Tobacco price elasticity in Bosnia: micro data analysis

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Abstract: Smoking is an endemic problem in Bosnia & Herzegovina (BiH), and BiH is among the top 10 countries in the world for cigarettes consumption (World Atlas, 2018). The state excise policy is one of the main available tool for reducing smoking prevalence because the cigarette prices are under direct impact of this policy. The specific excise on cigarettes introduced in BiH in 2009 and have increased every year so it was the main driver of cigarettes price growth. In order to determine effect of increase in cigarette prices, and thus effect of excise policy on demand for cigarettes in BIH, in this paper we estimate price elasticity of demand for cigarettes. We follow Deaton (1988) demand model and apply it on micro data, obtained from the Household Budget Surveys in BiH in 2011 and 2015. Our results show that the price elasticity coefficient is statistically significant and amounts to -0.65. This means that if cigarette prices in BIH increase by 10%, the demand for cigarettes, among smokers of cigarettes, will decrease by 6.5% i.e. continuous increasing in specific excise in BiH can be efficient measure for reducing smoking prevalence in BiH.

Keywords: smoking prevalence, price elasticity of demand for cigarettes, specific excise on cigarettes, cigarettes prices.

1. Introduction

Tobacco consumption continues to be behavior engaged in by a large percentage of Bosnia & Herzegovina (BiH) citizens. According to the official statistics nearly 40% of the state's adults, that is about 1,200,600 people, consume tobacco product on a daily base. Smoking prevalence in BiH is close to 40% with a significant difference between men (46.9%) and women (28.5%). BiH is amongst the top 10 countries in the world for cigarettes consumption (World Atlas, 2018). Authorities of Bosnia & Herzegovina have not done much to reduce smoking in the country.

The state excise policy is one of the main available tool for reducing smoking prevalence, due to the fact that the cigarette prices is under direct impact of this policy. In order to determine effect of increase in cigarette prices, and thus

effect of excise policy on demand for cigarettes in BIH, it is necessary to estimate prices elasticity.

Evidence from countries of all income levels suggest that increase in cigarette prices are highly effective in reducing demand (Eozenou & Fishburn, 2001). Previous researches, conducted in low and middle income countries (such as Bosnia), found that price elasticity of demand for cigarettes is in the range between -0.5 and -1. This implies that state excise policy in this countries can be effective in reducing tobacco consumption.

Due to the missing of long enough and accurate time-series data in low and middle income countries, micro data can be more reliable source in estimating price elasticity. Methodology, which use micro data from Household Budget Surveys in estimating price elasticity, has developed by Angus Deaton. In this paper, we follow Deaton (1988) demand model and apply it on micro data, obtained from the Household Budget Surveys in BiH in 2011 and 2015.

In the section 2, we shortly present Deaton's demand model and describe empirical methodology to estimate price elasticity using this model. In the section 3 we present descriptive statistic of the indicators which is relevant for research topic. We present the results of the analysis in the section 4 and the fifth section concludes the paper.

2. Econometric model and methods

Deaton demand model is a model of consumer behavior in which households choose both quantity and quality. Then the expenditure on a good is the product of quantity, quality and price. Deaton (1997) provides detailed exposition of the methodology and, in this paper we only describe the basic equations and procedure to estimate the price elasticity using HBS data.

Deaton model uses within cluster information to estimate total expenditure elasticities and then uses between cluster information to estimate price elasticities. Unit values, which are calculated from the households consumption diary, in this model is used as a proxy for price. In practice, unit values depend on the actual market prices, but cannot be used as direct substitutes for prices. Unit values are different from prices so far as there are measurement errors involved in quantity and variations in quality due to heterogonous nature of the commodity (John, 2005). For example, when the cigarettes prices change, while the budget is constant, the household can decrease their consumption of the cigarettes and stay with the same brand or redirect to less expensive brand and

keep their consumption at the same level, which is referred to as quality shading.

Deaton's model consists of two equations:

$$w_{hc} = \alpha^0 + \beta^0 lnx_{hc} + \gamma^0 . z_{hc} + \theta lnp_c + u_{ch}^0 \quad (1)$$

$$lnv_{hc} = \alpha^1 + \beta^1 lnx_{hc} + \gamma^1 . z_{hc} + \psi lnp_c + u_{hc}^1 \quad (2)$$

where indices *h* and *c* represent households and clusters respectively. Variable w_{hc} denotes the share of the household budget spent on cigarettes (in percentages) and v_{hc} denotes unit values. Variable x_{hc} is total expenditures of the household *h* in cluster *c*, z_{hc} denotes other household characteristics, p_c is price of the cigarettes in cluster c, while u_{ch}^0 and u_{hc}^1 are the error term.

We can rewrite equation (2) to express lnp_c as a function of other variables and plug that into the equation (1) to estimate a linear relationship between the budget share as the dependent variable, and unit values and other variables as the independent variables:

$$w_{hc} = \alpha^2 + \beta^2 lnx_{hc} + \gamma^2 . z_{hc} + \hat{\phi} lnv_{hc} + u_{ch}^2 \quad (3)$$

Estimated parameter $\hat{\phi}$ is a hybrid of price and quality elasticity and it is equal to θ/ψ (Deaton, 1990).

In practice, the estimation of the model is performed in three stages. We can not estimate equations (2) and (3) as such because the true market prices are not observed. With the assumption that market prices do not vary for a given commodity within each cluster over the relevant reporting period, the parameters $\beta^0, \beta^1, \gamma^0, \gamma^1$ in both equations can be consistently estimated by standard OLS. This is the first stage of estimation of Deaton model.

In the second stage, we use the estimates from the first stage and remove the effects of the total household expenditure and other household characteristics from the budget shares and the unit values (i.e. purging the quality effects).

$$\tilde{y}_{hc}^0 = w_{hc} - \tilde{\beta}^0 lnx_{hc} - \tilde{\gamma}^0 z_{hc} \quad (4)$$

$$\tilde{y}_{hc}^1 = lnv_{hc} - \tilde{\beta}^1 lnx_{hc} - \tilde{\gamma}^1 z_{hc} \quad (5).$$

The dependent variables ($\tilde{y}_{hc}^{0}$ and $\tilde{y}_{hc}^{1}$) in equation (4) and (5) contain the price information and we use it to create cluster averages of budget shares and unit values

$$y_c^0 = \alpha^0 + \theta lnp_c + f_c + u_c^0 \qquad (6)$$

$$y_c^1 = \alpha^1 + \psi lnp_c + u_c^1 \qquad (7).$$

Parameters θ and ψ cannot be estimated directly from the data as market prices are not observed. But we can consistently estimate their ratio $\phi = \theta/\psi$

$$\widehat{\phi} = \frac{\mathrm{cov}(\hat{y}_c^0, \hat{y}_c^1) - \hat{\sigma}^{01}/n_c}{\mathrm{var}(\hat{y}_c^1) - \hat{\sigma}^{11}/n_c^+} \qquad (8)$$

where n_c is the number of all the households per cluster and n_c^+ is number of households with cigarette purchases.

In the third stage, we introduce the assumption on weak separability and the definition of the budget share as the product of quantity of cigarettes and unit value divided by the total expenditures. From there it can be shown (Deaton, 1990) that the parameter θ can be calculated as

$$\theta = \phi/[1 + (w - \phi)\zeta] \qquad \text{where } \zeta = \frac{\beta^1}{\beta^0 + w(1-\beta^1)} \qquad (9)$$

where β^1 and β^0 are estimated from the equations (1) and (2), while *w* is the average value of the budget share. If β^1 is small, ζ will be small, and so will be the correction to θ in equation (9); when the income elasticity of quality (β^1) is small, there will be little shading of unit value in response to price (Deaton, 1997).

Since budget shares in the equation (1) are not in log form, the formula for price elasticity of demand is (Deaton, 1997):

$$\epsilon_p = \left(\frac{\theta}{w}\right) - \psi \qquad (10)$$

Additionally, since in the equation (1) on the left hand side we have budget shares and not logarithm of quantity, parameter β^0 does not estimate the expenditure elasticity of demand. The budget shares can be defined as the product of quantity and unit value by total expenditure (w = q*v/x). So, we can

estimate the total expenditure elasticity by taking the log and the first derivative with respect to expenditure of this identity:

$$\frac{\partial lnw}{\partial lnx} = \frac{\partial lnq}{\partial lnx} + \frac{\partial lnv}{\partial lnx} - \frac{\partial lnx}{\partial lnx} \quad (11)$$

where $\frac{\partial \ln q}{\partial \ln x}$ represents the total expenditure elasticity of demand, $\frac{\partial lnw}{\partial lnx}$ is the budget share elasticity which can be estimated from equation (1) as $\frac{\beta^0}{w}$, while $\frac{\partial lnv}{\partial lnx}$ is the elasticity of quality to expenditure from equation (2). After we rearrange the equation and replace the identities with estimates from equations (1) and (2) we estimate the total elasticity of expenditure as (Deaton, 1997):

$$\epsilon_x = 1 - \beta^1 + (\frac{\beta^0}{w}) \quad (12).$$

Due to the calculation procedure, standard errors cannot be taken directly from the regression analyses. Instead we use bootstrapping procedure with 1000 replications to calculate the standard error of the estimated price elasticity. This allow us to determine statistical significance of the estimated price elasticity coefficient.

3. Data and stylized facts

In order to estimate the price elasticity of the cigarettes consumption we use the Household Budget Survey (HBS) data for 2011 and 2015. HBS provides detailed information of the household members, analysis socioeconomic characteristics of households in BiH, participation of households in the labor market, conditions housing, level and structure of household expenditures, poverty analysis (BHAS, 2018). Additionally, the data also contains information municipalities in which the surveyed households reside.

Unit values are calculated as a ratio of monthly household expenditure on cigarettes and the number of cigarette packs purchased by the household during a month. The unit values are expressed in Bosnia and Herzegovina BAM per cigarette pack. We calculate budget share as a ratio of monthly household expenditure on cigarettes and the total monthly household expenditure. Both cigarette and total expenditure variables are deflated to their real values from 2011, by using Consumer Price Index [1].

Table 1. Descriptive statistic of household – monthly data

[1] Available online from the Agency for Statistic BiH website http://www.bhas.ba/?lang=en

Year	House-hold	Number of house-hold	Percent-age of household	Total expendit-ures	Consum-ption of cigare-ttes (in pack)	Expendi-tures on cigare-ttes	Unit value of pack (in BAM)	Budget share on cigare-ttes
2011	non smoking	3,636.0	51.6%	1,329.4				
	smoking	3,412.0	48.4%	1,798.6	32.34	76.52	2.37	5.17%
2015	non smoking	4,803.0	66.2%	1,237.1				
	smoking	2,447.0	33.8%	1,739.9	22.86	83.89	3.65	5.69%
2011 and 2015	non smoking	8,439.0	59.0%	1,276.8				
	smoking	5,859.0	41.0%	1,774.1	28.38	79.60	2.91	5.39%

Author's calculation based on the HBS data.

Table 1 shows that share of smoking households significantly declined, from 48.4% in 2011 to 33.8% in 2015. At same time, the number of cigarettes pack consumed per households decrease from 32.34 to 22.86, or by 29.3%. Total monthly expenditures (monthly households budget) are much lower in non-smoking households. The difference between smoking and non-smoking households budget was 469.2 and 509.2 BAM in 2011 and 2015 respectively (1EUR = 1.95583BAM). When we look at both years together, difference is about 497 BAM.

Unit value of cigarettes, which represents not only the changes of the prices of the cigarettes but also the changes in the choice of cigarettes quality (brands), increased from 2.37 BAM to 3.65 BAM, or about 54%. The average price of cigarettes, which was determined by the national statistical agency, increased from 2.13 BAM to 3.42 BAM or by 60.6 %. Therefore, increasing in unit value was lower than increasing in cigarette prices. This is referred to as "quality shading". When the cigarettes prices increase, due to the budget constraint, households substitute to less expensive brands and try to decrease their consumption as little as possible i.e. households shade down both quality and quantity. Share in expenditures on cigarettes in total expenditures has increased from 5.17% in 2011 to 5.69% in 2015, as a results of both increasing in cigarette prices and falling in total households budgets.

In this report we estimate elasticity only for cigarettes, although other tobacco products, including cigars and cut tobacco, are available in the BiH market yet they still present insignificant share. The results obtained from the data analysis based on the HBS shows that in 2011 only 14 households out of 7,048 covered by survey consumed cigar (about 0.2%) showing a small increase in 2015 where there were 32 households out of 7,250 (about 0.44%). The household budget

share of cigars, which is calculated as a ratio of expense on cigars and total expense of households, had increased from 0.49% in 2011 to 0.77% in 2015. As expected, this kind of product is consumed by the wealthier part of the population whose an average household monthly budget was 2.903 BAM compared to 1.739 BAM (66,9% higher) a monthly households budget of those that consume cigarettes.

The number of households, which consumed cut tobacco increased from 99 (out of 7,048) in 2011 to 842 (out of 7,245) in 2015, 1.4 % and 11.62% respectively. Such an increase in consumption of cut tobacco could be explained by the cigarettes price increase. The budget share of cut tobacco in total households was 3.04% and 4.05% in 2011 and 2015 respectively. If we compare households which consume cigarettes and households which opt for cut tobacco, we can see that budget share of cut tobacco was significantly smaller than the budget share of cigarettes for 2.13% in 2011 and 1.59% in 2015. The households which consume cut tobacco have the lower regular income. The average monthly budget of the first group of households was 1,410 BAM, compared to 1,739 BAM, the budget that had the second group of households. However, we have also identified that 58 households in 2011 and 287 households in 2015 simultaneously consumed cut tobacco and cigarettes. The average budget share of both cigarettes and cut tobacco was 6.45% and 6.42% in 2011 and 2015 respectively. This type of households are those that have a larger number of members 3.55 (the average household in BIH, based on HBS in 2011 and 2015, has 3 members).

4. Results

Definition of clusters and the vector of covariates

For BiH, we define clusters based on the information on municipalities and years, i.e. the cluster is defined as a municipality x in the year t. According to this definition we generate 271 clusters, which contain 14,298 households. In each cluster, on average, we have about 53 households. Every cluster must have at least two households, which is condition to estimate the Deaton's model. According to the criteria requested to apply Deaton model, we drop the households which have not expense on cigarettes, households which monthly expenditure is more than five standard deviation higher than the mean monthly expenditure of the sample, and clusters which have only one household. So, due to the Deaton model estimation procedure, we reduced the sample and it now contain 253 clusters and 5820 households.

In the first stage regression we control for total expenditures (ln), as well as household size (ln), age and gender composition of the household, as well as the mean and maximum level of education of the household members. Additionally, we control for the household type by economic activity, by taking the "maximum" activity of the household members. The households are split to four household types 1) employed, 2) self-employed, 3) pensioner and 4) unemployed[2]. All expenditure variables, and consequently the unit value of cigarettes, are used in real values. The descriptive statistics of the variables used in the estimation of the first stage regressions are presented in table 2.

The data indicate that about 41% of the households have expenses on cigarettes (share of available observations on unit value and budget share). Households with zero expenditure are eliminated from the analysis. We drop 30 households whose total household expenditure is 5 standard deviations higher than mean expenditure in the overall sample. Additionally, we drop 9 clusters which contain only one household. Total sample for the regression analysis amounts to 5,820 households which belong to 253 cluster.

The budget share of cigarettes, which is calculated as a ratio of expense on cigarettes and total expense of households, is about 5.4% (among households which consume cigarettes). The households that enter first stage regression have average male ratio of about 50%, while the children (i.e. those aged 14 or less) represent about 13% of the household members. Mean and maximum years of education of 7.79 and 10.7 suggest that on average adult household members have primary level of education, which is very low[3]. Significant part of population belongs to the Baby-Boom Generation, born two decades after the 2nd World War, have only first four years of primary school due to the low living standard in BIH (BIH was penultimate country on the list of development in former Yugoslavia).

Table 2: Descriptive statistics of variables used in the first-stage regression

Variable	Obs	Mean	Std. Dev.	Min	Max
Unit Value, cigarettes (ln)	5,820	1.035711	0.251343	0.182322	1.683126
Budget share, cigarettes	5,820	0.053975	0.042527	0.000888	0.697053

[2] We rank the labor market activity of the household members in the following order 1) employed; 2) self-employed, 3) pensioner, 4) unemployed. If there is a member of the household which is employed, the household is labelled as "employed". If there are no employees, in the household, but there are self-employed, the household type is "self-employed". If there are no employees or self-employed, but there is a pensioner in the household, the household is marked as "pensioner, and finally if the adult household members are all inactive or unemployed the household is labelled as "unemployed".

[3] Approximately equal mean and maximum education suggests education sorting of the household members.

Total expenditure (ln)	5,820	7.298488	0.587254	4.950885	8.796021
Household size (ln)	5,820	1.09196	0.519452	0	2.70805
Male ratio	5,820	0.499899	0.230828	0	1
Adult ratio	5,820	0.827576	0.20999	0	1
Mean education	5,820	7.785834	3.424927	0	18
Maximum education	5,820	10.72852	3.485049	0	20
Rural Settlements	5,820	0.402062	0.490356	0	1
Household type - Employed	5,820	0.704811	0.456167	0	1
Self-employed	5,820	0.15945	0.366127	0	1
Pensioners	5,820	0.093299	0.290876	0	1
Unemployed	5,820	0.04244	0.201608	0	1

Author's calculation based on the HBS data.

Note: Conditional on being in the first stage regression.

About 40% of the households are from urban areas, while approximately 70% has at least one person employed with additional 16% of the households having at least one person self-employed. Household type "pensioner" makes about 9%, while household type "unemployed" makes about 4% of the households.

First stage – household level regression

Table 3 presents the results of the household level regression. We first comment on the results of the unit values equation. The coefficient for total expenditure is significant and it indicates that the quality elasticity of expenditure is about 0.06%. In other words, households with 10% higher expenditure will buy cigarettes that are about 0.6% more expensive. This result is consistent with the results from other countries (e.g. John, 2008 for India) and indicates that there is quality shading in Bosnia. The use of the Deaton's model is therefore necessary for obtaining an unbiased estimate of cigarette price elasticity.

Coefficient of the household size from unit value regression has the expected signs, unit value is lower in larger households. Male ratio is not statistically significant. Adult ratio is statistically significant and negative, which means that households with older family members buy cigarettes with lower unit value. Additionally, "pensioner" and "unemployed" household type spent lower amount of money on the cigarette packs, while the same does not hold for "self-unemployed" households.

Education variables have significant and positive effect on unit value. Household, which members have higher education level, spend more money on cigarettes pack. Finally, cluster fixed effects are statistically significant and relatively large, confirming that spacial/time variation is pronounced.

Table 3: First-stage regression results

VARIABLES	Unit Value (per pack, ln)		Cigarettes budget share (in %)	
Total expenditure (ln)	0.059***	(0.003)	-0.024***	(0.001)
Household size (ln)	-0.040***	(0.004)	-0.005***	(0.001)
Male ratio	-0.008	(0.007)	0.019***	(0.002)
Adult ratio	-0.033***	(0.009)	0.009***	(0.003)
Mean education	0.003***	(0.001)	-0.000	(0.000)
Maximum education	0.003***	(0.001)	-0.001***	(0.000)
Household type - Employed	Omitted			
Unemployed	-0.023***	(0.008)	0.003	(0.003)
Pensioners	-0.024***	(0.006)	-0.002	(0.002)
Self-employed	-0.006	(0.005)	-0.001***	(0.002)
Cluster dummies	F(252, 5558) 71.160***		F(252, 5558) 3.235***	
Constant	0.626***	(0.025)	0.230***	(0.008)
Observations	5820		5820	
R-squared	0.811		0.282	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Author's calculation based on the HBS data.

Now we will analyze the estimated coefficients from the budget share equation. All other things equal, households with higher levels of expenditure spend lower share of their budget on cigarettes. Households with 10% higher expenditure, spend about 0.24 percentage points less of their budget on cigarettes. Budget share spent on cigarettes is larger among smaller households, in households with higher shares of men and adults. Also, budget share spent on cigarettes is lower in the households where maximum education is higher.

Opposite to unit value equation, cigarettes budget share in "unemployed" and "pensioners" household type is not statistically different compare to the "employed" household type. "Self-employed" households spend lower budget share on cigarettes than the "employed" households.

Similarly to the unit value equation, cluster fixed effects are significant and indicate substantial variability in the budget shares between the clusters.
Estimated values of the coefficients for logarithm of total expenditure from equations (1) and (2) are used for estimation the total expenditure elasticity of demand, by using the formula from the equation (12). The estimated value of

total expenditure elasticity is, in line with the expectations positive and estimate at 0.496. However, this estimate should be treated with caution, as it indicates the elasticity on intensive margin, i.e. in the sample of households with positive consumption. In other words, among the households which consume cigarettes, 10% higher total expenditure is associated with 4.96% higher the quantity of cigarettes smoked.

Second stage – cluster level estimates

After the formation of the second stage variables we additionally purge regional effects from the variability of the budget share and unit values. Results indicate that regional effects on both unit values and budget shares are significant and that regional preferences play a role in the choice of unit value and the budget share allocation towards cigarettes.

In the final stage of the estimation we arrive at the estimated price elasticity of the cigarettes demand. Results indicate a negative price elasticity of -0.649. The same caution in the interpretation mentioned for the total expenditure elasticity should be applied here, as the estimate indicates the elasticity on intensive margin, i.e. in the sample of households with positive consumption. This means that if cigarette prices in BIH increase by 10%, the demand for cigarettes, among smookers of cigarettes, will decrease by 6.5%. Standard error of the elasticity, calculated via bootstrapping procedure (1000 replications) indicates that the value of the price elasticity is significantly different from and lower than zero (ξ= -0.649; SE_{ξ} = 0.092, t = -7.053).

5. Conclusions

In this paper we use the Household Budget Survey data for 2011 and 2015 and Deaton's demand model to estimate the price elasticity of cigarettes consumption in BIH. We found a negative price elasticity of demand for cigarettes of -0.649. This result is in line with previous estimates in low- and middle-income countries (Chaloupka et al. 2000). It demonstrates that the demand for cigarette is responsive to their prices and that tobacco tax policy can be used effectively to reduce cigarette consumption in BIH.

References

BHAS, the Household Budget Survey (HBS) data for 2011 and 2015.

BHAS (2018). Economics Statistics. Retrieved from http://www.bhas.ba/?option=com_publikacija&id=2&lang=sr

Chaloupka, FJ., Hu, TW., Warner, KE., Jacobs, R., Yurekli, A. (2000). The taxation of tobacco products. In: Jha P, Chaloupka FJ (eds). Tobacco control in developing countries. Oxford and New York: Oxford University Press, pp. 237–72. Retrieved form http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.542.8248

Eozenou, P., and Fishburn, B. (2001). Price Elasticity Estimates of Cigarette Demand in Vietnam. MPRA Paper No. 12779. Retrieved form https://ideas.repec.org/p/dpc/wpaper/0509.html

Deaton, A. (1988). Quality, quantity, and spatial variation of price. American Economic Review 78 (3), 418–430. Retrieved from https://pdfs.semanticscholar.org/f88c/33eadd1b197a02b9a1c1505e656738ef72af.pdf

Deaton, A. (1990). Price elasticities from survey data: extensions and Indonesian results. *Journal of econometrics*, *44*(3), 281-309. Retreived from https://doi.org/10.1016/0304-4076(90)90060-7

Deaton, A. (1997). The Analysis of Household Surveys: A Microeconometric Approach to Development Policy. Johns Hopkins University Press, Baltimore.

John, R. M. (2005). Price Elasticity Estimates for Tobacco and Other Addictive Goods in India, WP-2005-003.

John, R. M. (2008). Price elasticity estimates for tobacco products in India. Health Policy and Planning, 23(3), 200-209. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2800993/

The World Bank. (2018). Bosnia and Herzegovina Country Data. Retrieved from: https://data.worldbank.org/country/bosnia-and-herzegovina?view=chart

The World Atlas.(2018). Which Countries Smoke The Most Cigarettes? Retrieved from: https://www.worldatlas.com/articles/countries-that-smoke-the-most-cigarettes.html