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ORIGINAL SCIENTIFIC PAPER

Estimation of Tobacco Products Price and Income Elasticity using Aggregate Data

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ABSTRACT

The main aim of this paper is to estimate long run and short run price and income elasticity for cigarettes based on aggregate level data for period 2002-2016 using Error Correction model. In order to estimate elasticity of demand for tobacco products authors of this paper used aggregate level data. Because the cigarettes make the largest share in overall consumption of tobacco products in Serbia, conducted research is based on approach that 90% of total consumption of tobacco products are cigarettes. This research is unique in the SEE countries, while research conducted in other low and middle income countries in Western Balkan region showed similar results. Price elasticity among the SEE countries is in range between -0.44 and -0.78 Research among low and middle income countries over the world empirically showed that demand for tobacco products is usually inelastic. Analysis conducted in the Republic of Serbia showed that price elasticity ranged between -0.76 and -0.62 while income elasticity ranged between 0.34 and 0.39.

Key words: *tobacco products, consumption, elasticity, price*

JEL Classification: E20, H20, C13

INTRODUCTION

In order to empirically estimate the long-term and short-term effects of increasing cigarettes price on cigarettes consumption in Serbia we have used the Error Correction model (ECM). This model is often used in research among countries with low and middle income to estimate price elasticity using macro aggregate data (Ross and Al-Sadat, 2007). Research nalysis aims to present price and income elasticity for tobacco products in Serbia using official statistical data for the period 2002-2016.

According to official Institute for Public Health “Batut” data more than one half of total population consumed tobacco products in a lifetime (Health and Statistical Yearbook for Serbia, 2018), while World Bank data shows that in 2017 at least 33% population above age 15 in Serbia smokes at least one cigarette per day, amounting to about 2,457,000 active smokers (Tobacco Control Fact Sheet, Serbia). Thus, tobacco products’ consumption in Serbia should be of high concern to policymakers. Results of empirical research shown in this paper can help policy makers (in the field of economics, finance and health) to understand the factors affecting the demand for cigarettes including their prices/taxes, others tobacco control policies, and income so that they can design policies to lower tobacco use in Serbia.

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The main obstacle in this analysis was the lack of data to construct a long time series. Given that only a short time series is available, we have carefully defined variables to assure that they are compatible and found the best methodological approach to deal with data deficiency. We opted for a classic linear model of cigarette demand with consumption per adult as a depended variable, while real tobacco price and real income are the primary independent variables. The model tested for the impact of various tobacco policies as well as for a summary index of tested tobacco control policies. Other relevant variables that could affect consumption such as tertiary education, life expectancy at birth for male and female, average employment and employment rates for male and female were also tested in the models but not included in the final specification and presentation of results due to concerns related to the degree of freedom.

DATA

Cigarette demand price and income elasticities were estimated using annual data. We have constructed several linear models of cigarette demand with a maximum of three independent variables to preserve the degree of freedom.

Cigarettes consumption and cigarette price data in Serbia are available only for the period after year 2002. Several measures of cigarette consumption and cigarette price have been accounted for and tested their properties to assess their suitability for our models.

The *dependent variable* is the annual cigarette consumption per capita of adult population[1]. This measure of aggregate cigarette consumption is calculated using retail sales volume as reported by the Statistical Office of the Republic of Serbia. Since the volume is measured in the sticks, we divided it by 20 to get cigarette consumption in packs (Figure 1).

We have also considered an estimate of consumption based on the Household Budget Survey data (HBS). However real consumption is underreporting in HBS data by a large amount and was therefore abandoned. Another possible measure of consumption can be derived from cigarette production added to net import and export level. This measure resulted in unstable estimates, most probably due to time lags of recording foreign trade, so we excluded it from further analysis.

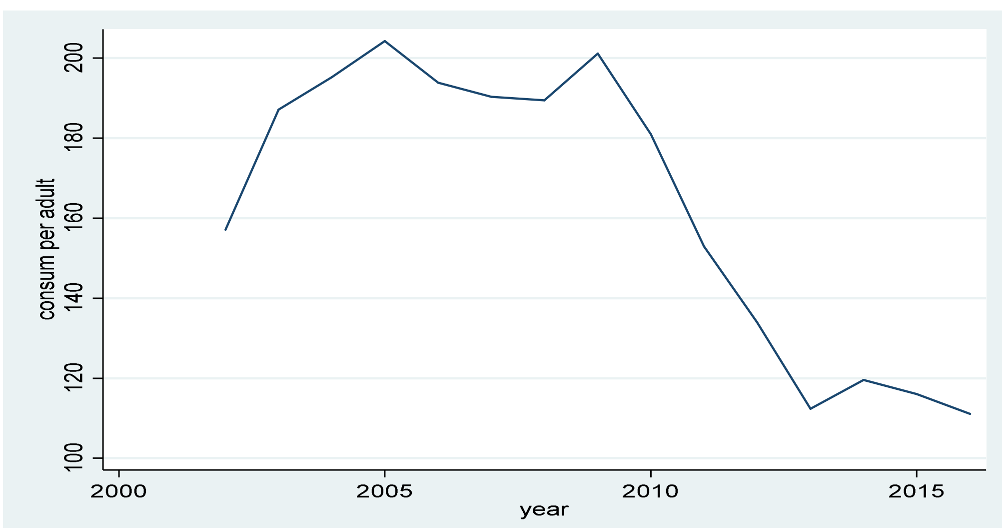

Figure 1. Cigarettes in packs per adult, 2002-2016

Source: Statistical Office of the Republic of Serbia

[1] Population of age 15 and older

The most important *independent variable* is the price. We first considered official data on weighted average cigarette price and the price of the most sold brand[2], but their values do not exist for all years included in the model. Therefore, we opted for real (or relative) tobacco price index[3] (real tobacco CPI; Figure 2) that we obtained by deflating (using general CPI) nominal tobacco CPI published annually since 2007 by the Statistical Office.

Methodology for creating tobacco CPI was implemented in 2007 by Statistical Office of the Republic of Serbia. So we extended time series data using official Statistical Office methodology for calculation and extrapolation of real tobacco CPI. Real tobacco CPI in the period 2002-2016 is shown in figure 2.

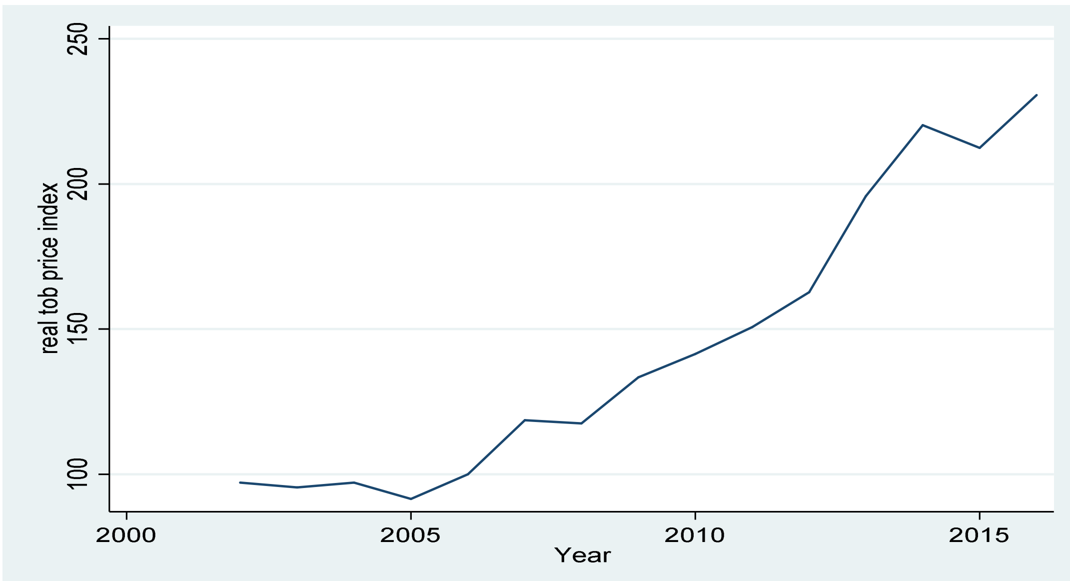

Figure 2. Tobacco price index (Real Tobacco CPI), 2002-2016

Source: Statistical Office of the Republic of Serbia

Real income was measured by real gross domestic product (GDP) per capita obtained from the Statistical Office of the Republic of Serbia.

[2] Available in Official Gazette of Republic of Serbia

[3] Tobacco price index is official data available in Statistical Yearbook, published annually by Statistical Office of Republic of Serbia. It represents a retail price index of tobacco products, calculated by weights that present structure of household consumption of cigarette and other tobacco products. It is obtained from the data of HBS, National Accounts, Trade and Catering Trades statistics, particular ministries etc. Note that in Serbia, cigarettes are main consumed tobacco product. Because this index is available as chained, we converted into base index and extended time series.

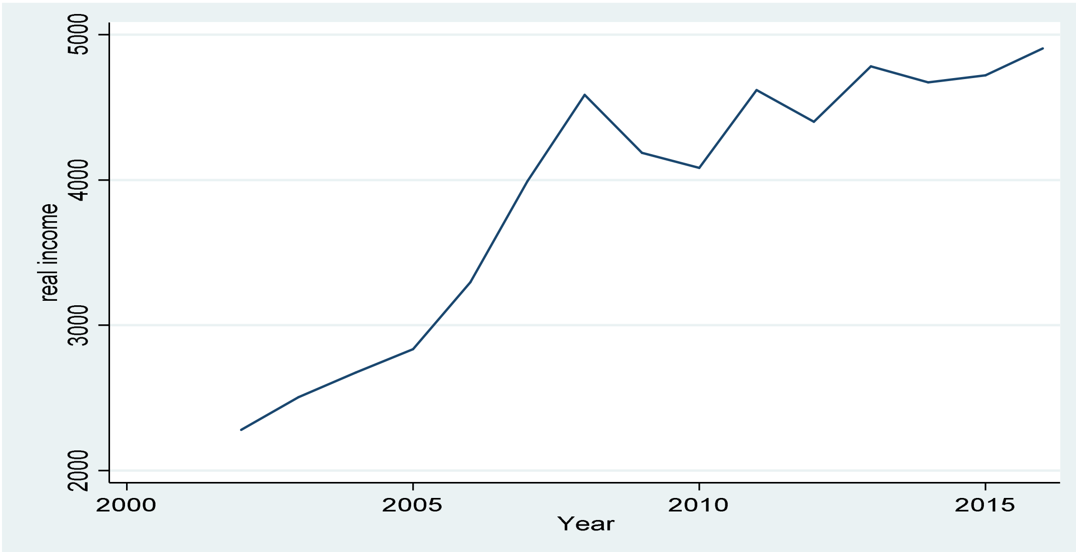

Figure 3. Real GDP per capita, 2002-2016

Source: Statistical Office of the Republic of Serbia

Tobacco control policies are an essential factor in the demand for cigarettes as well as for all other tobacco products consumption We have analyzed the impact of two policies in our models using dummy variables for *the ban on smoking* in all public indoor areas (value 0 before 2005, value 1 otherwise) and *the ban on tobacco advertising* (value 0 before 2010, value 1 otherwise). Effects of implementing regulatory policies were measured separately, including one by one variable in the model. We created a tobacco policy index by adding up the two dummy variables which represent the summary measure for tobacco control policies. Even though many factors influence the final price of cigarettes, the most essential policy-related determinants of cigarette prices are taxes (Chaloupka et al., 2010).

Chronically poor competitiveness of Serbian market during the global economic crisis has become a basic weakness of Serbian economy. Therefore, the negative effects of the crisis in Serbia felt widely, exposing the deep structural problems of Serbian economy (Domazet, Stošić, 2013). Those are reasons why we decided to include in analysis several variables more. Current socio-economic environment indicate the importance of employment (male and female) into our study (Đuričin, Pantić, 2015). We have used other independent variables such as the number of graduates with tertiary education (to measure impact of education on cigarette demand), average level of employment (an alternative measure of income and stress level) life expectancy at birth for male and female (to assess the impact of the return to the investment in health). Structural changes lead to changes in the level of employment, especially in the private sector (Ognjanović, 2013). In recent decades, women have successfully fought for their equality in society and proved they are capable of great achievements, so we used average level of employment for women in our study (Ljumović, Pavlović, 2017). However, results of the models including these variables are available upon request. Table 1 and Table 2 summarized the data used in our analysis.

Table 1. Data used in the macro model of cigarette demand, 2002-2016

Year	Retail volume (consumption of cigarettes, packs per adult)*	Real tobacco consumer price index**	Real GDP per capita***	Tobacco Control Policy Index	*Law[1]*	*Law[2]*
2002	157.11	97.10	2280	0	0	0
2003	187.08	95.45	2505	0	0	0
2004	195.17	97.11	2675	0	0	0
2005	204.24	91.53	2836	1	1	0
2006	193.77	100.00	3297	1	1	0
2007	190.29	118.60	3990	1	1	0
2008	189.42	117.54	4586	1	1	0
2009	201.12	133.44	4187	1	1	0
2010	180.89	141.50	4082	2	1	1
2011	152.96	150.68	4619	2	1	1
2012	133.96	162.75	4400	2	1	1
2013	112.35	195.81	4781	2	1	1
2014	119.55	220.32	4672	2	1	1
2015	116.08	212.42	4720	2	1	1
2016	111.12	230.61	4904	2	1	1

**Source: Statistical Office of Republic of Serbia, 2017*

***Source: Statistical Office of Republic of Serbia, 2017*

****Source: Statistical Office of Republic of Serbia, 2017*

Law 1 is The Law on the protection of the population from exposure to tobacco (2004)

Law 2 is Advertising Law (2009)

Table 2. Data used in the macro model of cigarette demand, control variables, 2002-2016

Year	Education, graduated students	Life expectancy at birth, female (%)	Life expectancy at birth, male (%)	Life expectancy at birth, total (%)	Employ-ment level, average	Employ-ment rate, women	Employ-ment rate, male	Employ-ment rate, total
2002	18,709	75	69.7	72.3	2,207,903	40.3	57.5	48.6
2003	19,748	75.1	69.9	72.4	2,168,678	38.7	56.9	47.6
2004	22,047	75.5	70	72.7	2,166,949	36.3	54.9	45.2
2005	27,537	75.6	70.2	72.8	2,171,457	32.9	52.4	42.3
2006	29,406	76.1	70.8	73.4	2,115,135	32.0	49.3	40.4
2007	32,039	76.5	70.9	73.6	2,085,242	33.8	50.3	41.8
2008	34,671	76.6	71.3	73.9	2,081,676	36.5	53.2	44.4
2009	40,330	76.7	71.4	74.0	1,984,740	34.0	49.1	41.2
2010	43,545	77	71.8	74.3	1,901,198	31.1	45.3	37.9
2011	46,162	77.2	72	74.5	1,866,170	29.0	43.1	35.8
2012	47,523	77.5	72.3	74.8	1,865,614	28.7	42.8	35.5
2013	47,797	77.9	72.6	75.2	1,864,783	30.8	45.2	37.7
2014	58,728	78	72.8	75.3	1,845,494	33.0	46.9	39.7
2015	50,501	77.9	72.8	75.3	1,896,000	35	50	43
2016	50,326	77.8	72.8	75.2	1,921,000	38	53	45

Source: Statistical Office of Republic of Serbia, 2017

THE MODEL SPECIFICATION TESTS

Conventional model in linear form is used to estimate the price and income elasticity of cigarette demand. All variables are used in real values.

(1) $Y_t = \alpha + \beta_1 X_{1t} + \beta_2 X_{2t} + \varepsilon_t$, where t=1, …,15 *(1.1)*

Where the following represent:

Y_t- cigarette consumption per adult (retail sales volume in packs, per adult)

X_{1t}- real tobacco price index (real tobacco CPI)

X_{2t}- real gross domestic product per capita (real GDP per capita)

β_1- price coefficient

β_2- income coefficient

Model (1) includes only price and income measures as independent variables. Therefore, their coefficients represent the upper bound, since the impact of tobacco control variables is not taken into account.

Model (2) is similar to Model (1), but includes tobacco control policy. In this case, we used variable *tban* (law2) to reflect the adoption of the Advertising Law (ban on advertising of tobacco products). B_3 is a coefficient capturing the impact of advertising law on cigarette consumption.

(2) $Y_t = \alpha + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \varepsilon_t$, where t=1,…,15 *(1.2)*

We estimated several versions of demand model with tobacco control policies/event to find an adequate specification, but because the analysis is limited with the degrees of freedom, all individual policies could not be included in just one model. Besides variable *tban* which is used in the model (2), variable *tlaw1* (law on the protection of the population from exposure to tobacco) is implemented in the model (3). Tobacco control policy index (*tpi*) defined as the sum of the other two indicators is used in the model (4). Apart from these variables, we took into consideration *life expectancy at birth*[4] (total) in estimated model 5[5]. Because life expectancy at birth of a female is not integrated at the same order as dependent and independent variables, we did not use it in final estimation of cigarette demand.

The diagnostics of variables listed in Table 1 starts with stationarity unit root tests. The classic analysis of time series is based on the assumption that the data are stationary, which implies a constant mean and a constant variance over time. The time series is stationary if the following conditions are satisfied:

1) $E(X_t)$= const, t=1,2,3…
2) $v(X_t)$= const, t=1,2,3…
3) $cov(X_t, X_{t-k}) = f(k)$. t=1,2,3…. k=1,2…

In practice, many time series do not meet this requirement. For example, a random shock that would weaken its impact over time in case of a stationary series can have a permanent effect for an indefinite period if the time series is not stationary (or has a unit root). To test for stationarity, we used Dickey-Fuller (DF) statistics for the presence of unit root (Mladenović and Nojković, 2007).

We tested two main hypotheses in the first step:

[4] Life expectancy at birth is average number of years a newborn is expected to live *if mortality patterns at the time of its birth remain constant in the future*.

[5] Dickey-Fuller test results are presented in Table 2.

H_0: Time series is not stationary, has a unit root

H_1: Time series is stationary

The result for a level order of integration shows that we cannot accept H_0 hypothesis that the variables are stationary because DF statistic is above than all critical values. Therefore, we proceeded with the second step and tested hypothesis.

The test revealed that cigarette consumption, price and income are stationary in their first differences and are integrated at first order (I) (Table 3).

Table 3. Results of DF unit root test

	Dickey-Fuller		
Variables	**ADF t-test statistic**		**Level/first dif.**
	H_0: variable has a unit root		
	Level Z(t)	**First dif. Z(t)**	**Decision**
Main variable			
Consumption	-0.102	-3.029**	I(1)
Real tobacco CPI	0.988	-3.278**	I(1)
GDP per capita	-1.526	-3.492**	I(1)
Control variable			
Tobacco Policy Index	-1.412	-3.986***	I(1)
tlaw1 (Regulator policy 1)	-2.171	-3.606**	I(1)
tban (Regulator policy 2)	0.857	-3.606**	I(1)
Employment, average	-1.411	-2.071	I(2)
Employment rate, total	-1.755	-1.605	I(2)
Employment rate, male	-1.829	-1.385	I(2)
Employment rate, female	-1.650	-1.678	I(2)
Education-graduated students	-1.236	-4.787***	I(1)
Life expectancy at birth, (male)	-1.137	-3.739***	I(1)
Life expectancy at birth, (female)	-1.688	-2.317	I(2)
Life expectancy at birth, (total)	-1.398	-2.979*	I(1)

*Note: Z(t) is compared with corresponding test critical values;*** indicates rejection of H_0 at the 1% significance level, **5% significance level, and * 10% significance level.*

Source: authors own calculation

Based on the results presented in Table 2, we observe that measure of cigarette consumption in Serbia is integrated at first order I(1), it is stationary at first differences since the reported value of Z(t) test statistic was -3.029, on 5% significance level. Real tobacco CPI and real GDP per capita are integrated at first order I(1) at 5% significance level, with reported Z(t) test statistic values: -3.278 and -3.429, respectively. *Tobacco control policy index*, and individual regulatory variables *tlaw1* and *tban* are integrated at same order as main independent variables I(1), all significant at 1% and 5% level. Different measures of employment in Serbia cannot be included in the further analysis, because DF test results show integration at second order I(II). DF test statistics for employment rate female is Z(t)= -2.695, p=0.023, employment rate male is Z(t)= -3.406, p=0.007 and for employment rate total is Z(t)= -2.988, p=0.014.[6]

[6] Results of DF test shows us that variables of employment are not integrated at first difference.

To determine the existence of a long-term relationship between our variables of interest, we applied a test for cointegration- Dickey-Fuller residual tests (DFR). If the time series are co-integrated, then the residual series is stationary, while the non-stationarity of the residual means that the time series are not cointegrated. If a H_0 hypothesis is accepted than the residuals are non-stationary and the time series are not co-integrated. The rejection of the zero hypotheses (H_0) confirms the stationarity of the residual, and therefore the cointegration of given time series.

Using the DFR test, we found that the variables in models (1), model (2) and model (4) are co-integrated and thus, they have a long-run relationship. To confirm this result, we applied another test for cointegration, Johansen cointegration test (Johansen, 2005).

Table 4 present results of the Johansen cointegration test for variables in authors preferred models- model (1), model (2) and model (4).

Table 4, Results of Johansen co-integration tests.

Model 1					
Null Hypotheses	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Max-Eigen**	**0.05 Critical Value**
H0: (R=0)*	0.0000	23.2142	24.3100	14.4272	177.8900
H0: (R≤1)	0.6432	8.7869	12.5300	8.7478	11.4400
H0: (R≤2)	0.4647	0.0392	3.8400	0.0392	3.8400
Model 2					
H0: (R=0)	0.0000	45.5888	39.8900	25.2938	23.8000
H0: (R≤1)*	0.8358	20.2950	24.3100	13.4566	17.8900
H0: (R≤2)	0.3748	6.8385	12.5300	6.5662	11.4400
Model 4					
H0: (R=0)	0.0000	57.0688	39.8900	29.1951	23.8000
H0: (R≤1)	0.8757	27.8737	24.3100	17.1833	17.8900
H0: (R≤2)*	0.7069	10.6904	12.5300	10.4773	11.4400

Note: Johansen, S. 1995. Likelihood-Based Inference in Cointegrated Vector Autoregressive Models. Oxford: Oxford University Press.
*R is the number of the cointegrating equation. *indicates the rejection of the null hypothesis at the 5% level.*
Source: authors own calculation

Results of Max-Eigen and Trace statistics indicate that H_0 of no cointegration vector can be rejected and that there exists one co-integration equation at the 5% significance level in Model 1.

After stationarity and cointegration tests, we proceed with estimating long-run and short-run relationships. Engle-Granger two step method is used to estimate long run and short run price and income elasticities. First, long-run relationships between cigarette consumption, price and income is estimated using the classic linear demand model (equations 1.1 and 1.2) Because models are specified in linear form, price and income elasticity is calculated multiplying the estimated price and income coefficient β_1 and β_2 by price and income fitted values, divided by fitted value of cigarette consumption in packs. The use of fitted values instead of actual average values is required to obtain results based on the long run equilibrium (Ross and Al-Sadat, 2007).

Since cointegration exists in observed models, we estimated the second step of the Engle-Granger method - the Error Correction Model (ECM) – to estimate short-run price and income elasticities (Ross and Al-Sadat, 2007). This model used the first difference of all variable and lagged residual from the long-run model (Mladenović and Petrović, 2007). The short-run ECM model can be expressed as follows (Mladenović and Nojković, 2012):

$$\Delta Y_t = \gamma_0 u_{t-1} + \gamma_{11} \Delta Y_{t-1} + ... \gamma_{1k} \Delta Y_{t-k} + \gamma_{21} \Delta P_{t-1} + ... + \gamma_{2k} \Delta P_{t-k} + \gamma_{31} \Delta I_{t-1} + ... + \gamma_{3k} \Delta I_{t-k} + \gamma_{41} \Delta Z_{t-1} + ... + \gamma_{4k} \Delta Z_{t-k} + \varepsilon_{1t} \quad (1.3)$$

where k represents the number of lags; Δ is the difference operator; γ's are parameters to be estimated; ε_{1t} is the error term; u_{t-1} is error correction term that represents residuals from the long-run equation, and γ_0 measures the speed of adjustment toward equilibrium in long-run. In our specification of ECM model, we choose to use one lag to avoid losing too many degrees of freedom because our time series are short (a small number of observations).

$$\Delta Y_t = \gamma_0 u_{t-1} + \gamma_1 \Delta P_{t-1} + \gamma_2 \Delta I_{t-1} + \varepsilon_{1t} \quad (1.4)$$

$$\Delta Y_t = \gamma_0 u_{t-1} + \gamma_1 \Delta P_{t-1} + \gamma_2 \Delta I_{t-1} + \gamma_3 \Delta tban_{t-1+} \varepsilon_{1t} \quad (1.5)$$

ECM model for cigarette demand which includes only measures of tobacco price and income is given with equation 1.4. The equation for cigarette demand model which includes tobacco control policy index or regulatory variables like *tban* or *law1* is given in 1.5. Since we are using lin-lin form, price and income elasticities are calculated using lin-lin form of the model:

RESULTS

Table 5 presents results of the long-run cigarette demand for several different demand models.

Table 5. Long-run cigarette demand function

	1 (basic)	**2 (tban)**	**3 (tlaw1)**	**4 (tpi)**	**5 (lifetotal)**
VARIABLES	**consumption**	**consumption**	**consumption**	**consumption**	**consumption**
rtobcpi	-0.86335	-0.6995449	-0.7958605	-0.8467552	-0.7820187
GDPpc	0.01406	0.0150893	0.0046155	0.0161606	0.019342
Regulatory 1 (tban)		-20.07846			
Regulatory 2 (tlaw1)			18.38403		
Regulatory (policy index)				-3.70036	
Life expectancy at birth, total					-7.962421
Constant	232.7062	214.455	245.1503	226.8379	789.4529
Observations	15	15	15	15	15
Dickey-Fuller test for unit root - residuals	Test statistic	Test statistic	Test statistic	Test statistic	Test statistic

	1 (basic)	**2 (tban)**	**3 (tlaw1)**	**4 (tpi)**	**5 (lifetotal)**
VARIABLES	**consumption**	**consumption**	**consumption**	**consumption**	**consumption**
Adj. R-squared	Z(t)= -3.323	Z(t)=-3.671	Z(t)= -3.247	Z(t)= -3.419	Z(t)= -3.465
Dickey-Fuller test for unit root - residuals Hausman test m-statistic					
	--------	----------	m=0.04	m=0.64	m=0.04

*Note: t-statistics in brackets;*** p<0.01, ** p<0.05, * p<0.1;*

Source: authors own calculation

All variables in model 1 are statistically significant. This model is the basic model, because it includes only two independent variables, without any other controls. Real tobacco price index has a negative sign, which is in line with the economic theory - if the price of cigarettes increases, their consumption will go down. Real income has a positive sign which is also in line with the economic theory of normal good – the higher the income, the higher the consumption. R^2 value is 0.845, meaning that 84.5% variability in the model is explained with selected variables.

Real tobacco price index and real income in model 2 are statistically significant with sings similar to model 1. Variable *tban* which represents one tobacco control policy (ban on tobacco advertising) is not statistically significant, but it's inclusion leads to the improvement in R^2 value. The statistical insignificance of the policy variable can be explained by the short length of the time series.

In model 3, variable *tlaw1* is not statistically significant (p=0.317), and it has the opposite sign. The tobacco policy index (tpi) in Model 4 is also not statistically significant (p=0.760), but it has the expected sign.

In model 5 we include life expectancy at birth (total), and results show that variable is not statistically significant (p=0.730), but has a negative coefficient sign. It is expected result even if we did not get significant in the model, one of reason can be a very short and limited time-series data.

The values of long-run price elasticities for our favorite models are shown in Table 6, including the results bootstrapping.

Table 6. Long-term price and income elasticity for tobacco products

Long-run	**Model 1**	**Model 2**	**Model 4**
Price elasticity	***-0.764408***	***-0.6193687***	***-0.749707***
Price elasticity bootstrapped (100 replication)	-0.7808978 (0.1583772)	-0.5985788 (0.2150423)	-0.7562662 (0.1607641)
Income elasticity	***0.3368191***	***0.3612285***	***0.3868732***
Income elasticity bootstrapped (100 replication)	0.3461998 (0.0085674)	0.3972342 (0.0085617)	0.4354273 (0.0139486)

Note: SE in brackets

Source: authors own calculation

The long-run price elasticity in Model 1 is -0.764, which is in line with results obtained in other low- and middle-income countries. This implies that 1% increases in prices of cigarettes lead to a 0.76% decrease in cigarette demand. Price elasticity is higher in model 1 than model 2, because this specification does not control the impact of tobacco control policies.

The value of long-run income elasticity coefficient was 0.34 which implies that 1% increases in real GDP per capita lead to a 0.34% increase in cigarette demand.

When variable *tban* is included in the model (model 2), the value of long-run price elasticity coefficient is - 0.62 which implies that 1% increases in prices of cigarettes led to a 0.62% decrease in cigarette demand. The value of long-run income elasticity coefficient was 0.36 and implies that 1% increases in real GDP per capita led to a 0.36% increase in cigarette demand. However, this result is not statistically significant. When variable *tpi* is included in model 4, the value of price elasticity is -0.75 which is almost similar to basic model 1. Value of income elasticity is 0.38 but this result also is not statistically significant.

Table 7. Short run cigarette demand function

	Model 1	**Model 2**	**Model 4**
VARIABLES	D.consumption	D.consumption	D.consumption
D.rtobcpi	-0.8802679**	-0.8574294***	-0.8563312**
	-2.67	-3.41	-2.63
D.GDPpc	-0.0049126	-0.0004975	-0.0012268
	-0.45	-0.05	-0.1
D.regulatory (D.tban)		-2.107591	
		-0.17	
D.regulatory (D.tpi)			4.280726
			0.37
L.Residuals	**-0.7381731****	**-0.9576962*****	**-0.8358793****
	-2.68	-3.67	-2.68
Constant	5.581537	4.85751	4.040065
	1.13	1.19	0.71
Observations	14	14	14
R-squared	0.517	0.7284	0.5679
Adj. R-squared	0.3721	0.6077	0.3759
Breusch-Pagan/ Cook-Weisberg test for heteroskedasticity	chi2(1) =0.43	chi2(1) = 0.15	chi2(1) = 0.09
Ho: Constant variance	Prob > chi2 = 0.5140	Prob > chi2 = 0.7023	Prob > chi2 = 0.7612
Durbin's alternative test for autocorrelation	chi2(1) = 0.0023	chi2(1) = 0.168	chi2(1) = 5.568
H0: no serial correlation	Prob > chi2 = 9.290	Prob > chi2 = 0.6815	Prob > chi2 = 0.0174
	Lags 1	Lags 1	Lags1
Breusch-Godfrey LM test for autocorrelation	chi2(1) = 0.0077	chi2(1)=0.289	chi2(1)=5.800
H0: no serial correlation	Prob > chi2 = 7.111	Prob > chi2 = 0.5911	Prob > chi2 = 0.0160
	Lags 1	Lags 1	Lags 1

Ramsey RESET test	F(3, 6) = 2.77	F(3, 6)=0.10	F(3,6)=1.43
Ho: model has no omitted variables	Prob > F =0.1205	Prob > F =0.9565	Prob > F =0.3238
Skewness/Kurtosis tests for Normality	adj chi2(2)= 2.97	adj chi2(2)= 3.96	adj chi2(2)=0.87
Ho: normality	Prob>chi2= 0.2264	Prob>chi2= 0.1404	Prob>chi2= 0.6484
Jarque-Bera normality test	Chi(2)=1.084	Chi(2)= .6345	Chi(2)= .6974
Ho: normality	Prob>chi2= .5817	Prob>chi2= 0.9099	Prob>chi2= .7209
Mean VIF	1.19	1.37	1.4

*Note: t-statistics in brackets;*** p<0.01, ** p<0.05, * p<0.1;*

Source: authors own calculation

The results presented in Table 7 shows a negative real tobacco CPI coefficient in all models. It means that an increase in cigarette price in the short run will have a negative effect on consumption. Income coefficient in all models (models 1, 2 and 4) are negative, but not significant, so in a short-run increase of real GDP per capita leads to decrease in cigarette consumption. Estimated parameters for price in all three models are statistically significant at 5% and 1% level, while estimated parameters for income in all three models are not statistically significant. Coefficient for a regulatory variable *tban* has no statistically significant effect on the tobacco consumption, but has a negative sign. Same sign has a tobacco control policy index in model 4. Negative sign of tobacco control policy variables in models is in line with the assumption that tobacco control policies leads to decrease cigarette consumption in a short run.

Error correction parameters values are -0.738, -0.957, -0.836 for models 1, 2 and 4 respectively[7]. Interpretation of these coefficients is that 73.8% to 95.7% deviation from long-run equilibrium will be corrected in the following year.

The diagnostic test was applied in order to analyze the presence of heteroscedasticity, autocorrelation, multicollinearity and specification of functional form. Also, the normality of residuals is checked with Jarque-Bera and Skewness/Kurtosis tests (Mladenović and Nojković, 2012). Results of all specification tests are presented in Table 7.

The short-run elasticities of cigarette demand are presented in Table 8.

Table 8 Short run price and income elasticities

Short-run	**Model 1**	**Model 2**	**Model 4**
Price elasticity	-0.05	-0.05	-0.05
Income elasticity	-0.01	-0.001	-0.001

Source: authors own calculation

In the short-run model, real tobacco CPI is statistically significant, and it implies that changes in price have an impact on the demand for cigarettes even in the short run. Short-run price elasticity is quite low, which is quite common for addictive products such as cigarettes (Ross and Al-Sadat, 2007) since consumers may need some time to quit. On the other hand, real income does not have a significant impact on cigarettes consumption, so we can conclude that in short-period of time smokers in Serbia will change their consumption of cigarettes. The impact of price and income changes in a short run is smaller compared to the long-run, as expected. We were not able

[7] Error correction parameters are statistically significant on 5% and 1% level, respectively.

to do bootstrap standard errors for the short-term price elasticities, because we have an insufficient number of observations.

CONCLUSION

Tobacco taxes are the most effective measure for preventing initiation and reducing tobacco consumption. Studies about tobacco taxation topic provide evidence that higher tobacco prices lead to a significant reduction in tobacco products consumption. These studies estimate the price elasticity of consumption in the range from -0.25 to -0.50, but the estimates for low- and middle-income countries are higher (Chaloupka et al., 2010). Ross and Al-Sadat (2007) suggest that in low- and middle-income countries a 10% increase in cigarette prices can reduce cigarette consumption by 4%-8%.

The results presented in this study represent the first estimates of the price and income elasticities of cigarette demand in the Republic of Serbia. We used official data from the Statistical Office of the Republic of Serbia for this analysis covering the period 2002-2016. We found that 10% increase in cigarette prices would reduce cigarette consumption by 6.2%-7.6% in the long-run, and by 0.5% in the short-run. This means that the total cigarette demand would decline by 6.7% to 8.1% in response to a 10% increase in price. Based on empirical research, price elasticity for cigarettes in Serbia is quite similar to other low and middle income countries who estimate price elasticity using the same methodology.

Even though research was conducted on a small number of observations (short time-series), our results correspond to the results obtained in other low- and middle-income countries. This confirms that higher tobacco taxes that lead to higher cigarette prices have the potential to reduce cigarette use in Serbia substantially. This would be desirable given the large toll of tobacco use on both public health and the economy.

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