Semiparametric Analysis of the Effect of Income on the Consumption of Tobacco and Alcohol Products in Turkey

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Abstract

This paper estimates the effect of income on the probability of consuming alcohol and tobacco, and the spending levels for households in Turkey using a semiparametric Bayesian approach based on a data set derived from the 2010 Turkish Household Expenditure Survey. We find that when restricting our samples to only smokers and drinkers both tobacco and alcohol products are normal goods. However, for the general population, tobacco products are an inferior good, and alcohol is a normal good. The results support the claim that taxing tobacco products is most likely to keep individuals from smoking and drinking for the lower income group which includes young adults.

1 Introduction

The main research objective of this paper is to investigate the effect of income on the consumption of alcohol and tobacco products, but rather than estimating the marginal effects averaged over all income groups, which would be done in the linear regression framework, we allow income to enter the conditional mean function semi-parametrically.

Alcohol and tobacco products are considered to be addictive goods. Are these two goods normal or inferior? This is investigated in the context of Turkish consumers using a data set derived from the 2010 Turkish Household Expenditure Survey (THES) conducted by the Turkish Statistical Institute (TUIK). One complication of the issue is the fact that Turkey is a predominately Muslim country where consumption of alcohol is legal, even though there is a formal prohibition of alcohol in Islam. At the same time there is no definite prohibition in Islam of tobacco products and in our sample about 54 percent are smokers and only 7 percent are drinkers. This paper estimates the effect of income on the probability of being an alcohol and tobacco consumer and the spending levels for households in Turkey using a semiparametric Bayesian approach, based on Koop and Poirier (2004), Koop and Tobias (2006) and Munkin and Trivedi (2008).

The topic of the paper is a very interesting economics question and at the same time is a very relevant policy issue. The adverse economic and health effects of tobacco and alcohol consumption can be considerable. For developing countries the costs of smoking are most likely high, but it is difficult to estimate. However, reducing smoking and drinking rates is always a desirable objective for any government. A reasonable policy instrument could be imposing taxes on tobacco and alcohol products making them more expensive in the attempt to force price sensitive consumers into quitting. However, given the addictive nature of these goods the extent at which this policy would be successful is not clear.

In general as a policy instrument preventing tobacco use among youth is critical to ending a tobacco epidemic in any country. It is believed that tobacco use is started and established primarily during adolescence according to the U.S. Department of Health and Human Services (USDHHS, 2012). In the United States nearly 9 out of 10 cigarette smokers first tried smoking by age 18, and 99% first tried smoking by age 26. Each day in the United States, more than 3,200 youth aged 18 years or younger smoke their first cigarette, and an additional 2,100 youth and young adults become daily cigarette smokers. It is reasonable to assume that start smoking patterns are very similar across different countries.

Tobacco causes around 100,000 deaths in Turkey each year which makes roughly a quarter of all annual deaths. The number of lung cancers has increased 15 times over the last 40 years (Bilir et al. 2009; Ekuklu et al. 2004). Turkey's per capita consumption of alcohol for people over the age of 15 is relatively small 1.4 L, compared with 9.9 L in Germany and 10.8 L in the United Kingdom (TAPDK 2012). The World Health Organization (WHO, 2004) reports that 4 million people are alcoholic, and 13 million consume alcoholic products in Turkey. It is estimated that 50% of observed violence scenes were associated with alcohol use. Nearly 20% of health-care expenditure is spent on alcohol-related diseases annually (Bilir et al. 2009; Ekuklu et al. 2004).

The Turkish government has enacted laws restricting advertising and consumption of tobacco products. Smoking has been banned in all public places including schools, bars and restaurants (Todays Zaman News 2013). The new laws prohibit campaigns, promotions, or events that aim to encourage use or sale of alcoholic drinks. Images of alcoholic beverages on TV and in movies are prohibited (Todays Zaman News 2013).

A special consumption tax (SCT) on alcohol and tobacco products was introduced. First it was set at 18% in 2002, and then increased to 63% in 2009 and 65% in 2011. Subsequently, the government ended the SCT on alcoholic beverages, but "Lump sum" taxes on alcohol were raised from 1.30 Turkish Liras (TL) in 2009 to 1.50 TL in 2010 to offset the eliminated SCT. The levied taxes are used to fund treatments of nicotine and alcohol dependence, prevention programs, and treatment of certain cancers.

The WHO and the U.S. Centers for Disease Control and Prevention reported that the percentage of smokers 15 years or older in Turkey decreased from 31.3% in 2008 to 27% in 2012. Global Adult Tobacco Survey (GATS) also reported that smoking rates declined from 47.9% to 41.4% for males and from 15.2% to 13.1% for females during the same period. These decreases in the age categories of 25–34 and 35–44 were from 40.3% and 39.6% in 2008 to 34.9% and 36.2% respectively in 2012. (Bilgic and Yen, 2015). Alcohol consumption, on the other hand, doubled from 500 million liters in 2003 to 1.07 billion liters in 2009 (TUIK, 2012).

The rest of the paper is organized as follows. The next section defines the Econometrics framework and defines the model. Section 3 outlines the estimation procedure. Section 4 describes the data and deals with the application.

2 Econometric framework

First we specify the probit model with a non-parametric component. Assume that we observe N independent observations for individuals who choose whether to start consumption of a product. In our application section this will either be a tobacco or alcohol product. Let d_i be the binary random variable $(i = 1, ..., N)$ representing this choice such that $d_i = 1$ if consuming and $d_i = 0$ otherwise. The latent utility approach defines the binary probit model assuming existence of a latent variable (Z_i) representing the gain in utility received from consuming $(d_i = 1)$ relative to the alternative $(d_i = 0)$. To allow for income to enter such utility nonparametrically we follow recent work on Bayesian semiparametric techniques by Koop and Poirier (2004) and Koop and Tobias (2006). Let the participation equation be specified as

$$Z_i = f(s_i) + \mathbf{W}_i\boldsymbol{\alpha} + \varepsilon_i, \tag{1}$$

where $\mathbf{W}_i$ is a vector of regressors, $\boldsymbol{\alpha}$ is a conformable vector of parameters, and the distribution of the error term ε_i is $\mathcal{N}(0, 1)$. Function $f(.)$ is unknown, s_i is income of individual i and parameter $\boldsymbol{\alpha}$ does not include an intercept. The consumption variable is defined as

$$d_i = I_{[0,+\infty)}(Z_i), \tag{2}$$

where $I_{[0,+\infty)}$ is the indicator function for the set $[0,+\infty)$.

Values $f(s_i)$ $(i = 1, ..., k_\gamma)$ correspond to k_γ distinct values of income sorted in the increasing order. The nonparametric approach treats all k_γ values of $f(s_i)$ as parameters. Since the observed income variable takes almost the same number of distinct values as the number of observations, this potentially leads to the problem of too many parameters to estimate. It seems reasonable to assume that the probability of consuming will not change much for small increments in income. We round the income variable up to a hundred TL to get a reasonable number of k_γ relative to the total number of observations N.

We sort the data by values of s so that s_1 is the lowest level of income and s_N is the largest. The main assumption that we make on function $f(.)$ is that it is smooth such that it is differentiable and its slope does not change too fast (Shiller, 1984).

Stacking (1) over i we obtain

$$\mathbf{Z} = \mathbf{P}\boldsymbol{\gamma} + \mathbf{W}\boldsymbol{\alpha} + \boldsymbol{\varepsilon},$$

where

$$\boldsymbol{\gamma} = \begin{bmatrix} f(s_1) \\ f(s_2) \\ \dots \\ f(s_{k_\gamma}) \end{bmatrix},$$

and $\mathbf{P}$ is an $N \times k_\gamma$ matrix constructed to select the appropriate element of γ for each observation i.

Define an $k_\gamma \times k_\gamma$ matrix $\mathbf{R}$ such that $\boldsymbol{\psi} = \mathbf{R}\boldsymbol{\gamma}$ is a vector of slope changes of function $f(.)$,

$$\psi_j = \frac{\gamma_j - \gamma_{j-1}}{s_j - s_{j-1}} - \frac{\gamma_{j-1} - \gamma_{j-2}}{s_{j-1} - s_{j-2}}, \quad j = 3, ..., k_\gamma,$$

and the first two elements are simply $\psi_1 = f(s_1)$ and $\psi_2 = f(s_2)$. One can think of parameters ψ_j $(j = 3, ..., k_\gamma)$ as numerical approximations to the second order derivatives of function $f(s_j)$, calculated at $k_\gamma - 2$ points corresponding to $j = 3, ..., k_\gamma$. Then

$$\mathbf{Z} = \mathbf{P}\mathbf{R}^{-1}\boldsymbol{\psi} + \mathbf{W}\boldsymbol{\alpha} + \boldsymbol{\varepsilon}.$$

Specifying priors on the numerical second derivatives places priors on the degree of smoothness of $f(.)$. Assume an informative prior such that

$$\psi_j \sim \mathcal{N}(0, \eta), \quad j = 3, ..., k_\gamma.$$

where for the smoothing parameter η, we try different values.

To identify the regression curve $f(.)$ one has to also specify priors on ψ_1 and ψ_2. One can think of the pair ψ_1 and ψ_2 as the initial two points of the regression curve that determines the level of the curve while parameters

ψ_j $(j = 3, ..., k_\gamma)$ set its degree of smoothness. We place flat but still proper priors on (ψ_1, ψ_2) as $\mathcal{N}(\mathbf{0}_2, \mathbf{I}_2)$.

Parameters η determines the tightness of the prior for ψ_j. If the prior of η is selected to be too tight, it can result in the regression function to be simply linear. After experimenting with different values we select η to be in the interval $[10^{-5}, 10^{-4}]$ and find it to produce smooth posteriors. We select proper prior distributions for parameter $\boldsymbol{\alpha}$,

$$\boldsymbol{\alpha} \sim \mathcal{N}(\mathbf{0}, 10\mathbf{I}_k).$$

2.1 The MCMC algorithm

Let $\Delta_i = (\mathbf{W}_i, \boldsymbol{\psi}, \boldsymbol{\alpha})$, and denote $\mathbf{P}_i$ the i^{th} row of matrix $\mathbf{P}$. For each observation i the likelihood is

$$\begin{aligned}\Pr[d_i, Z_i|\Delta_i] &= (2\pi)^{-1/2} \exp\left[-0.5\left(Z_i - \mathbf{P}_i\mathbf{R}^{-1}\boldsymbol{\psi} - \mathbf{W}_i\boldsymbol{\alpha}\right)^2\right] \\ &\quad \times \left[d_i I_{[0,+\infty)}(Z_i) + (1 - d_i) I_{(-\infty,0)}(Z_i)\right]\end{aligned}$$

The joint distribution for all observations is the product of such N independent observations over $i = 1, ...N$. The posterior density is proportional to the product of the prior density of the parameters and the joint distribution of observables and included latent variables.

We block the parameter set as Z_i, $[\boldsymbol{\psi}, \boldsymbol{\alpha}]$ and adopt a Gibbs sampler algorithm. The steps of the MCMC algorithm are the following:

1. The latent vectors Z_i $(i = 1, ...N)$ are conditionally independent with bivariate normal distribution $Z_i \overset{iid}{\sim} \mathcal{N}\left[\overline{Z}_i, \overline{H_i}^{-1}\right]$ where

$$\overline{H_i} = 1, \;\; \overline{Z}_i = \mathbf{P}_i \mathbf{R}^{-1} \boldsymbol{\psi} + \mathbf{W}_i \boldsymbol{\alpha}$$

   and subject to

$$\begin{aligned} Z_{ji} &\geqslant 0 \text{ if } d_{ji} = 1 \text{ and} \\ Z_{ji} &< 0 \text{ if } d_{ji} = 0. \end{aligned}$$

2. Let the prior distributions of $\boldsymbol{\psi}$ be $\mathcal{N}\left[\underline{\boldsymbol{\psi}}, \underline{\mathbf{H}}_{\psi}^{-1}\right]$ and $\boldsymbol{\alpha}$ be $\mathcal{N}\left[\underline{\boldsymbol{\alpha}}, \underline{\mathbf{H}}_{\alpha}^{-1}\right]$. Denote $\mathbf{G}_i = (\mathbf{P}_i \mathbf{R}^{-1}, \mathbf{W}_i)$, $\boldsymbol{\theta}' = (\boldsymbol{\psi}', \boldsymbol{\alpha})$ with the prior distribution $\mathcal{N}\left[\underline{\boldsymbol{\theta}}, \underline{\mathbf{H}}_{\theta}^{-1}\right]$. Then the full conditional distribution of $\boldsymbol{\theta}$ is $\mathcal{N}\left[\overline{\boldsymbol{\theta}}, \overline{\mathbf{H}}_{\theta}^{-1}\right]$ where

$$\begin{aligned} \overline{\mathbf{H}}_{\theta} &= \underline{\mathbf{H}}_{\theta} + \sum_{i=1}^{N} \mathbf{G}_i' \mathbf{G}_i \\ \overline{\boldsymbol{\theta}} &= \overline{\mathbf{H}}_{\theta}^{-1} [\underline{\mathbf{H}}_{\theta} \underline{\boldsymbol{\theta}} + \sum_{i=1}^{N} \mathbf{G}_i' Z_i]. \end{aligned}$$

This concludes the MCMC algorithm.

2.2 Application

We use a data set built from the 2010 THES conducted by TUIK. A subset of the data set was previously used by Bilgic and Yen (2015). The sample has 10,082 observations, obtained between January 1 and December 31, 2010. Households headed by individuals under age 20 are deleted from the sample. Table 1 presents the descriptive statistics.

The THES collected socio-demographic characteristics of the households. Household head characteristics include gender, marital and employment status, age categories, education, and health insurance coverage, while household characteristics include number of automobiles, number of technologies (computers, cellphones, Internet, and TVs), number of properties (shops, grocery stores, lands, apartments, vineyards, orchards), income, home ownership, presence of children by age categories. Monthly expenditures are reported on alcohol and tobacco products.

The first column of Table 1 presents means and standard deviations (second raw) of the variables of interest for the whole sample of 9822 observations. The second and third columns do it for only those individuals who have positive tobacco and alcohol expenditures respectively. Clearly the smoking and drinking populations are different in many respects of which the differences in income and education are most striking. The drinking population is more educated and more affluent than the smoking one. Drinking individuals are more likely to have a smaller household, live in an urban area and be a male. They are also less likely to have kids of any age.

First we estimate the Probit model for the binary variables indicating smoking and drinking status. The model allows income enter the conditional mean semiparametrically. Since income is a continuos variable it takes almost as many distinct values as the number of observations which makes it impossible to estimate close to 9822 parameters. Therefore, we round income values up to 0.04 which makes it 400 TL annually. It seems reasonable to assume that the probability of consumption will not change much for small increments in income. Rounding gives us $k_\gamma = 309$ distinct values of income and that many income parameters to estimate. The results on the estimated posterior means and standard deviations of all parameters except income are presented in Tables 2 and 3 respectively. The estimated income parameters are plotted in Figures 1 and 2 for smoking and drinking respectively.

As expected education negatively affects the probability of being a smoker. A higher level of education measured in the number of years of schooling means better understanding the harm caused by smoking. Having kids of all ages, being homeowner and being married have negative impacts on smoking. A possible explanation of this is that having a bigger family makes an individual more likely to be concerned about his own health because of the influence from his family members. The excluded age category is 60 years and older which means that being younger than 60 has a positive impact on being a smoker. Surprisingly employment has no statistical effect on smoking.

As a check we estimate a regular Probit model in which income enters the conditional mean linearly and find that income does not have any significant linear effect on the smoking decision. The results for the Semiparametric Probit model are presented in Figure 1. The relationship between income and probability of being a smoker is not linear. Although for lower income levels higher income affects the smoking decision in a linear way until it reaches about the 25th percentile after which it flattens indicating that for large enough values of income the decision of smoking perhaps depends on other factors but not on income. For the top 10th percentile though the probability of smoking drops substantially but because there is very few observations in that range the standard errors become larger. These findings should have direct policy implications. The results support the claim that taxing tobacco products as an instrument to combat smoking is most effective for the lower income individuals. That would included young adults. If making tobacco products more expensive can keep them from smoking that would increase the probability of reducing the number of life-time smokers. In fact this conclusion is consistent with the data from Global Adult Tobacco Survey regarding Turkey in that there was a substantial decrease in the number of smokers in Turkey after all the increases in tobacco consumption taxes in the last decade.

Regarding alcohol, education leads to a higher probability of consumption. Household size, living in an urban area, being a homeowner and married have a negative impact on the probability of drinking. Figure 2 shows that the effect of income is not linear just like in the case of smoking, however, there is a fundamental difference in consumption behavior for the super rich. The inverted S-shaped curve is consistent with first diminishing marginal returns of income on the probability of drinking. Then a point is reached of a very high income level after which additional income exponentially increases the probability of drinking alcohol. Even though both tobacco and alcohol are addictive goods, drinking is more appealing to the high income. Once again this interpretation is subject to a much smaller number of observation for the high income individuals. If taxing alcohol can have any effect on reducing drinking it could be most effective for the low income group.

The Semiparametric Probit model can be easily modified to allow for a continuous dependent variable instead of the binary outcome. The changes to the MCMC algorithm are minimal: there is no need to draw the latent variable Z_i, propensity to consume, the full conditional kernel is defined given the observed expenditure Y_i instead of Z_i and the full conditional of the parameters in equation

$$Y_i = f(s_i) + \mathbf{W}_i\boldsymbol{\alpha} + \varepsilon_i$$

is the same as in the Probit model with Y_i used instead of Z_i. In fact, we define Y_i as the logarithm of expenditure and estimate the model for positive tobacco and alcohol expenditures respectively with results presented in Tables 4 and 5 and Figures 3 and 4.

Once again education negatively affects the level of smoking through better understanding the harm caused by smoking. Having kids of all ages has negative impacts on smoking since having more kids makes an individual more likely to be concerned about his own health. After the decision to consume has been made either tobacco or alcohol is considered an addictive good for the individuals in the conditional samples. Therefore, in principle, there might be different patterns of the effect of income on the level of consumption from those of the probability of consumption. The effect of income never flattens which is consistent with more income leading to more consumption as is expected. The level of consumption first increases linearly with income and then explodes for the super rich for both tobacco and alcohol products. For the sample that includes both smokers and non-smokers tobacco products are an inferior good as consumption declines with higher income. However, for the smokers tobacco products are just a normal good with consumption levels increasing as income increases.

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Table 1: Summary statistics

		Full sample	If TobcExpd>0	If AlchExpd>
AlchExpd	alcohol expenditure (TL per month)	3.391	4.814	46.133
		17.579	20.794	47.272
TobcExpd	tobacco expenditure (TL per month)	70.574	130.346	120.047
		92.933	90.333	107.937
Homowner	= 1 if resides in own house	0.623	0.570	0.550
		0.485	0.495	0.498
Numbtech	number of technologies owned	5.799	6.110	7.307
		2.581	2.542	2.674
Numbauto	number of automobiles owned	0.318	0.323	0.494
		0.467	0.469	0.500
NProprty	number of properties owned	1.186	1.073	1.133
		1.033	1.003	1.061
Income	annual income in 10,000 TL	2.297	2.377	3.484
		2.121	2.006	3.499
HSize	size of household	3.772	4.070	3.321
		1.881	1.898	1.346
Urban	= 1 if urban	0.685	0.710	0.749
		0.465	0.454	0.434
Gender	= 1 if male	0.854	0.895	0.920
		0.353	0.307	0.272
Age20-29	= 1 if age is 20-29	0.073	0.080	0.080
		0.260	0.271	0.272
Age30-39	= 1 if age is 30-39	0.234	0.253	0.256
		0.423	0.435	0.437
Age40-49	= 1 if age is 40-49	0.260	0.291	0.278
		0.439	0.454	0.449
Age50-59	= 1 if age is 50-59	0.207	0.219	0.260
		0.405	0.413	0.439
CompHIns	= 1 if has compulsory health insurance	0.773	0.744	0.837
		0.419	0.436	0.370
GrnCard	= 1 if receives government health support	0.123	0.127	0.053
		0.328	0.333	0.223
Mstatus	= 1 if married	0.855	0.888	0.875
		0.352	0.315	0.331
Employed		0.677	0.724	0.766
		0.468	0.447	0.424
Educnyrs	Years of education	6.786	6.885	9.238
		4.333	4.010	4.364
Kid0-5	= 1 if kid(s) present: age 0–5	0.274	0.305	0.191
		0.446	0.460	0.393
Kid6-14	= 1 if kid(s) present: age 6–14	0.401	0.434	0.338
		0.490	0.496	0.473
Kid15-19	= 1 if kid(s) present: age 15–19	0.268	0.301	0.258

Table 2: Probit Model for Smoking

EDUCNYRS	-0.027	0.004
NUMBTECH	0.055	0.007
NUMBAUTO	-0.070	0.032
NPROPRTY	-0.101	0.018
GENDER	0.398	0.055
MSTATUS	-0.119	0.054
EMPLOYED	0.033	0.035
Age20-29	0.361	0.066
Age30-39	0.346	0.054
Age40-49	0.368	0.049
Age50-59	0.356	0.043
COMPHINS	-0.346	0.046
GRNCARD	-0.199	0.057
HOMOWNER	-0.199	0.036
Kid0-5	-0.109	0.039
Kid6-14	-0.218	0.037
Kid15-19	-0.109	0.037
HSIZE	0.124	0.012
URBAN	0.036	0.032

Figure 1: Effect of Income on the Smoking Probability

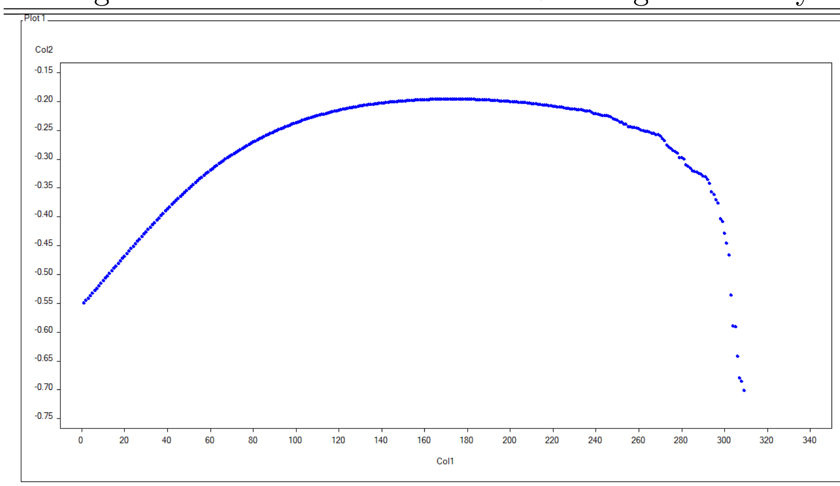

Table 3: Probit Model for Drinking

EDUCNYRS	0.020	0.006
NUMBTECH	0.075	0.010
NUMBAUTO	0.098	0.047
NPROPRTY	-0.041	0.027
GENDER	0.403	0.091
MSTATUS	-0.222	0.084
EMPLOYED	0.052	0.056
Age20-29	0.152	0.105
Age30-39	0.221	0.087
Age40-49	0.144	0.080
Age50-59	0.247	0.069
COMPHINS	-0.251	0.068
GRNCARD	-0.031	0.099
HOMOWNER	-0.135	0.054
Kid0-5	-0.162	0.064
Kid6-14	-0.033	0.057
Kid15-19	0.050	0.059
HSIZE	-0.123	0.022
URBAN	-0.151	0.050

Figure 2: Effect of Income on the Drinking Probability

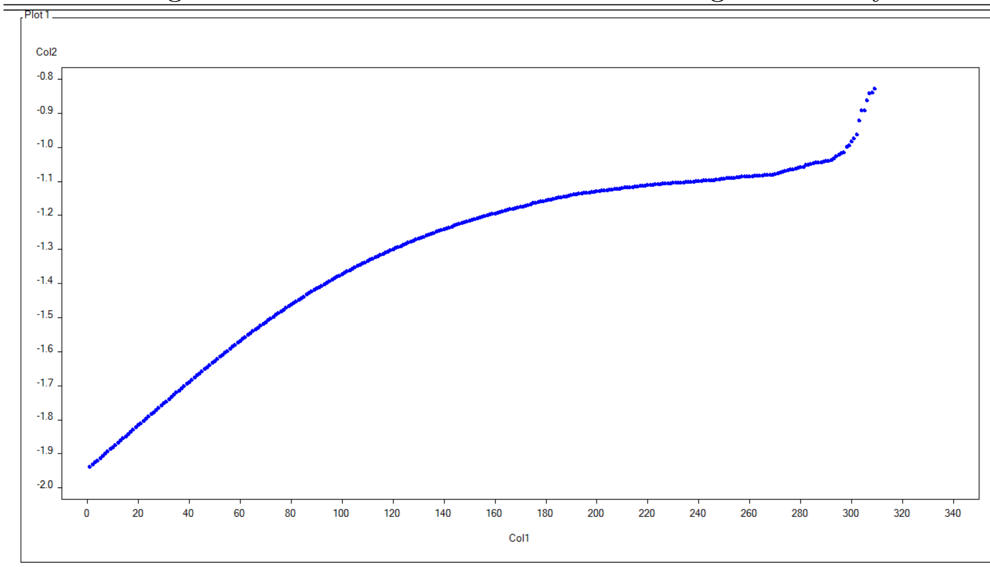

Table 4: Model for Smoking Expenditure

EDUCNYRS	-0.018	0.004
NUMBTECH	0.023	0.007
NUMBAUTO	0.007	0.033
NPROPRTY	-0.043	0.019
GENDER	0.261	0.063
MSTATUS	-0.093	0.062
EMPLOYED	0.067	0.037
Age20-29	-0.112	0.071
Age30-39	0.028	0.058
Age40-49	0.068	0.053
Age50-59	0.112	0.048
COMPHINS	-0.111	0.044
GRNCARD	-0.285	0.056
HOMOWNER	-0.030	0.037
KID0-5	-0.122	0.040
KID6-14	-0.116	0.037
KID15-19	-0.085	0.037
HSIZE	0.037	0.011
URBAN	-0.044	0.034

Figure 3: Effect of Income on Smoking Expenditure

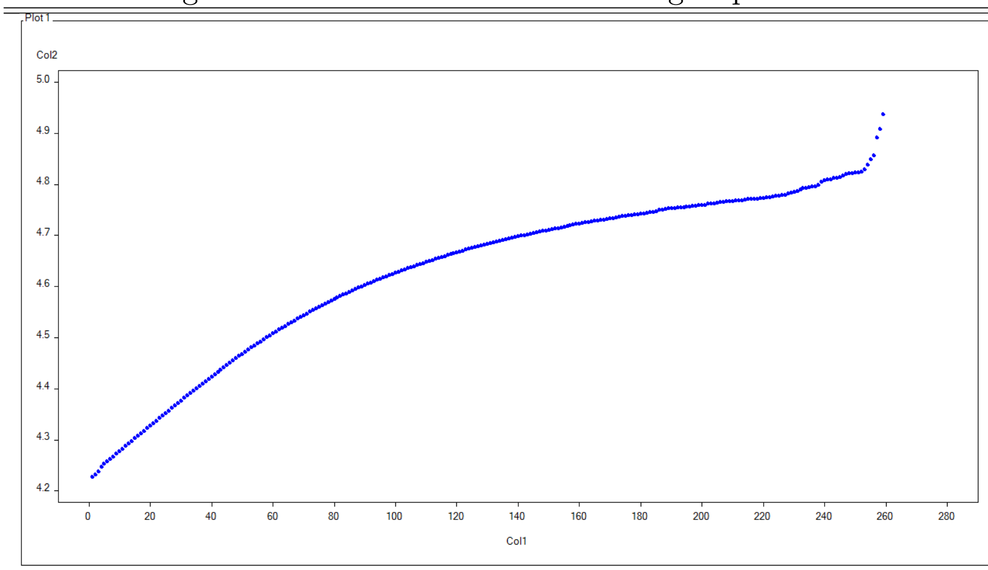

Table 5: Model for Alcohol Expenditure

EDUCNYRS	0.005	0.011
NUMBTECH	0.030	0.018
NUMBAUTO	0.077	0.082
NPROPRTY	-0.056	0.049
GENDER	0.419	0.160
MSTATUS	-0.156	0.142
EMPLOYED	-0.031	0.105
Age20-29	-0.649	0.190
Age20-29	-0.576	0.161
Age20-29	-0.206	0.149
Age20-29	-0.089	0.135
COMPHINS	-0.042	0.126
GRNCARD	0.001	0.205
HOMOWNER	-0.010	0.103
KID0-5	-0.031	0.123
KID6-14	-0.007	0.106
KID15-19	-0.152	0.107
HSIZE	-0.041	0.044
URBAN	-0.230	0.096

Figure 4: Effect of Income on Drinking Expenditure