beta(S)(1+r)$ in equation (2) assumed to be one since $\beta = 1/(1+\sigma)$ and discount factor σ set to be same as market interest rate, r. But under the assumption that time preference is a function of S, $\beta(S)(1+r)$ is not necessarily to be one because individual consumer decides to spend the amount of S for patience formation.

By implementing total differentiation with equations (1), (2), and (3) after putting all exogenous variables into right hand side, and using Cramer's rule, we can get $\delta Y_1/\delta P_{Y1}$, $\delta Y_2/\delta P_{Y2}$ and $\delta S/\delta P_S$ as below,

$$\delta Y_1/\delta P_{Y1} = \lambda / U^1_{Y1Y1} \quad (4)$$

$$\delta Y_2/\delta P_{Y2} = \lambda \cdot \beta'' U^2 / [\, \beta U^2_{Y2Y2}\, \beta'' U^2 - (\beta' U^2_{Y2})^2] \quad (5)$$

$$\delta S/\delta P_S = \lambda \cdot \beta U^2_{Y2Y2} / [\, \beta U^2_{Y2Y2}\, \beta'' U^2 - (\beta' U^2_{Y2})^2] \quad (6)$$

The signs of equation (4), (5) and (6) are negative because of the concavity of utility function. In order to see the relationship between Y_2 and S with money wealth held constant, we can get

$$\delta Y_2/\delta P_S = -\lambda \cdot \beta' U^2_{Y2} / [\beta U^2_{Y2Y2}\, \beta'' U^2 - (\beta' U^2_{Y2})^2] \tag{7}$$

By dividing equation (7) by equation (6), and add some manipulations,

$$(\delta Y_2/\delta S)(S/Y_2) = -\varepsilon/\eta \tag{8}$$

where $\varepsilon = (\delta\beta/\delta S)(S/\beta) > 0$

$\eta = (U^2_{Y2Y2})(Y_2/U^2_{Y2}) < 0$

Equation (8) shows the effect of increase in S in period 1 on future consumption with money wealth held constant. Consumption in period 2 will increase as S in period 1 increases since $-\varepsilon/\eta$ is positive. The elasticity of S on Y_2 depends on the relative magnitudes of ε and η. If ε is large, which means that future utility is getting more important relative to current utility, consumer tends to increase future consumption for inter-temporal utility maximization. On the other hand, if η is large, which means that increment of Y_2 causes large decrease of marginal utility in period 2, consumer will be reluctant to increase future consumption.

Suppose utility function has a quadratic form and time preference function $\beta(S)$ is defined as $S/(1+S)$ which goes to zero as S is close to zero, and goes to 1 as S goes to infinity. These characteristics are plausible for time preference function since the condition, $0 \leq \beta(S) \leq 1$ is generally accepted assumption in inter-temporal choice analysis. Let's assume market interest rate $r = 0$. With these functions and using first order conditions for inter-temporal utility maximization, the marginal utility of wealth-constant demand function of Y_1, Y_2 and S can be derived as below,[2]

$$Y_t = \lambda P_{Yt}/[U_{YY}(S/(1+S))^{t-1}] \quad \text{where } t = 1, 2 \tag{9}$$

$$S = [(a_y + 1/2U_{YY}Y_2^2)/\lambda \cdot P_S]^{1/2} - 1 \tag{10}$$

[2] With quadratic utility function $U(Y_t) = a_y + 1/2U_{YY}Y_t^2$ and $\beta(S) = S/(1+S)$,
$U^1_{Y1}(Y_1) = U_{YY}Y_1 = \lambda P_{Y1}$
$\beta(S)U^2_{Y2}(Y_2) = S/(1+S)U_{YY}Y_2 = \lambda P_{Y2}$
$\beta'(S) \cdot U^2(Y_2) = [1/(1+S)^2]U^2(Y_2) = \lambda P_S$

From the equation (9), the demand for Y_1 is determined by marginal utility of wealth λ, own price P_{Y1} and the second derivative of utility function, $U_{YY,}$ but not by patience formation factor, S. Since U_{YY} is negative by the concavity of utility function, the demand curve of Y_1 has downward slope on its own price. Unlike the demand function of $Y_{1,}$ S is one of the main factors which affect the demand function of $Y_{2.}$ The demand for Y_2 is determined by marginal utility of wealth λ, own price $P_{Y2,}$ the second derivative of utility function, $U_{YY,}$ and patience formation factor, S. The relationship between Y_2 and S can be shown as below,

$$\delta Y_2/\delta S = -\lambda P_{Y2}/U_{YY}S^2 \tag{11}$$

The sign of equation (11) is positive, the same as in equation (8). It means that if consumer invests more in S, future utility is getting more important and consumer has an incentive to consume more of Y_2. Put differently, raising S tends to reduce the price effect of P_{Y2} on Y_2 and raises consumption of Y_2 with P_{Y2} held constant. Therefore, consumer with higher S tends to respond less sensitively to price change.

Endogenous time preference and inter-temporal consumption of addictive good

Now, let's include addictive good in this simple system. The system turns to two-period utility maximization problem with choice variables of normal good Y_t, addictive good C_t and patience formation factor S.

$$\text{Max. } V = U^1(C_1, A_1, Y_1) + \beta(S)U^2(C_2, A_2, Y_2)$$

$$\text{s.t. } P_{C1}\cdot C_1 + P_{Y1}\cdot Y_1 + P_S\cdot S + (P_{C2}\cdot C_2 + P_{Y2}\cdot Y_2)/(1+r) = W_0$$

where U^1 and U^2 represent current and future utility respectively, and A_t represents cumulative stock of addictive good and can be defined as $A_1 = C_1$, and $A_2 = C_2 + (1 - \delta)C_1$ for this simple model. For simplicity, depreciation rate δ is assumed to be zero and hence, $A_2 = C_2 + C_1$. Therefore, it can be rewritten as below.

$$\text{Max. } V = U^1(C_1, Y_1) + \beta(S)U^2(C_2, C_1, Y_2)$$

$$\text{s.t. } P_{C1}\cdot C_1 + P_{Y1}\cdot Y_1 + P_S\cdot S + (P_{C2}\cdot C_2 + P_{Y2}\cdot Y_2)/(1+r) = W_0$$

If addictive good has harmful effects on health, marginal utility of A_t would be negative. In this sense, consuming harmful addictive good such as cigarette has three different routes in affecting consumer's utility. Since C_t is directly included in utility function in each period, U^1_{C1}, U^2_{C2} would be positive. But the effect of cigarette consumption in period 1 on future utility would be negative ($U^2_{C1} < 0$) because of the harmful effect of smoking on consumer's future health. This is called tolerance effect of addictive goods. Furthermore, C_1 raises marginal utility of C_2 due to reinforcement effect of addictive goods ($U^2_{C2C1} > 0$). Y_t means other composite commodity consumed in period 1 and 2, and is regarded as numeraire, $P_{Yt} = 1$. S is resource which is used for the sake of patience formation only in period 1. P_{Ct} is the price of addictive good, for example cigarette and P_S is the price of S respectively. W_0 is initial asset and consumer is assumed to have no income in each period and exhaust the initial asset in two periods. Note that cigarette consumption in current period, C_1 is included both in current and future utility functions because of the addictive nature of cigarette smoking.

Under the assumption of concavity of utility function, the first derivatives with respect to C and Y are positive, U_C, $U_Y > 0$, and negative in the second derivatives, U_{CC}, $U_{YY} < 0$. Conditions regarding S are same as in the model of non-addictive good.

Using Lagrangian multiplier,

$$L = U^1(C_1, Y_1) + \beta(S)U^2(C_2, C_1, Y_2)$$

$$+ \lambda\{A_0 - [P_{C1}\cdot C_1 + Y_1 + P_S\cdot S + (P_{C2}\cdot C_2 + Y_2)/(1+r)]\}$$

First order conditions with respect to choice variables in period 1 are,

$$\delta L/\delta C_1 = U^1{}_{C1}(C_1, Y_1) + \beta(S)\cdot U^2{}_{C1}(C_2, C_1, Y_2) - \lambda\cdot P_{C1} = 0 \quad (12)$$

$$\delta L/\delta Y_1 = U^1{}_{Y1} - \lambda = 0 \quad (13)$$

$$\delta L/\delta S = \beta'(S)\cdot U^2(C_2, C_1, Y_2) - \lambda\cdot P_S = 0 \quad (14)$$

First order conditions with respect to choice variables in period 2 are,

$$\delta L/\delta C_2 = \beta(S)\cdot U^2{}_{C2}(C_2, C_1, Y_2) - \lambda\cdot P_{C2}/(1+r) = 0 \quad (15)$$

$$\delta L/\delta Y_2 = \beta(S)\cdot U^2{}_{Y2}(C_2, C_1, Y_2) - \lambda/(1+r) = 0 \quad (16)$$

If the second order sufficient conditions are satisfied, there exist optimal solutions, C_1^*,

C_2^*, Y_1^*, Y_2^* and S^* which satisfy all these conditions. Primarily, we are interested in equations (9), (11) and (12) because these conditions pertain to current and future consumption of cigarette and determinant of time preference. We can rearrange these equations as below,

$$[U^1_{C1}(C_1, Y_1) + \beta(S)\cdot U^2_{C1}(C_2, C_1, Y_2)]/P_{C1} = \lambda \quad (12)'$$

$$\beta(S)(1+r)\cdot U^2_{C2}(C_2, C_1, Y_2)/P_{C2} = \lambda \quad (15)'$$

$$\beta'(S)\cdot U^2(C_2, C_1, Y_2) = \lambda P_S \quad (14)'$$

The first equation means consumer decides how much consume cigarettes in period 1 based on the condition that sum of monetary value of marginal utility of cigarette consumption in period 1 and marginal effect of current period's cigarette consumption on future utility discounted by time preference rate is equal to marginal utility of wealth. Equation (15)' and Equation (14)' are same as in the model of non-addictive model except inclusion of addictive good in the second period's utility function.

Let's assume that consumptions of C_t and S are not affected by consumption of Y_t and price of Y_t. Even though this assumption seems to be quite strong, it may be plausible if the share of C_t and S in consumer's total consumption is very small and if it's hard to find substitutes for these goods in commodity bundle. If this assumption is acceptable, equations (13) and (16) in the first order conditions need not to be considered in the analysis.

Suppose market interest rate r = 0 and by implementing total differentiation with equations (12)', (15)', and (14)' after putting all exogenous variables into right hand side, and using Cramer's rule, we can get $\delta C_1/\delta P_{C1}$, $\delta C_2/\delta P_{C2}$ and $\delta S/\delta P_S$, as below[3],

$$\delta C_1/\delta P_{C1} = -\lambda \cdot \psi \cdot \beta'' U^2/[\pi^2 - \Phi \cdot \psi] \quad (17)$$

$$\delta C_2/\delta P_{C2} = -\lambda \cdot \Phi \cdot \beta'' U^2/[\pi^2 - \Phi \cdot \psi] \quad (18)$$

$$\delta S/\delta P_S = -\lambda \cdot \mu \cdot \beta'' U^2/[\pi^2 - \Phi \cdot \psi] \quad (19)$$

where $\Phi = (U^1{}_{C1C1} + \beta U^2{}_{C1C1})\beta'' U^2 - (\beta' U^2{}_{C1})^2$

$\pi = \beta U^2{}_{C1C2}\beta'' U^2 - \beta' U^2{}_{C2}\beta' U^2{}_{C1}$

$\psi = \beta U^2{}_{C2C2}\beta'' U^2 - (\beta' U^2{}_{C2})^2$

$\mu = (U^1{}_{C1C1} + \beta U^2{}_{C1C1})\beta U^2{}_{C2C2} - (\beta U^2{}_{C1C2})^2$

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[3] For derivation of the equations, see Appendix

From the second order sufficient condition for constrained maximization problem, the determinant of bordered Hessian matrix, |H| ($= -\beta''U^2/[\pi^2 - \Phi\cdot\psi]$) should be positive and Φ, π and μ are negative because of concavity assumption of inter-temporal utility function. Therefore, $\delta C_1/\delta P_{C1}$, $\delta C_2/\delta P_{C2}$ and $\delta S/\delta P_S$ with money wealth held constant are negative just like ordinary normal goods. As we can see in the above equations, unlike other normal goods, own price effect of addictive goods is determined by tolerance effect (U^2_{C1}, U^2_{C1C1}), reinforcement effect (U^2_{C1C2}), and time preference factor ($\beta(S)$, first and second derivatives of $\beta(S)$) as well as marginal utility of wealth and marginal utilities of first and second periods' consumptions.

Suppose utility function has quadratic form and time preference function is defined as in the non-addictive model, $\beta(S) = S/(1+S)$. If we expand the model with infinite time horizon rather than just two periods, and consumer is assumed to determine S in each period, the inter-temporal utility maximization problem will be turned out to be as below.

$$\text{Max. } V = \Sigma_{t=1}\, \beta^{t-1}U(C_t, C_{t-1}, Y_t)$$

$$\text{s.t. } \Sigma_{t=1}(P_{Ct}\cdot C_t + Y_t + P_{St}\cdot S_t)/(1+r)^{t-1} = W_0$$

where $U(C_{t-1}, C_t, Y_t) = a_{C1} + a_{C2} + a_Y + 1/2U_{11}C_{t-1}^2 + 1/2U_{22}C_t^2 + 1/2U_{YY}Y_t^2 + U_{12}C_{t-1}C_t + U_{1Y}C_{t-1}Y_t + U_{2Y}C_tY_t$ and $\beta(S_t) = S_t/(1+S_t)$

The first order conditions for inter-temporal utility maximization with choice variables, C_t, C_{t-1}, Y_t and S_t would be,

$$\beta^{t-1}U_{Yt} = \lambda/(1+r)^{t-1} \qquad (20)$$

$$\beta^{t-1}U^1_{Ct}(C_{t-1}, C_t, Y_t) + \beta^t U^2_{Ct}(C_t, C_{t+1}, Y_{t+1}) = \lambda \cdot P_{Ct}/(1+r)^{t-1} \qquad (21)$$

$$(t-1)\, \beta^{t-2}\beta' U(C_{t-1}, C_t, Y_t) = \lambda \cdot P_S/(1+r)^{t-1} \qquad (22)$$

Suppose market interest rate $r = 0$ and $t = 2$. By solving first order condition for Y_t and substituting the result into the equations (21) and (22), we can get the marginal utility of wealth-constant demand functions of C_t and S_t.[4]

[4] $\theta = -(U_{YY}U_{12} - U_{1Y}U_{2Y})/[(U_{22}U_{YY} - U_{2Y}^2) + S/(1+S)(U_{11}U_{YY} - U_{1Y}^2)]$
$\theta_1 = \lambda\beta^{-1}U_{YY}/[(U_{22}U_{YY} - U_{2Y}^2) + S/(1+S)(U_{11}U_{YY} - U_{1Y}^2)]$

$$C_2 = \theta C_1 + \beta\theta C_3 + \theta_1 P_{C2} \quad (23)$$

$$S_2 = [U/\lambda \cdot P_S]^{1/2} - 1 = S(\lambda, P_S, C_1, C_2, C_3) \quad (24)$$

Equation (23) is a little bit different from that of Becker, Grossman and Murphy (1994) in the sense that the coefficient of P_{C2} includes the inverse of β. This is because time preference function is assumed to be exogenous and equal to 1/(1+r) in their paper, while it is assumed to be endogenous and hence, discount rate is not necessarily equal to market interest rate in this study. In equation (24), S is determined by past, current and future consumptions of addictive goods as well as marginal utility of wealth and own price. Since past, current and future consumptions of addictive goods are determined by prices of entire periods, S is also affected by prices of addictive goods. If a consumer's degree of addiction is quite strong compared to others, he faces much higher tolerance effect than others and hence, his total utility level is relatively lower. Therefore, he will demand less S than others and tend to discount future more heavily than others.

According to Becker, Grossman and Murphy (1994), long-run price effect of cigarette consumption can be defined as below.

$$LR = \theta_1/(1 - \theta - \beta\theta) \tag{25}$$

Under the hypothesis that those who discount future utility heavily (low time preference rate) tend to respond more sensitively to price change, the effect of S on long-run price effect is worth being examined.

$$\delta LR/\delta S = (\delta\theta_1/\delta S)/(1 - \theta - \beta\theta) - [\theta_1/(1 - \theta - \beta\theta)^2][\delta(1 - \theta - \beta\theta)/\delta S]$$

$$= - LR[Z/X(1+S)^2 + \theta(1 + \beta)Z/XY(1+S)^2 + 1/S^2 - \theta/(1+S)^2] \tag{26}$$

where $Z = U_{11}U_{YY} - U_{1Y}{}^2$

$X = (U_{22}U_{YY} - U_{2Y}{}^2) + S/(1+S)(U_{11}U_{YY} - U_{1Y}{}^2)$

$Y = 1 - \theta - \beta\theta$

In the rational addiction model, θ is assumed to be positive and less than 1. Therefore, the sum of last terms in the above bracket is positive and $\delta LR/\delta S > 0$. Since long-run price effect LR itself is negative, $\delta LR/\delta S > 0$ means that the sensitivity of response to price change is getting weaker as S increases. So, those who discount future utility heavily (with low time preference rate) responds more sensitively to price change than people with high time preference rate.

In addition, θ serves important role in the rational addiction model. Positive and appropriate value of θ means that past consumption affects current consumption positively, and current consumption is also affected by future consumption with non-zero time preference rate. Hence, θ can be regarded as index of the degree of addiction and it's worth examining the relationship between time preference and the degree of addiction.

$$\delta\theta/\delta S = (U_{YY}U_{12} - U_{1Y}U_{2Y})(U_{11}U_{YY} - U_{1Y}^2)/X^2(1+S)^2 \qquad (27)$$

where $X = (U_{22}U_{YY} - U_{2Y}^2) + S/(1+S)(U_{11}U_{YY} - U_{1Y}^2)$

Since $(U_{YY}U_{12} - U_{1Y}U_{2Y})$ is negative so as for θ to be positive, and $(U_{11}U_{YY} - U_{1Y}^2)$ is positive, $\delta\theta/\delta S$ is negative. This means that people who discount future utility heavily tend to be more addicted than those with high time preference rate (discount future utility lightly).

Empirical framework

In order to verity the theoretical implications of relationship between time preference and addictive behavior presented in previous section, cigarette consumption and smoking participation functions are estimated with non-addictive, myopic and rational addiction models.

Becker, Grossman and Murphy (1994) implemented empirical study for the theoretical model of rational addiction hypothesis presented by Becker and Murphy (1988). Their cigarette demand function for empirical analysis was derived as below,

$$C_t = \theta C_{t-1} + \beta\theta C_{t+1} + \theta_1 P_t$$

where C_t is cigarette consumption of current period, C_{t-1} and C_{t+1} are past and future of cigarette consumptions respectively, P_t is cigarette price of current period, and β is the rate of time preference. From the first order condition of inter-temporal utility maximization with life time budget constraint, cigarette demand equation is derived with marginal utility of wealth held constant. The utility function assumed to be quadratic in C_t, and consumption of a composite commodity Y_t and time non-separable because past consumption C_{t-1} as well as C_t is included in the function.

The meaning of above cigarette demand equation is straightforward. Since cigarette is normal good, θ_1 is expected to be negative with marginal utility of wealth, past and future consumption, and shift variables held constant. If cigarette consumption is addictive, then θ would be positive. If cigarette consumer behaves extremely myopically ($\beta = 0$), future consumption does not affect current consumption. In this sense, the equation can be used in either rational addiction model or myopic model of cigarette consumption. Three dependent variables of the equation are used in estimation, the proportion of smokers in full sample, the average amount of cigarette consumption of smokers, and per capita cigarette consumption.

Using state-level aggregated cross section and time series data, OLS method is adopted in estimating non-addictive cigarette demand function, while OLS and two stage least squares methods are adopted in myopic and rational addiction model because of endogeneity of past and future consumptions included in right hand sides of equations. Past consumption C_{t-1} and future consumption C_{t+1} are likely correlated with disturbance term mainly due to unobserved variables which affect current, past and future consumptions, and without taking into account the endogeneity of past and future consumption, OLS estimation of cigarette demand function can result in inconsistent estimates of parameters. In order to overcome the endogeneity problem of estimating cigarette demand function, two stage least squares (2SLS) method is used along with OLS method. Even though past and future consumptions might be correlated with disturbance term, past and future prices of cigarette might not be correlated with disturbance term with past and future consumptions held constant since past and future prices can affect current consumption only through past and future consumptions. Therefore past and future prices can be used as instrument variables for past and future consumptions. Furthermore, since the solution of cigarette demand equation is fully composed of current, all past and future prices because of the nature of difference equation, using as many lags and leads of prices as possible as instrument variables in the first stage in 2SLS estimation is suitable.

In this study, 4 leads and lags of prices, 4 leads, current and 4 lags of state and federal excise taxes as well as all other explanatory variables including state and year dummies are used as instrument variables with diverse combinations. In myopic model, 2 lags of prices, 2 lags of prices and current and 2 lags of taxes, 4 lags of prices, 4 lags of taxes including current tax, 3 lags of prices and taxes including current tax, and 4 lags prices and taxes including current tax are used as instrument variables in the first stage in predicting past consumption. In rational addiction model, 2 lags and leads of prices, 4 lags and leads of prices, 2 lags and leads of taxes including current tax, 4 lags and leads of taxes including current tax, 4 lags of prices and 4 leads of taxes including current tax, and 4 lags and leads of prices and taxes including tax are used as instrument variables in the first stage in predicting past and future consumption.

Along with other explanatory variables such as age, income, gender, education, employment, marital status and race, state and year dummies are included in estimation. Since each state has different regulation and tax system from the others and also different geographic and demographic characteristics, state dummies pin down heterogeneous characteristics among states. Year dummies also control year specific elements which might affect individual behavior. Especially, since this analysis assumes that marginal utility of wealth is constant over time, year dummies can also control effects of unexpected change of wealth.

So as to get robust results of estimation, three relevant tests are executed, i.e., Wu-Hausman test for the consistency of OLS estimates, F-test for significance of instrument variables, and over-identification test for either validity of instrument variables or proper specification of structural equation. The over-identification is to verify whether the structural equation is justly specified. If subsets of instrument variables have no ability to explain any variation in dependent variable that is not explained by explanatory variables, the hypothesis that the estimated coefficients of subset of instrument variables are zero cannot be rejected. If the null hypothesis can be rejected, then the matrix of instruments is valid and the structural equation is properly specified. Chi-square statistic is used in the over-identification test.

Additionally, instead of using current price as right hand side explanatory variable in cigarette demand equation, current excise tax replaced current price in estimating the equation since there are some arguments regarding endogeneity of cigarette price itself. Gruber and Koszegi (2001) argued that tax should be used as true exogenous variable to identify cigarette consumption-price relationship since excise tax changes explain only about 80 percent of the within state variation of prices and hence, there may be endogeneity bias in the price-consumption relationship due to the remaining variation in the price. So, estimation of cigarette demand equation using current excise tax as well as current price of cigarette as explanatory variable has been implemented.

Based on the estimates of parameters in interests, long-run and short-run price elasticities of cigarette consumption are calculated. According to Becker, Grossman and Murphy (1994), long-run and short-run price effects can be calculated with following formula. For rational addiction model[5],

$$LR = \theta_1/(1 - \theta - \beta\theta) \qquad SR = 2\theta_1/[1 - 2\beta\theta + (1 - 4\beta\theta^2)^{1/2}]$$

For myopic model ($\beta = 0$),

$$LR = \theta_1/(1 - \theta) \qquad SR = \theta_1$$

Elasticities can be calculated with these long-run and short-run price effects, average cigarette consumption and average price. Along with these elasticities, the degrees of addiction are also calculated using the estimates of coefficient of past consumption, average cigarette consumption of current and past period once the estimates are statistically significant, which means that cigarette smoking is addictive.

All the procedures described above are applied in each sub-group with different time preferences as well as full sample in order to see the relationship between time preference and addictive behavior. Since patience formation factor S, can be interpreted

[5] LR and SR price effects are calculated from the solution of difference equation,
$LR = dC_\infty/dP = \theta_1/\theta(1 - \varphi_1)(\varphi_2 - 1)$
$SR = dC_t/dP^*_t = \theta_1/\theta(1 - \varphi_1)\varphi_2$
where $\varphi_1 = [1 - (1 - 4\beta\theta^2)^{1/2}]/2\theta$ and $\varphi_2 = [1 + (1 - 4\beta\theta^2)^{1/2}]/2\theta$

in several way, full sample can be divided into different time preference sub-groups, such as groups with different educational achievement, different age groups, and groups with different attitudes toward health. One may divide full sample into sub-groups with different income level in the sense that time preference can vary among different income groups. But since income is known to be closely and positively correlated with education based on lifetime earning-education profiles, different education groups are expected to have quite similar characteristics to different income groups in terms of time preference and addictive behavior.

In addition to estimation of cigarette demand equation in different time preference sub-groups, I include the proxy variables of time preference in right hand side of cigarette demand equation for full sample. The proxy variable chosen for time preference are exercise and checkup. Those who exercise regularly and those who visit doctors regularly for routine checkup are regarded to have low time preference because they care about their future.

Data

Data used in the empirical analysis of relationship between endogenous time preference and addictive behavior are from the Behavioral Risk Factor Surveillance System (BRFSS) which is initiated in 1984 by the Center for Disease Control and Prevention (CDC) and U.S. states. Initially, 15 states participated in collecting surveillance data on individual's risk behaviors through monthly telephone interviews with adults only. By 1996, the number of states participating in the survey increased to all states and so did number of observations from 12,254 in 1984 to 264,684 in 2003. The BRFSS questionnaire contains queries about current health-related perception, conditions and behaviors, e.g., health status, health insurance, diabetes, tobacco and alcohol use, selected cancer screening procedures, and HIV/AIDS risks as well as questions on demographic characteristics.[6]

Since rational addiction model as well as myopic model of cigarette smoking is used in this analysis, past and future consumption variables along with current consumption are needed in estimating cigarette demand and smoking participation

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[6] Quoted from overviews of BRFSS, each year.

functions. To get three consecutive cigarette consumptions, the data are aggregated at state-level because it's impossible to get continuous observations with heterogeneous repeated survey data which is not longitudinal. The data sets are classified into three categories. One for estimation of smoking participation function in full sample, one for estimation of per-capita cigarette consumption function in full sample, and one for estimation of cigarette demand function in smoker-only sample. Therefore, cigarette consumption variable in estimating smoking participation function represents the proportion of smokers in full sample in each state, each year, and similarly, it represents per-capita cigarette consumption in full sample in estimating per-capita demand function, and average daily consumption in smoker-only sample in each state, each year. Since the query which asks interviewers whether they are smokers or not has been changed in 1996 from asking whether they are current smokers to whether they smoke everyday, some days or not at all, some adjustments needed to be done for respondents of some-day smokers. Since there are huge leap in the proportion of smokers if some-day smokers are classified as current smokers, and those who responded as some-day smokers did not report the amount of cigarette consumption, they are treated as non-smokers. Furthermore, several thousands of respondents who replied as current smokers did not specify the amount of cigarette consumption even before 1996. If they are treated as current smokers even though they do not consume any cigarette at all, estimation of smoking participation and per-capita cigarette consumption function can be biased due to discrepancy of responses. Hence, those respondents are regarded as non-smokers to avoid such distortion.

From 2001 survey, the numbers of average daily cigarette consumption are not available any more and therefore, the empirical analysis is restricted to the period from 1985 to 1999 since three consecutive consumption variables are needed to make use of rational addiction model. The number of states participated in 1985 survey was 22 and it increased up to 51 states in 1999. So, there are some missing observations in state level and hence, the data set is unbalanced panel data. As for independent variables except one lag and lead of current consumption, the analysis includes several socio-economic variables such as age, education, employment, marital status, race, gender and income as well as state and year dummies.

Age variable shows average ages of respondents in each state. Since the survey has been conducted to those aged above 17 years, the average ages are relatively high, around 40. Other independent variables except income are dichotomized in raw data level according to their nature of response. For example, respondents in the survey are supposed to answer the question regarding their education level in a way that if they never attended school or only attend kindergarten, they choose answer No. 1, if elementary school, answer 2, etc. In this study, those who attended educational institutions above high school regarded as 1, otherwise 0. Hence, education variable shows the proportion of respondents educated above high school diploma in each state because the observations are aggregated at state level. Employment variable shows the proportion of respondents who are employed or self-employed. As for marital status, it represents the proportion of married respondents. And race variable represents the proportion of non-whites, and gender shows the proportion of male. In query of asking respondent's income, the answers are categorized into 7 groups (8 groups from 1996) according to income brackets. Group 1 includes people whose income is less than 10,000 dollars, group 2 belongs to between 10,000 and 14,999 dollars, group 3 between 15,000 and 19,999, etc. The highest income bracket is more than or equal to 50,000 dollars (75,000 dollars from 1996). In this analysis, medians of income brackets where respondents belong to are calculated and used as their incomes. For example, if a respondent belongs to income bracket between 20,000 and 24,999 dollars, his income is regarded as 22,500 dollars. As for open bound brackets such as less than 10,000 or more than 50,000 (75,000 from 1996), incomes are calculated according to the half of income bracket next to or prior to. Since the data are aggregated at state level, income variable represents average income of respondents, deflated with CPI in 1982 - 1983. The unit of income variable is thousand dollars. This study also includes state and year dummy variables, 1 if state or year pertains to, 0 otherwise. To avoid dummy variable trap, one of state and year dummies are dropped in estimation. As for the proxy variables of time preference, exercise and checkup variables are used. Exercise represents the proportion of people who exercise regularly, and checkup for those checkup routinely.

In addition to the survey data, cigarette prices are collected from the Tobacco Institute's annual Tax Burden on Tobacco. The raw data from the Institute measure state level average retail price of a pack as of November 1 each year including state and federal taxes. Since this study needs average annual cigarette prices, deflated with CPI in 1982-1983, I calculated monthly before-tax cigarette prices from the difference of two consecutive annual prices. Average monthly changes of prices which are calculated from the differences of two consecutive annual prices divided by 12 after excluding state and federal taxes are added accumulatively to previous year's annual price in each month and added by state and federal taxes. If applicable, the changes of state and federal tax are also reflected to monthly prices based on the dates of tax change and then, averages of after tax annual prices are calculated and deflated with CPI in 1982-1983. Data of state and federal taxes also collected from the Institute.

The BRFSS identifies respondents through telephone-based method. This method may cause bias in empirical results. According to overviews of BRFSS each year, although 95% of U.S. households have telephones, coverage ranges from 87-98% across states and varies for subgroups as well. For example, persons living in the South, minorities, and those in lower socioeconomic groups typically have lower telephone coverage. Because of this reason, the BRFSS endows weights on individual observations. The weights are not direct methods to compensate for non-telephone coverage, but partially correct for any bias caused by non-telephone coverage. According to overviews, these weights adjust for differences in probability of selection and non-response as well as non-coverage, and the BRFSS recommends these weights must be used for deriving representative population-based estimates of risk behavior prevalences. Following the recommendation, this study used the weights for estimating state-weighted average value of all observations. The state-weighted average value of x_{ijt} is calculated by following formula.

$$x_{jt} = \Sigma_{(i)}x_{ijt}\cdot(w_{ijt})/\Sigma_{(i)}(w_{ijt}) \quad \text{where } i = \text{individual}, j = \text{state, and } t = \text{year.}$$

In order to analyze smoking behavior between different time preference groups, the data set is divided into several sub-groups according to age, education, exercise, and checkup. Typically, those more aged, more educated, exercise regularly, or do routine checkup tend to be more future oriented and discount future utility less compared to counterpart groups. Age sub-groups are composed of the old and the young, based on whether respondents are above 34 years old or not. As for education, if respondents achieved educational level above high school diploma, they classified as ‘high’, otherwise, ‘low’. Sub-groups of exercise and checkup are classified based on whether respondents exercise regularly or visit doctors routinely for checkup.

Also, smoker-only data set is divided by heavy and light smoker groups. Since the representative unit of cigarette sold to smokers is a pack with 20 pieces of cigarettes, those who smoke more than 20 pieces daily on average are regarded as heavy smokers and smokers consume less than a pack a day are classified as light smokers.

Table 1. State-aggregated Variables, Descriptions and Statistics

Variables	Definition and Statistics
C_{it}	- Per capita average daily cigarette consumption in pieces in state i, year t in full sample (mean=4.1811 , SD=0.9712) - Proportion of cigarette smokers in full sample (mean=0.2214 , SD=0.0407) - Average daily cigarette consumption in pieces in smoker-only sample (mean=18.7590 , SD=1.5526)
P_{it}	Average retail cigarette price per pack including state and federal excise taxes in calendar year t, deflated with CPI 1982-83 (mean=130.3997 , SD=31.6754)
T_{it}	State and federal excise tax in state i, calendar year t (mean=26.76, SD=16.6744)
Income	Average of medians of income brackets each respondent belongs to, in thousand dollars, deflated with CPI in full sample (mean=25.2089, SD=3.2024), in smoker-only sample (mean=22.7063, SD=2.9041) For example, if a respondent belongs to income bracket between \$20000 - \$25000, his income is regarded as \$22500. As for open bound brackets such as less than \$10000 or more than \$50000 (\$75000 from 1996), it adjusts according to the half of income bracket next to or prior to.
Education	Proportion of people above high school diploma in full sample (mean=0.5227, SD=0.0728), in smoker-only sample (mean=0.3977, SD=0.0692)
Sex	Proportion of female respondents in full sample (mean=0.5086, SD=0.0134) , in smoker-only sample (mean=0.4766, SD=0.0362)
Race	Proportion of non-white respondents in full sample (mean=0.143, SD=0.1376) , in smoker-only sample (mean=0.1378 , SD=0.1371)
Employment	Proportion of employed or self-employed respondents in full sample (mean=0.660, SD=0.0451) , smoker-only sample (mean=0.7032, SD=0.0562)
Marital	Proportion of married respondents in full sample (mean=0.6259, SD=0.0641 , in smoker-only sample (mean=0.5658, SD=0.0789)
Age	Average age of respondents in full sample (mean=43.47, SD=1.5156) , in smoker-only sample (mean=40.64, SD=1.4109)
Exercise	Proportion of respondents exercise regularly in full sample (mean=0.7037, SD=0.0834) , in smoker-only sample (mean=0.4765, SD=0.2815)
Checkup	Proportion of respondents checkup routinely in full sample (mean=0.6823, SD=0.0539) , in smoker-only sample (mean=0.6167, SD=0.0539)
Dummies	1 if each year(state) pertains to, otherwise 0

Results

Estimations of cigarette demand function with respect to non-addictive, myopic and rational addiction model are presented in this section. First of all, without any estimation, some descriptive statistics show interesting characteristics in terms of relationship between time preference and smoking behaviors. As we can see in the table 1 and 2, those who are regarded as having high rate of time preference tend to smoke less and have lower probability to smoke compared to those with low rate of time preference. While the proportion of respondents in full sample who answer their educational achievements are above high school diploma in 0.5277 on average, the proportion of people above high school diploma in smoker-only sample is 0.3977 on average. Also, the average age of respondents in smoker-only sample is 40.64 while the average age of respondent in full sample is 43.47. These mean that more educated, and more aged people tend not to smoke. The fact that people with high time preference tend to smoke less is more apparently shown in the proxy variables of time preference. People who exercise regularly occupy 70.37 percent on average in full sample, but the proportion of those who exercise regularly in smoker-only sample turn out to be only 47.65 percent. Since those

Table 2. Comparison of smoking behaviors between different time preference groups

Sample	Age		Education		Checkup		Exercise	
Mean	Old	Young	High	Low	Routine	Rare	Yes	No
Participation	0.2123	0.2375	0.1688	0.2791	0.1970	0.2618	0.2033	0.2868
Smokers only	20.108	16.680	18.020	19.215	17.954	19.917	17.911	20.481
Per capita	3.4387	3.3947	3.0565	5.9713	3.5578	5.2576	3.6611	5.9162

Note, participation represents the proportion of smokers in full sample, smokers only means average daily cigarette consumption of smokers only, and per capita captures per-capita average daily cigarette consumption. In sub-groups, 'Old' means those aged equal to or more than 35years and 'Young' means those aged less than 35 years. People above high school diploma are categorized as 'High', and 'Low' means those not included in 'High'. 'Routine' checkup represents those who visit doctors for checkup within a year. Otherwise, people categorized as 'Rare'. In exercise, 'Yes' represents those who responded 'yes' being asked whether they exercise regularly, and 'No' means do not exercise at all.

who exercise regularly are caring about their future and therefore, regarded to have high rate of time preference, they tend not to smoke compared to those who seldom exercise. The proportion of respondents who visit doctors for routine checkup is 0.6823 in full sample while the proportion of those in smoker-only sample is 0.6167. As for income variable, average income of respondents deflated with CPI 1982-83 in full sample is US$ 25,209, while average income of smokers is US$ 22,706.

In short, the low educated, the less aged, the poor, and those reluctant to take care of their health are likely to participate in smoking actively compared to the counterparts.

If we take a look at smoking behaviors in different time preference sub-groups as in table 2 rather than descriptive statistics of those variables, the relationship between time preference and smoking behavior is revealed to be more obvious. In different age groups, the proportion of smokers in young age group is slight higher than that of smokers in old age group, while the differences of proportions of smokers in different education, exercise, and checkup groups are much more significant. Especially, the proportion of smokers in low education group is about 11 percentage points higher than that of smokers in high education group. Hence, the smoking participation rates are consistently higher in groups discount future heavily than in groups with high rate of time preference. As for intensity of smoking, those with low rate of time preference tend to smoke heavily compared to the counterpart except for different age groups. Unlike smoking participation, young age group smoke less heavily than the old. This might be caused from the addictive nature of cigarette smoking. Even though the proportion of smokers in old age group is smaller than young age group, those who smoke even in old age may be more addicted than young smokers since they consume cigarette so long time, and hence they tend to smoke more heavily. If we divide the full sample into two groups based on the intensity of smoking, this phenomenon becomes more apparent. Heavy smoker group is confined to smokers who smoke more than a pack a day and consume

34.87 cigarettes on average while light smoker group is consisted of smokers who consume less than a pack and smoke 9.84 cigarettes a day. The average age of heavy smoker group is 43.19 while that of light smoker group is 38.90. So, old smokers tend to smoke more heavily than young smokers. Furthermore, heavy smokers seem not to care about their health compared to light smokers. The proportions of people who exercise regularly or do routine checkups in heavy smoker group are 0.5538 and 0.5489 respectively, while those in light smoker group are 0.6844 and 0.6794. Also, the proportion of people above high school diploma in heavy smoker group is 0.3720, lower than light smoker group's 0.4313. Interestingly, the average income of heavy smoker group (US$ 23,790) is slightly higher than that of light smoker group (US$ 22,278). This seems to be caused by income effect on cigarette consumption.

Departing from descriptive statistics, let's see the empirical results of non-addictive model of cigarette consumption. As we can see in table 3 and 4, own price effect of cigarette consumption is consistently negative and significant as expected regardless the scope of estimation and the types of dependent variables. As for smoking participation, the price elasticity in full sample is -0.2062, but price elasticities between different time preference groups are obviously different. The range of elasticities of high

Table 3. Estimation of non-addictive smoking participation equations (Dependent variable = proportion of smokers, C_t)

	Full	Age		Education		Checkup		Exercise	
	Sample	Old	Young	High	Low	Routine	Rare	Yes	No
Pt	-0.00035	-0.00023	-0.00053	-0.00022	-0.00056	-0.00017	-0.00044	-0.00025	-0.00051
	(5.93)**	(3.54)**	(5.56)**	(3.11)**	(6.07)**	(2.70)**	(4.37)**	(3.11)**	(3.75)**
Income	0.0003	-0.0001	0.0011	-0.0010	0.0011	0.0009	0.0001	0.0004	0.0020
	(0.53)	(0.22)	(1.32)	(1.79)*	(1.14)	(1.27)	(0.04)	(0.64)	(1.66)*
Sex	0.1295	0.0060	0.2132	-0.0161	-0.0273	0.0423	-0.0693	0.1004	-0.0389
	(1.43)	(0.08)	(2.40)**	(0.35)	(0.53)	(0.86)	(1.60)	(1.60)	(0.74)
Race	0.0077	0.0478	-0.0437	-0.0340	0.0306	0.0530	-0.0967	0.0204	0.0789
	(0.29)	(1.38)	(1.43)	(0.97)	(1.00)	(1.88)*	(2.46)**	(0.55)	(1.79)*
Employ	0.0457	0.0747	0.0319	0.0039	0.0942	0.0550	-0.0025	0.0563	0.0439
	(1.92)*	(2.76)**	(1.22)	(0.17)	(2.68)**	(2.15)**	(0.09)	(1.39)	(0.91)
Education	-0.0556	-0.0300	-0.1317	-	-	-0.0558	-0.0921	-0.1270	-0.0857
	(2.26)**	(1.18)	(4.46)**	-	-	(1.88)*	(2.86)**	(4.36)**	(2.14)**
Age	-0.0011	-	-	0.0024	-0.0022	-0.0001	-0.0031	-0.0008	-0.0022
	(1.12)	-	-	(2.32)**	(2.06)**	(0.01)	(2.48)**	(0.74)	(1.79)*
Marital	-0.0296	0.0104	-0.0668	-0.0374	-0.0201	-0.0208	-0.0297	-0.0548	0.0340
	(1.00)	(0.34)	(2.04)**	(1.26)	(0.53)	(0.68)	(0.81)	(1.50)	(0.74)
R^2	0.5069	0.4266	0.4564	0.4571	0.2589	0.4569	0.3081	0.5959	0.1688
Elasticity	-0.2062	-0.1437	-0.2897	-0.1669	-0.2622	-0.1125	-0.2212	-0.1581	-0.2306

Notes, ** = significant at 5% level and * = significant at 10% level.

time preference groups is from -0.1125 to -0.1669, while that of low time preference groups is from -0.2212 to -0.2897. These results are almost same when dependent variable is cigarette consumption of smokers except different age groups.

The price elasticity of cigarette consumption of old age group is -0.1012, more than double of young age group's -0.0489. This phenomenon also can be found in different

Table 4. Estimation of non-addictive cigarette demand equations

	Per Capita Consumption										
	Full	Age		Education		Checkup		Exercise		Intensity	
	Sample	Old	Young	High	Low	Routine	Rare	Yes	No	Heavy	Light
P_t	-0.0073	-0.0039	-0.0101	-0.0033	-0.0163	-0.0029	-0.0093	-0.0046	-0.0117	-	-
	(5.62)**	(2.00)**	(3.75)**	(2.30)**	(3.86)**	(2.11)**	(3.80)**	(2.82)**	(3.35)**	-	-
Inc.	0.0115	-0.0330	0.0142	-0.0171	0.0329	0.0223	0.0053	0.0129	0.0449	-	-
	(0.84)	(1.67)*	(0.85)	(1.43)	(0.97)	(1.49)	(0.25)	(0.91)	(1.43)	-	-
Sex	-1.0620	-3.7907	-1.8134	-1.2702	-2.1609	-0.2831	-2.0143	-0.7607	-2.9706	-	-
	(0.57)	(3.00)**	(1.53)	(1.35)	(1.83)*	(0.27)	(1.94)**	(0.59)	(2.05)**	-	-
Edu.	-1.6378	-1.1783	-2.0895	-	-	-1.8213	-2.7721	-2.6597	-2.1813	-	-
	(3.03)**	(1.91)*	(3.69)**	-	-	(2.83)**	(3.58)**	(4.44)**	(2.11)**	-	-
Age	0.0167	-	-	0.0650	-0.0443	0.0117	0.0048	0.0136	0.0119	-	-
	(0.78)	-	-	(3.03)**	(1.76)*	(0.65)	(0.16)	(0.63)	(0.37)	-	-
R^2	0.4847	0.3761	0.2345	0.4100	0.0850	0.4469	0.3734	0.5550	0.2467	-	-
Elast.	-0.2277	-0.1462	-0.3873	-0.1398	-0.3569	-0.1075	-0.2303	-0.1636	-0.2584	-	-

	Smokers Only										
	Full	Age		Education		Checkup		Exercise		Intensity	
	Sample	Old	Young	High	Low	Routine	Rare	Yes	No	Heavy	Light
P_t	-0.0109	-0.0156	-0.0063	-0.0066	-0.0146	-0.0072	-0.0101	-0.0094	-0.0154	-0.0219	-0.0029
	(3.74)**	(4.33)**	(1.56)	(1.59)	(3.85)**	(2.02)**	(2.06)**	(2.36)**	(2.51)**	(4.07)**	(1.66)*
Inc.	0.0427	0.0084	0.0519	-0.0015	0.0643	0.0594	0.0255	0.0284	0.0081	0.0155	-0.0011
	(1.64)	(0.29)	(1.97)**	(0.06)	(2.02)**	(2.02)**	(0.81)	(0.99)	(0.19)	(0.53)	(0.09)
Sex	-4.3358	-6.3891	-1.7323	-4.1708	-3.3951	-3.8865	-4.4145	-2.4107	-5.8499	-2.2019	-0.6489
	(4.35)**	(6.21)**	(2.01)**	(4.65)**	(3.49)**	(4.03)**	(4.26)**	(2.25)**	(5.12)**	(2.71)**	(1.67)*
Edu.	-2.8843	-1.2972	-4.4336	-	-	-2.3372	-3.1729	-2.1065	-1.6237	-1.1536	-0.6643
	(3.64)**	(1.56)	(5.83)**	-	-	(2.62)**	(3.41)**	(2.45)**	(1.52)	(1.50)	(1.82)*
Age	0.1335	-	-	0.1615	0.1191	0.1319	0.2086	0.1274	0.0983	0.0754	-0.0038
	(4.19)**	-	-	(4.97)**	(3.89)**	(4.60)**	(5.47)**	(3.57)**	(2.54)**	(2.44)**	(0.30)
R^2	0.4905	0.4565	0.3916	0.3402	0.3867	0.4119	0.3645	0.4537	0.3823	0.0607	0.4820
Elast.	-0.0759	-0.1012	-0.0489	-0.0474	-0.0990	-0.0525	-0.0661	-0.0682	-0.0985	-0.0820	-0.0378

Note, Race, Marital and Employment variables are omitted. Heavy (>20 pieces a day), Light (<20 pieces a day) smoking intensity groups. The price elasticity of heavy smokers is -0.0820 while that of light smokers is -0.0378. Therefore, it can be said that old smokers tend to be more addicted in smoking and smoke heavily, but price sensitive. This is somewhat different from general assumption that the old are more future oriented than the young. One that reassures well-known phenomenon of positive relationship between education and health is that the coefficients of education are consistently negative on cigarette consumption and significant in almost all cases.

Only in old and heavy smokers, education does not have significant effect on cigarette consumption. All these results of estimation of non-addictive model of cigarette consumption are almost same when current excise tax replaces current cigarette price in right hand side explanatory variable.

Now we turn to addiction model of cigarette consumption in full sample. In estimating rational addiction model of smoking participation equation, it's very hard to find evidences of applicability of rational addiction hypothesis using diverse combinations of instrument variables for past and future consumptions. Within 6 different combinations of instrument variables for right hand side endogenous variables in estimating coefficients of current price, past and future consumptions, only one out of 6

2SLS estimations shows positive and significant coefficient of future consumption. But it's larger than the coefficient of past consumption, and this is not acceptable because rational addiction model predicts smaller one. According to statistics of Wu-Hausman tests, the hypotheses that OLS estimates are consistent are rejected at 5% or 10% level in all 6 cases. On the contrary, strong addictive nature of smoking participation is shown in myopic addiction model. The estimated coefficients of past consumption are all positive and significant, but coefficients of price are not significant though their signs are all negative. Wu-Hausman F-ratios show the estimates of OLS are inconsistent. The hypotheses that all coefficients of instrument variables are zero are rejected at 1, 5 and 10% level. The statistics of over-identification test also show that instrument variables are valid and structural equations are properly specified. For example, when 4 lags of prices are used as instrument variables for past consumption, the estimated coefficient of past consumption is 0.7825 and significant at 5% level. The calculated degree of addiction is 0.7973. Long-run price elasticity is –0.2549 and short-run price elasticity is -0.0554 though the coefficient of price is not significant statistically. The results are almost same when current excise tax replaces current cigarette price in right hand side explanatory variable. When 4 lags and leads of taxes are used as instrument variables for past consumption, Wu-Hausman F-ratio is 4.18 and hence, OLS estimates are not consistent, and instrument variables are all significant at 5% level. Also, chi-squares statistic for over-identification test is quite low enough. The estimated coefficient of past consumption is 0.7188 and the calculated degree of addiction is 0.7324. But the coefficient of price turns out to be insignificant. Long-run and short-run price elasticities are -0.3084 and -0.0866, respectively. From these estimates, it can be inferred that once individual consumer becomes smoker, he tends to stay as smoker regardless the change of cigarette price. In case of estimation of average daily cigarette consumption of smokers, since Wu-Hausman F-ratios are significantly low in all 6 combinations of instrument variables, the hypotheses that OLS estimates are consistent can't be rejected both in myopic and rational addiction model. The consistent OLS estimates of rational addiction model show positive and significant coefficients of past and future consumptions, but coefficient of future consumption is still larger than that of past consumption. In myopic model, smokers are addicted in the amount of cigarette consumption, but the degree of addiction is much weaker than in the case of smoking participation. Unlike smoking participation case, smokers are price sensitive in cigarette consumption. The OLS estimated coefficients of price and past consumption are both significant. The coefficient

Table 5. Estimation of smoking participation equation in full sample
(Dependent variable = proportion of smokers)

Independent variables		TSLS						OLS
		I	II	III	IV	V	VI	
Myopic	C_{t-1}	0.6661	0.6134	0.7825	0.8357	0.6540	0.7563	0.1434
Model		(1.99)**	(2.05)**	(2.60)**	(2.49)**	(2.35)**	(2.88)**	(4.71)**
	P_t	-0.00012	-0.00014	-0.00009	-0.00008	-0.00013	-0.0001	-0.00028
		(1.07)	(1.30)	(0.82)	(0.63)	(1.20)	(0.97)	(3.72)**
	R^2	0.7883	0.7823	0.7937	0.7932	0.7881	0.7933	0.5803
	Wu-F	(3.36)	(3.22)	17.82	7.02	4.69	8.39	-
	Chi-sq	0.327	0.870	0.808	1.147	5.386	6.030	-
	(p-value)	0.5672	0.8326	0.8476	0.7657	0.4953	0.6439	-
	F-iv	4.89	2.89	3.39	2.89	1.95	1.93	-
	(p-value)	(0.0078)	(0.0219)	(0.0093)	(0.219)	(0.0605)	(0.0452)	-
	LR elast.	-0.2265	-0.2194	-0.2549	-0.2811	-0.2263	-0.2461	-0.1943
	SR elast.	-0.0756	-0.0848	-0.0554	-0.0462	-0.0760	-0.0600	-0.1664
Rational	C_{t-1}	0.6774	0.3242	0.5623	0.4767	0.5274	0.3990	0.1211
Addiction		(1.23)	(0.80)	(1.74)*	(1.65)*	(1.67)*	(2.17)**	(3.14)**
Model	C_{t+1}	0.1239	0.4886	0.1865	0.3267	0.2593	0.4160	0.1575
		(0.19)	(1.30)	(0.42)	(1.18)	(0.83)	(2.04)**	(3.56)**
	P_t	-0.00008	-0.00007	-0.00009	-0.00007	-0.00008	-0.00007	-0.0002
		(0.62)	(0.74)	(0.78)	(0.79)	(0.88)	(0.80)	(3.71)**
	R^2	0.8207	0.8539	0.8299	0.8474	0.8403	0.8256	0.6872
	Wu-F	(2.50)	3.73	(2.46)	3.80	4.05	5.65	-
	Chi-sq	0.690	2.888	3.383	8.578	7.895	15.111	-
	(p-value)	0.7080	0.8227	0.3362	0.2844	0.3420	0.0017	-
	F-iv_t-1	3.37	2.23	7.91	4.76	2.56	2.23	-
	(p-value)	(0.0097)	(0.0239)	(0.0000)	(0.0000)	(0.0070)	(0.0033)	-
	F-iv_t+1	2.59	3.35	8.90	7.22	3.44	2.26	-
	(p-value)	(0.0357)	(0.0009)	(0.0000)	(0.0000)	(0.0004)	(0.0027)	-
	LR elast.	-0.2330	-0.2137	-0.2162	-0.2189	-0.2209	-0.2191	-0.1848
	SR elast.	-0.0591	-0.1273	-0.0782	-0.0896	-0.0816	-0.1084	-0.1619

Notes for tables,

In whole estimations, ** = significant at 5% level and * = significant at 10% level. Long-run and short-run elasticities are not calculated, once the signs of past or future consumption are negative, or the sign of price is positive, and the sum of two coefficients of past and future consumption in rational addiction model exceeds 1. Chi-square statistics are displayed for over-identification test. Wu-F and F ratios for IV in parentheses mean the null hypothesis can be rejected at 10% level. Wu-F and F ratios for IV with (-) means the null hypothesis can't be rejected. Otherwise, the null hypothesis can be rejected at 5% level. All the other independent variables except Education are not displayed in myopic and rational addiction model. In the estimation of different educational level, education variable is substituted for income variable to be displayed at the tables. As for instrument variables, C_{t-1} and C_{t+1} are treated as endogenous right-hand side variables and estimated with instrument variables.

In Myopic model for full sample, Column I includes 2 lags of prices as instruments, II 2 lags of prices and current and 2 lags of taxes, III 4 lags of prices price, IV 4 lags of taxes including current tax, V 3 lags of prices and taxes including current tax, and VI includes 4 lags of prices and taxes including current tax.

In Rational addiction model for full sample, column I includes 2 lags and leads of prices as instruments, II 4 lags and leads of prices, III 2 lags and leads of taxes including current tax, IV 4 lags and leads taxes including current tax, V 4 lags of prices and 4 leads of taxes including current tax, and VI includes 4 lags and leads of prices and taxes including current tax.

As for instrument variables in sub-groups, in myopic model, column I includes 4 lags of prices as instruments, II 4 lags of taxes, III 4 lags of prices and taxes including current tax, and in rational addiction model, IV includes 4 lags and leads of prices, V 4 lags and leads of taxes including current tax, and VI includes 4 lags and leads of prices and taxes including current tax.

Table 6. Estimation of cigarette demand equation in full sample (Dependent variable = per capita consumption)

Independent variables		TSLS						OLS
		I	II	III	IV	V	VI	
Myopic	C_{t-1}	0.5152	0.5438	0.7517	0.6902	0.5359	0.6824	0.1249
Model		(0.96)	(1.13)	(1.53)	(1.43)	(1.24)	(1.60)	(3.19)**
	P_t	-0.00336	-0.00318	-0.00184	-0.00224	-0.00323	-0.00229	-0.00587
		(0.90)	(0.93)	(0.52)	(0.65)	(1.03)	(0.72)	(4.35)**
	R^2	0.7972	0.8035	0.8242	0.8218	0.8018	0.8213	0.5747
	Wu-F	0.63(-)	0.92(-)	2.43(-)	1.93(-)	1.10(-)	2.37(-)	-
	Chi-sq	0.038	0.120	1.122	1.370	6.015	6.596	-
	(p-value)	0.8447	0.9893	0.7718	0.7125	0.4215	0.5808	-
	F-iv	1.71	1.08	1.26	1.23	0.76	0.69	-
	(p-value)	(0.1819)	(0.3677)	(0.2831)	(0.2951)	(0.6243)	(0.7216)	-
	LR elast.	-0.2162	-0.2174	-0.2311	-0.2255	-0.2171	-0.2249	-0.2092
	SR elast.	-0.1048	-0.0992	-0.0574	-0.0699	-0.1007	-0.0714	-0.1831
Rational	C_{t-1}	0.6143	0.3730	0.3026	0.2137	0.2604	0.3118	0.1161
Addiction		(1.03)	(0.84)	(0.91)	(0.76)	(0.88)	(1.52)	(2.97)**
Model	C_{t+1}	0.3234	0.4511	0.6046	0.4492	0.4517	0.3814	0.1201
		(0.60)	(1.39)	(1.62)	(1.87)	(1.87)*	(1.96)**	(2.71)**
	P_t	-0.00064	-0.00145	-0.00102	-0.0247	-0.00216	-0.00223	-0.0050
		(0.23)	(0.60)	(0.43)	(1.20)	(1.03)	(1.16)	(3.61)**
	R^2	0.8660	0.8746	0.8737	0.8607	0.8673	0.8655	0.8278
	Wu-F	(2.67)	3.09	(2.79)	1.85(-)	(2.76)	3.11	-
	Chi-sq	0.350	3.938	2.879	14.254	13.338	19.904	-
	(p-value)	0.8396	0.6851	0.4106	0.0468	0.0643	0.1756	-
	F-iv_t-1	2.32	1.37	7.27	4.15	1.85	1.62	-
	(p-value)	(0.0556)	(0.2084)	(0.0000)	(0.0000)	(0.0577)	(0.0552)	-
	F-iv_t+1	2.71	3.12	6.69	5.43	3.51	2.13	-
	(p-value)	(0.0296)	(0.0019)	(0.0000)	(0.0000)	(0.0003)	(0.0054)	-
	LR elast.	-0.3204	-0.2619	-0.3426	-0.2283	-0.2337	-0.2268	-0.2042
	SR elast.	-0.0495	-0.1376	-0.2060	-0.1736	-0.1632	-0.1448	-0.1801

Table 7. Estimation of cigarette demand equation for smokers only
(Dependent variable = average daily cigarette consumption of smokers)

Independent variables		TSLS						OLS
		I	II	III	IV	V	VI	
Myopic	C_{t-1}	-0.0630	0.2263	0.0045	0.1397	0.2537	0.2192	0.0799
Model		(0.10)	(0.40)	(0.01)	(0.23)	(0.64)	(0.57)	$(1.95)^{*}$
	P_t	-0.01104	-0.00814	-0.01036	-0.00901	-0.00786	-0.00821	-0.00961
		(1.55)	(1.25)	(1.60)	(1.32)	(1.56)	$(1.66)^{*}$	$(3.13)^{**}$
	R^2	0.4261	0.6344	0.4993	0.5979	0.6428	0.6320	0.5616
	Wu-F	0.05(-)	0.07(-)	0.02(-)	0.01(-)	0.20(-)	0.13(-)	-
	Chi-sq	0.240	2.961	1.094	0.205	6.852	7.462	-
	(p-value)	0.6245	0.3977	0.7784	0.9767	0.3348	0.4877	-
	F-iv	1.13	0.07	0.70	0.61	0.84	0.68	-
	(p-value)	(0.3250)	(0.5905)	(0.5893)	(0.6549)	(0.5515)	(0.7290)	-
	LR elast.	-	-0.0731	-0.0724	-0.0728	-0.0732	-0.0731	-0.0726
	SR elast.	-	-0.0566	-0.0720	-0.0626	-0.0547	-0.0571	-0.0668
Rational	C_{t-1}	0.3466	0.3868	0.0695	0.1900	0.1712	0.2785	0.0827
Addiction		(0.65)	(0.97)	(0.15)	(0.56)	(0.49)	(1.17)	$(2.03)^{**}$
Model	C_{t+1}	0.4825	0.4449	0.6807	0.4211	0.4532	0.3465	0.0855
		(0.96)	(1.46)	$(1.78)^{*}$	$(1.71)^{*}$	$(1.87)^{*}$	$(1.67)^{*}$	$(2.08)^{**}$
	P_t	-0.00288	-0.00273	-0.00431	-0.00485	-0.00482	-0.00447	-0.00818
		(0.56)	(0.55)	(0.78)	(1.04)	(1.01)	(1.09)	$(2.65)^{**}$
	R^2	0.7328	0.7324	0.7058	0.7236	0.7227	0.7260	0.6112
	Wu-F	1.54(-)	1.94(-)	1.33(-)	0.91(-)	1.47(-)	1.55(-)	-
	Chi-sq	1.301	3.000	1.002	8.190	7.972	14.388	-
	(p-value)	0.5217	0.8089	0.8008	0.3161	0.3350	0.4963	-
	F-iv_t-1	2.00	1.13	3.25	2.03	1.03	1.12	-
	(p-value)	(0.0926)	(0.3410)	(0.0067)	(0.0341)	(0.4138)	(0.3309)	-
	F-iv_t+1	1.95	1.55	2.20	1.75	1.94	1.26	-
	(p-value)	(0.1010)	(0.1370)	(0.0527)	(0.0758)	(0.0444)	(0.2129)	-
	LR elast.	-0.1170	-0.1127	-0.1200	-0.0867	-0.0893	-0.0829	-0.0684
	SR elast.	-0.0655	-0.0567	-0.1112	-0.0687	-0.0726	-0.0570	-0.0627

of past consumption is 0.0799 and the calculated degree of addiction is 0.0801 which is extremely low compared to smoking participation case. Even when we compare this result with the estimates of OLS in smoking participation equation of myopic model, it's still low, 0.0801 vs. 0.1449. The price coefficient is -0.0096 and long and short-run price elasticities are -0.0726 and -0.0668, respectively.

However, when current excise tax instead of cigarette price is used in right hand side explanatory variable in estimating cigarette consumption equation of smokers, the results confirm rational addiction hypothesis in OLS estimation. The statistics of Wu-Hausman test show OLS estimates are consistent, and coefficients of past and future consumptions are positive and significant. Especially, the coefficient of future consumption is slightly smaller than that of past consumption and this is consistent with prediction of rational addiction model. The rate of time preference, β is calculated with the ratio of the estimated coefficient of future consumption to the estimated coefficient of past consumption and turns out to be 0.9915 which is equivalent to discount rate of 0.86%. The estimated coefficient of cigarette price is negative and significant. Long-run and short-run elasticities are -0.0792 and -0.0726, respectively. In myopic model, OLS estimates are consistent and the estimated coefficients of past consumption and cigarette price are both significant at 10% and 5% level respectively, and have signs as expected. Long-run price elasticity is -0.0831 and short-run elasticity is -0.0766, which are slightly higher than those elasticities when cigarette price is right hand side explanatory variable. The calculated degrees of addiction both in myopic and rational addiction model are 0.0795 and 0.0821, respectively. These results are not far from the case of putting cigarette price in right hand side explanatory variable.

Overall, we can say that while smoking participation is strongly addictive and price insensitive, the intensity of smoking in terms of average daily consumption is less addictive and price sensitive.

From now on, the empirical results are presented in context with time preference using cigarette price as right hand side explanatory variable. As for smoking participation equations, rational addiction models are not applicable for all cases, but myopic models show plausible results. Within different age groups in myopic model, OLS estimates of coefficients of past consumption and price are significant and have appropriate signs, but Wu-Hausman tests in 2SLS estimation imply they are inconsistent. The estimates of 2SLS with various combinations of instrument variables also should be discarded as the results of F-tests for the significance of instrument variables show that all instruments are

Table 8. Estimation of smoking participation equation in full sample on tax
(Dependent variable = proportion of smokers)

Independent variables		TSLS				OLS
		I	II	III	IV	
Myopic	C_{t-1}	0.3496	0.4061	0.4603	0.7188	0.1432
Model		(0.87)	(1.13)	(1.30)	(2.13)**	(3.68)**
	T_t	-0.00029	-0.00027	-0.00025	-0.00016	-0.00037
		(1.88)*	(1.89)*	(1.78)*	(1.15)	(5.30)**
	R^2	0.6873	0.7126	0.7326	0.7815	0.5587
	Wu-F	0.28(-)	0.58(-)	0.92(-)	4.18	-
	Chi-sq	-	0.105	0.439	2.140	-
	(p-value)	-	0.7456	0.8028	0.5438	-
	F-iv	5.44	3.44	2.47	2.55	-
	(p-value)	(0.0201)	(0.0327)	(0.0609)	(0.0383)	-
	LR elast.	-0.2388	-0.2437	-0.2498	-0.3084	-0.2262
	SR elast.	-0.1153	-0.1448	-0.1347	-0.0866	-0.1938
Rational	C_{t-1}	0.3202	0.5234	0.4029	0.3971	0.1206
Addiction		(0.72)	(1.66)*	(1.37)	(1.42)	(3.11)**
Model	C_{t+1}	0.0929	0.0001	0.3282	0.3178	0.1624
		(0.18)	(0.00)	(0.87)	(1.17)	(3.68)**
	T_t	-0.00026	-0.00022	-0.00014	-0.00015	-0.00030
		(1.66)*	(1.53)	(1.09)	(1.39)	(4.24)**
	R^2	0.7336	0.7537	0.8354	0.8331	0.6731
	Wu-F	0.14(-)	1.22(-)	1.71(-)	2.24(-)	-
	Chi-sq	-	0.454	3.315	6.244	-
	(p-value)	-	0.7970	0.3456	0.3986	-
	F-iv_t-1	4.30	4.34	2.95	2.59	-
	(p-value)	(0.0141)	(0.0018)	(0.0076)	(0.0089)	-
	F-iv_t+1	3.81	2.58	3.77	3.71	-
	(p-value)	(0.0226)	(0.0365)	(0.0011)	(0.0003)	-
	LR elast.	-0.2305	-0.2458	-0.2800	-0.2743	-0.2209
	SR elast.	-0.1544	-0.1172	-0.1461	-0.1465	-0.1925

Table 9. Estimation of cigarette demand equation in full sample on tax (Dependent variable = per capita consumption)

Independent variables		TSLS				OLS
		I	II	III	IV	
Myopic	C_{t-1}	0.1063	0.1266	0.1761	0.3388	0.1204
Model		(0.22)	(0.26)	(0.40)	(0.77)	(3.09)**
	T_t	-0.00771	-0.00756	-0.00720	-0.00600	-0.00761
		(1.98)**	(1.95)*	(2.00)**	(1.67)*	(4.96)**
	R^2	0.5526	0.5723	0.6172	0.7306	0.5664
	Wu-F	0.00(-)	0.00(-)	0.02(-)	0.26(-)	-
	Chi-sq	-	0.220	0.289	2.570	-
	(p-value)	-	0.6392	0.8656	0.4628	-
	F-iv	3.47	1.75	1.40	1.12	-
	(p-value)	(0.0629)	(0.1748)	(0.2406)	(0.3445)	-
	LR elast.	-0.2415	-0.2423	-0.2445	-0.2537	-0.2423
	SR elast.	-0.2161	-0.2117	-0.2017	-0.1680	-0.2130
Rational	C_{t-1}	0.0735	0.4059	0.1651	0.2548	0.1127
Addiction		(0.14)	(1.30)	(0.54)	(0.95)	(2.90)**
Model	C_{t+1}	0.37709	0.2447	0.6806	0.2676	0.1121
		(0.78)	(0.57)	(1.77)*	(1.07)	(2.53)**
	T_t	-0.00493	-0.00348	-0.00210	-0.00441	-0.00655
		(1.51)	(1.21)	(0.70)	(1.87)*	(4.19)**
	R^2	0.8025	0.8543	0.8663	0.8302	0.6657
	Wu-F	0.25(-)	1.31(-)	1.62(-)	0.81(-)	-
	Chi-sq	-	0.833	4.058	11.306	-
	(p-value)	-	0.6594	0.2553	0.0794	-
	F-iv_t-1	3.18	4.07	2.82	2.18	-
	(p-value)	(0.0422)	(0.0029)	(0.0103)	(0.0279)	-
	F-iv_t+1	4.20	2.44	2.89	3.08	-
	(p-value)	(0.0155)	(0.0456)	(0.0088)	(0.0021)	-
	LR elast.	-0.2515	-0.2791	-0.3806	-0.2585	-0.2367
	SR elast.	-0.2323	-0.1514	-0.03084	-0.1877	-0.2095

Table 10. Estimation of cigarette demand equation for smokers only on tax
(Dependent variable = average daily cigarette consumption of smokers)

Independent variables		TSLS				OLS
		I	II	III	IV	
Myopic	C_{t-1}	-0.7920	-0.6015	-0.0943	-0.0732	0.0793
Model		(0.37)	(0.50)	(0.16)	(0.13)	(1.95)*
	T_t	-0.02151	-0.01949	-0.0141	-0.0139	-0.01225
		(1.55)	(1.44)	(1.96)*	(1.97)**	(3.51)**
	R^2	0.1299	0.0329	0.3751	0.4026	0.5551
	Wu-F	0.31(-)	0.48(-)	0.09(-)	0.07(-)	-
	Chi-sq	-	0.019	0.484	0.515	-
	(p-value)	-	0.8914	0.7849	0.9155	-
	F-iv	0.37	0.47	0.88	0.70	-
	(p-value)	(0.5430)	(0.6272)	(0.4496)	(0.5935)	-
	LR elast.	-	-	-	-	-0.0831
	SR elast.	-	-	-	-	-0.0766
Rational	C_{t-1}	-0.3713	0.1930	-0.0632	0.3117	0.0819
Addiction		(0.25)	(0.38)	(0.11)	(0.92)	(2.01)**
Model	C_{t+1}	0.6720	0.4924	0.8882	0.2147	0.0812
		(0.82)	(0.83)	(1.39)	(0.72)	(1.97)**
	T_t	-0.00968	-0.00550	-0.00044	-0.00693	-0.00106
		(0.78)	(0.93)	(0.62)	(1.35)	(3.01)**
	R^2	0.4810	0.7252	0.6662	0.711	0.6039
	Wu-F	0.51(-)	0.72(-)	1.30(-)	0.47(-)	-
	Chi-sq	-	0.980	2.309	7.160	-
	(p-value)	-	0.6126	0.5108	0.3063	-
	F-iv_t-1	0.68	1.94	1.54	1.23	-
	(p-value)	(0.5058)	(0.1026)	(0.1616)	(0.2809)	-
	F-iv_t+1	2.09	1.26	0.93	1.22	-
	(p-value)	(0.1247)	(0.2852)	(0.4731)	(0.2861)	-
	LR elast.	-	-0.1089	-	-0.0914	-0.0792
	SR elast.	-	-0.0853	-	-0.0608	-0.0726

insignificant. In case of young age group, while consistency of OLS estimates is rejected at 10% level, the 2SLS estimates of price and past consumption are significant when 4 lags of prices are used as instruments, but these estimates need generous significance level in over-identification test. The long-run price elasticity is -0.3283 and short-run elasticity is -0.1712 and the degree of addiction is 0.4860.

As for different educational level in myopic model, high education group shows non addictive behavior in smoking participation both in OLS and 2SLS estimation, while low education group behaves addictively in 2SLS estimation. When 4 lags and taxes including current tax are used as instruments for past consumption in low education group, the estimated coefficients of price and past consumption are significant and have signs as expected. Long-run and short-run elasticities are -0.4268 and -0.1330 respectively, and the degree of addiction is 0.6971. In comparing price sensitivities of OLS estimates between different education groups, long-run price elasticity of low education group is -0.2587 which is higher than -0.1424 of high education group.

The OLS estimates of routine checkup group in myopic model are consistent and the estimated coefficients of past consumption and price are significant and have appropriate signs. Long-run and short-run price elasticities are -0.1111 and -0.1011 respectively, and the degree of addiction is 0.0903. As for rare checkup group, when 4 lags of prices are used as instrument variables in 2SLS estimation, OLS estimates are inconsistent, and the results of F-test and over-identification test are acceptable. The estimated coefficient of past consumption is significant and positive, but the coefficient of price is not significant. The calculated degree of addiction is 0.7381. In case of different exercise groups, OLS estimates are consistent in both groups. The estimated coefficient of past consumption in regularly exercise group is significant but negative, insignificant in no exercise group. The estimated coefficients of price in both groups are significant and negative. Long-run price elasticity of regularly exercise group can't be calculated since the coefficient of past consumption is negative. Long-run and short-run price elasticities of no exercise group are -0.2688 and -0.2649, respectively.

In general, those with high rate of time preference tend to be more addicted in smoking participation and more sensitive to cigarette price compared to those with low rate of time preference.

In estimation of cigarette consumption equation of smokers of different time preference groups, it's quite hard to find addictive characteristics of cigarette consumption. Almost all cases, OLS estimates are consistent, but the estimated coefficients of past or future consumptions are insignificant or negative. This is so when current excise tax instead of cigarette price is used as right hand side explanatory variable. So, as far as amount of cigarette consumption concerns, both myopic and rational addiction model do not seem to be applicable in estimating separated cigarette consumption equations of different time preference groups. Even when smokers are classified into two categories according to the intensity of smoking, it's still hard to apply both myopic and rational addiction model in estimating cigarette consumption equation even for heavy smokers because the estimated coefficients of past consumption and price are insignificant or negative. Light smokers do not even show any sensitivity to cigarette price, while heavy smokers are obviously sensitive to price. When I use exercise and checkup as proxy variables for time preference, the estimated coefficients of these variables are insignificant and sometimes have opposite signs. This is likely due to inappropriateness of these variables as proxies of time preference.

Throughout whole empirical research, much evidence can't be found supporting both myopic and rational addiction model compared to non-addictive model. This may be caused by multi-collinearity problem between the instruments seemingly due to relatively short time period of estimation. The results of estimation of cigarette price coefficients in non-addictive model can be regarded as biased estimates of long-run price effects of rational addiction model since past and future consumption variables which are right had side endogenous variables are omitted in estimation. Even ignoring addictive property of cigarette consumption, those who discount future utility heavily tend to respond sensitively to cigarette price because cigarette price takes relatively large portion of total cost of cigarette consumption which is composed of price and money value of the future adverse effect of cigarette consumption. This is so, because those with low time preference rate (discount future heavily) take harmful effect of cigarette consumption less seriously than those with high time preference rate. Also, the fraction of disposable income that those with low time preference rate allocate to addictive goods is likely to exceed the corresponding fraction that those with high preference rate allocate to these goods. In addition, as Becker (1992) pointed out, the young are expected to be more sensitive to changes of prices of addictive goods than the old because they value the future consequences less, discount future more heavily, and are more sensitive to peer pressure.

In summary, smoking participation in full sample is strongly addictive but price insensitive, while the intensity of smoking in terms of average daily consumption is less addictive but price sensitive. For different time preference groups, those who discount the future heavily tend to be more addicted in smoking participation and more sensitive to cigarette price compared to those with high rate of time preference.

Conclusions

Both theoretical and empirical analyses were implemented so as to verify the relationship between time preference and addictive behavior under the assumption of endogeneity of time preference. With simple 2 periods inter-temporal utility maximization model with choice variables of time preference factor, non-addictive and addictive goods, I found that time preference factor is one of most important determinants of consumer's addictive behavior using comparative static analysis and estimating marginal utility of wealth-constant demand function of cigarette consumption. Especially, the theoretical implications show that once a person is addicted, he discounts the future more heavily, and in turn, becomes more addicted. Also, those who discount the future heavily tend to show high sensitivity to cigarette price and those with high time preference rate respond less sensitively to price change.

Using the BRFSS data from 1984 to 2000, I estimated cigarette consumption and smoking participation function with non-addictive, myopic and rational addiction model. By grouping sample with different time preference, I compared addictive behaviors of different time preference groups. Overall, rational addiction model was not applicable both in cigarette consumption equation and smoking participation equation. Empirical results suggest that smoking participation in full sample is strongly addictive, but price insensitive, while the intensity of smoking is less addictive, but price sensitive. Especially, education has significant negative effect on cigarette consumption of smokers, but not on smoking participation. For different time preference groups, while the relationships between time preference and the amount of cigarette consumption of smokers are ambiguous, those with low rate of time preference (discount the future heavily) are more addictive in smoking participation and more sensitive to cigarette price compared to the counterpart.

Appendix

By using Cramer's rule,

$\delta C_1/\delta P_{C1} = -\lambda[\beta U^2_{C2C2}\beta'' U^2 - (\beta' U^2_{C2})^2]/|H|$

$\delta C_2/\delta P_{C2} = -\lambda[(U^1_{C1C1} + \beta U^2_{C1C1})\beta'' U^2 - (\beta' U^2_{C1})^2]/\ |H|$

$\delta S/\delta P_S = -\lambda[(U^1_{C1C1} + \beta U^2_{C1C1})\beta U^2_{C2C2} - (\beta U^2_{C1C2})^2]/|H|$

$|H|$

$= (U^1_{C1C1} + \beta U^2_{C1C1})\beta U^2_{C2C2}\beta'' U^2 + 2\beta' U^2_{C2}\beta' U^2_{C1}\beta U^2_{C2C1} - (\beta' U^2_{C1})^2\beta U^2_{C2C2} - (U^1_{C1C1} + \beta U^2_{C1C1})(\beta' U^2_{C2})^2 - (\beta U^2_{C1C2})^2\beta'' U^2$

$= -\ \beta'' U^2[(\beta U^2_{C1C2})^2 - 2(\beta' U^2_{C1})(\beta' U^2_{C2}/\beta'' U^2)\beta U^2_{C2C1} + (\beta' U^2_{C2}/\beta'' U^2)^2(\beta' U^2_{C1})^2 - (\beta' U^2_{C2}/\beta'' U^2)^2(\beta' U^2_{C1})^2] + (U^1_{C1C1} + \beta U^2_{C1C1})\beta U^2_{C2C2}\beta'' U^2 - (\beta' U^2_{C1})^2\beta U^2_{C2C2} - (U^1_{C1C1} + \beta U^2_{C1C1})(\beta' U^2_{C2})^2$

$= -\ \beta'' U^2[(\beta U^2_{C1C2}) - (\beta' U^2_{C2}/\ \beta'' U^2)(\beta' U^2_{C1})]^2 + (\beta' U^2_{C2})^2(\beta' U^2_{C1})^2/\beta'' U^2 + [(U^1_{C1C1} + \beta U^2_{C1C1})\beta'' U^2][U^2_{C2C2}\beta'' U^2 - (\beta' U^2_{C2})^2]/\beta'' U^2 - (\beta' U^2_{C1})^2\beta U^2_{C2C2}\beta'' U^2/\beta'' U^2$

$= -\ (\beta'' U^2)^{-1}[(\beta U^2_{C1C2})\beta'' U^2 - \beta' U^2_{C2}\beta' U^2_{C1}]^2 + (\beta'' U^2)^{-1}\{[(U^1_{C1C1} + \beta U^2_{C1C1})\beta'' U^2 -$

$(\beta' U^2_{C1})^2][U^2_{C2C2}\beta'' U^2 - (\beta' U^2_{C2})^2]\}$

$= -(\beta'' U^2)^{-1}\{[(\beta U^2_{C1C2})\beta'' U^2 - \beta' U^2_{C2}\beta' U^2_{C1}]^2 - [U^2_{C2C2}\beta'' U^2 - (\beta' U^2_{C2})^2][(U^1_{C1C1} + \beta U^2_{C1C1})\beta'' U^2 - (\beta' U^2_{C1})^2]\}$

Therefore,

$$\delta C_1/\delta P_{C1} = -\lambda \cdot \psi \cdot \beta'' U^2/[\pi^2 - \Phi \cdot \psi]$$

$$\delta C_2/\delta P_{C2} = -\lambda \cdot \Phi \cdot \beta'' U^2/[\pi^2 - \Phi \cdot \psi]$$

$$\delta S/\delta P_S = -\lambda \cdot \mu \cdot \beta'' U^2/[\pi^2 - \Phi \cdot \psi]$$

where $\Phi = (U^1_{C1C1} + \beta U^2_{C1C1})\beta'' U^2 - (\beta' U^2_{C1})^2$

$\pi = \beta U^2_{C1C2}\beta'' U^2 - \beta' U^2_{C2}\beta' U^2_{C1}$

$\psi = \beta U^2_{C2C2}\beta'' U^2 - (\beta' U^2_{C2})^2$

$\mu = (U^1_{C1C1} + \beta U^2_{C1C1})\beta U^2_{C2C2} - (\beta U^2_{C1C2})^2$

Table 11. Estimation of smoking participation equations for different age groups (Dependent variable = proportions of smokers)

Independent Variables		Old (age>=35)				Young (age<35)			
		TSLS			OLS	TSLS			OLS
		I	II	III		I	II	III	
Myopic model	C_{t-1}	1.0397	1.0489	1.1140	0.0679	0.4785	0.6343	0.4088	0.0613
		(1.86)*	(1.72)*	(2.13)**	(1.74)*	(1.84)*	(1.79)*	(2.00)**	(1.54)
	P_t	0.00001	0.00001	0.00001	-0.00018	-0.00031	-0.00024	-0.00034	-0.0005
		(0.00)	(0.02)	(0.10)	(2.70)**	(1.99)**	(1.25)	(2.49)**	(5.02)**
	R^2	0.6611	0.6605	0.6558	0.3777	0.6782	0.6841	0.6675	0.4998
	Wu-F	6.62	5.70	9.64	-	(3.21)	(3.69)	(3.45)	-
	chi-sq	1.389	0.909	3.107	-	6.337	0.768	18.750	-
	(p-val)	0.7082	0.8233	0.9275	-	0.0963	0.8570	0.0163	-
	F-iv	1.42(-)	1.20(-)	0.78(-)	-	3.88	(2.36)	(2.65)	-
	LR-e	-	-	-	-0.1169	-0.3283	-0.3648	-0.3182	-0.2902
	SR-e	-	-	-	-0.1090	-0.1712	-0.1334	-0.1881	-0.2724
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	-0.0308	0.3183	0.4747	0.0538	0.6442	0.5808	0.3704	0.0593
model		(0.03)	(0.50)	(1.73)*	(1.39)	(2.18)**	(2.18)**	(2.20)**	(1.49)
	C_{t+1}	0.8063	0.4945	0.4929	0.0763	-0.3826	-0.0755	0.1480	0.0788
		(1.11)	(1.11)	(2.05)**	(1.73)*	(0.80)	(0.23)	(0.62)	(1.82)*
	P_t	-0.00001	-0.00001	0.00001	-0.00024	-0.00042	-0.00030	-0.00029	-0.00046
		(0.08)	(0.12)	(0.16)	(2.12)**	(1.86)*	(1.64)	(1.81)*	(4.50)**
	R^2	0.6759	0.7207	0.7316	0.4220	0.4807	0.6555	0.7123	0.5593
	Wu-F	4.54	3.12	7.38	-	3.21	(2.99)	(2.73)	-
	chi-sq	2.231	4.847	7.373	-	7.177	6.857	28.305	-
	(p-val)	0.8973	0.6787	0.9464	-	0.3048	0.4439	0.0197	-
	F_t-1	0.78(-)	1.58(-)	1.14(-)	-	2.86	4.27	2.15	-
	F_t+1	(2.56)	3.40	1.82	-	1.30(-)	4.49	1.30(-)	-
	LR-e	-	-0.0377	-	-0.0989	-	-	-0.3292	-0.2903
	SR-e	-	-0.0228	-	-0.0936	-	-	-0.1996	-0.2731

Table 12. Estimation of cigarette demand equations for different age groups
(Dependent variable = average daily cigarette consumption of smokers)

Independent Variables		Old (age>=35)				Young (age<35)			
		TSLS			OLS	TSLS			OLS
		I	II	III		I	II	III	
Myopic model	C_{t-1}	0.0130	-0.3640	-0.0521	0.0336	-0.5754	-0.2642	-0.0897	0.0213
		(0.01)	(0.42)	(0.08)	(0.82)	(1.01)	(0.45)	(0.22)	(0.51)
	P_t	-0.01473	-0.01994	-0.01563	-0.0445	-0.00898	-0.00720	-0.00620	-0.00556
		(0.76)	(1.57)	(1.58)	(3.85)**	(1.52)	(1.30)	(1.28)	(1.32)
	R^2	0.4621	0.1460	0.4246	0.4722	0.0127	0.0674	0.2555	0.3846
	Wu-F	0.00(-)	0.24(-)	0.02(-)	-	1.52(-)	0.26(-)	0.08(-)	-
	chi-sq	1.303	0.770	10.985	-	1.257	3.647	7.184	-
	(p-val)	0.7285	0.8567	0.2026	-	0.7395	0.3022	0.5169	-
	F-iv	0.12(-)	0.35(-)	0.23(-)	-	1.01(-)	0.74(-)	0.66(-)	-
	LR-e	-0.0968	-	-	-0.0970	-	-	-	-0.0444
	SR-e	-0.0955	-	-	-0.0937	-	-	-	-0.0435
Rational addiction model		IV	V	VI		IV	V	VI	
	C_{t-1}	0.5252	0.1081	0.0224	0.0350	-0.2093	0.0413	0.0946	0.0236
		(1.14)	(0.32)	(0.09)	(0.86)	(0.56)	(0.12)	(0.35)	(0.56)
	C_{t+1}	0.4655	0.4065	0.2991	0.0428	0.2447	0.1243	0.2280	-0.0038
		(1.29)	(1.70)*	(1.52)	(1.05)	(0.69)	(0.37)	(0.80)	(0.09)
	P_t	-0.00019	-0.00668	-0.00926	-0.01242	-0.00692	-0.00551	-0.00519	-0.0056
		(0.03)	(1.05)	(1.75)*	(3.26)**	(1.39)	(1.17)	(1.12)	(1.32)
	R^2	0.6050	0.5928	0.3181	0.4786	0.3461	0.5045	0.5725	0.3800
	Wu-F	3.65	1.18(-)	1.13(-)	-	0.46(-)	0.09(-)	0.28(-)	-
	chi-sq	1.836	13.984	22.747	-	4.409	6.471	10.551	-
	(p-val)	0.9341	0.0515	0.0897	-	0.6215	0.4860	0.7837	-
	F_t-1	1.02(-)	2.36	1.08(-)	-	1.05(-)	1.07(-)	0.84(-)	-
	F_t+1	1.42(-)	2.75	1.41(-)	-	0.98(-)	0.71(-)	0.72(-)	-
	LR-e	-0.1323	-0.0893	-0.0885	-0.0873	-	-0.0516	-0.0599	-
	SR-e	-0.0113	-0.0792	-0.0865	-0.0843	-	-0.00435	-0.0541	-

Table 13. Estimation of cigarette demand equations for different age groups (Dependent variable = per capita cigarette consumption)

Independent Variables		Old (age>=35)				Young (age<35)			
		TSLS			OLS	TSLS			OLS
		I	II	III		I	II	III	
Myopic model	C_{t-1}	-0.2844	-0.8318	0.0242	-0.0009	0.4102	0.4959	0.1541	0.0043
		(0.40)	(1.10)	(0.06)	(0.02)	(0.99)	(1.00)	(0.43)	(0.10)
	P_t	-0.00420	-0.00761	-0.00229	-0.00244	-0.00724	-0.00654	-0.00931	-0.01053
		(0.86)	(1.42)	(0.71)	(1.23)	(1.60)	(1.29)	$(2.31)^{**}$	$(3.74)^{**}$
	R^2	0.1450	0.0028	0.3581	0.3400	0.4007	0.4072	0.3235	0.2245
	Wu-F	0.17(-)	2.18(-)	0.0(-)	-	1.13(-)	1.25(-)	0.19(-)	-
	chi-sq	3.345	1.203	13.540	-	3.995	0.444	10.331	-
	(p-val)	0.3414	0.7523	0.0946	-	0.2621	0.9309	0.2426	-
	F-iv	0.47(-)	0.69(-)	0.57(-)	-	1.63(-)	1.22(-)	0.86(-)	-
	LR-e	-	-	-0.0888	-	-0.4713	-0.4985	-0.4229	-0.4061
	SR-e	-	-	-0.0867	-	-0.2780	-0.2513	-0.3577	-0.4044
Rational addiction model		IV	V	VI		IV	V	VI	
	C_{t-1}	0.4497	0.3345	0.3169	-0.0038	0.6343	0.5302	0.3723	0.0033
		(1.07)	(0.96)	(1.09)	(0.09)	$(1.83)^{*}$	(1.52)	(1.52)	(0.08)
	C_{t+1}	0.5147	0.4223	0.4267	-0.0081	-0.0112	0.0758	0.0686	0.0244
		$(1.75)^{*}$	$(1.95)^{*}$	$(2.08)^{**}$	(0.18)	(0.02)	(0.16)	(0.24)	(0.57)
	P_t	0.00266	0.00162	0.00153	-0.00196	-0.00538	-0.00523	-0.00657	-0.00999
		(0.70)	(0.50)	(0.51)	(0.98)	(0.89)	(0.94)	(1.48)	$(3.49)^{**}$
	R^2	0.5898	0.5959	0.5946	0.3248	0.3991	0.4318	0.4230	0.2356
	Wu-F	(2.88)	3.08	3.58	-	3.25	(2.69)	1.38(-)	-
	chi-sq	7.020	10.434	14.876	-	7.433	6.225	19.959	-
	(p-val)	0.3190	0.1653	0.4604	-	0.2826	0.5137	0.1735	-
	F_t-1	0.97(-)	2.00	0.77(-)	-	(1.82)	2.41	1.09(-)	-
	F_t+1	2.06	2.37	(1.63)	-	1.29(-)	3.15	1.00(-)	-
	LR-e	-	-	-	-	-	-0.5100	-0.4512	-0.3949
	SR-e	-	-	-	-	-	-0.2278	-0.2787	-0.3936

Table 14. Estimation of smoking participation equations for different educational level (Dependent variable = proportion of smokers)

Independent Variables		High (above High school diploma)				Low (otherwise)			
		TSLS			OLS	TSLS			OLS
		I	II	III		I	II	III	
Myopic model	C_{t-1}	0.5389	0.2979	0.5229	0.0385	0.7527	0.9545	0.6885	0.0491
		(0.99)	(0.63)	(1.64)	(0.99)	(2.33)**	(2.32)**	(2.48)**	(1.22)
	P_t	-0.00008	-0.00013	-0.00008	-0.00018	-0.00026	-0.00018	-0.00028	-0.00053
		(0.58)	(1.06)	(0.80)	(2.55)**	(1.53)	(0.90)	(1.83)*	(5.48)**
	R^2	0.6713	0.6154	0.6700	0.4650	0.5637	0.5439	0.5665	0.2891
	Wu-F	1.11(-)	0.33(-)	(3.05)	-	7.68	9.67	8.13	-
	chi-sq	0.443	1.592	4.301	-	2.993	2.800	9.237	-
	(p-val)	0.9313	0.6613	0.82901.16	-	0.3928	0.4235	0.3227	-
	F-iv	0.90(-)	1.00(-)	(-)	-	3.35	2.54	(1.89)	-
	LR-e	-0.1298	-0.1381	-0.1307	-0.1424	-0.4918	-1.8898	-0.4268	-0.2587
	SR-e	-0.0599	-0.0970	-0.0623	-0.1369	-0.1216	-0.0859	-0.1330	-0.2460
Rational addiction model		IV	V	VI		IV	V	VI	
	C_{t-1}	0.3899	0.4045	0.3814	0.0385	0.4153	0.5114	0.2922	0.0333
		(0.52)	(0.64)	(1.23)	(0.99)	(1.43)	(2.15)**	(1.86)*	(0.82)
	C_{t+1}	0.2176	0.3911	0.3569	0.0389	0.2421	-0.0889	0.2030	0.0470
		(0.39)	(0.74)	(1.07)	(0.87)	(0.59)	(0.33)	(1.07)	(1.06)
	P_t	-0.00007	-0.00004	-0.00005	-0.00016	-0.00025	-0.00038	-0.00031	-0.00048
		(0.58)	(0.38)	(0.55)	(2.29)**	(1.32)	(2.29)**	(2.16)**	(4.88)**
	R^2	0.7136	0.7317	0.7300	0.4876	0.6165	0.5032	0.5864	0.3200
	Wu-F	1.31(-)	2.04(-)	3.57	-	3.08	3.14	(2.59)	-
	chi-sq	3.756	4.268	6.962	-	10.397	18.827	38.899	-
	(p-val)	0.7096	0.7484	0.9587	-	0.1089	0.0087	0.0007	-
	F_t-1	0.68(-)	1.49(-)	0.95(-)	-	2.63	4.18	2.40	-
	F_t+1	1.51(-)	2.27	1.08(-)	-	1.58(-)	5.55	1.92	-
	LR-e	-0.1348	-0.1580	-0.1505	-0.1353	-0.3390	-	-0.2885	-0.2445
	SR-e	-0.0768	-0.0784	-0.0820	-0.1301	-0.1802	-	-0.1985	-0.2363

Table 15. Estimation of cigarette demand equations for different educational level (Dependent variable = average daily cigarette consumption of smokers)

Independent Variables		High (above High school diploma)				Low (otherwise)			
		TSLS			OLS	TSLS			OLS
		I	II	III		I	II	III	
Myopic model	C_{t-1}	0.9319	-0.6997	-0.0836	0.0091	-0.3254	-0.4997	-0.3437	0.0204
		(0.26)	(0.62)	(0.18)	(0.24)	(0.71)	(1.13)	(1.02)	(0.48)
	P_t	-0.00277	-0.00916	-0.00674	-0.00638	-0.01895	-0.02133	-0.01919	-0.0142
		(0.28)	(1.33)	(1.48)	(1.53)	(2.51)**	(2.83)**	(3.08)**	(3.56)**
	R^2	0.4139	0.0008	0.2928	0.3581	0.0041	0.0409	0.0010	0.4006
	Wu-F	0.42(-)	0.65(-)	0.04(-)	-	0.65(-)	1.79(-)	1.37(-)	-
	chi-sq	0.332	3.773	11.038	-	1.204	0.895	6.661	-
	(p-val)	0.9540	0.2871	0.1996	-	0.7520	0.8267	0.5736	-
	F-iv	0.10(-)	0.26(-)	0.42(-)	-	1.30(-)	1.58(-)	1.09(-)	-
	LR-e	-0.2942	-	-	-0.0466	-	-	-	-0.0985
	SR-e	-0.0200	-	-	-0.0462	-	-	-	-0.0965
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	0.2367	-0.6808	-0.0291	0.0045	0.0733	0.0313	0.1128	0.0209
model		(0.46)	(0.97)	(0.10)	(0.12)	(0.21)	(0.12)	(0.54)	(0.50)
	C_{t+1}	-0.1948	-0.1696	0.0528	-0.0294	0.3925	0.1714	0.1654	0.0334
		(0.47)	(0.38)	(0.18)	(0.70)	(1.47)	(0.86)	(0.93)	(0.80)
	P_t	-0.00579	-0.00873	-0.00596	-0.00608	-0.00758	-0.01047	-0.00941	-0.01207
		(1.21)	(1.45)	(1.35)	(1.45)	(1.25)	(2.00)**	(1.87)*	(3.01)**
	R^2	0.3281	0.0109	0.3506	0.3254	0.6072	0.5370	0.5764	0.4236
	Wu-F	0.11(-)	0.36(-)	0.12(-)	-	1.51(-)	0.12(-)	0.41(-)	-
	chi-sq	1.945	4.875	14.857	-	7.223	16.198	22.606	-
	(p-val)	0.9247	0.6753	0.4618	-	0.3007	0.0234	0.0929	-
	F_t-1	0.48(-)	0.36(-)	0.63(-)	-	1.46(-)	3.19	1.41(-)	-
	F_t+1	0.61(-)	0.80(-)	0.71(-)	-	2.28	3.17	1.83	-
	LR-e	-	-	-	-	-0.0963	-0.0892	-0.0836	-0.0866
	SR-e	-	-	-	-	-0.0890	-0.0819	-0.0819	-0.0848

Table 16. Estimation of cigarette demand equations for different educational level (Dependent variable = per capita cigarette consumption)

Independent Variables		High (above High school diploma)				Low (otherwise)			
		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	-0.1136	0.0287	0.4755	0.0417	1.5011	1.5594	1.1248	0.0431
		(0.12)	(0.05)	(1.22)	(1.07)	(1.21)	(1.37)	(1.35)	(1.03)
	P_t	-0.00297	-0.00254	-0.00118	-0.00250	0.00881	0.00982	0.00233	-0.01631
		(0.91)	(1.10)	(0.59)	(1.72)*	(0.39)	(0.46)	(0.15)	(3.63)**
	R^2	0.3062	0.4171	0.6433	0.4270	0.3450	0.3434	0.3573	0.1258
	Wu-F	0.03(-)	0.00(-)	1.54(-)	-	4.54	6.11	(3.82)	-
	chi-sq	0.237	4.051	9.111	-	1.068	0.995	4.070	-
	(p-val)	0.9714	0.2560	0.3330	-	0.7849	0.8024	0.8508	-
	F-iv	0.23(-)	0.60(-)	0.74(-)	-	0.50(-)	0.62(-)	0.34(-)	-
	LR-e	-	-0.1115	-0.1060	-0.1113	-	-	-	-0.3722
	SR-e	-	-0.1083	-0.1013	-0.1066	-	-	-	-0.3562
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	0.0755	0.3963	0.2602	0.0415	0.2592	0.5695	0.3564	0.0437
model		(0.16)	(0.77)	(0.93)	(1.06)	(0.29)	(1.00)	(0.97)	(1.04)
	C_{t+1}	0.2119	0.3464	0.2898	0.0332	0.4323	0.2635	0.3473	0.0439
		(0.59)	(0.97)	(1.08)	(0.74)	(0.92)	(0.79)	(1.45)	(1.00)
	P_t	-0.00187	-0.00678	-0.00118	-0.00229	-0.00480	-0.00240	-0.00460	-0.01510
		(0.98)	(0.33)	(0.67)	(1.55)	(0.47)	(0.28)	(0.62)	(3.28)**
	R^2	0.5958	0.7308	0.7040	0.4523	0.4616	0.4473	0.4652	0.1797
	Wu-F	0.23(-)	0.42(-)	1.31(-)	-	(2.87)	3.81	(2.69)	-
	chi-sq	5.041	9.193	14.973	-	7.109	8.875	12.908	-
	(p-val)	0.5386	0.2391	0.4534	-	0.3109	0.2617	0.6094	-
	F_t-1	0.64(-)	0.96(-)	0.76(-)	-	0.72(-)	2.35	0.64(-)	-
	F_t+1	1.28(-)	1.59(-)	1.12(-)	-	2.63	4.13	(1.49)	-
	LR-e	-0.1119	-0.1124	-0.1121	-0.1060	-0.3401	-0.3144	-0.3391	-0.3614
	SR-e	-0.1033	-0.0591	-0.0803	-0.1013	-0.2389	-0.0950	-0.1978	-0.3456

Table 17. Estimation of smoking participation equations for different checkup groups (Dependent variable = proportion of smokers)

Independent		Routine (within a year)				Rare (otherwise)			
Variables		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	0.8011	0.6657	0.6512	0.0903	0.7301	0.4527	0.4040	0.0081
		(1.46)	(1.57)	(1.87)*	(2.13)**	(1.95)*	(1.39)	(1.40)	(0.19)
	P_t	-0.00005	-0.0007	-0.00007	-0.00015	-0.00022	-0.00030	-0.00031	-0.00043
		(0.41)	(0.68)	(0.75)	(2.36)**	(1.32)	(2.03)**	(2.25)**	(4.07)**
	R^2	0.7878	0.7831	0.7821	0.5295	0.5590	0.5371	0.5274	0.2963
	Wu-F	2.65(-)	2.54(-)	(3.60)	-	5.98	2.30(-)	2.27(-)	-
	chi-sq	3.659	7.168	11.338	-	1.764	5.599	8.594	-
	(p-val)	0.3008	0.0667	0.1833	-	0.6229	0.1328	0.3777	-
	F-iv	1.18(-)	1.72(-)	1.11(-)	-	2.66	2.72	1.49(-)	-
	LR-e	-0.1564	-0.1329	-0.1319	-0.1111	-0.4046	-0.2716	-0.2610	-0.2136
	SR-e	-0.0311	-0.0444	-0.0455	-0.1011	-0.1092	-0.1486	-0.1556	-0.2118
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	-0.1882	0.2581	0.3488	0.0846	0.7364	0.3627	0.3310	0.0045
model		(0.37)	(0.77)	(1.58)	(1.99)**	(1.38)	(1.21)	(1.58)	(0.10)
	C_{t+1}	0.7821	0.4632	0.4684	0.0924	0.1633	0.3479	0.4271	0.0317
		(1.78)*	(1.46)	(1.93)*	(2.01)**	(0.24)	(0.87)	(1.85)*	(0.71)
	P_t	-0.00004	-0.00004	-0.00002	-0.00013	-0.00013	-0.00018	-0.00016	-0.00038
		(0.37)	(0.41)	(0.27)	(1.98)**	(0.70)	(1.13)	(1.14)	(3.61)**
	R^2	0.7105	0.8083	0.8194	0.5945	0.5938	0.6248	0.6302	0.3303
	Wu-F	(2.89)	2.16(-)	3.97	-	5.18	3.72	5.44	-
	chi-sq	5.098	13.604	18.886	-	1.598	10.866	15.764	-
	(p-val)	0.5314	0.0587	0.2189	-	0.9528	0.1446	0.3979	-
	F_t-1	1.26(-)	1.93	(1.51)	-	1.58(-)	2.83	1.74	-0.1980
	F_t+1	2.15	3.48	1.37(-)	-	1.04(-)	2.58	1.36(-)	-0.1971
	LR-e	-	-0.0864	-0.0833	-0.1046	-0.6725	-0.3092	-0.3351	
	SR-e	-	-0.0605	-0.0467	-0.0957	-0.0968	-0.1776	-0.2014	

Table 18. Estimation of cigarette demand equations for different checkup groups
(Dependent variable = average daily cigarette consumption of smokers)

Independent Variables		Routine (within a year)				Rare (otherwise)			
		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	-0.4397	-0.3597	-0.4603	-0.0305	1.1175	-0.9539	0.3547	0.0157
		(0.96)	(0.92)	(1.32)	(0.76)	(0.82)	(0.64)	(1.02)	(0.35)
	P_t	-0.00994	-0.00947	-0.01006	-0.00751	0.00219	-0.01520	-0.00422	-0.0706
		$(2.06)^{**}$	$(2.10)^{**}$	$(2.23)^{**}$	$(2.06)^{**}$	(0.16)	(1.06)	(0.69)	(1.39)
	R^2	0.0640	0.1170	0.0528	0.3881	0.4684	0.2034	0.4964	0.3814
	Wu-F	0.98(-)	0.82(-)	1.90(-)	-	1.47(-)	0.82(-)	1.08(-)	-
	chi-sq	0.372	2.507	6.064	-	2.464	2.123	8.835	-
	(p-val)	0.9459	0.4739	0.6400	-	0.4817	0.5472	0.3564	-
	F-iv	1.19(-)	1.54(-)	0.92(-)	-	0.30(-)	0.22(-)	1.02(-)	-
	LR-e	-	-	-	-	-	-	-0.0428	-0.0470
	SR-e	-	-	-	-	-	-	-0.0276	-0.0463
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	-0.0174	-0.1651	-0.1118	-0.0361	1.0222	0.4345	0.4739	0.0131
model		(0.05)	(0.58)	(0.50)	(0.89)	(1.33)	(0.80)	$(1.70)^{*}$	(0.29)
	C_{t+1}	0.0005	-0.2912	-0.2699	-0.0298	0.1238	0.4732	0.4258	-0.00286
		(0.00)	(1.14)	$(1.38)^{**}$	(0.71)	(0.28)	(1.58)	(1.59)	(0.07)
	P_t	-0.00658	-0.00938	-0.00894	-0.00689	0.00326	0.00023	0.00030	-0.0062
		(1.54)	$(2.09)^{**}$	$(2.13)^{**}$	$(1.87)^{*}$	(0.34)	(0.03)	(0.05)	(1.21)
	R^2	0.3818	0.0742	0.1560	0.3485	0.4770	0.5280	0.5280	0.3541
	Wu-F	0.00(-)	0.92(-)	0.78(-)	-	(2.35)	2.24(-)	4.11	-
	chi-sq	3.116	5.521	12.927	-	4.493	6.822	10.062	-
	(p-val)	0.7941	0.5967	0.6080	-	0.6102	0.4476	0.8158	-
	F_t-1	1.11(-)	1.44(-)	1.08(-)	-	0.48(-)	0.77(-)	1.05(-)	-
	F_t+1	1.51(-)	1.47(-)	1.24(-)	-	1.48(-)	1.59(-)	1.07(-)	-
	LR-e	-	-	-	-	-	-	-	-
	SR-e	-	-	-	-	-	-	-	-

Table 19. Estimation of cigarette demand equations for different checkup groups (Dependent variable = per capita cigarette consumption)

Independent		Routine (within a year)				Rare (otherwise)			
Variables		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	1.4747	0.5657	0.4779	0.0751	0.6908	0.4037	0.1834	-0.0082
		(0.65)	(0.90)	(0.97)	(1.77)*	(1.18)	(0.89)	(0.48)	(0.19)
	P_t	0.01187	-0.00121	-0.00145	-0.00251	-0.00298	-0.00517	-0.00685	-0.00831
		(0.18)	(0.53)	(0.72)	(1.79)*	(0.55)	(1.18)	(1.78)*	(3.29)**
	R^2	0.7232	0.7859	0.7713	0.5159	0.6115	0.5824	0.5045	0.3500
	Wu-F	1.20(-)	0.78(-)	0.79(-)	-	2.18(-)	0.98(-)	0.27(-)	-
	chi-sq	1.286	2.869	8.784	-	0.391	2.073	5.906	-
	(p-val)	0.7325	0.4123	0.3609	-	0.9422	0.5573	0.6577	-
	F-iv	0.14(-)	0.73(-)	0.49(-)	-	1.07(-)	1.38(-)	0.77(-)	-
	LR-e	-	-0.1025	-0.1016	-0.0995	-0.2391	-0.2150	-0.2080	-
	SR-e	-	-0.0445	-0.0530	-0.0920	-0.0739	-0.1282	-0.1698	-
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	0.1729	0.5988	0.2735	0.0731	1.1973	0.3177	0.3797	-0.0094
model		(0.47)	(0.18)	(1.24)	(1.71)*	(1.11)	(1.03)	(1.64)	(0.22)
	C_{t+1}	0.3682	0.1684	0.1819	0.0460	-0.3997	0.4997	0.4658	0.0080
		(1.35)	(0.62)	(0.86)	(1.00)	(0.32)	(1.27)	(1.73)*	(0.18)
	P_t	-0.00092	-0.00184	-0.00127	-0.00221	-0.00091	-0.00214	-0.00188	-0.00767
		(0.50)	(1.08)	(0.76)	(1.55)	(0.14)	(0.53)	(0.51)	(2.99)**
	R^2	0.8033	0.6488	0.7821	0.5565	0.4913	0.6845	0.6844	0.3581
	Wu-F	1.30(-)	0.24(-)	1.09(-)	-	(3.25)	3.25	4.40	-
	chi-sq	8.516	14.961	23.816	-	0.531	9.593	14.846	-
	(p-val)	0.2027	0.0365	0.0683	-	0.9974	0.2128	0.4626	-
	F_t-1	1.07(-)	1.43(-)	1.28(-)	-	0.83(-)	2.57	1.45(-)	-
	F_t+1	2.16	2.56	1.39(-)	-	0.84(-)	2.18	1.12(-)	-
	LR-e	-0.0733	-0.0875	-0.0857	-0.0918	-	-0.2915	-0.3015	-0.2003
	SR-e	-0.0597	-0.0822	-0.0609	-0.0850	-	-0.1760	-0.1529	-0.1984

Table 20. Estimation of smoking participation equations for different exercise groups (Dependent variable = proportion of smokers)

Independent Variables		Exercise regularly TSLS			Exercise regularly OLS	Do not exercise TSLS			Do not exercise OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	0.1643	0.2570	0.2437	-0.0865	-0.3644	0.0094	-0.2962	0.0142
		(0.47)	(0.82)	(0.97)	(1.69)*	(0.86)	(0.02)	(0.83)	(0.25)
	P_t	-0.00023	-0.00021	-0.00021	-0.00029	-0.00074	-0.00058	-0.00071	-0.00058
		(1.56)	(1.42)	(1.53)	(2.55)**	(2.72)**	(2.14)**	(2.83)**	(3.01)**
	R^2	0.5432	0.5754	0.5714	0.4089	0.0023	0.0369	0.0002	0.0384
	Wu-F	0.58(-)	1.45(-)	2.12(-)	-	0.96(-)	0.00(-)	0.87(-)	-
	chi-sq	5.064	2.119	7.328	-	4.890	3.504	7.161	-
	(p-val)	0.1671	0.5480	0.5017	-	0.1800	0.3202	0.51930.85	-
	F-iv	1.58(-)	(2.10)	1.45(-)	-	1.43(-)	1.04(-)	(-)	-
	LR-e	-0.1781	-0.1802	-0.1800	-	-	-0.2684	-	-0.2688
	SR-e	-0.1489	-0.1339	-0.1361	-	-	-0.2658	-	-0.2649
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	-0.0221	0.1177	0.0533	-0.1173	0.3701	0.2384	0.1422	-0.0009
model		(0.06)	(0.44)	(0.25)	(2.12)**	(1.37)	(1.29)	(0.93)	(0.01)
	C_{t+1}	-0.2829	0.2180	0.1097	-0.0684	0.3217	0.2376	0.1703	0.0303
		(0.72)	(0.55)	(0.45)	(1.01)	(1.01)	(0.62)	(0.76)	(0.42)
	P_t	-0.00040	-0.00020	-0.00026	-0.00037	-0.00031	-0.00037	-0.00041	-0.00048
		(2.11)**	(1.01)	(1.59)	(2.73)**	(1.14)	(1.47)	(1.72)	(2.12)**
	R^2	0.2024	0.5610	0.4928	0.3008	0.3426	0.2385	0.1516	0.0364
	Wu-F	0.40(-)	0.37(-)	1.61(-)	-	2.24(-)	(2.62)	1.70(-)	-
	chi-sq	2.799	2.585	8.461	-	18.483	12.134	35.247	-
	(p-val)	0.8336	0.9206	0.9040	-	0.0051	0.0963	0.0023	-
	F_t-1	0.95(-)	(2.10)	1.03(-)	-	(1.75)	2.04	1.88	-
	F_t+1	0.69(-)	1.63(-)	1.04(-)	-	2.32	(1.82)	(1.57)	-
	LR-e	-	-0.1965	-0.1975	-	-0.4571	-0.3174	-0.2692	-
	SR-e	-	-0.1361	-0.1869	-	-0.2608	-0.2369	-0.2303	-

Table 21. Estimation of cigarette demand equations for different exercise groups
(Dependent variable = average daily cigarette consumption of smokers)

Independent		Exercise regularly				Do not exercise			
Variables		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	-0.2043	0.1501	0.3371	-0.1011	-0.3457	0.4845	-0.1189	-0.0289
		(0.45)	(0.33)	(1.34)	(1.90)*	(0.81)	(0.93)	(0.44)	(0.50)
	P_t	-0.01885	-0.01125	-0.01308	-0.0166	-0.02703	-0.01299	-0.02319	-0.02167
		(1.68)*	(0.99)	(0.87)	(2.88)**	(2.26)**	(0.96)	(2.29)**	(2.38)**
	R^2	0.3442	0.5740	0.5980	0.4449	0.0613	0.5399	0.2872	0.3785
	Wu-F	0.05(-)	0.34(-)	4.11	-	0.62(-)	1.28(-)	0.12(-)	-
	chi-sq	1.115	2.502	7.342	-	4.005	5.325	19.860	-
	(p-val)	0.7735	0.4749	0.5002	-	0.2609	0.1495	0.0109	-
	F-iv	0.94(-)	1.00(-)	(1.71)	-	1.36(-)	1.07(-)	1.43(-)	-
	LR-e	-	-0.0963	-0.0795	-	-	-0.1604	-	-
	SR-e	-	-0.0819	-0.0527	-	-	-0.0827	-	-
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	-0.0763	0.4191	0.3135	-0.0953	-0.3682	-0.0387	-0.0975	-0.0251
model		(0.17)	(0.87)	(1.18)	(1.66)*	(1.32)	(0.13)	(0.52)	(0.39)
	C_{t+1}	0.3015	0.3775	0.3683	-0.1173	-0.2834	-0.2060	-0.1982	-0.0675
		(0.75)	(0.84)	(1.11)	(1.69)*	(0.65)	(0.71)	(0.79)	(1.02)
	P_t	-0.01626	-0.00587	-0.00803	-0.0199	-0.02202	-0.01971	-0.01962	-0.01649
		(1.58)	(0.50)	(0.88)	(3.00)**	(1.48)	(1.60)	(1.65)	(1.59)
	R^2	0.5927	0.6303	0.6326	0.4015	0.0056	0.1823	0.1304	0.3082
	Wu-F	0.44(-)	(2.81)	5.12	-	1.40(-)	0.07(-)	0.12(-)	-
	chi-sq	5.386	8.075	12.539	-	10.922	7.648	25.697	-
	(p-val)	0.4953	0.3261	0.6379	-	0.0908	0.3647	0.0413	-
	F_t-1	0.66(-)	1.93	1.08(-)	-	1.16(-)	1.04(-)	1.05(-)	-
	F_t+1	0.96(-)	1.37(-)	1.03(-)	-	1.03(-)	1.35(-)	1.00(-)	-
	LR-e	-	-0.2100	-0.1837	-	-	-	-	-
	SR-e	-	-0.1004	-0.1173	-	-	-	-	-

Table 22. Estimation of cigarette demand equations for different exercise groups
(Dependent variable = per capita cigarette consumption)

Independent		Exercise regularly				Do not exercise			
Variables		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	0.3702	0.5151	0.3961	-0.0450	-0.4751	0.2195	-0.2776	0.0144
		(0.88)	(1.42)	(1.83)*	(0.85)	(1.26)	(0.55)	(0.92)	(0.25)
	P_t	-0.00299	-0.00198	-0.00281	-0.00588	-0.01755	-0.00988	-0.01537	-0.01215
		(0.75)	(0.52)	(0.90)	(2.39)**	(2.50)**	(1.46)	(2.47)**	(2.41)**
	R^2	0.6889	0.7084	0.6942	0.4560	0.0342	0.3859	0.0011	0.1199
	Wu-F	1.24(-)	(3.51)	5.76	-	2.20(-)	0.28(-)	1.06(-)	-
	chi-sq	2.290	0.657	5.332	-	5.684	5.927	12.942	-
	(p-val)	0.5144	0.8832	0.7215	-	0.1281	0.1152	0.11391.20	-
	F-iv	1.31(-)	(2.03)	2.31	-	(2.02)	1.50(-)	(-)	-
	LR-e	-0.1692	-0.1458	-0.1659	-	-	-0.2792	-	-0.2717
	SR-e	-0.1066	-0.0707	-0.1002	-	-	-0.2179	-	-0.2678
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	-0.0390	0.2794	0.1801	-0.0537	0.1007	0.1690	0.0838	0.0274
model		(0.07)	(0.86)	(0.82)	(0.92)	(0.46)	(0.91)	(0.55)	(0.43)
	C_{t+1}	0.1988	0.5907	0.4278	-0.0279	0.2590	0.1716	0.1603	-0.0004
		(0.34)	(1.11)	(1.25)	(0.40)	(0.77)	(0.50)	(0.64)	(0.01)
	P_t	-0.00675	-0.00246	-0.00397	-0.00787	-0.00751	-0.00756	-0.00822	-0.00958
		(1.46)	(0.55)	(1.09)	(2.72)**	(1.13)	(1.18)	(1.32)	(1.62)
	R^2	0.5960	0.7644	0.7550	0.3800	0.5017	0.5039	0.3948	0.1455
	Wu-F	0.36(-)	2.18(-)	4.18	-	0.54(-)	1.80(-)	0.96(-)	-
	chi-sq	4.800	1.800	7.438	-	28.664	16.056	42.911	-
	(p-val)	0.5697	0.9701	0.9443	-	0.0001	0.0246	0.0001	-
	F_t-1	0.80(-)	(1.80)	1.44(-)	-	2.52	2.18	1.93	-
	F_t+1	0.49(-)	1.15(-)	0.95(-)	-	2.44	(1.79)	1.47(-)	-
	LR-e	-	-0.6736	-0.3611	-	-0.2586	-0.2526	-0.2397	-
	SR-e	-	-0.4358	-0.2601	-	-0.2318	-0.2086	-0.2194	-

Table 23. Estimation of cigarette demand equations for different smoking intensities (Dependent variable = average daily cigarette consumption of smokers)

Independent Variables		Heavy (>20 cigarettes a day)				Light (<20 cigarettes a day)			
		TSLS			OLS	TSLS			OLS
Myopic model		I	II	III		I	II	III	
	C_{t-1}	-0.2231	0.9218	0.1414	-0.0204	0.1325	0.0178	0.0804	0.0549
		(0.41)	(0.89)	(0.36)	(0.46)	(0.24)	(0.04)	(0.21)	(1.37)
	P_t	-0.02440	-0.00709	-0.01889	-0.02134	-0.00230	-0.00270	-0.00248	-0.00257
		(2.43)**	(0.41)	(2.28)**	(3.75)**	(0.88)	(1.11)	(1.14)	(1.49)
	R^2	0.0150	0.0582	0.0793	0.0520	0.5223	0.4848	0.5075	0.4989
	Wu-F	0.14(-)	1.55(-)	0.17(-)	-	0.02(-)	0.01(-)	0.00(-)	-
	chi-sq	3.098	1.709	9.958	-	0.487	0.443	4.019	-
	(p-val)	0.3767	0.6349	0.2683	-	0.9217	0.9312	0.8554	-
	F-iv	0.92(-)	0.46(-)	0.76(-)	-	0.68(-)	0.89(-)	0.66(-)	-
	LR-e	-	-0.3390	-0.0823	-	-0.0352	-0.0365	-0.0358	-0.0474
	SR-e	-	-0.0265	-0.0707	-	-0.0305	-0.0358	-0.0329	-0.0448
Rational addiction model		IV	V	VI		IV	V	VI	
	C_{t-1}	-0.2465	-0.1962	0.0251	-0.0176	-0.4569	-0.0261	-0.3569	0.0612
		(0.64)	(0.40)	(0.09)	(0.41)	(0.92)	(0.04)	(1.19)	(1.52)
	C_{t+1}	-0.1120	0.2720	-0.0764	-0.0121	0.2374	0.6342	0.0253	0.0259
		(0.40)	(0.67)	(0.38)	(0.29)	(0.52)	(1.26)	(0.09)	(0.60)
	P_t	-0.02571	-0.01807	-0.02096	-0.02046	-0.00398	-0.00133	-0.00402	-0.00228
		(2.64)**	(1.72)*	(2.70)**	(3.62)**	(1.39)	(0.43)	(1.76)*	(1.30)
	R^2	0.0057	0.0328	0.0398	0.0426	0.2918	0.5280	0.2691	0.5071
	Wu-F	0.23(-)	0.00(-)	0.02(-)	-	0.42(-)	0.50(-)	1.03(-)	-
	chi-sq	7.261	8.215	19.553	-	4.918	1.272	10.888	-
	(p-val)	0.2974	0.3141	0.1898	-	0.5544	0.9892	0.7605	-
	F_t-1	0.87(-)	1.36(-)	0.77(-)	-	0.72(-)	0.84(-)	0.73(-)	-
	F_t+1	1.30(-)	1.56(-)	1.13(-)	-	0.90(-)	0.56(-)	0.82(-)	-
	LR-e	-	-	-	-	-	-	-	-0.0331
	SR-e	-	-	-	-	-	-	-	-0.0310

Table 24. Estimation of non-addictive smoking participation equations on Tax (Dependent variable = proportion of smokers, C_t)

	Full	Age		Education		Checkup		Exercise	
	Sample	Old	Young	High	Low	Routine	Rare	Yes	No
T_t	-0.00044	-0.00031	-0.00064	-0.00029	-0.00066	-0.00023	-0.00052	-0.00035	-0.00061
	(6.39)**	(3.97)**	(5.88)**	(3.66)**	(6.21)**	(3.14)**	(4.51)**	(3.79)**	(3.88)**
Income	0.0001	-0.0003	0.0009	-0.0011	0.0009	0.0008	0.0001	0.0003	0.0021
	(0.22)	(0.39)	(1.07)	(2.00)**	(0.94)	(1.23)	(0.01)	(0.45)	(1.69)*
Sex	0.1068	-0.0138	0.2123	-0.0149	-0.0416	0.0391	-0.0677	0.1120	-0.0532
	(1.24)	(0.18)	(2.39)**	(0.32)	(0.72)	(0.80)	(1.57)	(1.77)*	(1.02)
Race	0.0101	0.0509	-0.0412	-0.0408	0.0349	0.0526	-0.0975	0.0222	0.0801
	(0.38)	(1.44)	(1.34)	(1.16)	(1.13)	(1.85)*	(2.48)**	(0.59)	(1.82)*
Employ	0.0397	0.0689	0.0299	-0.0023	0.0953	0.0569	0.0025	0.0242	0.0456
	(1.66)	(2.44)**	(1.14)	(0.10)	(2.69)**	(2.23)**	(0.09)	(0.60)	(0.94)
Education	-0.0553	-0.0349	-0.1266	-	-	-0.0551	-0.0932	-0.1291	-0.0783
	(2.23)**	(1.39)	(4.29)**	-	-	(1.86)*	(2.90)**	(4.41)**	(1.96)*
Age	-0.0013	-	-	0.0022	-0.0021	0.0001	-0.0030	-0.0010	-0.0024
	(1.34)	-	-	(2.09)**	(1.98)**	(0.03)	(2.41)**	(0.95)	(1.97)**
Marital	-0.0332	0.0141	-0.0712	-0.0363	-0.0287	-0.0247	-0.0346	-0.0498	0.0248
	(1.10)	(0.46)	(2.17)**	(1.22)	(0.75)	(0.81)	(0.94)	(1.35)	(0.54)
R^2	0.4961	0.4302	0.4390	0.4459	0.2353	0.4559	0.3055	0.5924	0.1494
Price Elasticity	-0.2318	-0.1688	-0.3136	-0.2030	-0.2787	-0.1010	-0.2345	-0.2043	-0.2498

Notes, ** = significant at 5% level and * = significant at 10% level.

Table 25. Estimation of non-addictive cigarette demand equations on tax

	Dependent variable = Per Capita Consumption										
	Full	Age		Education		Checkup		Exercise		Intensity	
	Sample	Old	Young	High	Low	Routine	Rare	Yes	No	Heavy	Light
T_t	-0.0089	-0.0051	-0.0115	-0.0047	-0.0200	-0.0038	-0.0113	-0.0067	-0.0129	-	-
	(5.99)**	(2.32)**	(3.74)**	(2.90)**	(4.13)**	(2.37)**	(4.04)**	(3.55)**	(3.15)**	-	-
Inc.	0.0111	-0.0328	0.0135	-0.0174	0.0304	0.0219	0.0046	0.0125	0.0454	-	-
	(0.82)	(1.67)*	(0.81)	(1.49)	(0.90)	(1.46)	(0.22)	(0.88)	(1.44)	-	-
Sex	-1.1369	-3.7976	-1.6818	-1.2775	-2.1474	-0.3272	-1.9943	-0.8739	-2.7881	-	-
	(0.61)	(3.01)**	(1.42)	(1.36)	(1.82)*	(0.31)	(1.93)**	(0.68)	(2.04)**	-	-
Edu.	-1.6586	-1.1723	-2.1012	-	-	-1.8138	-2.7994	-2.6513	-2.1484	-	-
	(3.08)**	(1.91)*	(3.71)**	-	-	(2.82)**	(3.62)**	(4.45)**	(2.07)**	-	-
Age	0.0187	-	-	0.0663	-0.0428	0.0121	0.0070	0.0156	0.0115	-	-
	(0.87)**	-	-	(3.09)**	(1.70)*	(0.67)	(0.23)	(0.72)	(0.36)	-	-
R^2	0.4775	0.3809	0.2229	0.4105	0.0795	0.4447	0.3701	0.5550	0.2331	-	-
Elast.	-0.2493	-0.1745	-0.3981	-0.1820	-0.3928	-0.1242	-0.2513	-0.2148	-0.2542	-	-

	Dependent variable = average daily cigarette consumption of smokers only										
	Full	Age		Education		Checkup		Exercise		Intensity	
	Sample	Old	Young	High	Low	Routine	Rare	Yes	No	Heavy	Light
T_t	-0.0135	-0.0201	-0.0066	-0.0095	-0.0169	-0.0084	-0.0131	-0.0134	-0.0151	-0.0254	-0.0039
	(4.04)**	(4.89)**	(1.42)	(2.01)**	(3.87)**	(2.04)**	(2.33)**	(2.89)**	(2.10)**	(4.11)**	(1.97)**
Inc.	0.0409	0.0102	0.0489	-0.0006	0.0630	0.0588	0.0229	0.0268	0.0097	0.0146	-0.0019
	(1.57)	(0.36)	(1.85)*	(0.02)	(1.99)**	(1.99)**	(0.72)	(0.94)	(0.23)	(0.50)	(0.15)
Sex	-4.4391	-6.5893	-1.7834	-4.2102	-3.5659	-3.9563	-4.4226	-2.5267	-5.8701	-2.2507	-0.6709
	(4.46)**	(6.45)**	(2.07)**	(4.70)**	(3.69)**	(4.08)**	(4.28)**	(2.36)**	(5.13)**	(2.76)**	(1.73)*
Edu.	-2.9240	-1.4016	-4.3559	-	-	-2.3544	-3.1978	-2.1112	-1.6708	-1.1808	-0.6595
	(3.70)**	(1.70)*	(5.75)**	-	-	(2.65)**	(3.44)**	(2.46)**	(1.57)	(1.53)	(1.81)*
Age	0.1347	-	-	0.1619	0.1215	0.1324	0.2102	0.1283	0.0973	0.0740	-0.0029
	(4.23)**	-	-	(5.01)**	(3.98)**	(4.62)**	(5.52)**	(3.61)**	(2.51)**	(2.40)**	(0.23)
R^2	0.4822	0.4519	0.3770	0.3392	0.3669	0.4068	0.3589	0.4516	0.3739	0.0598	0.4795
Elast.	-0.0844	-0.1168	-0.0459	-0.0612	-0.1028	-0.0551	-0.0770	-0.0879	-0.0862	-0.0853	-0.0464

Note, Race, Marital and Employment variables are not displayed. Heavy (>20 pieces a day), Light (<20 pieces)

Table 26. Estimation of smoking participation for different age groups on tax (Dependent variable = proportions of smokers)

Independent Variables		Old (age>=35)				Young (age<35)			
		TSLS			OLS	TSLS			OLS
		I	II	III		I	II	III	
Myopic model	C_{t-1}	0.3862	0.4511	0.9449	0.0743	0.4292	0.4489	0.5297	0.0567
		(0.55)	(0.75)	(1.50)	$(1.89)^{*}$	(1.16)	(1.21)	(1.52)	(1.43)
	T_t	-0.00018	-0.00016	-0.00005	-0.00025	-0.00042	-0.00041	-0.00037	-0.00061
		(1.00)	(1.03)	(0.29)	$(3.28)^{**}$	$(1.89)^{*}$	$(1.84)^{*}$	$(1.71)^{*}$	$(5.40)^{**}$
	R^2	0.5656	0.5925	0.6600	0.3691	0.6626	0.6660	0.6752	0.4787
	Wu-F	0.22(-)	0.46(-)	(3.71)	-	1.19(-)	1.33(-)	2.36(-)	-
	chi-sq	0.529	0.536	1.737	-	0.126	0.422	0.676	-
	(p-val)	0.4669	0.7649	0.6287	-	0.7224	0.8099	0.8789	-
	F-iv	1.53(-)	0.95(-)	0.90(-)	-	3.63	(2.44)	(2.23)	-
	LR-e	-0.1601	-0.1640	-0.5171	-0.1483	-0.3626	-0.3666	-0.3867	-0.3180
	SR-e	-0.0984	-0.0901	-0.0284	-0.1374	-0.2069	-0.2021	-0.1820	-0.3001
Rational addiction model		IV	V	VI		IV	V	VI	
	C_{t-1}	0.31478	0.2681	0.4481	0.0599	0.6614	0.5679	0.4615	0.0545
		(0.50)	(0.42)	(0.71)	(1.53)	$(2.23)^{**}$	$(1.95)^{*}$	$(1.77)^{*}$	(1.37)
	C_{t+1}	0.1723	0.3197	0.3173	0.0781	-0.3247	0.1250	0.0883	0.0837
		(0.27)	(0.52)	(0.67)	$(1.77)^{*}$	(0.55)	(0.27)	(0.27)	$(1.94)^{*}$
	T_t	-0.00012	-0.00009	-0.00005	-0.00020	-0.00047	-0.00029	-0.00036	-0.00057
		(0.88)	(0.68)	(0.46)	$(2.64)^{**}$	(1.59)	(1.18)	$(1.88)^{*}$	$(4.92)^{**}$
	R^2	0.6234	0.6620	0.7020	0.4140	0.5137	0.7081	0.6985	0.5464
	Wu-F	0.33(-)	0.84(-)	1.96(-)	-	(2.80)	(2.84)	2.07(-)	-
	chi-sq	0.686	1.358	4.292	-	0.393	3.573	5.824	-
	(p-val)	0.7098	0.7154	0.6372	-	0.8217	0.3114	0.4432	-
	F_t-1	1.32(-)	1.01(-)	0.87(-)	-	4.13	2.75	2.52	-
	F_t+1	1.39(-)	(2.03)	(1.83)	-	1.53(-)	2.20	2.23	-
	LR-e	-0.1312	-0.1229	-0.1277	-0.1290	-	-0.4707	-0.3981	-0.3237
	SR-e	-0.0875	-0.0866	-0.0586	-0.1212	-	-0.1811	-0.2065	-0.3058

Table 27. Estimation of cigarette demand for different age groups on tax
(Dependent variable = average daily cigarette consumption of smokers)

Independent Variables		Old (age>=35)				Young (age<35)			
		TSLS			OLS	TSLS			OLS
		I	II	III		I	II	III	
Myopic model	C_{t-1}	0.1251	-0.3734	-0.4651	0.0249	-0.8514	-0.2666	-0.2351	0.0269
		(0.07)	(0.40)	(0.52)	(0.61)	(0.97)	(0.47)	(0.42)	(0.65)
	T_t	-0.01788	-0.02518	-0.02652	-0.01935	-0.01135	-0.00756	-0.00735	-0.00565
		(0.67)	(1.76)*	(1.92)*	(4.54)**	(1.31)	(1.21)	(1.19)	(1.17)
	R^2	0.5065	0.1260	0.0548	0.4650	0.0927	0.0524	0.0766	0.3777
	Wu-F	0.00(-)	0.22(-)	0.39(-)	-	1.85(-)	0.30(-)	0.24(-)	-
	chi-sq	0.108	0.188	0.246	-	0.001	2.732	3.310	-
	(p-val)	0.7423	0.9102	0.9698	-	0.9694	0.2551	0.3463	-
	F-iv	0.14(-)	0.41(-)	0.36(-)	-	1.11(-)	1.08(-)	0.81(-)	-
	LR-e	-0.1190	-	-	-0.0337	-	-	-	-0.0407
	SR-e	-0.1041	-	-	-0.0328	-	-	-	-0.0398
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	0.1253	-0.3036	0.2285	0.0267	-0.0924	-0.0562	0.0575	0.0293
model		(0.22)	(0.47)	(0.70)	(0.66)	(0.22)	(0.13)	(0.16)	(0.70)
	C_{t+1}	0.4667	0.8194	0.1329	0.0454	0.2512	0.4393	0.2232	-0.0004
		(0.91)	(1.38)	(0.49)	(1.12)	(0.43)	(0.86)	(0.58)	(0.01)
	T_t	-0.00834	-0.00846	-0.01260	-0.01702	-0.00598	-0.00528	-0.00510	-0.00584
		(1.06)	(0.87)	(1.80)*	(3.92)**	(0.99)	(0.84)	(0.91)	(1.20)
	R^2	0.5989	0.4768	0.5619	0.4722	0.4588	0.5311	0.5506	0.3774
	Wu-F	1.14(-)	1.33(-)	0.33(-)	-	0.16(-)	0.53(-)	0.11(-)	-
	chi-sq	0.248	2.834	10.371	-	3.131	3.159	5.993	-
	(p-val)	0.8834	0.4179	0.1099	-	0.2090	0.3677	0.4240	-
	F_t-1	1.76(-)	1.37(-)	1.21(-)	-	1.54(-)	1.16(-)	0.94(-)	-
	F_t+1	(2.10)	1.47(-)	1.55(-)	-	0.76(-)	0.68(-)	0.77(-)	-
	LR-e	-0.1190	-	-0.1150	-0.1067	-	-	-0.0499	-
	SR-e	-0.1032	-	-0.0879	-0.1041	-	-	-0.0468	-

Table 28. Estimation of cigarette demand for different age groups on tax
(Dependent variable = per capita cigarette consumption)

Independent Variables		Old (age>=35)				Young (age<35)			
		TSLS			OLS	TSLS			OLS
		I	II	III		I	II	III	
Myopic model	C_{t-1}	0.1750	0.3411	-0.05312	-0.0035	0.4548	0.4527	0.4286	0.0046
		(0.16)	(0.31)	(0.87)	(0.09)	(0.93)	(0.92)	(0.92)	(0.11)
	T_t	-0.00265	-0.00146	-0.0077	-0.00393	-0.00808	-0.00810	-0.00831	-0.01213
		(0.33)	(0.18)	(1.52)	$(1.73)^{*}$	(1.43)	(1.43)	(1.52)	$(3.78)^{**}$
	R^2	0.4608	0.5289	0.0459	0.3441	0.4003	0.4002	0.3979	0.2132
	Wu-F	0.03(-)	0.11(-)	0.99(-)	-	1.03(-)	1.02(-)	0.99(-)	-
	chi-sq	0.744	2.447	2.930	-	0.016	0.321	0.363	-
	(p-val)	0.3884	0.2939	0.4025	-	0.8982	0.8518	0.9478	-
	F-iv	0.40(-)	0.27(-)	0.78(-)	-	(2.40)	1.60(-)	1.30(-)	-
	LR-e	-0.1094	-0.0757	-	-	-0.5109	-0.5101	-0.5017	-0.4204
	SR-e	-0.0901	-0.0499	-	-	-0.2786	-0.2791	-0.2865	-0.4182
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	0.5601	0.6127	0.3168	-0.0063	0.8066	0.5384	0.4996	0.0030
model		(0.67)	(1.29)	(0.91)	(0.16)	(1.48)	(1.48)	(1.46)	(0.07)
	C_{t+1}	0.5813	0.5611	0.3469	-0.0121	-0.6607	0.2427	0.1270	0.0246
		(1.33)	(1.59)	(1.29)	(0.27)	(0.57)	(0.46)	(0.27)	(0.57)
	T_t	0.00402	0.00428	0.00095	-0.00341	-0.01313	-0.00441	-0.00617	-0.01183
		(0.66)	(0.84)	(0.24)	(1.48)	(1.04)	(0.64)	(1.03)	$(3.63)^{**}$
	R^2	0.5771	0.5748	0.5964	0.3266	0.0977	0.4692	0.4455	0.2249
	Wu-F	3.53	2.08(-)	2.03(-)	-	(2.40)	(2.88)	(2.34)	-
	chi-sq	0.132	0.134	10.829	-	1.543	4.342	5.452	-
	(p-val)	0.9363	0.9874	0.0938	-	0.4624	0.2269	0.4872	-
	F_t-1	0.69(-)	1.16(-)	1.14(-)	-	3.07	(2.05)	1.75(-)	-
	F_t+1	2.54	2.53	1.96	-	0.93(-)	1.54(-)	1.54(-)	-
	LR-e	-	-	-	-	-	-0.6967	-0.5704	-0.4195
	SR-e	-	-	-	-	-	-0.2524	-0.2646	-0.4182

Table 29. Estimation of smoking participation for different educational level on tax
(Dependent variable = proportion of smokers)

Independent Variables		High (above High school diploma)				Low (otherwise)			
		TSLS			OLS	TSLS			OLS
		I	II	III		I	II	III	
Myopic model	C_{t-1}	-0.2465	-0.2439	0.0397	0.0402	0.5533	0.4921	0.8081	0.0448
		(0.25)	(0.25)	(0.07)	(1.03)	(1.47)	(1.40)	(2.19)**	(1.10)
	T_t	-0.00033	-0.00033	-0.00025	-0.00025	-0.00043	-0.00046	-0.00033	-0.00064
		(1.15)	(1.15)	(1.35)	(3.11)**	(2.17)**	(2.42)**	(1.58)	(5.81)**
	R^2	0.2577	0.2595	0.4648	0.4652	0.5459	0.5340	0.5515	0.2568
	Wu-F	0.09(-)	0.09(-)	0.00(-)	-	2.41(-)	2.01(-)	7.33	-
	chi-sq	0.037	1.366	1.671	-	0.005	0.431	3.873	-
	(p-val)	0.8473	0.5051	0.6431	-	0.9435	0.8060	0.2755	-
	F-iv	0.46(-)	0.31(-)	0.56(-)	-	4.12	2.97	2.75	-
	LR-e	-	-	-0.1789	-0.1789	-0.4042	-0.3762	-0.7113	-0.2808
	SR-e	-	-	-0.1719	-0.1715	-0.1807	-0.1912	-0.1365	-0.2681
Rational addiction model		IV	V	VI		IV	V	VI	
	C_{t-1}	-0.2486	-0.0864	-0.1959	0.0403	0.5309	0.4767	0.5072	0.0291
		(0.17)	(0.07)	(0.21)	(1.03)	(2.01)**	(1.95)**	(2.15)**	(0.71)
	C_{t+1}	1.1279	0.9102	0.6014	0.0413	-0.4073	0.2163	-0.0537	0.0491
		(0.92)	(0.95)	(1.01)	(0.92)	(0.81)	(0.53)	(0.20)	(1.11)
	T_t	-0.00009	-0.00009	-0.00018	-0.00023	-0.00064	-0.00032	-0.00046	-0.00059
		(0.35)	(0.40)	(0.96)	(2.85)**	(2.11)**	(1.26)	(2.49)**	(5.20)**
	R^2	0.5977	0.6528	0.5827	0.4895	0.2451	0.6046	0.5045	0.2913
	Wu-F	1.87(-)	2.14(-)	1.31(-)	-	(2.99)	2.27(-)	(2.68)	-
	chi-sq	0.467	0.809	3.059	-	0.455	8.277	16.855	-
	(p-val)	0.7917	0.8473	0.8014	-	0.7964	0.0406	0.0098	-
	F_t-1	0.64(-)	0.44(-)	0.49(-)	-	5.05	3.42	3.04	-
	F_t+1	1.36(-)	1.27(-)	1.52(-)	-	1.47(-)	3.00	2.97	-
	LR-e	-	-	-	-0.1741	-	-0.4417	-	-0.2664
	SR-e	-	-	-	-0.1671	-	-0.2038	-	-0.2590

Table 30. Estimation of cigarette demand for different educational level on tax
(Dependent variable = average daily cigarette consumption of smokers)

Independent Variables		High (above High school diploma) TSLS			High OLS	Low (otherwise) TSLS			Low OLS
		I	II	III		I	II	III	
Myopic model	C_{t-1}	-0.1832	-0.4292	-0.6098	0.0096	-1.1664	-0.5416	-0.5531	0.0223
		(0.15)	(0.45)	(0.62)	(0.25)	(1.00)	(1.17)	(1.24)	(0.53)
	T_t	-0.01015	-0.01104	-0.01170	-0.00945	-0.0345	-0.02525	-0.02543	-0.0169
		(1.55)	(1.76)*	(1.72)*	(2.00)**	(1.84)*	(2.95)**	(3.01)**	(3.70)**
	R^2	0.2075	0.0393	0.0011	0.3574	0.3122	0.0892	0.0957	0.3826
	Wu-F	0.03(-)	0.27(-)	0.58(-)	-	2.56(-)	2.00(-)	2.27(-)	-
	chi-sq	3.465	2.999	2.975	-	0.004	0.849	0.849	-
	(p-val)	0.0627	0.2233	0.39550.30	-	0.9501	0.6540	0.8377	-
	F-iv	0.28(-)	0.37(-)	(-)	-	0.87(-)	2.01(-)	1.64(-)	-
	LR-e	-	-	-	-0.0621	-	-	-	-0.1050
	SR-e	-	-	-	-0.0612	-	-	-	-0.1028
Rational addiction model		IV	V	VI		IV	V	VI	
	C_{t-1}	-0.4835	-0.4839	-0.4513	0.0054	-0.0941	0.0664	0.0995	0.0225
		(0.60)	(0.61)	(0.69)	(0.14)	(0.25)	(0.18)	(0.39)	(0.54)
	C_{t+1}	-0.3754	-0.3413	-0.4072	-0.0261	0.4379	0.3714	0.0682	0.0359
		(0.60)	(0.64)	(0.94)	(0.63)	(0.96)	(0.84)	(0.28)	(0.86)
	T_t	-0.01238	-0.01222	-0.01249	-0.00916	-0.01028	-0.00888	-0.01290	-0.01453
		(1.71)*	(1.74)*	(1.94)*	(1.92)*	(1.38)	(1.23)	(2.14)**	(3.17)**
	R^2	0.0053	0.0034	0.0043	0.3274	0.5309	0.6010	0.5120	0.4135
	Wu-F	0.28(-)	0.54(-)	0.63(-)	-	0.37(-)	0.25(-)	0.07(-)	-
	chi-sq	2.129	2.174	2.827	-	4.180	12.586	15.851	-
	(p-val)	0.3450	0.5371	0.8302	-	0.1237	0.0056	0.0146	-
	F_t-1	0.50(-)	0.45(-)	0.36(-)	-	3.13	2.73	2.25	-
	F_t+1	0.99(-)	0.90(-)	0.81(-)	-	(2.32)	1.77(-)	2.36	-
	LR-e	-	-	-	-	-	-0.0962	-0.0945	-0.0941
	SR-e	-	-	-	-	-	-0.0897	-0.0849	-0.0919

Table 31. Estimation of cigarette demand for different educational level on tax (Dependent variable = per capita cigarette consumption)

Independent Variables		High (above High school diploma)				Low (otherwise)			
		TSLS			OLS	TSLS			OLS
Myopic model		I	II	III		I	II	III	
	C_{t-1}	-0.5395	-0.7709	-0.8158	0.0383	1.9116	0.9923	1.4794	0.0417
		(0.46)	(0.66)	(0.76)	(0.98)	(0.84)	(0.91)	(1.32)	(1.00)
	T_t	-0.00629	-0.00725	-0.00743	-0.00393	0.01506	-0.00233	0.00688	-0.02034
		(1.22)	(1.37)	(1.51)	(2.37)**	(0.34)	(0.11)	(0.30)	(3.99)**
	R^2	0.0678	0.0172	0.0120	0.4263	0.3405	0.3660	0.3506	0.1165
	Wu-F	0.35(-)	0.86(-)	1.20(-)	-	(3.19)	1.48(-)	5.32	-
	chi-sq	0.980	0.940	0.903	-	0.029	1.072	1.044	-
	(p-val)	0.3221	0.6284	0.8247	-	0.8651	0.5850	0.7907	-
	F-iv	0.43(-)	0.36(-)	0.34(-)	-	0.43(-)	0.51(-)	0.60(-)	-
	LR-e	-	-	-	-0.1566	-	-5.9742	-	-0.4160
	SR-e	-	-	-	-0.1505	-	-0.0459	-	-0.3985
Rational addiction model		IV	V	VI		IV	V	VI	
	C_{t-1}	0.0385	0.2072	0.0191	0.0382	0.2254	0.0426	0.8127	0.0423
		(0.05)	(0.31)	(0.04)	(0.97)	(0.31)	(0.06)	(1.24)	(1.01)
	C_{t+1}	0.8661	0.5607	0.1179	0.0290	0.5558	0.7726	0.0495	0.0396
		(1.10)	(1.03)	(0.34)	(0.65)	(1.01)	(1.38)	(0.12)	(0.91)
	T_t	-0.00118	-0.00143	-0.00351	-0.00371	-0.00491	-0.00383	-0.00446	-0.01896
		(0.30)	(0.42)	(1.36)	(2.20)**	(0.50)	(0.36)	(0.43)	(3.63)**
	R^2	0.6938	0.7288	0.4997	0.4488	0.4536	0.5033	0.3830	0.1637
	Wu-F	1.27(-)	0.78(-)	0.03(-)	-	(2.39)	2.20(-)	(2.71)	-
	chi-sq	2.179	3.330	7.656	-	0.553	1.563	5.592	-
	(p-val)	0.3364	0.3435	0.2644	-	0.7585	0.6678	0.4704	-
	F_t-1	0.61(-)	0.45(-)	0.45(-)	-	1.68(-)	1.20(-)	0.97(-)	-
	F_t+1	0.79(-)	0.81(-)	1.24(-)	-	2.59	2.83	2.55	-
	LR-e	-0.4751	-0.1566	-0.1562	-0.1522	-0.4444	-0.4064	-0.6347	-0.4046
	SR-e	-0.4562	-0.1505	-0.1531	-0.1465	-0.3272	-0.3885	-0.0962	-0.3788

Table 32. Estimation of smoking participation for different checkup groups on tax
(Dependent variable = proportion of smokers)

Independent Variables		Routine (within a year)				Rare (otherwise)			
		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	-0.2549	-0.7287	0.5566	0.0868	0.7614	0.3358	0.3554	0.0076
		(0.32)	(0.85)	(1.30)	(2.05)**	(1.49)	(1.09)	(1.16)	(0.18)
	T_t	-0.00028	-0.00037	-0.00013	-0.00021	-0.00027	-0.00041	-0.00040	-0.00051
		(1.66)*	(1.97)**	(1.11)	(2.91)**	(1.23)	(2.56)**	(2.52)**	(4.28)**
	R^2	0.2530	0.0366	0.7679	0.5274	0.5604	0.5108	0.5167	0.2937
	Wu-F	0.21(-)	1.59(-)	1.52(-)	-	(3.53)	1.30(-)	1.49(-)	-
	chi-sq	0.686	1.488	7.646	-	2.335	5.711	5.977	-
	(p-val)	0.4076	0.4752	0.05391.54	-	0.1265	0.0575	0.1128	-
	F-iv	0.80(-)	0.72(-)	(-)	-	(2.89)	3.76	2.86	-
	LR-e	-	-	-0.1662	-0.1400	-0.5087	-0.2738	-0.2782	-0.2301
	SR-e	-	-	-0.0752	-0.1277	-0.1255	-0.1820	-0.1794	-0.2283
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	0.4885	0.1199	0.1340	0.0817	0.5681	0.4949	0.3220	0.0039
model		(0.86)	(0.27)	(0.40)	(1.92)*	(1.40)	(1.05)	(1.06)	(0.09)
	C_{t+1}	-0.3430	0.1804	0.4245	0.0884	0.3516	0.7980	0.4112	0.0315
		(0.53)	(0.38)	(1.36)	(1.92)*	(0.44)	(1.00)	(1.01)*	(0.70)
	T_t	-0.00022	-0.00016	-0.00010	-0.00019	-0.00018	-0.00004	-0.00023	-0.00047
		(1.48)	(1.31)	(1.01)	(2.51)**	(0.65)	(0.15)	(1.31)	(3.87)**
	R^2	0.5332	0.6746	0.7728	0.5906	0.6244	0.6302	0.6295	0.3285
	Wu-F	0.42(-)	0.95(-)	1.29(-)	-	(2.81)	3.19	3.08	-
	chi-sq	0.991	5.020	11.117	-	3.026	3.764	8.626	-
	(p-val)	0.6091	0.1703	0.0848	-	0.2202	0.2881	0.1957	-
	F_t-1	1.50(-)	1.13(-)	1.43(-)	-	2.97	2.83	2.32	-
	F_t+1	1.40(-)	2.14	2.16	-	0.86(-)	0.86(-)	1.55(-)	-
	LR-e	-	-0.1369	-0.1391	-0.1352	-0.9978	-	-0.3928	-0.2161
	SR-e	-	-0.1199	-0.1190	-0.1238	-0.2152	-	-0.2428	-0.2152

Table 33. Estimation of cigarette demand for different checkup groups on tax
(Dependent variable = average daily cigarette consumption of smokers)

Independent		Routine (within a year)				Rare (otherwise)			
Variables		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	-0.8694	-0.4039	-0.4148	-0.0307	-4.3493	-3.1793	-0.6266	0.0155
		(1.22)	(1.03)	(1.05)	(0.76)	(0.36)	(0.40)	(0.49)	(0.35)
	T_t	-0.01473	-0.01162	-0.01169	-0.00913	-0.04610	-0.03635	-0.01508	-0.0972
		(1.98)**	(2.22)**	(2.23)**	(2.18)**	(0.44)	(0.52)	(1.19)	(1.68)*
	R^2	0.0254	0.0791	0.0723	0.3827	0.3627	0.3494	0.1006	0.3784
	Wu-F	2.58(-)	1.07(-)	1.13(-)	-	2.64(-)	1.80(-)	0.36(-)	-
	chi-sq	0.617	2.461	2.947	-	0.060	0.195	2.719	-
	(p-val)	0.4320	0.2921	0.3998	-	0.8070	0.9070	0.4371	-
	F-iv	1.49(-)	2.08(-)	1.56(-)	-	0.07(-)	0.06(-)	0.21(-)	-
	LR-e	-	-	-	-	-	-	-	-0.0582
	SR-e	-	-	-	-	-	-	-	-0.0581
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	-0.4355	-0.4623	-0.1719	-0.0364	0.7196	0.7827	0.5955	0.0126
model		(1.08)	(1.15)	(0.60)	(0.90)	(1.10)	(1.12)	(1.07)	(0.28)
	C_{t+1}	-0.1286	-0.1318	-0.3327	-0.0308	0.1342	0.4243	0.3054	-0.00049
		(0.33)	(0.33)	(1.26)	(0.73)	(0.26)	(0.92)	(0.86)	(0.11)
	T_t	-0.01177	-0.01196	-0.01189	-0.00856	-0.00158	0.00017	-0.00101	-0.0088
		(2.00)**	(2.02)**	(2.27)**	(2.03)**	(0.15)	(0.16)	(0.12)	(1.52)
	R^2	0.0138	0.0074	0.0474	0.3433	0.4984	0.5133	0.5208	0.3500
	Wu-F	0.84(-)	0.52(-)	1.11(-)	-	0.99(-)	2.11(-)	1.80(-)	-
	chi-sq	2.307	2.451	4.391	-	3.474	4.136	5.721	-
	(p-val)	0.3155	0.4843	0.6239	-	0.1760	0.2471	0.4552	-
	F_t-1	1.67(-)	1.70(-)	1.35(-)	-	0.89(-)	0.61(-)	0.61(-)	-
	F_t+1	1.41(-)	1.05(-)	1.37(-)	-	1.39(-)	1.42(-)	1.45(-)	-
	LR-e	-	-	-	-	-0.0634	-	-0.0599	-
	SR-e	-	-	-	-	-0.0122	-	-0.0131	-

Table 34. Estimation of cigarette demand for different checkup groups on tax (Dependent variable = per capita cigarette consumption)

Independent		Routine (within a year)				Rare (otherwise)			
Variables		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	-0.0891	-0.1996	0.4712	0.0729	0.6619	0.2676	0.2660	-0.0085
		(0.11)	(0.24)	(0.71)	(1.72)*	(1.06)	(0.66)	(0.66)	(0.19)
	T_t	-0.00408	-0.00444	-0.00221	-0.00354	-0.00495	-0.00814	-0.00115	-0.01037
		(1.29)	(1.38)	(0.79)	(2.20)**	(0.81)	(1.84)*	(1.84)*	(3.61)**
	R^2	0.3259	0.2033	0.7707	0.5143	0.6117	0.5451	0.5445	0.3476
	Wu-F	0.04(-)	0.12(-)	0.42(-)	-	1.71(-)	0.51(-)	1.57(-)	-
	chi-sq	2.104	2.641	4.173	-	0.119	1.624	1.681	-
	(p-val)	0.1470	0.2670	0.2434	-	0.7302	0.4439	0.6411	-
	F-iv	0.70(-)	0.48(-)	0.60(-)	-	1.81(-)	(2.10)	1.57(-)	-
	LR-e	-	-	-0.1378	-0.1255	-0.3259	-0.2476	-0.0350	-
	SR-e	-	-	-0.0731	-0.1164	-0.1102	-0.1811	-0.0258	-
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	0.2515	-0.1482	-0.0514	0.0711	0.6105	0.4939	0.3973	-0.0099
model		(0.57)	(0.39)	(0.15)	(1.67)	(1.69)*	(1.00)	(1.33)	(0.23)
	C_{t+1}	0.0134	0.3629	0.0942	0.0431	-0.0340	1.2921	0.3345	0.0056
		(0.03)	(0.83)	(0.34)	(0.93)	(0.03)	(1.22)	(0.83)	(0.13)
	T_t	-0.00277	-0.00259	-0.00337	-0.00320	-0.00501	-0.00374	-0.00403	-0.00971
		(1.14)	(1.02)	(1.65)	(1.96)**	(0.55)	(0.42)	(0.90)	(3.33)**
	R^2	0.6815	0.5963	0.4679	0.5533	0.5941	0.6765	0.6741	0.3530
	Wu-F	0.10(-)	0.57(-)	0.18(-)	-	(2.43)	4.04	(2.51)	-
	chi-sq	2.384	4.780	11.779	-	0.365	1.192	7.599	-
	(p-val)	0.3036	0.1886	0.0671	-	0.8334	0.7549	0.2690	-
	F_t-1	1.59(-)	1.34(-)	1.12(-)	-	3.04	2.41	(1.92)	-
	F_t+1	1.39(-)	1.58(-)	1.94(-)	-	0.37(-)	0.69(-)	1.47(-)	-
	LR-e	-0.1238	-	-	-0.1190	-	-	-0.3346	-
	SR-e	-0.0927	-	-	-0.1107	-	-	-0.1767	-

Table 35. Estimation of smoking participation for different exercise groups on tax
(Dependent variable = proportion of smokers)

Independent		Exercise regularly				Do not exercise			
Variables		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	0.0406	0.0227	0.0006	-0.0723	0.4021	0.3219	0.2270	0.0158
		(0.11)	(0.06)	(0.00)	(1.44)	(0.67)	(0.57)	(0.42)	(0.28)
	T_t	-0.00040	-0.00040	-0.00041	-0.00044	-0.00060	-0.00063	-0.00067	-0.00076
		(2.03)**	(2.08)**	(2.14)	(3.18)**	(1.72)*	(1.89)*	(2.10)**	(3.32)**
	R^2	0.4585	0.4487	0.4363	0.3917	0.2272	0.1754	0.1177	0.0288
	Wu-F	0.10(-)	0.08(-)	0.05(-)	-	0.48(-)	0.32(-)	0.16(-)	-
	chi-sq	0.584	0.705	1.110	-	1.286	1.748	2.432	-
	(p-val)	0.4446	0.7030	0.7747	-	0.2568	0.4172	0.4877	-
	F-iv	(2.80)	1.91(-)	1.45(-)	-	1.40(-)	0.99(-)	0.79(-)	-
	LR-e	-0.2388	-0.2384	-0.2380	-	-0.4099	-0.3810	-0.3548	-0.3145
	SR-e	-0.2292	-0.2332	-0.2380	-	-0.2450	-0.2585	-0.2743	-0.3097
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	-0.3202	-0.0823	-0.1159	-0.1024	0.4971	0.4139	0.3321	0.0053
model		(0.68)	(0.22)	(0.32)	(1.81)*	(1.91)*	(1.56)	(1.54)	(0.08)
	C_{t+1}	-0.4223	0.0036	-0.0689	-0.0352	-0.1905	0.7195	-0.0346	0.0113
		(0.59)	(0.01)	(0.14)	(0.52)	(0.14)	(0.80)	(0.07)	(0.16)
	T_t	-0.00080	-0.00048	-0.00054	-0.00051	-0.00058	-0.00029	-0.00056	-0.00059
		(1.50)	(1.20)	(1.41)	(2.73)**	(1.08)	(0.64)	(1.72)*	(2.22)**
	R^2	0.0326	0.3337	0.2688	0.2979	0.0831	0.4400	0.0978	0.0205
	Wu-F	0.28(-)	0.00(-)	0.02(-)	-	(2.36)	(2.86)	(2.45)	-
	chi-sq	0.194	2.210	2.494	-	5.005	4.826	10.696	-
	(p-val)	0.9074	0.5301	0.8691	-	0.0819	0.1850	0.0982	-
	F_t-1	1.77(-)	1.43(-)	1.28(-)	-	3.33	2.21	(1.87)	-
	F_t+1	0.67(-)	0.52(-)	0.66(-)	-	0.70(-)	1.18(-)	0.98(-)	-
	LR-e	-	-	-	-	-	-	-	-0.2450
	SR-e	-	-	-	-	-	-	-	-0.2437

Table 36. Estimation of cigarette demand for different exercise groups on tax
(Dependent variable = average daily cigarette consumption of smokers)

Independent Variables		Exercise regularly				Do not exercise			
		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	-12.853	-0.1141	-0.0591	-0.1133	1.1068	-0.0023	0.4149	-0.0258
		(0.04)	(0.21)	(0.12)	(2.14)**	(0.67)	(0.00)	(0.84)	(0.45)
	T_t	-0.3797	-0.02523	-0.02369	-0.02520	-0.00476	-0.02344	-0.01641	-0.02384
		(0.04)	(1.53)	(1.59)	(3.70)**	(0.15)	(1.51)	(1.14)	(2.23)**
	R^2	0.3912	0.4277	0.4727	0.4285	0.5024	0.3879	0.5362	0.3664
	Wu-F	0.34(-)	0.00(-)	0.01(-)	-	1.16(-)	0.00(-)	0.99(-)	-
	chi-sq	0.001	0.563	0.617	-	1.652	6.396	5.985	-
	(p-val)	0.9804	0.7547	0.8924	-	0.1987	0.0408	0.1123	-
	F-iv	0.00(-)	0.84(-)	0.82(-)	-	0.40(-)	0.60(-)	1.13(-)	-
	LR-e	-	-	-	-	-	-	-0.1605	-
	SR-e	-	-	-	-	-	-	-0.0936	-
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	-1.3156	-1.0246	0.0771	-0.1113	0.4533	0.1003	-0.0646	-0.0258
model		(0.64)	(0.74)	(0.16)	(1.95)*	(0.77)	(0.24)	(0.22)	(0.40)
	C_{t+1}	0.1281	0.0683	0.2635	-0.1311	-0.3005	-0.2518	-0.1746	-0.0661
		(0.17)	(0.11)	(0.67)	(1.91)*	(0.79)	(0.75)	(0.61)	(0.99)
	T_t	-0.05995	-0.05289	-0.02117	-0.03086	-0.02217	-0.02215	-0.02070	-0.01768
		(1.11)	(1.41)	(1.48)	(3.98)**	(1.31)	(1.48)	(1.46)	(1.46)
	R^2	0.0925	0.0353	0.6174	0.3686	0.4165	0.2647	0.1304	0.2995
	Wu-F	1.24(-)	0.04(-)	0.93(-)	-	2.06(-)	0.12(-)	0.06(-)	-
	chi-sq	0.326	0.565	6.873	-	3.409	5.996	7.839	-
	(p-val)	0.8495	0.9043	0.3328	-	0.1819	0.1118	0.2502	-
	F_t-1	0.29(-)	0.60(-)	0.56(-)	-	0.32(-)	0.81(-)	0.89(-)	-
	F_t+1	0.24(-)	0.71(-)	0.92(-)	-	(2.06)	1.39(-)	1.16(-)	-
	LR-e	-	-	-0.2100	-	-	-	-	-
	SR-e	-	-	-0.1934	-	-	-	-	-

Table 37. Estimation of cigarette demand for different exercise groups on tax
(Dependent variable = per capita cigarette consumption)

Independent		Exercise regularly				Do not exercise			
Variables		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	0.2711	0.2733	0.3103	-0.0562	1.0264	0.3867	0.3238	0.0712
		(0.65)	(0.65)	(0.74)	(1.07)	(1.03)	(0.69)	(0.71)	(0.30)
	T_t	-0.00582	-0.00580	-0.00543	-0.00909	-0.00373	-0.01085	-0.01153	-0.01484
		(1.13)	(1.12)	(1.04)	(3.14)**	(0.28)	(1.23)	(1.45)	(2.48)**
	R^2	0.6612	0.6620	0.6747	0.4471	0.5609	0.5380	0.4909	0.1102
	Wu-F	0.71(-)	0.72(-)	0.92(-)	-	2.24(-)	0.51(-)	0.51(-)	-
	chi-sq	0.043	0.119	0.558	-	1.448	5.102	5.377	-
	(p-val)	0.8365	0.9425	0.9060	-	0.2288	0.0780	0.1462	-
	F-iv	(2.45)	1.63(-)	1.24(-)	-	0.97(-)	1.09(-)	1.18(-)	-
	LR-e	-0.2555	-0.2550	-0.2515	-	-	-0.3500	-0.3373	-0.2988
	SR-e	-0.1872	-0.1855	-0.1737	-	-	-0.2148	-0.2279	-0.2935
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	-0.0465	-0.0160	0.1692	-0.0693	0.3903	0.2709	0.1805	0.0306
model		(0.12)	(0.04)	(0.44)	(1.19)	(1.59)	(1.13)	(0.90)	(0.48)
	C_{t+1}	0.0934	0.2662	0.3724	-0.0422	0.2873	0.5872	0.1486	-0.0026
		(0.13)	(0.38)	(0.52)	(0.61)	(0.51)	(1.09)	(0.39)	(0.03)
	T_t	-0.01046	-0.00889	-0.00594	-0.01168	-0.00663	-0.00454	-0.00893	-0.01104
		(1.19)	(1.02)	(0.69)	(3.43)**	(0.73)	(0.48)	(1.14)	(1.59)
	R^2	0.4993	0.6470	0.7435	0.3457	0.6531	0.6474	0.4886	0.1346
	Wu-F	0.04(-)	0.07(-)	0.24(-)	-	2.29(-)	2.31(-)	1.87(-)	-
	chi-sq	0.278	0.685	1.917	-	7.181	8.593	16.084	-
	(p-val)	0.8702	0.8767	0.9271	-	0.0276	0.0352	0.0133	-
	F_t-1	1.64(-)	1.12(-)	0.89(-)	-	2.79	2.38	2.07	-
	F_t+1	0.30(-)	0.21(-)	0.31(-)	-	1.79(-)	1.56(-)	1.20(-)	-
	LR-e	-	-	-0.4147	-	-0.4068	-0.6334	-0.2633	-
	SR-e	-	-	-0.3395	-	-0.2244	-0.4195	-0.2143	-

Table 38. Estimation of cigarette demand for different smoking intensities on tax
(Dependent variable = average daily cigarette consumption of smokers)

Independent		Heavy (>20 cigarettes a day)				Light (<20 cigarettes a day)			
Variables		TSLS			OLS	TSLS			OLS
Myopic		I	II	III		I	II	III	
model	C_{t-1}	1.125247	1.1543	0.7758	-0.0204	-0.3084	-0.2563	-0.2736	0.0531
		(0.87)	(0.97)	(0.82)	(0.46)	(0.39)	(0.42)	(0.45)	(1.33)
	T_t	-0.00589	-0.00541	-0.01173	-0.02504	-0.00524	-0.00501	-0.00508	-0.00361
		(0.25)	(0.24)	(0.66)	(3.87)**	(1.27)	(1.45)	(1.47)	(1.82)*
	R^2	0.0532	0.0526	0.0634	0.0508	0.2899	0.3252	0.3135	0.4961
	Wu-F	1.79(-)	2.28(-)	1.15(-)	-	0.24(-)	0.29(-)	0.32(-)	-
	chi-sq	0.001	0.004	1.824	-	0.234	0.256	0.335	-
	(p-val)	0.9732	0.9978	0.6095	-	0.6289	0.8799	0.9532	-
	F-iv	0.71(-)	0.57(-)	0.47(-)	-	0.80(-)	0.86(-)	0.65(-)	-
	LR-e	-	-	-0.1758	-	-	-	-	-0.0455
	SR-e	-	-	-0.0394	-	-	-	-	-0.0429
Rational		IV	V	VI		IV	V	VI	
addiction	C_{t-1}	0.2751	-0.2091	-0.1561	-0.0179	-0.0807	-0.1406	-0.2176	0.0594
model		(0.30)	(0.25)	(0.33)	(0.41)	(0.11)	(0.21)	(0.35)	(1.47)
	C_{t+1}	0.7111	0.5493	0.1531	-0.0141	0.6305	0.5147	0.4656	0.0242
		(0.48)	(0.39)	(0.34)	(0.34)	(0.97)	(0.88)	(0.84)	(0.56)
	T_t	-0.00307	-0.01476	-0.02250	-0.02381	-0.00208	-0.00275	-0.00329	-0.00323
		(0.12)	(0.62)	(1.82)*	(3.70)**	(0.41)	(0.58)	(0.77)	(1.61)
	R^2	0.0625	0.0318	0.0318	0.0399	0.5173	0.5069	0.4771	0.5039
	Wu-F	0.60(-)	0.31(-)	0.05(-)	-	0.67(-)	0.61(-)	0.42(-)	-
	chi-sq	0.221	4.102	8.606	-	0.077	0.428	0.873	-
	(p-val)	0.8953	0.2507	0.1970	-	0.9624	0.9343	0.9900	-
	F_t-1	0.82(-)	0.75(-)	0.65(-)	-	0.53(-)	0.52(-)	0.39(-)	-
	F_t+1	0.19(-)	0.26(-)	0.53(-)	-	0.66(-)	0.52(-)	0.42(-)	-
	LR-e	-0.7440	-	-	-	-	-	-	-0.0420
	SR-e	-0.4650	-	-	-	-	-	-	-0.0394

Bibliography

Becker, Gary S., *Accounting for Tastes*, Harvard University Press (1996)

Becker, Gary S., "Habits, Addictions and Traditions", *Kyklos* 45(3): 327-346

Becker, Gary S. and Kevin M. Murphy, "A Theory of Rational Addiction", *Journal of Political Economy* 96 (August 1988): 675-700

Becker, Gary S., Michael Grossman and Kevin M. Murphy, "Rational Addiction and the Effect of Price on Consumption", *American Economic Review* 81 (May 1991): 237-241

Becker, Gary S., Michael Grossman and Kevin M. Murphy, "An Empirical Analysis of Cigarette Addiction", *American Economic Review* 84 (June 1994): 396-418

Becker, Gary S. and Casey B. Mulligan, "The Endogenous Determination of Time Preference", *Quarterly Journal of Economics* 112 (1997): 729-58

Bretteville-Jensen, A. L., "Addiction and Discounting", *Journal of Health Economics* 18 (1999): 393-407

Chaloupka, Frank, "Rational Addictive Behavior and Cigarette smoking", *Journal of Political Economy* 99 (August 1991): 722-42

Chaloupka, Frank and Michael Grossman, "Price, Tobacco Control Policies and Youth Smoking", *NBER* Working Paper 5740 (1996)

Chaloupka, Frank and Rosalie Liccardo Pacula, "An Examination of Gender and Race Differences in Youth Smoking Responsiveness to Price and Tobacco Control Policies", *NBER* Working Paper 6541 (April 1998)

Chaloupka, Frank and H. Wechsler, "Price, Tobacco Control Policies, and Smoking among Young Adults", *Journal of Health Economics* 16(1997): 359-373

Chaloupka, Frank and H. Saffer, "Clean Indoor Air Laws and the Demand for Cigarettes", *Contemporary Policy Issues* (1992): 72-83

Evans W. N. and M. C. Farrelly, "The Compensating Behavior of Smoker: Taxes, Tar and Nicotine", *Rand Journal* 29 (1998): 578-595

Fuchs, Victor R., "Time Preference and Health: An Exploratory Study", Victor R. Fuchs, ed., *Economic Aspects of Health*, University of Chicago Press (1982)

Fuchs, Victor R., "The Future of Health Economics", *Journal of Health Economics* 19 (2000): 141-57

Grossman, Michael, "The Demand for Cigarettes", *Journal of Health Economics* 10 (1991): editorial 101-103

Gruber, Jonathan and Botond Koszegi, "Is Addiction Rational? Theory and Evidence", *Quarterly Journal of Economics* 467 (November 2001): 1261-1303

Lewit, Eugene M. and Douglas Coate, "The Potential for Using Excise Taxes to Reduce Smoking", *Journal of Health Economics* 1 (August 1981): 121-45

Lewit, Eugene M. , Douglas Coate and Michael Grossman, "The Effects of Government Regulation on Teenage Smoking", *Journal of Law and Economics* 24 (December 1981): 545-69

Tobacco Institute, *The Tax Burden on Tobacco*, Washington D.C., Tobacco Institute, Each year

Trostel, Phillip A. and Grant A. Taylor, "A Theory of Time Preference", *Economic Inquiry* 39 (July 2001): 379-95

Wasserman, Jeffrey, Willard G. Manning, Joseph P. Newhouse and John D. Winkler, "The Effects of Excise Taxes and Regulations on Cigarette Smoking", *Journal of Health Economics* 10 (1991): 43-64

Tobacco Institute, *The Tax Burden on Tobacco*, Washington D.C., Tobacco Institute, Each year

Trostel, Phillip A. and Grant A. Taylor, "A Theory of Time Preference", *Economic Inquiry* 39 (July 2001): 379-95

Wasserman, Jeffrey, Willard G. Manning, Joseph P. Newhouse and John D. Winkler, "The Effects of Excise Taxes and Regulations on Cigarette Smoking", *Journal of Health Economics* 10 (1991): 43-64