Estimating tobacco price elasticity in Kosovo: using the micro data from Household Budget Survey (2007 – 2017) and Deaton demand model

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**The analysis is part of the national study "Accelerating Progress on Effective Tobacco Tax Policies in Kosovo".*

Abstract:

This analysis aims at estimating price elasticity of demand for cigarettes in Kosovo. Data from Kosovo Household Budget Survey for the years from 2007-2017 are used and the Deaton demand model is utilized to make the estimations. Deaton (1988) demand model uses unit values as a proxy for price, spatial variation, and the structure imposed by a weak separability assumption account for the effect of the quality of the good. Basic idea of the model is that all households within a cluster (typically a small territory unit, such as municipality or village) face the same market price and that within-cluster variations in purchases depend only on total household expenditure and household characteristics, while cross-cluster variations in purchase are due to genuine price variations, among other factors. The estimation of the model consists of three stages. Results of the estimation indicate a negative price elasticity of cigarettes which amounts to −0.288.Standard error of the elasticity calculated via bootstrapping procedure (1000 replications) indicates that the elasticity is significantly lower than zero (ξ= -0.288; SEξ = 0.097, t = -2.969).

Keywords: Tobacco consumption, Deaton demand model, Household, Expenditure, Demand elasticity, Kosovo

Introduction

Tobacco consumption, apart from its health effects, contributing to a considerable number of non-communicable diseases, comes with a large economic burden on individual level and the society at large, especially in low- and middle-income countries (LMIC) (Do and Bautista, 2015), such as Kosovo. In the developing countries, tobacco expenditure represents a significant portion of the household budget (John, 2008a), especially in poor household, it exacerbates poverty by increasing healthcare costs, reducing incomes, and decreasing productivity. In addition, tobacco use diverts family resources "from basic needs and investments in nutrition and education which interrupt the vicious circle of poverty" (Chaloupka and Blecher, 2018).

In LMIC, households' consumption responses to the price changes are typically more pronounced than in the developed countries (Chaloupka et al. 2000). A fundamental building block of economic theory is the fact that increasing (or decreasing) the price of a commodity reduces (or increases) demand for that commodity. Evidence from international research shows that price-elasticity of demand for cigarettes in developed countries ranges between -0.25 to –0.5, as compared to the low and middle-income countries where the estimates vary between -0.5 and -1. To date, there are no reliable estimates of the price-elasticity of demand for cigarettes for Kosovo, nor in any other country in the Western Balkans region.

The cigarette prices' dynamics is under the impact of the excise policy, which is often used by the governments as a mechanism to reduce the smoking prevalence in the country. However, governments might be reluctant to take such decision if they do not know the impact of increasing excise tax on the government revenue. It is therefore important for the government to know the price elasticity of cigarette demand.

Price elasticity can be measured in many ways, and various methods have different advantages and disadvantages. One of the methods extensively used in estimating price elasticity is by using the macro-level time series approach, which relies on price and consumption (and other control variables) changes over time. However, these models have been criticized for the lack a theoretical background and arbitrary choice of functional form and variables, while typically, time series which are long enough for reliable estimates are in practice unavailable (Deaton, 1997).
Alternative approach has its theoretical foundation in the consumer theory. One of the first models – Almost Ideal Demand System (AIDS model) for the estimation of price elasticity was proposed by Deaton and Muellbauer (1980) and it relies on household budget data and prices. However, the information on prices is frequently not available in the combination with the individual or household expenditure data on certain goods (McKelvey, 2011).

On the other hand, information from the household budget surveys typically contains both expenditure and quantity of the certain good. Their ratio can then be used to create a unit value of the good, which is then used as a proxy for the price. Although an imperfect proxy, mainly since it reflects both quality and quantity of the purchased good (McKelvey, 2011), unit value has been extensively used and its value demonstrated.

Deaton (1988) demand model uses unit values as a proxy for price, spatial variation, and the structure imposed by a weak separability assumption account for the effect of the quality of the good. Basic idea of the model is that all households within a cluster (typically a small territory unit, such as municipality or village) face the same market price and that within-cluster variations in purchases depend only on total household expenditure and household characteristics, while cross-

cluster variations in purchase are due to genuine price variations, among other factors. The estimation of the model consists of three stages. In the first stage, the effects of total household expenditure and other household characteristics are by the means of regression analysis purged from the budget share of the consumption and unit value. In the second stage, cluster average values of budget share and unit values are used to estimate unit value elasticity of consumption. In the final, third stage, we use separability assumption to separate the effect of price elasticity from the quality effects contained in unit value elasticity.

In this paper the author utilizes Deaton's (1988) demand model and Household Budget Survey (HBS data) from 2007 – 2017 to estimate the elasticity of cigarettes consumption to (time and spatial) price variation. This paper is organized in four sections, after this introduction the second section presents the Deaton's demand model and its equations in detail, while in the third section is discussed the data used for the analysis. In the fourth section are presented the results of the analysis.

Econometric model and methods

Deaton's model

Deaton (1988) uses unit values of cigarettes as a proxy for price and the structure imposed by the weak separability assumption to impute the extent of the quality substitution in estimating the price elasticity. Deaton's model consists of two equations:

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

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

where indices *h* and *c* represent households and clusters respectively. The left-side variables in the model are w_{hc} – share of the household budget spent on cigarettes (in percentages) and v_{hc} – unit values. On the right side of both equations we have x_{hc} – total consumption of the household *h* in cluster *c*, z_{hc} – other household characteristics, p_c – price of the cigarettes in cluster c, while u^0_{ch} and u^1_{hc} represent the error term. Since the prices are not observed, the parameters θ and ψ cannot be directly estimated from the equations (1) and (2). However, the assumption that the market prices do no vary within the cluster (hence the absence of the index h) enables consistent estimates of the remaining parameters by using cluster deviation-from-the-mean approach which cancels the effect of the prices from the equations as they do not vary within cluster.

In practice, the parameters are estimated by including dummy variables for each cluster[1] in the regression, which yields identical estimates as deviation-from-the-mean approach and is less computationally demanding (Frisch-Waugh, 1933).

As unit values represent a ratio between expenditures and quantity of a good, and their dynamic represents not only the changes of the prices of the cigarettes but also the changes in the choice of cigarettes quality. When the cigarettes prices change, with the same budget, the household can decrease their consumption of the cigarettes and stay with the same brand or opt to by less expensive brand and keep their consumption at the same level, which is referred to as quality shading.

Therefore, the change in the consumption as a function of the unit value contains both the response of the household to the changes in the prices, but also possible quality shading. In the unit value equation (equation 2), coefficient β^1 represents "quality elasticity" or expenditure elasticity of quality, while ψ represents the changes in the unit value of cigarettes as a function of the changes in the prices. If there is no quality shading the value of ψ should be equal to one (as the change of the unit value would correspond to change of the price) and β^1 approximately equal to zero.

The estimation of the parameter θ, which represents the semi-elasticity of prices is not possible as the prices are not observed. However, in Deaton's model we use the fact that price is present in both equations in order to estimate the parameter. In the first step we re-write the equation (2) so the prices ($\ln p_c$) are on the left side of the equation, while on the right side are unit value, household expenditure and other household variables and the error term. We then substitute re-organized equation (2) instead of price term (lnp_c) in the equation (1) and obtain a linear relationship between the budget share on the left-side, and unit values and other variables and error terms on the right-hand side:

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

Estimated parameter $\hat{\phi}$ is a hybrid of price and quality elasticity and it can be show it is equal to $\psi^{-1}\theta$ (Deaton, 1990). These effects are later separated by introduction of the weak separability assumption. As previously mentioned if there is no quality shading and the unit value changes represent the price changes ψ equals one and then the coefficient $\hat{\phi}$ is the unbiased estimate of price

[1] This analyses are not interested in the size of the effect of each cluster, stata absorb (cluster) function is used for this estimation.

semi-elasticity (θ). However, in the presence of values of ψ lower than one, quality shading $\hat{\phi}$ overestimates the parameter θ and needs to be corrected.

Estimation of the model

The estimation of the model is performed in three stages. In the first stage, as already mentioned equations (1) and (2) can be estimated by using the deviation-from-the-mean approach and cluster regression estimates. Therefore the parametersβ^0,β^1,γ^0,γ^1 and the error terms in these equations are unbiased.

In the second stage, we use these estimates to remove the effects of the total household expenditure and other household level characteristics from the budget share and unit values:

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

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

These variables are then used to create cluster averages of budget shares and unit values

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

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

Variance and covariance of u_{hc}^1 and u_{hc}^0 from estimated residuals of equations (1) and (2) are estimated by $\hat{\sigma}^{00} = e_0' e_0/(n-k-C)\hat{\sigma}^{11} = e_1' e_1/(n_1-k-C)\hat{\sigma}^{01} = e_1' e_0/(n_1-k-C)$, where n is the total number of households, n_1 is the number of households which have purchased cigarettes, k is the number of explanatory variables; and e_1 and e_0 are the residuals from equations (1) and (2). If n_c is the number of all the households per village and n_c^+ is number of households with positive purchases the parameter ϕ from the equation (3) can then be estimated as

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

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

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

whereβ^1 and β^0 are estimated in the equations (1) and (2), while *w* is the average value of the budget share. Therefore, if β^1, estimated elasticity of unit value to expenditure is low there is no quality shading and price semi-elasticity is unbiasedly estimated by ϕ. If there is quality shading θ has to be corrected downwards. Finally, as in the equation (1) budget share is not in the logs, the elasticity of budget share with respect to prices can be written as θ/w. Additionally, since the budget share is unit value times quantity divided by total expenditure the final formula for price elasticity to quantity is (Deaton, 1997):

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

In addition, 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. Instead, as the budget shares can be defined as the product of quantity and quality divided by total expenditure, i.e. w = q*v/x, we are able to arrive to an estimate of total expenditure elasticity by taking the log and the first derivative with respect to expenditure of this identity. Thus, we arrive to:

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

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). Finally, 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):

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

We follow John (2008b) and impose symmetry restrictions to increase the precision of the parameter estimates. Due to the calculation procedure, standard errors cannot be taken directly from the regression analyses. Instead we use boostrapping procedure with 1000 replications to arrive to standard error of the estimated price elasticity.

Data and stylized facts

To estimate the price elasticity of the cigarettes consumption we use yearly data from the Household Budget Survey (HBS) from 2007 to 2017. HBS provides detailed information on household consumption as well as the information on set of individual characteristics of the household members. Additionally, data contain information on the municipality in which the respondents live.

As mentioned in the introduction, main variables in the Deaton's model are unit value and budget share of cigarettes. Unit values are calculated as a ratio of monthly household expenditure on cigarettes and total packs of cigarettes household has purchased during that month. Therefore, the unit values are expressed in Euro per cigarette pack. On the other hand, we calculate budget share as a ratio of monthly household expenditure on cigarettes and total monthly household expenditure.

Table 1 presents the analyses which explore the time variation of the cigarettes unit values and budget shares of the total household expenditure. The results indicate that both unit value and budget share show considerable time variation.

Table 1 Unit value of cigarettes, budget shares for cigarettes from total household expenditure

VARIABLES	Cigarette Unit Value (mean per month)	Cigarettes budget share(mean per month for HHs buying cigarettes)	Average monthly household expenditures for all HHs
2007	1.03	0.06	604.36
2008	0.99	0.06	639.84
2009	1.22	0.06	655.80
2010	1.13	0.06	663.03
2011	1.13	0.07	619.25
2012	1.26	0.08	645.67
2013	1.22	0.07	647.43
2014	1.23	0.08	641.88
2015	1.34	0.08	643.83
2016	1.43	0.08	646.83
2017	1.52	0.09	657.68
Observations[2]	8,993	10,217	25,797

Author's calculation based on the HBS data.

[2] Note: the different number of observations for cigarette unit values and cigarette budget shares is due to missing values, for unit values is 17,318, while for budget shares is 16,094.

Despite that the unit value of the cigarettes has been fluctuating throughout the years, the trend is mostly positive. In a period of ten years it has increased from 1.03 to 1.52 Euro, or for about 0.50 Euro. On the other hand, the budget share regression indicates that the households in Kosovo in 2007 spent about 6% of their budget on cigarettes, with other years spending between 7-8%, while in 2017 it reaches a record high percentage of 9%. The analysis also indicates that the budget share spent on cigarettes has increased over the years, along with an increase of the total house expenditure and an increase of the unit values.

Results

Definition of clusters and the vector of covariates

For Kosovo, 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 341 clusters.[3] In total 10,217households with positive expenditure on cigarettes enter the sample for the estimation.[4] In first stage regressions beside total household expenditure (ln), we control for household size (ln), gender, age and "maximum" economic activity structure of the household[5], as well as the mean and maximum level of education of the household members. The former characteristics represent the vector z_{hc} in equations (1) and (2). All expenditure variables, and consequently the unit value of cigarettes, are deflated to 2007 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 40% (10,217 of those with positive expenditure on cigarettes divided by 25,797 which is the total household number) of the households have expenses on cigarettes (share of available observations on unit value and budget share). One assumption we make here is that the preferences of the consumers and non-consumers of tobacco products are "differ radically", as consumption of cigarettes does not enter their utility function. We restrict our analysis to the analysis of expenditure on cigarettes packs and leave out cut tobacco, for two main reasons; data available in Kosovo and the model used for the analysis. First, according to the HBS data the cut tobacco is not even recognized as a type of tobacco product and therefore there's no data over the

[3] No cluster has less than two households, which is condition to estimate the Deaton's model.

4 Note: the focus is only on cigarettes' expenditure as cut tobacco is not recorded in neither the Kosovo Customs data nor in HBS data.

[5] The households are split to four household types: 1) employed; 2) self-employed; 3) pensioner; 4) unemployed. The labour market activity of the household members is ranked 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".

expenditure on cut tobacco. Second, the implementation of Deaton's model requires the use of the unit values, in this way the aggregation of the expenditures on different products was not possible.

In line with the expectations average male ratio is about 50%, while on average children (i.e. those aged 14 or less) represent about 22% of the household members in all the households. Mean and maximum level of education of 6.8 and 10.04 suggest that on average adult household members have secondary level of education. Furthermore, households with at least one member employed make about 64% of the households, while household types self-employed, pensioners and unemployed make 19%, 14% and 2% of the sample respectively.

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

	Obs	Mean	Std dev.	Min	Max
Unit Value, Cigarettes (ln)	8,993	0.11	0.43	-1.71	1.19
Budget share, Cigarettes	10,217	0.07	0.04	0.00	0.78
Total expenditure (ln)	25,797	6.33	0.50	3.69	8.86
Household size (ln)	25,797	1.58	0.53	0	3.36
Male ratio	25,797	0.50	0.18	0	1
Adult ratio	25,797	0.78	0.20	0	1
Mean education	25,797	6.82	2.86	0	16
Maximum education	25,797	10.04	3.30	0	16
Household type – Employed	25,797	0.64	0.23	0	1
Self-employed	25,797	0.19	0.35	0	1
Pensioners	25,797	0.14	0.15	0	1
Unemployed	25,797	0.02	0.39	0	1

Author's calculation based on the HBS data.

First stage – household level regression

Table 3 presents the estimation results of equations (1) and (2). We first comment on the results of the unit values equation. The coefficient for total expenditure (β^1 from the equation (2)) is significant and it indicates that the quality elasticity of expenditure is about 0.2%. In other words, households with 10% higher expenditure will buy about 2% more expensive cigarettes. This result is consistent with the previous results from other countries (e.g. John, 2008a for India). Therefore, in Kosovo there is quality shading and the use of the Deaton's model was necessary for unbiased estimate of the tobacco price elasticity.

Remaining coefficients from unit value regression have expected signs: unit value is lower in larger households and if there are more elderly in the household. Additionally, in household type self-employed the money spent on the cigarette packs is higher. There are no effects of education on unit value. Finally, cluster fixed effects are statistically significant and relatively large.

We now turn to the estimated coefficients from the budget share equation. All other things equal, households with higher levels of expenditure spend lower share of their expenditure on cigarettes. Households with 1% higher expenditure, spend about 0,042 less % of their budget share on cigarettes. Additionally, budget share spent on cigarettes is larger in the households with higher number of members, in households with higher shares of men and adults, but lower in the households where mean and maximum education are higher. Similarly, to unit value equation, in unemployed type of households the budget share spent on the cigarettes is lower. Finally, cluster fixed effects are significant.

Table 3: First-stage regression results

VARIABLES	Unit Value (per pack, ln)		Cigarettes budget share (in %)	
Total expenditure (ln)	0.208***	(0.010)	-0.042***	(0.001)
Household size (ln)	-0.121***	(0.011)	0.005***	(0.001)
Male ratio	-0.019	(0.025)	0.014***	(0.002)
Adult ratio	-0.086***	(0.025)	0.013***	(0.002)
Mean education	0.001	(0.002)	-0.001***	(0.000)
Maximum education	0.001	(0.002)	-0.001**	(0.000)
Household type – Employed	omitted			
Unemployed	-0.044	(0.038)	-0.003***	(0.003)
Pensioners	-0.002	(0.014)	0.001	(0.001)
Self-employed	0.028**	(0.010)	0.001	(0.001)
Cluster dummies	F(340, 8643) 5.674***		F(343, 9864) 3.975***	
Constant	-0.964***	(0.065)	-0.331***	(0.006)
Observations	8,993		10,217	
R-squared	0.2612		0.2924	

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

Relying on the formula from the equation (12) and using the values of the coefficients for logarithm of total expenditure from equations (1) and (2) is the estimate the total expenditure elasticity of demand. The estimated value of total expenditure elasticity is, in line with the expectations positive and estimate at 0.242. 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. Said differently, among the households which consume cigarettes, 10% higher total expenditure is associated with 2.42% higher the quantity of cigarettes smoked.

Second stage – cluster level estimates

After the formation of the second stage variables (from equations (6) and (7)) 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 prices are significant and that regional preferences play a role in the choice of unit value and consumption of cigarettes.

In the final stage of the estimation according to the equations (8) to (10) we arrive at the estimated elasticity of price to cigarettes quantity. Results of the estimation indicate a negative price elasticity of cigarettes which amounts to −0.288. When interpreting this result, we have to be cautious of the sample of the analysis; the households with positive consumption, with such sample the estimate indicates the elasticity on intensive margin. However, if the prices in Kosovo increase by 10% the demand for cigarettes will decrease by 2.8%. Standard error of the elasticity calculated via bootstrapping procedure (1000 replications) indicates that the elasticity is significantly lower than zero (ξ= -0.288; SE_{ξ} = 0.097, t = -2.969).

Conclusions

In this paper the Household Budget Survey (2007 – 2017) data from Kosovo Statistics Agency were used and Deaton's demand model to estimate the price elasticity of cigarettes consumption was utilized. After an extensive research, we figured out that previous estimates for Kosovo and the rest of the Western Balkan countries are non-existent. In Deaton's model we use unit value of cigarettes as approximation of the prices and find a negative price elasticity of demand for cigarettes of -0.288. Although the previous estimates for Kosovo are non-existing and therefore it is impossible to make any comparison, this result is in line and validated with the theoretically expected and previous estimates of price elasticity for cigarettes for low and middle income countries (Chaloupka et al., 2000).

It is necessary to add that the results presented in this paper rely in two assumptions. The first assumption is that initiation of cigarette consumption is not linked to the cigarette price *per se* and therefore households with zero cigarette expenditure were left out of this analysis, producing an estimated price elasticity on the intensive margin. Moreover, in the Kosovo HBS data, cut tobacco is not registered, and for that and methodological reasons cut tobacco is also excluded from the analysis which indicates an elasticity on intensive margin, i.e. the sample with only the households with positive consumption.

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ABOUT THE PROJECT

Commissioned by Bloomberg Philanthropies, the University of Illinois in Chicago (UIC, the leading organization in charge of managing the project Accelerating Progress on Effective Tobacco Tax Policies in Low- and Middle-Income Countries), has contracted the Institute for Economic Studies (IES) in Belgrade, and sub-contracting the Centre for Political Courage (CPC) to conduct economic research on tobacco taxation in Kosovo. UIC is a key partner of the Bloomberg Philanthropies Initiative to reduce tobacco use. The views and opinions expressed in this document cannot be attributed to, nor do they represent the views of the UIC, the Research and Health Policy Institute, or the Bloomberg Philanthropies.