

## PRICE ELASTICITY OF DEMAND FOR CIGARETTES IN SLOVAKIA

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## Price Elasticity of Demand for Cigarettes in Slovakia

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### ABSTRACT

In recent years there is huge effort to decrease tobacco consumption in the world by several methods as cancelation of small package of cigarettes, pubs and restaurants smoking restrictions, health warnings and imagines of diseases caused by smoking, and the most important - price increasing by taxation. Therefore the main aim of this paper is estimate price elasticity of demand for cigarettes in Slovakia by applying Heckman sample selection model on Households Budget Survey data for time period 2006 – 2012. We also investigate difference in price elasticity between households with light, moderate and heavy cigarette consumption by quantile regression. Results show that price elasticity of demand for cigarettes is inelastic and has decreasing trend with higher cigarettes consumption.

Keywords: cigarettes, Heckman sample selection, price elasticity, smoking, quantile regression

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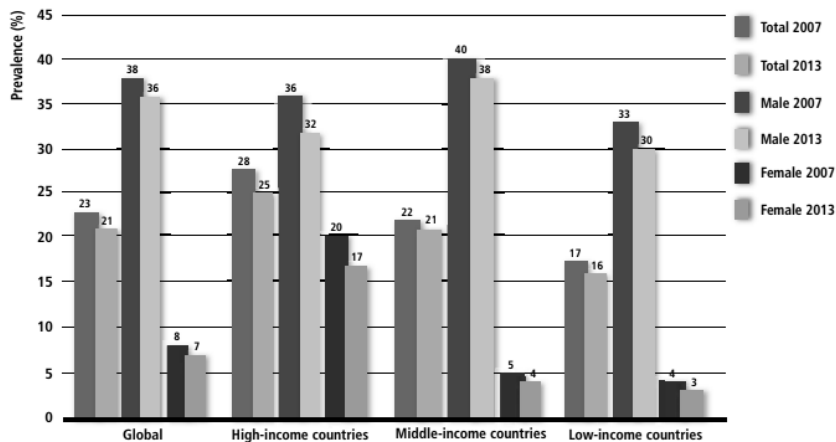
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## INTRODUCTION

Negative effect of smoking on health is well known. Many studies confirm that cigarettes and other tobacco product causes serious health damage and death (WHO, 2015; Jha, 2009; Doll, et al., 2004; HHS, 2004). World Health Organization (2017) state that tobacco kills almost half of its users and yearly died more than 7 mil. people as the result of direct or indirect – second hand tobacco using. These are the main reasons why smoking cessation efforts are constantly growing around the world. WHO in 2005 introduce Framework Convention on Tobacco Control with several policies – monitoring, smoke-free environments, cessation programmes, warning labels, mass media, advertising bans and taxation. In 2015 more than half of world’s countries have implemented one or more from these policies at the highest level of accomplishment (WHO, 2015).

The enormous increase in smoking occurred during world wars. After increasing in knowledge of the negative effect of smoking on health in later twentieth century it became less popular. Currently prevalence of smoking declined in North America and Western Europe, but tobacco companies focussed their promotions into less developed countries in Africa, the Middle East, Asia or Latin America (Cancer Council, 2017). Smoking prevalence across countries with different income levels shows Figure 1.

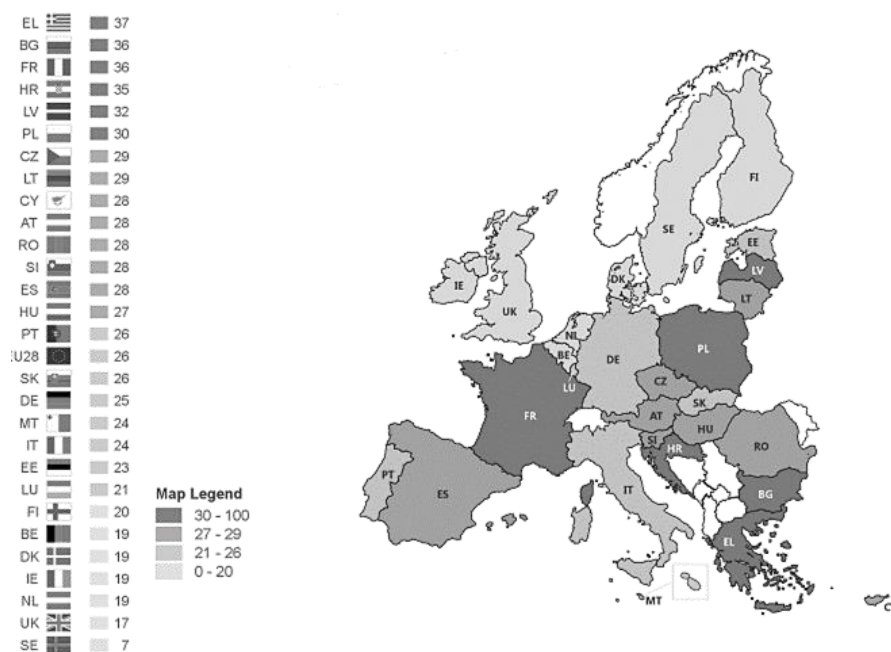
Figure 1 Adult tobacco smoking prevalence 2007-2013



Source: WHO Report on the Global Tobacco Epidemic, 2015

In most EU countries number of smoker has decline between 2006 and 2014, but remained stable since then. The highest decrease in proportion of smokers was in UK (16 pp) and Denmark (13 pp). Percentage of smokers in European countries are in Figure 2. Smoking in Slovakia had declining trend till 2014 and since it raised. According to results from Eurobarometer in 2017 smoked 26 % of Slovaks what is equal to EU average, while in 2014 had smoked only 21 % of citizens and in 2006 it was 25 % (Eurobarometer, 2017).

Figure 2 Proportion of smokers (%) in EU countries, 2017



Source: Special Eurobarometer 458: Attitudes of Europeans towards tobacco and electronic cigarettes

In 2007 WHO presented several policies also known as MPOWER. This policies represent methods as cancelation of small package of cigarettes, smoking restrictions in pubs and restaurants, health warnings and graphic picture of diseases caused by smoking, etc. As the most important policy WHO identify taxation which has strong influence on price increasing in tobacco products. Government use tax policy as a main tool for reducing smoking, because price is major determinant which influence cigarette consumption (Bosanquet, 1992, Godfrey and Maynard, 1988, Townsend, 1994). Majority of smokers and ex-smokers identify price as an important factor when choosing brand of cigarettes. In Slovakia 86 % of respondent answered this way, which was the 6th highest

number (first was Greece with 92 %), while in North EU countries it was less than 40 % (Eurobarometer, 2017). Saenz-de-Miera (2010) analysed changes in consumption after cigarette tax increase. Consumption generally declined, but people who smoke more than 5 cigarettes a day had worse response on higher tax, also heavier smokers are less likely to quit smoking. Boulos et al. (2009) found statistically significant differences between light, moderate and heavy smokers. Light smokers were mostly younger with higher levels of education and they have higher willingness to stop smoking. Based on these results we expect that differences between mentioned groups of smokers will be also possible to observe from our estimation of price elasticity. We expect that price elasticity of light smoking households will be higher than moderate and heavy smoking households, also because cigarettes can be considered as addictive goods.

## 2. Data and methodology

For analysis we use data from Household Budget Survey in Slovakia 2006 – 2012. Because of missing prices we calculated them by dividing expenditure on alcohol by quantities of alcohol consumed by household. This calculation method also used Sousa, 2014. There remains households with zero consumption and therefore with zero prices. For these households we calculated average prices by region, quarter and year and substitute the missing prices with these average prices. The same approach suggest Cox and Wohlgenant (1986).

Table 1 Variables used in models

<b>Dependent variable (Y)</b>	<b>Definition</b>
ln_cig	log number of smoked cigarettes by household per month
<b>Explanatory variable (P)</b>	<b>Definition</b>
ln_p_cig	log price of cigarettes
<b>Instruments (Z)</b>	<b>Definition</b>
ln_income	log income of household per month
male_hh	dummy variable, 1 – head of household is a man, 0 - woman
employed_hh	dummy variable, 1 – head of household is employed, otherwise 0
edu2	dummy variable, 1 – head of household has high school education, 0 – primary education
edu3	dummy variable, 1 – head of household has university education, 0 – primary education

n_adults	number of adults in household
year	trend for period 2006 - 2012

Source: own processing

For estimation we use model firstly proposed by Heckman in 1976 to treat the censoring of observations, because in database is significant number of household with zero expenditure on cigarettes. We are trying to find condition, based on we make households more or less likely to be in the sample. Final sample selection variable is not omitted.

Model has two equations. First is a participation equation, where we estimate the probability that a households has a non-zero observation. Assume two part model where a participant is fully observed outcome. We need to define dummy variable  $d$ :

- for participants  $d = 1$  if  $y > 0$ ,
- for nonparticipants  $d = 0$  if  $y = 0$ .

Quantity equation – in case that a household consumes a certain type of alcohol, we estimate amount of this consumption.

$$\begin{aligned} d_{ij} &= Z_j \beta_i + \log P_j \gamma_i + X_j \delta_i + e_i \\ \log Y_i &= \log P_j \varphi_i + X_j \pi_i + \phi_i \lambda_{ij} + u_{ij} \end{aligned} \quad (1)$$

where  $Z_j$  are instruments,  $P_j$  are prices,  $X_j$  are control variables and  $Y_i$  are dependent variables, then

$$E[u_i | d_i = 1] \neq E[u_i] = 0 \quad \text{and} \quad E[y_i | x_i, d_i = 1] = x_i \beta + E[u_i | d_i = 1] \quad (2)$$

shows that Heckman model treats selection bias, because variable causing the bias is in the equation. Heckman proposed write out the determinants of  $d_i$  and estimate bias factor to solve selection bias problem with using truncated normal distribution  $X \sim N(\mu, \sigma^2)$  and  $a$  is a constant,

$E[X | X > a] = \mu + \sigma \lambda(\alpha)$ , where:  $\alpha = \frac{a - \mu}{\sigma}$ , probability density function is  $\phi(\alpha)$  and inverse

Mills ratio is given as  $\lambda(\alpha) = \frac{\phi(\alpha)}{1 - \Phi(\alpha)} = \frac{\phi(\alpha)}{\Phi(-\alpha)}$ .

Omitted variable bias is a function of the inverse Mills ratio and for solving this problem we estimate the inverse Mills ratio for each observation and contain it in equation, which will be:

$$y_i = x_i^* \beta + \delta \lambda_i + u_i \quad (3)$$

In case that this is the only source of bias in the equation, then the estimator  $\lambda$  will be consistent and unbiased.

Participation part is probit, so that means estimation by maximum likelihood function:

$$L = \prod_{y_i=0} 1 - \Phi\left(\frac{w_i \gamma}{\sigma_d}\right) \prod_{y_i>0} \Phi\left\{\left(w_i \gamma + \frac{\sigma_{dy}}{\sigma_y^2}(y_i - x_i' \beta)\right) \sqrt{\sigma_d^2 - \frac{\sigma_{dy}^2}{\sigma_d^2}}\right\} \times \frac{1}{\sigma_y} \phi\left(\frac{(y_i - x_i' \beta)}{\sigma_y}\right) \quad (4)$$

For estimation price elasticities of light, moderate and heavy smokers we use quantile regression. Application of this model is appropriate because it is likely that influence of independent variables vary across quantiles in comparison with estimation of average by OLS (Koenker a Bassett, 1978; Koenker a Hallok, 2001). Quantile regression is also more robust method, because it is not sensitive to normality of error distribution or to the outliers in the data. Model can be written as

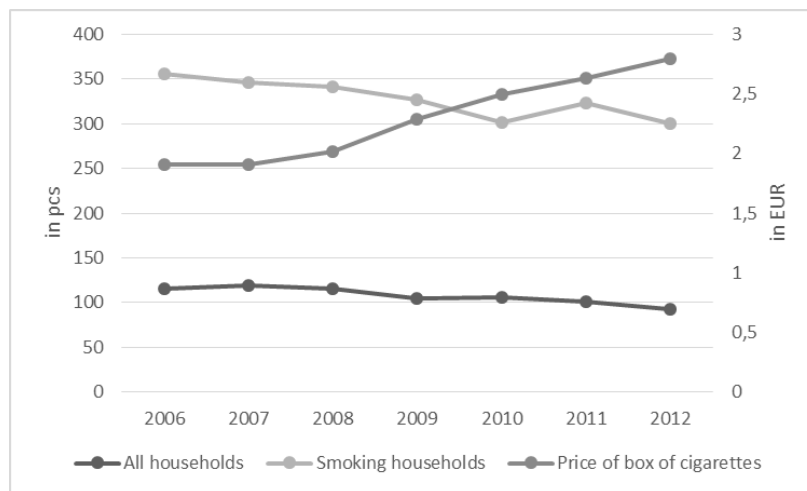
$$y_t = x_t' \beta_\theta + \varepsilon_{\theta t} \quad (5)$$

where  $y_t$  is dependent variable,  $x_i'$  represent explanatory variables,  $\beta_\theta$  is coefficient in  $\theta$  quantile of dependent variable and  $\varepsilon_{\theta i}$  is an error term.

### 3. Results and discussion

Between 2006 and 2012 price of cigarettes increase rapidly. Figure 3 shows average price of box of cigarettes calculated from HBS data. Average number of cigarettes smoked to all Slovak households was 92 per month in 2012, but when we count only households with positive expenditure, number of smoked cigarettes is more than triple. Overall trend was decreasing. Number of smoking households in our dataset is 11 595 and non-smoking 22 778.

Figure 3 Relation between average price of cigarettes and amount of cigarettes smoked by household



Source: HBS, authors' calculations

Estimated price elasticity is 0.92, which mean that 1 % change in price cause 0.92 % decrease in consumption of cigarettes. Elasticity is lower than one, therefore is inelastic. With higher income is related higher smoking, also households with male as a head have higher consumption of cigarettes. Employment and better education lower amount of cigarettes smoked. Higher income, drinking household or household with employed head have positive influence on fact, that household will be smoking. Details are in Table 2.

Table 2 Estimation of price elasticity by Heckman sample selection model

	Coefficients	Robust Std. Err.	[95% Conf. Interval]	
<b>ln_cig</b>				
ln_p_cig	<b>-.9214477***</b>	.0501194	-1.01968	-.8232156
ln_income	.1148679***	.0263369	.0632485	.1664873
male_hh	.0729091***	.0181642	.037308	.1085102
employed_hh	<b>-.3386446***</b>	.0302694	<b>-.3979716</b>	<b>-.2793176</b>
edu2	-.0510501	.0269521	-.1038754	.0017751
edu3	<b>-.1423168***</b>	.0364067	<b>-.2136726</b>	<b>-.0709611</b>
n_adults	.0270319**	.0092054	.0089896	.0450743
year	.0412066***	.005338	.0307442	.0516689
_cons	<b>-75.28756***</b>	10.70073	<b>-96.26061</b>	<b>-54.3145</b>
<b>smoking</b>				
ln_income	.1854854***	.0141518	.1577484	.2132224

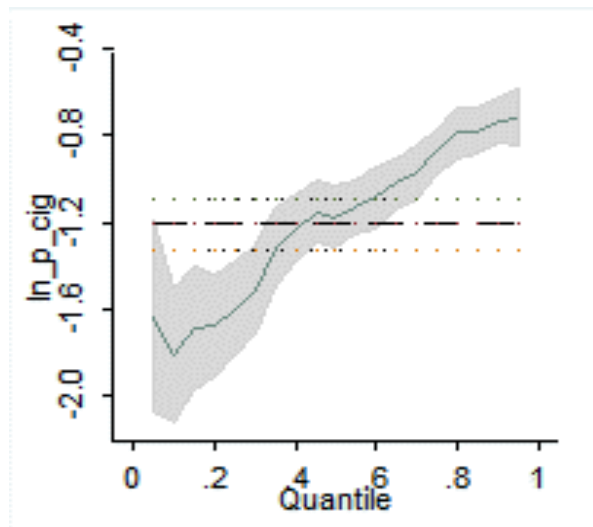


drinking	.1873716***	.0169666	.1541176	.2206255
employed_hh	.2271663***	.0177343	.1924077	.2619248
_cons	-1.984247***	.0889953	-2.158674	-1.809819

Source: HBS, authors' calculations. Note: \* p<.05, \*\* p<.01, \*\*\* p<.001

Figure 4 show distribution of price elasticity among smoking households. These with lowest cigarette consumption have highest price elasticity (-1.8) and with rising consumption sensitivity to price change from elastic to inelastic. Median household has elasticity -1.17 and really heavy smoking households are less sensitive to price change (-0.70). Results confirm our expectation what is clearly visible on figure.

Figure 4 Price elasticity of light, moderate and heavy smokers by quantile regression



Source: HBS, authors' calculations

#### 4. Conclusion

The main aim of this paper was estimation of price elasticity of demand for cigarettes. Firstly by using Heckman sample selection model we estimated overall elasticity of Slovak households which was -0.92. Secondly, to find out how price elasticity vary across households with different level of cigarettes consumption we use quantile regression. From the results we can confirm, that households with light cigarettes consumption are more sensitive to price change than moderate and heavy smoking households. Therefore taxation as a main instrument can be used for decreasing of

smoking, but this policy should be supported by other tools, mainly to persuade heavy smoking household to quite. For analysis were used HBS data from 2006 to 2012. During this period has smoking in Slovakia declining trend what we find out from Eurobarometer reports and from our data too. We also noticed that later (from 2014) this trend has turned. Why this happened and how price elasticity changed we plan to investigate in the future.

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