The Effect of Cigarette Prices on Smoking Decision and Intensity in China

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Abstract

This paper examines the smoking behavior in China using the urban data set from the 1995 Chinese Household Income Study. We investigate the two parts of elasticity through employing two main models. We find the estimate of overall cigarette price elasticity is –0.654 by combining the estimates of participation elasticity and conditional elasticity. The result implies that people still care about the price of cigarettes in China. An increase in the tax on cigarettes might be an effective means to reduce cigarette consumption.

Keywords: Smoking, Price, Elasticity, China

1. Introduction

In past several decades, cigarette consumption fell in developed countries, while it increased in middle- and low-income countries, including China. During this period of rapid growth, China became the biggest cigarette consumer country in the world. Approximately 320 million individuals in China are smokers according to a 1996 national survey with 63% of adult (15 year is old or over) male and 3.8% of adult female smokers (Chinese Academy of Preventive Medicine, 1997).

There is a policy dilemma between public health concerns and the economic benefit of tobacco production. While the tax on cigarettes is a main part of government revenues and tobacco industry provides a large number of job opportunities, smoking damages people's health and increases medical costs. Jiang and Jin (2000) estimated that approximately 514 thousand premature deaths occurred in 1998 due to smoking-related disease. The study used the 1998 national health services survey data to estimate that medical costs related to smoke were estimated at 22.9 billion Chinese Yuan (Y) (US$2.76 billion), which accounted for 6.1% of total medical costs in China during 1998 (Ministry of Health 2000). On the other hand, taxes from the tobacco industry reached 10.26% of total government revenue in 1998.

Since smoking is a major public health problem, the study of smoking behavior came to has attracted more attention from economists in recent years. There are two different points on the study of cigarettes smoking behavior and price in low-income countries. Some believe that people respond to changes in cigarettes. Xu et al. (1998) employed the data from 1978 to 1992 to find overall elasticity estimates concentrated on -0.75. Mao and Jiang (1997) reported that the overall elasticity of demand for cigarettes is

calculated at –0.68. Teh-Wei Hu (1997) mentioned that the imposition of a cigarette tax increase would have a significant effect in generating revenue and reducing cigarette consumption. On the other hand, some argue that the elasticity is not as great as other researchers have suggested. Lance et al. (2004) concluded the price elasticity is virtually 0, with a range of 0 to -0.15. This implies that people in China are virtually non-sensitive to the price of cigarettes. They further conclude that raising prices in China might not reduce smoking as much as previously mentioned.

Through examining the data from ten provinces in China for 1995, this paper revisits these issues. We explore the price and income elasticity through two models, a probit model and a linear model. We found the overall price elasticity is –0.654, which is very close to the range of the price elasticity of the demand for cigarettes (-0.50 to-0.65) by Hu, Mao (1997). We suggest that raising tax of cigarettes could be an effective means to reduce cigarette consumption.

2. Data

We use the 1995 Chinese Household Income Project (CHIP) data in this paper. The CHIP data was collected as a part of major research program of the Chinese Academy of Social Sciences (CASS). CHIP data comes from two distinct samples of both rural and urban surveys in cooperation with the State Statistical Bureau (SSB) that collects significantly larger samples. Each survey consists of two data files; one in which the individual is the unit of analysis and a second in which the household is the unit of analysis. The data we used in this paper is from the urban survey, which includes 10 provinces and Beijing: 10 provinces include Shanxi, Liaoning, Jiangsu, Anhui, Henan,

Hubei, Guangdong, Sichuan, Yunnan and Gansu. Considering that individual and family factors may affect smoking behavior, we merge the individual and household data. In the household data, we found that two household have the same identification number. Since we don't know which one is the correct data, we deleted these observations in both individual and household data. Further, we delete all data collected from Beijing due to the small effective smoking sample size from this region. In China, the smoking prevalence among men is far higher than women. Almost 92 % of our smoker sample is males. To avoid the disturbance from female samples, we deleted all female observations from data set. Therefore, we focus on males' smoking behavior.

After the total consumption expenditures and age variables with missing values were eliminated, we obtain 8200 men over age 14 in the merged data. Table 1 provides a brief look at the key variables in the data. The male smoking rate is 49.9%. A smoker consumes a daily average of 13.88 cigarettes. The proportion of adults in the sample is 86.5 %, while children and seniors account for 6% and 7.5% of the sample respectively. The main component of smokers is male adults with average smokers' age of 41.17 years. Men with an education level greater than the primary school account for 62.7% of total sample. An individual's household contains 0.28 other family member who smoke. Smokers spend around 1.47 Y ($0.18) per day. The average annual expenditure per male is around Y3918 ($ 477.8).

The variable fcigs is the sum of number of cigarettes each person smoked in a family per day. We use fcigs and the family consumption on cigarettes to measure the price of a pack of cigarettes[1]. To diminish effects of abnormal cigarette prices, we further delete price outliers that are lower than 0.3 Y ($0.036) and higher than 50Y($6.024).

[1] The price of a pack of cigarettes = (family consumption on cigarettes)/(fcigs*365/20)

Then we calculated a mean price and a median price for each region. Table 2 presents the mean and median price for each region. After we tried some simple models, we find the mean price provides more reasonable results.[2] We adopt the mean price of each region as the price of cigarettes in each region. The mean price for nine regions is Y2.112 ($0.254). From the table 2, we find that the two highest cigarette prices are located in Sichuan and Guangdong. (Guangdong is the wealthiest province in China.)

3. Model

We employ two main models to explore smoking behavior. The first one is the standard probit model used to estimate how the variables affect an individual's decision to smoke. We use this probit model to estimate the participation elasticity. The second is the linear regression model conditional on the smoking intensity. We obtain the estimate of the conditional elasticity from this linear model. The estimate of overall elasticity is the sum of estimates of participation and conditional elasticities.

$$\eta_t = \eta_p + \eta_c \tag{1}$$

where η_t is the overall elasticity, η_p is the participation elasticity and η_c is the conditional elasticity.

To estimate influences on the decision to smoke, we adopt the following model.

$$\Pr(S_i = 1 | \boldsymbol{x}) = \Phi(\beta \ \boldsymbol{x}) \tag{2}$$

[2] There may be a problem with the price data as there is little price variation in our sample.

Where S_i =1 if an individual currently smokes and zero otherwise. $\Phi(\cdot)$ is the standard normal cumulative distribution function. β and $\boldsymbol{x}$ are the vector of parameters and the vector of each individual's characteristics respectively.

Table 3 presents estimates of smoking participation using the two probit models. As we expect, two models give us almost same results regarding to the decision to smoking. Education plays a negative role on the decision of smoking. An individual with higher education (which is higher than primary school education in model 2) is less likely to smoke. An increase in the price leads to the probability of smoking to decline. We found that older people more likely smoke than younger people in China, although the marginal effect is decreasing when people are getting older. The positive sign of N_others' parameter suggests that an individual might be influenced in by those around him. While Individual's income is positively related to the decision of smoking, per capita total family consumption affects the decision of smoking in either way. The higher the consumption level or personal income level, the lower the probability of smoking. We divide the income at the 25th, 50th, or 75th percentiles into four groups. We add the four income dummies in to the probit model. Only the lowest income group dummy is significant, implying that increasing income of the poorest persons will increase the probability of smoking.

We believe that per capita total family consumption is more persuasive to present an individual's ability to consume than individual income. Considering this reason, we adopt the probit model 2 to estimate the participation elasticity, which includes the variable of per capita total family consumption.

Since we use the natural log of an individual consumption and price of cigarettes into the probit model, we adopt the method mentioned by Constantin O. and Gregory B. (2003) to compute the price and income elasticity as follows:

$$\eta_j = \frac{\phi(\beta x)\beta_j}{\Phi(\beta x)} \tag{3}$$

Where η_j is the elasticity of the participation respect to the variable *j*, $\phi(\cdot)$ is the probability density function of the standard normal variable estimated at the means of the independent variables, β_j is coefficient of the natural log of variable *j*, and $\Phi(\cdot)$ is the cumulative probability function for the standard normal variable estimated at the means of the independent variables.

From the probit model, we found that the estimated price elasticity of participation is –0.435, while the participation per capital total consumption elasticity is –0.075.

To estimate the smoking intensity, we employ the linear regression model that is conditional on smoking.

$$\ln(Cigs) = \delta \mathbf{z} \tag{4}$$

Where the dependent variable, ln (*Cigs*), is the natural log of *Cigs*, δ and $\mathbf{z}$ are the vector of linear parameters and the vector of each individual's characteristics respectively. In the linear model, all the samples are smokers who smoke cigarettes greater than zero.

Table 3 presents the brief results of four different models. We note that the first two models are the sample selection models. In the linear model, we use the samples in which the number of cigarettes smoked is greater than 0. That means all samples in the model are male smokers, who smoke at least one cigarette per day. It could present some

of potential sample election problems.[3] The variable of lambda[4], the correction factor, is the evidence of the selectivity bias from the mentioned probit model. In order to consider the potential smokers may be a factor to affect the quantity of cigarettes smoked, we include lambda into first two linear regression models as follows

$$\ln(Cigs) = \delta \mathbf{z} + \rho\lambda\ (\beta x) \qquad (5)$$

If the parameter of lambda is not statistically significant, we could say the sample selection model will be equal to the simple regression model (4).

The first two models are only made up of a few basic variables. Unfortunately, Price, is not significant in the two models. The intercept and lambda are significant in both two models. In second model, the lpconsum is an additional significant factor to dependent variable compared with the first model. Based on this result, we add additional variables, including education and age, to the model. Since the lambda is high correlated with education levels, lambda appears insignificant in several models we try. Lambda is not as useful as we expected. Due to high correlation between lambda and education, we eliminate lambda from both last two models.

We find a few common results in these two models. There is no obvious evidence to support that an individual with a primary school education smokes a different number of cigarettes than those without a primary education. However, people who have middle education level smoke less. Thus education negatively affects the number of cigarettes smoked, if it is higher than primary level. As we expected, the sign of age is positive,

[3] Due to the social stigmas of smoking, certain people may hide their smoking habits from the survey respondent. It could make sample size underreported.

[4] The correlation factor is the ratio between the standard normal pdf and standard normal cdf at any constant value.

while that of age-squared is negative. That is, older people smoke more than young people. But as same as the probit model, the marginal effects decrease as people age.

After we compare the last two models, especially the parameters of lpincome and lpconsum, we find that the fourth model gives us more reasonable signs.

$$\ln(\text{Cigs}) = \beta_0 + \beta_1 \ln(\text{pconsom}) + \beta_2 \ln(\text{meanp}) + \beta_3 highedu + \beta_4 midedu + \beta_5 primary + \beta_6 age + \beta_7 age2 + \varepsilon \quad (6)$$

An individual with higher consumption ability smokes more. It represents that cigarette still is a normal good in China. Recalling the parameter of lpconsum in probit model, a possible explanation is that an individual who has high income is less likely to smoke, but once he decided to smoke, he would smoke more.

Under the model 4, we find that price and consumption elasticities are –0.219 and 0.031 respectively. Combining the results from the probit model and the linear model, we estimate overall price elasticity is -0.654 and overall income elasticity is –0.044.

4. Conclusion

Although the estimate of the income elasticity is very low, people are sensitive to the change of price of cigarettes. The price elasticity of –0.654 implies a 10% increase in price lead to a 6.54 % decrease in the consumption of cigarettes.

Table 5 present the production, sales and tax revenue of the tobacco industry in past decades. Cigarette production and sales in 1995 reached highest level in 1990s. The overall cigarette consumption is 34.7 million cases or 86.75 billion packs (one case is equal to 2,500 packs). If the cigarette prices increase by 10%, for example, the cigarette consumption could decline by 5.67 billion packs at the elasticity of -0.654.

The effective tax rate is about 40% in China (Hu, Mao (2000)). Government levies more 21 cents in tax from Y0.84 to Y1.05 tax per pack. Correspondently, the price each pack increases by 10% from Y2.11 to Y2.32. While Government will receive Y12.26 billion more revenue, the tobacco industry only loses Y7.2 billion. That means government still has 5.06 billion more revenue after offsetting the loss in the tobacco industry. Raising cigarette tax may be an effective way to reduce cigarette consumption.

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Table 1

Variable Descriptions

Variable (N=8200)	N	Description	Mean	Std Dev
SMOKE	4092	Smoke=1 if currently smoke	0.499	0.500
CIGS	_	Equals average number of cigarettes smoked per day	13.876	8.108
MEANP	_	the price of a pack cigarettes if currently smoke	2.046	0.312
AGE	_	Each individual's age	41.167	15.154
AGE2	_	Square value of age	1924.34	1319.12
PCONSUM	_	Average consumption per person in a family	3918.27	3412.14
LPCONSUM	_	Log value of Pconsum	8.087	0.713
HIGHEDU	1978	Highedu=1 if the person has professional shool education or above	0.241	0.428
MIDEDU	3169	Midedu=1 if the person has middle level professional education or upper middle school	0.386	0.487
PRIMARY	2946	Primary=1 if the person has lower middle school education or elementary school	0.359	0.480
LOWEDU	107	Lowedu=1 if the person has the education below elementary school	0.013	0.113
CHILD	493	Child =1 if the age <18	0.060	0.238
ADULT	7091	Adult=1 if the age is between 18 and 65	0.865	0.342
SENIOR	616	Senior if the age is >65	0.075	0.264
N_OTHERS	8200	Number of smokers in a family except himself	0.280	0.538

Table 2

The Price of a Pack of Cigarettes for Ten Regions

Region	**Mean Price**	**Median Price**	**N**
Liaoning	1.665	1.107	143
Henan	1.707	1.091	268
Anhui	2.315	1.315	166
Shanxi	1.729	1.311	251
Yunnan	1.793	1.37	163
Jiangshu	2.028	1.37	57
Guangdong	2.404	1.644	130
Sichuan	2.547	1.644	224
Hebei	2.259	1.737	166
Guansu	1.955	1.509	174
Average	2.0402	1.4098	1742[a]

a: total number

Table 3

Probit estimates of Smoking Participation

	Model 1		Model 2	
Variable	Coefficient	Std. Error	Coefficient	Std. error
Intercept	-2.064***	0.191	-2.141***	0.233
Lmeanp	-0.4691***	0.095	-0.386***	0.096
Lpincome	0.1127***	0.009	-	-
Lpconsum	-	-	-0.067***	0.021
Education				
Highedu	-0.7578***	0.139	-0.524***	0.138
Midedu	-0.4882***	0.137	-0.296**	0.136
Primary	-0.3693***	0.136	-0.213	0.135
Age	0.1029***	0.007	0.159***	0.006
Age2	-0.0012***	0.000	-0.002***	0.000
N_others	0.2111***	0.0298	0.198***	0.029

*Statistically significant at the 0.10 level; ** at the 0.05 level; ***at the 0.01 level (two tail tests)

Table 4

Linear Regression Models Conditional on Smoking

Variable	Description	Model 1		Model 2		Model 3		Model 4	
		Coefficient	Std error	Coefficient	Std error	Coefficient	Std error	Coefficient	Std error
Intercept	–	2.703***	0.095	2.482***	0.138	1.761***	0.156	1.561***	0.191
Lpincome	Log value of an individual annual gross income	-0.013	0.008	_	_	0.009	0.00898	_	_
Lpconsum	Log value of average consumption per person in a family	_	_	0.047***	0.016	_	_	0.031*	0.017
Lmeanp	Log value of mean price	-0.077	0.075	-0.083	0.78	-0.199***	0.074	-0.219***	0.075
Lambda		-0.454***	0.054	-0.497***	0.055	–	–	–	–
Highedu	–	–	–	–	–	-0.280***	0.106	-0.285***	0.105
Midedu	–	–	–	–	–	-0.199*	0.1046	-0.202*	0.104
Primary	–	–	–	–	–	-0.105	0.1035	-0.106	0.103
Age	–	–	–	–	–	0.042***	0.00583	0.044***	0.005
Age2	–	–	–	–	–	-0.0004***	–	-0.0005***	0.0001

*Statitiscally significant at the 0.10 level; ** at the 0.05 level; ***at the 0.01 level (two tail tests)

Table 5

Cigarette Production, Sales and Tax in past decades

Year	The Quantity of Production (Million Boxes)	The Quantity of sales (Million Boxes)	Tax Revenue (Billion Yuan)
1981	17.04	15.90	7.5
1982	18.85	16.08	9.76
1983	19.38	18.20	10.25
1984	21.20	20.39	10.7
1985	23.60	22.09	12.06
1986	25.61	23.71	14.5
1987	28.49	25.46	17
1988	30.51	26.65	21
1989	31.52	28.79	24
1990	32.60	30.17	27
1991	31.08	31.00	28
1992	32.79	32.20	30.5
1993	33.36	32.89	41
1994	33.91	33.63	55
1995	34.80	34.70	71
1996	34.42	34.00	83
1997	33.67	33.89	90
1998	33.49	32.85	95
1999	32.85	32.45	98.9
2000	33.35	33.34	105
2001	33.99	33.97	115
2002	34.45	34.99	140
2003	35.78	35.96	160

* The exchange rate of US $: Chinese Y is 8.3