Tobacco price elasticity in Montenegro: using the micro data from Household Budget Survey and Deaton demand model

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Abstract: The main goal of this research is to estimate the price elasticity of cigarette demand in Montenegro, applying Micro analysis. The data related to cigarettes consumption was derived from the Household Budget Survey (HBS), covering the period from 2006-2017. The long-run and short-run elasticities of cigarette demand, in context of price and income were estimated using Deaton's model. Results of the estimation indicate a negative price elasticity of cigarettes, while the value of total expenditure elasticity is positive (which was expected). The analysis of the tobacco market and regulatory shows that the increase in excise taxes will have direct positive effect – decrease in quantity of cigarettes demanded. The results are in line with the previously conducted research in low and middle-income countries.

Keywords: price and income elasticity of cigarette demand; HBS; excise taxes; Montenegro

1. Introduction

Tobacco expenditure represents a significant portion of the household budget, especially in middle income countries (John, 2008). In these countries, households' consumption responses to the price changes are typically more pronounced than in the developed countries (Chaloupka et al. 2000). Estimated price-elasticity of demand for cigarettes for developed countries ranges between -0.25 to –0.5, while in the low and middle-income countries the estimates vary between -0.5 and -1. However, there are no reliable estimates of the price-elasticity of demand for cigarettes in Montenegro, or in the Western Balkans region in general.

The cigarette prices' dynamics is under the impact of the excise policy, which is used both to reduce the smoking prevalence in the country and to increase budget revenues. These revenues can also be lower if the increase of the excises, and consequently the prices, creates lower demand for cigarettes. It is therefore important for the government to know the elasticity of household consumption to the prices changes.

Price elasticity can be estimated by using the macro-level time series approach, which relies on measures of price and consumption (and other control variables) per observation period. However, these models have been criticized for the lack of theoretical background and arbitrary choice of functional form and variables. In addition, time series are typically not long enough to produce reliable estimates (Deaton, 1997).

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An alternative approach has its theoretical foundation in 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 regional price differences. However, the price information that matches the individual or household expenditure data on certain goods is frequently not available (McKelvey, 2011).

On the other hand, information from the household budget surveys typically contains both expenditure and quantity purchased of certain goods. Their ratio can then be used to create a unit value of a good, which is then used as a proxy for price. Although an imperfect proxy, mainly due to the fact that it reflects both the 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 the price, spatial variation, and a structure imposed by a weak separability assumption accounting for the effect of good's quality. 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 HH 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 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, we use Deaton's (1988) demand model and Household Budget Survey (HBS data) from 2006 to 2017[2] to estimate the elasticity of cigarettes demand in Montenegro exploiting time and spatial price variation. Following this introduction, the second section presents the Deaton's demand model in more detail, while the third section discusses the data used for the analysis and provides some stylized facts. We present the results of the analysis in the fourth section, and the fifth section concludes the paper.

2. Econometric model and methods

Deaton's model

Deaton (1988) uses unit values of cigarettes as a proxy for the price and a 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:

[2] Year 2005 was excluded due to the lack of all necessary data (total household consumption). The sample does not contain year 2016, because Survey was not conducted in that year.

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

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

where indices *h* and *c* represent households and clusters respectively. The left-side variables in the model are w_{hc} – sharthe e 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 expenditures of the household *h* in cluster *c*, z_{hc} – other household characteristics, p_c – price of the cigarettes in cluster c, while u_{ch}^0 and u_{hc}^1 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[3] 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, their dynamic represents not only the changes of the prices of the cigarettes but also the changes in the choice of cigarettes quality (brands). 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 buy the less expensive brand and keep their consumption at the same level, which is referred to as quality shading.

Therefore, a change in consumption as a function of the unit value contains both the response of the household to the changes in prices and possible quality shading. In the unit value equation (equation 2), the 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 price is not possible as the price is not observed. However, the Deaton's model uses 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 unit values, household expenditure, other household characteristics, and the error term are on the right side. We then substitute re-organized equation (2) for the price (lnp_c) in the equation (1) and obtain a linear relationship between the budget share as the dependent variable, and unit values and other variables as the independent variables:

[3] Since we are not interested in the size of the effect of each cluster, we use stata absorb (cluster) function for this estimation.

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

Estimated parameter $\hat{\phi}$ is a hybrid of price and quality elasticity and it can be shown to equal to $\psi^{-1}\theta$ (Deaton, 1990). These effects are later separated by the introduction of the weak separability assumption. As mentioned previously, if there is no quality shading, the unit value changes represent the price changes, ψ equals one, and the coefficient $\hat{\phi}$ is the unbiased estimate of price semi-elasticity (θ). However, if the values of ψ is less than one (i.e.,there is 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, equations (1) and (2) can be estimated by using the deviation-from-the-mean approach and cluster regression estimates. Therefore the parameters β^0,β^1,γ^0, γ^1 and the error terms in these equations are unbiased.

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:

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

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

The results of the second stage 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 in 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 cluster and n_c^+ is a number of households with cigarette 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 the 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

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

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 (estimated unit value elasticity of expenditure) is close to zero there is no quality shading, and price semi-elasticity represents an unbiased estimate of ϕ. If there is quality shading, θ has to be corrected downwards. Finally, since budget shares in the equation (1) are not in log form, the price elasticity of budget share equal θ/w. Since the budget share is unit value times quantity divided by total expenditure, the final formula for price elasticity of demand is (Deaton, 1997):

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

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. 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 can arrive to an estimate of total expenditure elasticity by taking the log and the first derivative with respect to exthe penditure of this identity. 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). 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 (2008) 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 bootstrapping procedure with 1000 replications to arrive to the standard error of the estimated price elasticity.

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 years from 2006 to 2017, provided by Statistical Office of Montenegro - Monstat. HBS is the national annual survey, which focuses on households' expenditures and consumption related to goods and services. The data from the survey are broken down by household characteristics, such as income, socio-economic characteristics, size and composition, and municipality.

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 analysis focuses only on cigarettes consumption and excludes the households who report zero spending on tobacco. Additionally we have excluded households who report spending on other tobacco products, as these products have a negligible share – only 3.59% of households reported use of other types of tobacco. Households are surveyed during one month per year, which means that each household is surveyed only once a year. The unit values are expressed in EUR per cigarette pack. Budget share is calculated 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 2006, by using the Consumer Price Index[4].

Table 1 presents the results of regression analyses regarding the time and regional variation of the real cigarettes unit values and budget shares. The results indicate that both unit values and budget shares show considerable regional variation. Unit values also show significant time variation, while in case of budget shares these time variations are significant in the first four and the last year of the observed period.

Table 1: Regional and time variation of cigarettes unit values and budget shares

VARIABLES	Unit Value (per cigarette pack)	(2) se	Cigarettes budget share (in %)	(4) se
Region Center	omitted		omitted	
North	-0.082***	(0.009)	0.007***	(0.001)
South	0.040***	(0.004)	-0.004***	(0.000)
Year 2007	-0.031*	(0.017)	-0.014***	(0.002)
2008	-0.034**	(0.016)	-0.015***	(0.002)
2009	0.067***	(0.016)	-0.008***	(0.002)
2010	0.105***	(0.017)	-0.009***	(0.002)
2011	0.261***	(0.017)	-0.003	(0.002)
2012	0.412***	(0.017)	0.000	(0.002)
2013	0.493***	(0.017)	0.003	(0.002)
2014	0.560***	(0.017)	0.002	(0.002)
2015	0.526***	(0.017)	0.003	(0.002)
2017	0.518***	(0.025)	-0.010***	(0.003)
Constant	0.763***	(0.012)	0.051***	(0.001)
Observations	5,793		5,793	
R-squared	0.422		0.054	
F	351.4		27.50	
r2_a	0.421		0.0520	

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

The results from the unit value regression indicate that Unit Value as an approximation of average price of cigarettes per pack paid by household in

[4] Available online from the Statistical Office of Montenegro - Monstat website http://monstat.org/eng/page.php?id=26&pageid=26

Central Region amounted, EUR 0.763 (constant term) in 2006. In the same year, households in the North Region paid lower prices of cigarettes, while the South Region had slightly higher prices comparing Central Region. Considering the time variation, we can notice an increasing trend of the average price of cigarettes per pack.

The budget share regression indicates that the households in the Central Region spent about 5.1% of their budget on cigarettes in 2006. In the same year, households in the North Region spent more on cigarettes (0.7%), while in the South households spent less comparing the Central Region (-0.4%).

4. Results

Definition of clusters and the vector of covariates

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 209 clusters, which on average include about 59 households[5]. In total, there were 12,503 households in our sample. The first stage regression controlled for total expenditures (ln), as well as the household size (ln), age and gender composition of the household, the mean and maximum level of education of the household members and the household activity. The education of adult household members was divided into five levels: 1) without school 2) primary school 3) secondary school 4) Undergraduate and Master 5) Ph.D. We controlled for the household type by economic activity, by taking the "maximum" activity of the household members. The households were split into three household types 1) unemployed 2) pensioners 3) employed[6]. The household characteristics with the exception of total expenditures represent the vector z_{hc} in equations (1) and (2). For all expenditure variables, and consequently the unit value of cigarettes, we calculated real values using CPI[7] for each year (2006-2017). 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 46.33% of the households have expenses on cigarettes (share of available observations on unit value and budget share). We checked for outliers and found 18 observations below and above 5 standard deviation distance from the mean expenditure in the whole sample. The total sample for the regression analysis that includes households that reported expenses on cigarette consumption amounts to 5,775 households.

The households that enter the first stage regression have an average male ratio of about 50%, while the children (i.e., those aged 15 or less) represent about 12% of the household members. As already mentioned, we used the scale from

[5] No cluster has less than two households, which is condition to estimate the Deaton's model.
[6] We rank the labour market activity of the household members in the following order 1) unemployed; 2) pensioners, 3) employed. If the adult household members are all inactive or unemployed the household is labelled as "unemployed". If there are no employees or self-employed, but there is a pensioners in the household, the household is marked as "pensioners". If there is a member of the household which is employed or self-employed, the household is labelled as "employed".
[7] Statistical Office of Montenegro - Monstat

1 to 5 in order to define the level of education (5 represents maximum education). Mean education of 2.7 and maximum education of 3.17 suggest that on average adult household members have a secondary level of education. Furthermore, on average 3% of households are "unemployed", 19% are "pensioners", while the majority of households are in the group of "employed" - 78%.

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

	Obs.	Mean	Std dev.	Min	Max
Unit Value, Cigarettes (ln)	5,775	-0.08	0.40	-1.16	0.90
Budget share, Cigarettes	5,775	0.04	0.03	0.00	0.49
Total expenditure (ln)	5,775	6.49	0.52	4.15	7.97
Household size (ln)	5,775	1.11	0.56	0	4.02
Male ratio	5,775	0.50	0.24	0	1
Adult ratio	5,775	0.88	0.18	0.25	1
Mean education	5,775	2.70	0.57	1	5
Maximum education	5,775	3.17	0.68	1	5
Household type -					
Unemployed	5,775	0.03	0.18	0	1
Pensioners	5,775	0.19	0.39	0	1
Employed	5,775	0.78	0.41	0	1

Author's calculation based on the HBS data.

First stage – household level regression

Table 3 presents the results of equations (1) and (2). Results of unit value regression indicate that the coefficient for total expenditure (β^1 from the equation (2)) is significant. The quality elasticity of expenditure is about 0.19, meaning that households with 10% higher expenditure will buy cigarettes that are about 1.9% more expensive. This result is consistent with the results from other countries (e.g., John, 2008 for India). Considering that quality shading is represented in Montenegro, the use of the Deaton's model is necessary for obtaining an unbiased estimate of cigarette price elasticity.

Empirical results related to the other independent variables in the unit values regression have the expected signs. In particular, the lower unit value is associated with larger households, as well as households with more women and elderly people. Also, "pensioners" and "unemployed" household type spent less money on the cigarette packs comparing "employed" households. Conversely, the effect of education on the unit value is positive, indicating that households with higher mean education spent more money per cigarette pack. Cluster fixed effects are also statistically significant, confirming the results given in Table 1, showing the existence of the both regional and time variation.

Table 3: First-stage regression results

VARIABLES	Unit Value (per pack, ln)	se	Cigarettes budget share(in %)	se
Total expenditure (ln)	0.195***	(0.010)	-0.025***	(0.001)

Household size (ln)	-0.100***	(0.009)	-0.003**	(0.001)
Male ratio	-0.041***	(0.015)	0.013***	(0.002)
Adult ratio	-0.166***	(0.024)	0.010***	(0.003)
Mean education	0.050***	(0.012)	-0.001	(0.001)
Maximum education	0.014	(0.010)	-0.000	(0.001)
Household type – employed	omitted			
unemployed	-0.051**	(0.021)	-0.001	(0.002)
pensioners	-0.086***	(0.011)	-0.005***	(0.001)
Cluster dummies	F(192,5573) 27.025***		F(192,5573) 5.771***	
Constant	-1.236***	(0.061)	0.198***	(0.007)
Observations	5,775		5,775	
R-squared	0.579		0.288	
F	117.9		115.9	
r2_a	0.564		0.263	

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

When it comes to the estimated coefficients from the budget share equation, the result shows that households with higher levels of total expenditure spend a lower share of their budget on cigarettes. More precisely, households with 10% higher total expenditure, spent 0.2% less of their budget on cigarettes. Smaller households and households with higher shares of men and adults spent a larger share of the budget on cigarettes. Education had no significant effect on cigarettes budget share and "unemployed". As it was expected, in "pensioners" households the budget share spent on the cigarettes is lower than in the "employed" households. Like in the unit value regression, cluster fixed effects are significant and come from both spatial and time variation.

Estimated values of the coefficients for the logarithm of total expenditure from equations (1) and (2) are used to arrive at the estimate of the total expenditure elasticity of demand, by using the formula from the equation (12). Total expenditure elasticity is estimated using a sample of households with positive consumption, so it should be treated with caution. The estimated value of total expenditure elasticity is positive, what was expected, and amounts 0.268. This means that 10% higher total expenditure among the households which consume cigarettes is associated with 2.68% higher demand for cigarettes.

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 are important factor in the choice of unit value and the budget share allocation towards cigarettes.

Finally, the price elasticity of the cigarettes demand is determined using the equations (8) to (10). Estimated price elasticity is -0.57, meaning that if cigarette prices in Montenegro increase by 10%, the demand for cigarettes among the smokers will decrease by 5.7%. It should be noticed that elasticity is

estimated using a sample of households with positive cigarette consumption (elasticity on intensive margin). We used bootstrap procedure (with 1000 replications) to estimate the standard error of the elasticity, which shows that the value of the price elasticity is significantly different from and lower than zero (ξ= -0.578; SE_ξ = 0.1248, t = -4.63).

5. Conclusions

In this paper to estimate the price elasticity of the cigarettes consumption, we use the Household Budget Survey (HBS) data for years from 2006-2015 and 2017. According to Deaton's demand model cigarettes' unit values were used as an approximation of their prices. Estimated price elasticity of demand for cigarettes among the smokers is negative, statistically significant, and amounts -0.578. This result is in line with previous estimates in low- and middle-income countries (Chaloupka et al. 2000). Given that the households which report zero spending on tobacco are excluded, with the assumption that their spending decisions do not depend on cigarette prices, these estimates should be taken with caution. To our best knowledge, this is the first estimate of the price elasticity of cigarettes demand for Montenegro. We may conclude that price represents an important factor of the cigarettes demand variations, meaning that effective tobacco tax policy could result in significant decrease of cigarettes consumption in Montenegro.

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