The elasticity of tobacco products in Macedonia

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Abstract: The aim of this analysis is to explore the key factors that affect the aggregate demand for tobacco products in Macedonia. Given data limitations, we focus only on the demand for cigarettes, as data on other tobacco products are not available. Following the mainstream theoretical frameworks and empirical approaches, the analysis first estimates the price elasticity of demand, and then calculates the likely effect of an increase in excise duty rates on the prices of cigarettes, consumption of cigarettes and the excise revenues.

1. Theoretical framework

The theoretical framework used in this analysis follows the law of demand. According to the economic theory, given the utility function of individuals, prices, the budget constraint and other relevant factors, a demand function for a product is derived where the quantity demanded negatively relates to the price of that product. In the empirical work, an issue of interest is typically how the quantity demanded responds to changes in the prices and this is captured by the price elasticity of demand.

The conventional demand model for tobacco products is a static model where the demand for a tobacco product is a function of its price, prices of other products - close substitutes and complements, and consumers' disposable income.

$$Q_{it} = f(P_{it}, P_{jt}, Y_t, Z_t)$$

where *i* and *j* denote different tobacco products, and *t* stands for a time period. Q_{it} and P_{it} denote per capita consumption of product *i* and its real price, respectively; P_{jt} is the real price of product *j*, and Y_t is the real disposable income per capita. Vector Z_t accounts for other factors that are thought to affect the consumption of tobacco product *i*, in particular tobacco control policies (bans and restrictions on smoking in public and work places, increased information on the health risks of smoking, public information campaigns, bans on advertising and promotion of tobacco products, warning labels on cigarette boxes and other tobacco products, and treatment to help dependent smokers to quit).

2. Data

This study uses aggregate time-series data for Macedonia for 2002-2017 (Table 1).

Table 1. Cigarette consumption, prices of cigarettes and real income in Macedonia, 2002-2017

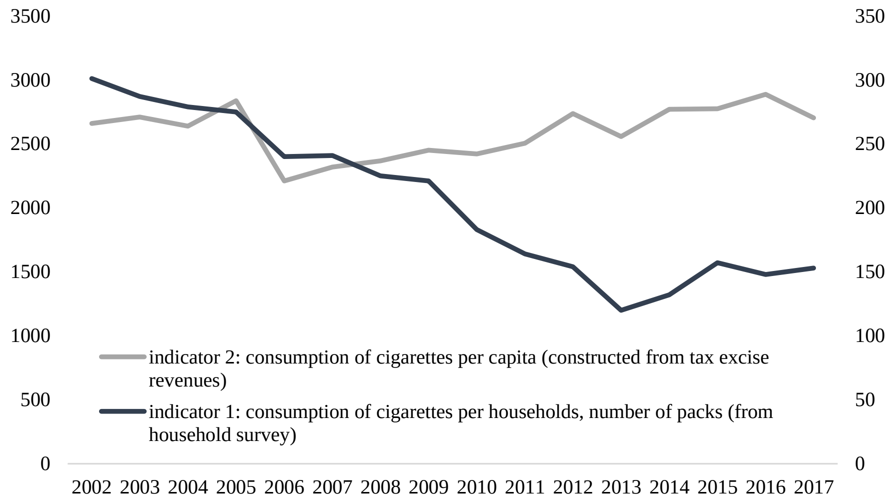
	indicator 1: consumption of cigarettes per households, number of packs (from household survey)	indicator 2: consumption of cigarettes per capita (constructed from tax excise revenues)	tobacco CPI (2017=100)	average real wage (deflated by CPI 2017=100), in denars
2002	301	2660	47	14736
2003	287	2711	47	15118
2004	279	2639	47	15781
2005	275	2837	52	16088
2006	240	2210	71	16722
2007	241	2319	73	17645
2008	225	2368	73	17982
2009	221	2451	74	22482
2010	183	2422	74	22799
2011	164	2504	75	22259
2012	154	2737	75	21600
2013	120	2558	77	21260
2014	132	2771	80	21570
2015	157	2776	86	22149
2016	148	2889	91	22647
2017	153	2704	100	22927
Mean (SD)	205	2597	71	19610

Source: Statistical Office, Ministry of finance and authors own calculations.

The dependent variable is **consumption of cigarettes.** We use two measures of cigarette consumption. The first is **consumption of cigarette packs per household** and is taken from the Household Consumption survey conducted and published by the State Statistical Office (SSO). Given that there is strong correlation between population growth and number of households we believe that this measure closely resembles per capita consumption of cigarettes. Because it is extracted from surveys using daily consumption diaries of households, this indicator should also capture the sale of cigarettes not captured by the excise authorities, which could represent a significant part of total cigarette consumption especially in the first half of the analyzed period.

The second indicator is **consumption of cigarettes per capita**, and is constructed following Ross and Al-Sadat (2007) from collected excise revenues and excise rates obtained from the Ministry of Finance. To calculate the consumption of cigarettes we assume that excise duties are the same for domestic and imported cigarettes, which was not the case before 2007. We had to use this assumption since data on excise tax revenues was not disaggregated by the cigarettes' origin. However, we believe that our approach can be justified by the fact that the share of imported cigarettes in the total consumption was small (about 7% of the total consumption). This assumption causes a slight upward bias in the estimate of cigarette consumption prior 2007. In addition, we had to calculate the effective excise tax rate by adding the specific excise (by cigarette) and the ad valorem excise (% from the retail price). This was done using the price of Boss cigarette brand, which is one of the few brands included in the tobacco price index and the only brand on which the SSO publishes data for the price. The price of Boss cigarettes displays high correlation with the CPI tobacco price index confirming that it is a good indicator for the dynamics of the average cigarette price. All in all, the second measure of consumption contains some measurement errors reflecting these two assumptions.

Figure 1. Consumption of cigarettes



Source: Statistical Office, Ministry of finance and authors own calculations.

Figure 1 shows the two consumption measures. The first measure, in line with our expectations, shows clear downward trend. The second indicator is more-less stable in the period 2002-2005, then there is a significant decline in 2006, then there is an upward trend until 2016. Clearly, the dynamics of the second indicator might also reflect efficiency in excise collection and any changes in cigarette tax avoidance and tax evasion. Given all this, our preferred measure for cigarette consumption is the first measure taken from the household survey. Interestingly, both measures demonstrate a convergence over time, so that the measures are almost similar by 2017: an average household consumes 153 packs per year or 3,060 cigarettes per household while the official consumption per capita is around 2,700 cigarettes per year.

Three **explanatory variables** used in the analysis are cigarette price, household disposable income, and tobacco control policies.

Tobacco price index is used as a measure of **cigarette price**[1]. This index is one of the twelve sub indices of the CPI by Classification of Individual Consumption according to Purpose (COICOP) calculated and published by the SSO. The indices are constructed from the monitored retail prices across the country (eight cities) by taking into consideration the structure of the personal consumption. The tobacco price index is calculated on the basis of monitored prices of several most consumed brands of cigarettes. More

[1] We also have data on price of Boss cigarettes, which is one of the brands included in the tobacco price index. The correlation between price of Boss cigarettes and total tobacco price index is very high. Therefore, in the analysis we decided to use only the index.

information on the methodology can be found in the Annual Yearbook of the SSO available on their website. The CPI index and its sub indices are published with monthly frequency. To get the annual number we use the average over the year.

Most econometric studies use real GDP per capita as proxy for disposable **income**. GDP may not be a good measure of disposable income, as it also includes profits of companies, which are very high in Macedonia. Having this in mind, we believe that real average wages are better proxy for the disposable income and this variable is included in our final econometric model. Anyway, as a robustness check we also estimate an econometric model with GDP per capita variable instead of wages and the results are presented in Appendix 1. As can be seen the diagnostic tests suggest that the model is not well specified and the estimated coefficients are counterintuitive and not significant. This can be result of the above mentioned weaknesses of the GDP variable being used as a proxy for the disposable income. Wages are published by the SSO with monthly frequency, and the yearly wage used in our analysis is calculated as the average wage for the period.

Tobacco control policies can be important determinants of cigarette consumption. Given that the period under analysis is relatively short we used only one policy variable that reflects the adoption of the Law on protection from smoking in 2010 when smoking was prohibited in all public indoor areas. We created a dummy variable that is equal to zero for 2002-2009, and one for the period 2010-2017.

3. Empirical analysis

To estimate the demand for cigarettes we use the conventional demand model, as explained above. The applied version of the model is:

$$C_t = \alpha + \alpha_1 P_t + \alpha_2 Y_t + \alpha_3 Policy + \varepsilon_t \tag{2}$$

Where C_t= aggregate consumption of cigarettes (per households); P_t= price variable (tobacco CPI index); Y_t= real average wages; $Policy$ = tobacco control policy (adoption of the Law on protection of smoking in 2010); α_1 and α_2 are coefficient of price and income, respectively, that are used estimate price and income elasticities.

The model does not include price of other tobacco products (as complementary or substitutes) due to concerns related to the degree of freedom and due to lack of reliable data.

Next, we tested the series for stationarity by using the Augmented Dickey Fuller (ADF) test. Results are presented in Appendix 2. Based on the results we concluded that all variables included in the econometric model are not stationary in levels, but stationary in their first difference. **In other words, consumption of cigarettes, tobacco prices and average wages are I(1) variables.** Given that our variables are I(1) the OLS estimates[2] might be spurious unless there exist cointegrating relationship between the variables. To that end we perform the Engle-Granger (EC) test for cointegration[3], which is in essence Augmented Dickey Fuller (ADF) test for stationarity of the OLS residuals.

Table 2 contains the results of the cointegration test. Contrary to our expectations, the results of the first test cannot reject the hypothesis of residual unit root i.e. no evidence of cointegration is found between our variables. However, this test has relatively low power in small samples. Closer look at the variables of interest actually reveals that there are two outliers[4] in the period 2013-2014 in the dependent variable (consumption of cigarettes). To control for this we created a dummy variable equal to one in 2013 and 2014 and 0 for all other periods. When this dummy variable is included in the equation **Engle-Granger test confirms a cointegration relationship in our model at 5% level of statistical significance.**

Table 2. Engle-Granger test for cointegration

[2] OLS estimates are presented in Appendix 1.

[3] EC test and ECM are estimated using command egranger in Stata. This command conducts tests for cointegration proposed by Engle and Granger (1987), reporting test statistics plus critical values calculated by MacKinnon (1990, 2010) and estimates an ECM (Error Correction Mechanism) model using the 2-step procedure proposed by Engle and Granger (1987).

[4] These outliers might represent measurement error in the consumption indicator. Namely, we observe a sudden decrease in consumption in 2013 and 2014 that cannot be explained by price changes or adoption of a new policy. Namely consumption of cigarettes drops to 120 and 132 packs per household in 2013 and 2014, respectively and then goes back to 157 in 2015.

	test statistic Z(t)	1% critical value	5% critical value	10% critical value
Engle-Granger test for cointegration	-3.072	-6.019	-4.895	-4.388
Engle-Granger test for cointegration (with dummy variable to correct for the outliers in 2013 and 2014)	**-5.489**	-6.617	-5.407	-4.865

Critical values from MacKinnon (1990, 2010)

Next, we estimated the long run relationship (equation 2) and the error correction model (ECM) (equation 3) including all the variables used in the cointegration test. ECM uses stationary data (first differences of all variables) and includes the lagged residuals from the long-run relationship.

$$\Delta C_t = \beta + \beta_1 \Delta P_t + \beta_2 \Delta Y_t + \beta_3 Policy + \pi \varepsilon_{t-1} + \vartheta_t \qquad (3)$$

Δ stands for the difference operator (for example, $\Delta C_t = C_t - C_{t-1}$), and $\vartheta_t$is the error term; ε_{t-1} is the lagged error term from the long run equilibrium equation (2). To revert to equilibrium, the adjustment coefficient π is expected to have a negative sign ($\pi < 0$). In this case, equation (2) describes the equilibrium relationship between consumption and the explanatory variables, whereas the error correction model (3) explains the short-run dynamics between those variables.

All variables in equation (2) and equation (3), with the exception of the dummy variable, enter in log forms[5]. Using logarithms instead of level of the variables is convenient because 1) it stabilizes the variance of the series[6] and 2) gives directly the elasticities of price and income[7]. This means that the estimated coefficients on price and income represent the percentage change in the dependent variables, due to a 1 percent change in the explanatory variables. In other world we obtain directly the elasticities of interest - the estimated coefficients β1 and β2 in model (3) are the short-run price and income elasticities, respectively, while the estimated coefficients α1 and α2 in model (2) are the long-run price and income elasticities.

[5] Log-variables that are included in the analysis are normally distributed. We performed the Jarque-Bera test for log of consumption, price, wages and income variable and the H0 of normal distribution cannot be rejected for all four variables at the conventional level of statistical significance (p-values of 0.52, 0.49, 0.36 and 0.55 for log of consumption, price, wages and income, respectively).

[6] Lütkepohl, H., Xu, F., 2012, The role of the log transformation in forecasting economic variables, Empirical Economics, 42 (3). pp. 619-638.

[7] Nguyen, L., Rosenqvist, G., Pekurinen, M. (2012), Demand for Tobacco in Europe – An Econometric Analysis of 11 Countries, PPACTE Project, National Institute for Health and Welfare (THL) – Finland

Table 3. Long run and short-run relationships

Engle-Granger 1st-step regression - long run relationship

Dependent variable is ln(consumption)

	coeff.	std. err	t-stat.	p-value
ln(price)	**-0.403**	0.114	-3.530	0.005
ln(wage)	-0.189	0.210	-0.900	0.387
law2010	**-0.287**	0.049	-5.840	0.000
dum2013-14	**-0.268**	0.043	-6.300	0.000
_cons	9.035	1.739	5.200	0.000

Engle-Granger 2 step - ECM

Dependent variable is first difference of ln(consumption)

	coeff.	std. err	t-stat.	p-value
lagged residuals	1.931	0.907	2.130	0.066
lagged diff(ln(price))	0.055	0.346	0.160	0.878
lagged diff(ln(wage))	-0.702	0.478	-1.470	0.180
lagged diff(law2010)	**-0.289**	0.148	-1.960	0.086
lagged diff(dum2013-14)	0.114	0.074	1.540	0.163
_cons	0.005	0.041	0.130	0.899

Table 3 summarizes the results. Results indicate that the effect of the price variable is significant at the conventional levels of statistical significance, with a negative sign and coefficient less than one, which is in line with the theoretical predictions. More intuitively, what this result tells us is that 10% increase in cigarettes price will lead to a decrease in consumption of cigarettes by 4%, on average, ceteris paribus. Similar results are found in tobacco demand analysis for other countries. Nguyen et al. (2012) estimated long-run price coefficient in the range of -0.2 to −1.5, with the typical value close to −1.0 for selected EU countries; Ross and Al-Sadat (2007) estimates for long-run price coefficient in the case of Malaysia lay within the range -0.57 to -0.76; Lee et al. (2005) reported price elasticities of -0.64 for domestic and -0.82 for imported cigarettes for Taiwan. On the other hand, the coefficient on the income variable is not significant, which may not be surprising, as higher income does not only mean having more money for cigarettes, but is also associated with higher awareness about the negative effects of smoking. As expected the adoption of the law that prohibited smoking in all public indoor areas had significant negative impact on consumption of cigarettes i.e. the adoption of the new law decreased the demand for cigarettes by 0.4%, on average, ceteris paribus. The dummy variable 2013-2014 is also significant.

In the ECM, all of the estimated coefficients are insignificant (exception is the law2010 dummy variable, which is significant at 10% level of significance) and most of them have wrong signs. The adjustment coefficient (lagged residuals) is significant at 10% level of significance; however it has positive sign implying that the process it not converging in the long run. This result usually indicates to some specification problems with the model itself, or some data issues.

As an alternative, we try to estimate the consumption model by using the Autoregressive Distributed Lag (ARDL) model which is better approach for short time series, like in our case. Table 4 summarizes the results of the ARDL model for consumption of cigarettes, prices of cigarettes, wages, dummy variable for the adoption of law that prohibited smoking in all public indoor areas and dummy variable for outliers in 2013-2014 period that all variables, as well the results from the diagnostic tests and the Pesaran, Shin, and Smith (2001) bounds test. We estimated ARDL model[8] with one lag for the dependent variable and no lags for the independent variable (ARDL(1 0 0)) on the basis of the information criteria (Akaike and Bayesian information criterion were both employed). This model will give us only the long-run price and income elasticities. In order to get intuition about the short run elasticities we try to estimate ARDL models with more lags, despite the small number of observations. However, the results were not stable – in most cases we cannot perform the bound test; the bound test (when it was possible to perform it) indicated no level relationship; some of the models have diagnostic problems (no serial correlation hypothesis was rejected at the conventional level of statistical significance); the estimated coefficients were counter intuitive (wrong sign and size) etc. Therefore we decide to continue with ARDL(1 0 0) model, as suggested by the information criteria and estimate only the long run elasticities. In addition, given the addictive nature of smoking, intuitively we expect the effects of prices and income on smoking to be larger and more significant in the long run.

Table 4. ARDL model - results

	Coef.	Std. Err.	t	P>t
Adjustment				
speed of adjustment	**-0.90**	0.14	-6.56	0.00
Long run				
ln(price)	**-0.37**	0.13	-2.79	0.02
ln(wage)	-0.16	0.25	-0.64	0.54
Short run				
law2010	**-0.27**	0.07	-4.08	0.00
dum2013_14	**-0.24**	0.05	-4.50	0.00
_cons	**7.71**	2.17	3.55	0.01

Pesaran, Shin, and Smith (2001) bounds test	p value (F-stat) 0.004
H0: no level relationship	p value (t-stat) 0.002
Ramsey RESET test H0: model has no omitted variables	p value (0.172)
Durbin-Watson test H0: no serial correlation	p value (0.706)
Jarque-Bera normality test H0: normality in the residuals	p value (0.886)
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity H0: Constant variance	p value (0.271)
Hausman test H0: difference in coefficients not systematic	p value (0.999)

[8] To estimate the model we used ardl command in Stata. Ardl command allows dummy variables to be specified as exogenous, and to be included only in the short run equation. We specified the dummy variable for the adoption of law that prohibited smoking in all public indoor areas and dummy variable for outliers in 2013-2014 period as exogenous.

The Pesaran, Shin and Smith bound test confirms the existence of a long-run, cointegrating relationship between consumption of cigarettes, prices and wages. All diagnostic tests show that the model is well specified, with normally distributed, homoscedastic and serially uncorrelated error term (H0 hypothesis is not rejected in all tests). Further, we also tested for possible price endogeneity in our preferred model. In economic theory price is endogenous if quantities and prices of a product are determined simultaneously. If price is endogenous, results of regression analysis would be biased. We performed Hausman test which basically tests whether there exists systematic difference between the price coefficient in our ARDL model estimated with OLS and the instrumental variable price coefficient. The p value of the test suggests no rejection of the null hypothesis that difference in coefficients is not systematic at all conventional level of significance suggesting that the price in our demand model is exogenous. This result is not surprising, especially in small and open economies where price of cigarettes is determined by costs of production on the world market and by cigarette taxes (Ross & Al-Sadat), Wilkins et al.). Estimated long run coefficient for price is -0.37 and it is statistically significant; wages remain insignificant, both dummy variables (law2010 and dum2013_14) are significant with negative sign. The speed of adjustment is negative and relatively high (coefficient of -0.9 indicates that around 90% of the deviation from the long-run equilibrium will be corrected in the following year). As argued by Ross & Al-Sadat (2007) this fast adjustment actually comes from the addictive nature of tobacco use.

4. Excise tax, cigarette prices and tax revenues

In this section we evaluate the potential impact of increase in excise on consumption of cigarettes and government tax revenues. To that end we performed three scenarios in which the price of cigarettes, as a result of higher excise taxes, will be increased by 10% (scenario 1), 30% (scenario 2) and 50% (scenario 3). In the simulation we use the ARDL long run coefficients[9]. This simulation is based on several assumptions:

- We use the price of Boss brand as proxy for cigarette prices. This is one of the few brands included in the tobacco price index and it is the only price of cigarette products published by the SSO. The price of Boss brand displays high correlation with the CPI tobacco price index confirming that it is a good indicator for the dynamics of average cigarette prices.
- The increase in the price comes from higher excise taxes.
- To calculate the impact on government tax revenues we apply the estimated price elasticity to the consumption calculated by using excise tax revenues data. As we acknowledged, this measure is less precise because it does not capture unrecorded sale of cigarettes. However, in the second half of the analyzed period the efficiency in public revenues has increased and unrecorded trade was reduced significantly. This is, also confirmed by the convergence between the two consumption indicators, as was previously underlined.
- Working age population growth is assumed to be 0.1% (the average growth in the last five years).
- The calculated effect is ceteris paribus effect i.e. it assumes only change in excise taxes ignoring other policy measures or change in consumer preferences.

[9] The results from the simulation with long run price and income coefficients estimated with EC-two step procedure didn't differ much, given that EC and ARDL produced very similar, in size parameters.

- This simulation does not take into account the income effect on consumption of cigarettes. Appendix III contains the calculations with included income effect, but we refrain from commenting the results in the main text because the income coefficient was not significant in all specifications.

The results of the simulation are summarized in Table 6.

Table 6. Effects of increase in excise tax on cigarette price, consumption and tax revenues

	Price of Boss cigarettes, per pack, in denars	**Effective excise, in denars, per pack** (0.9% from the retail price + per cigarette excise)	**Consumption of cigarettes**, per capita	**Excise tax revenues** (million of denars)
2017	82	48	2,703.86	11,011.00
Scenario 1	91	57	2,602.54	12,575.63
Scenario 2	107	66	2,399.90	15,223.74
Scenario 3	124	82	2,197.26	17,259.31
Change in %				
Scenario 1	10.0		-3.7	14.2
Scenario 2	30.0		-11.2	38.3
Scenario 3	50.0		-18.7	56.7

The simulation shows that increase in cigarette prices (as a result of higher excise taxes) in the range of 10% to 50% will lead to a decline in consumption of cigarettes per capita between 3.7% and 18.7% (or between 101 to 506 cigarettes per capita). On the other hand, even though consumption of cigarettes will decline, because of increase in tax rates, government excise revenues will be higher (14.2% to 56.7% or between 25.4 to 101.6 millions of Euros). This simulation shows a positive effect of higher excise taxes in terms of revenue and lower consumption. However, it doesn't capture other positive effects related to better public health, which will translate into lower government expenditures on health care and social insurance, and better economy overall in the medium/long run.

5. Conclusion

In this study we estimated the price elasticity of demand for cigarettes in the Republic of Macedonia. In line with the theory and findings in other empirical studies, the results show that the price elasticity of demand for cigarettes is around -0.4, implying that 1% increase in prices of cigarettes leads to a decline in consumption of cigarettes by 0.4%. The income elasticity of cigarette demand is not statistically significant, possibly due to short time series at hand.

The estimates of the long-run price elasticity (ARDL model) were used to simulate possible impact of higher excises and consequently higher cigarette prices. Three scenarios were prepared – scenario 1, 2 and 3 that assumed 10%, 30% and 50% increase in cigarette prices, respectively. According to the simulations, cigarette consumption will decline between 3.7% and 18.7% and the government will receive higher excise tax revenues between 14.2% and 56.7% (or additional revenues in the range of 25.4 to 101.6 millions of Euros).

The major limitation of this study is the data availability. This constrained more complex analysis and additional robustness checks. Future research could be based on monthly/quarterly data in order to increase the number of observations. To that end, the biggest challenge would be to construct monthly/quarterly series of consumption of cigarettes, given that data on prices, wages and GDP are readily available at lower frequencies.

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Appendix I. Linear demand model estimated with OLS

Table 1. Consumption model with wages as proxy for disposable income

Dependent variable is ln(consumption)	
ln(price)	**-0.408**
	(0.168)**
ln(wage)	-0.045
	(0.309)
law2010	**-0.391*****
	(0.081)
_cons	7.655
	(2.470)
Ramsey RESET test H0: model has no omitted variables	p value (0.544)
Durbin-Watson test H0: no serial correlation	p value (0.324)
Hausman test H0: difference in coefficients not systematic	p value (0.920)

Robust standard errors in parentheses
*p<0.1 ** p<0.05 *** p<0.01

Table 2. Consumption model with GDP as proxy for disposable income

Dependent variable is ln(consumption)	
ln(price)	0.068
	(0.445)
ln(income)	-1.097
	(0.929)
law2010	-0.311***
	(0.101)
_cons	18.389*
	(9.428)
Ramsey RESET test H0: model has no omitted variables	p value (0.057)
Durbin-Watson test H0: no serial correlation	p value (0.295)
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity H0: Constant variance	p value (0.024)

Robust standard errors in parentheses
*p<0.1 ** p<0.05 *** p<0.01

Appendix II. Unit root testing for the variables used in the econometric analysis

To test stationarity and order of integration of variables ADF test is used. The null hypothesis is **H0: the series has a unit root, i.e. is non-stationary.** If test statistics < critical value (in absolute values) at a certain level of significance then there are insufficient evidence for rejecting the null hypothesis at that level.

Table 1.

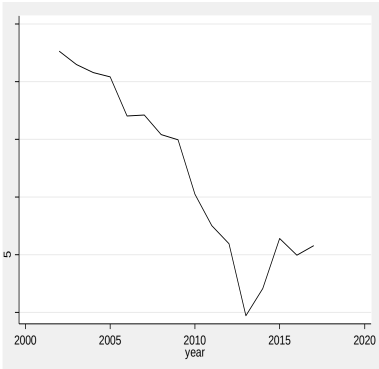
ADF test for the levels, one lag, intercept and trend included

	Test statistics	1% critical value	5% critical value	10% critical value	Note
Consumption of cigarettes per households	-1.313	-4.380	-3.600	-3.240	Durbin's alternative test for autocorrelation p value = 0.364
Tobacco price index	-2.490	-4.380	-3.600	-3.240	Durbin's alternative test for autocorrelation p value = 0.138
Average real wages	-1.474	-4.380	-3.600	-3.240	Durbin's alternative test for autocorrelation p value = 0.484

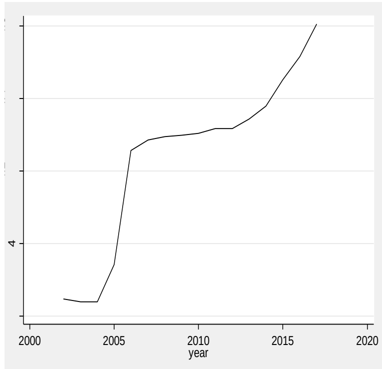
ADF test for the first difference, no lags, only intercept included

	Test statistics	1% critical value	5% critical value	10% critical value	Note
first difference of consumption of cigarettes	-3.403	-3.750	-3.000	-2.630	Durbin's alternative test for autocorrelation p value = 0.996
first difference of tobacco price index	-2.819	-3.750	-3.000	-2.630	Durbin's alternative test for autocorrelation p value = 0.751
first difference of average real wages	-3.296	-3.750	-3.000	-2.630	Durbin's alternative test for autocorrelation p value = 0.874

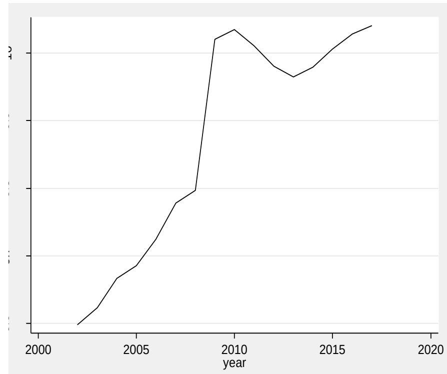
Consumption of cigarettes, per household (log level)



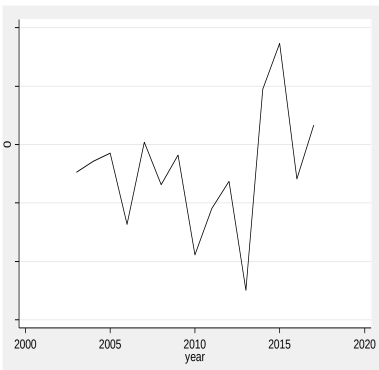
Tobacco price index (log level)



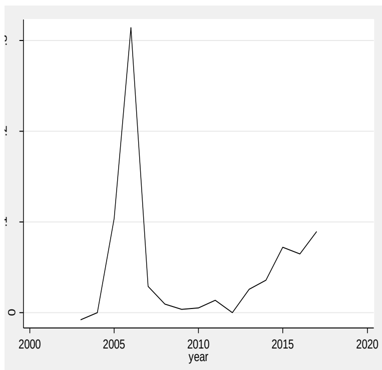
Average real wage (log level)



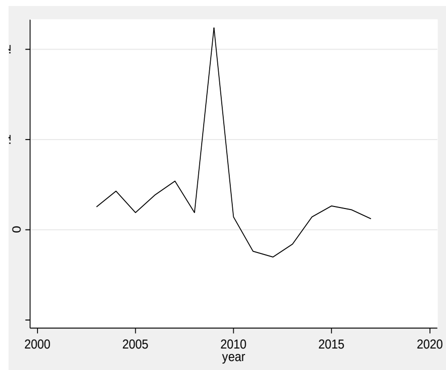
First difference of consumption of cigarettes, per household



First difference of tobacco price index



First difference of average real wage



The results from the unit root testing suggest that the levels of the variables are not stationary. Regarding the first difference of the series the results suggest that the first differences of the series is stationary (H0 is rejected at 5%, for the first difference of consumption and wages, and at 10% level of significance, for the first difference of prices). Therefore, we conclude that **consumption of cigarettes, wages and prices of cigarettes are I(1) variables.**

Appendix III. Effects of increase in cigarette price and income to consumption of cigarettes and tax revenues

For this simulation we use the same assumptions as in the simulation in the main text. Additionally, we included the income effect in order to see what will be the likely impact on the consumption of cigarettes and excise tax revenues. To that end, we use the estimated long run income parameter (ARDL model) and we assume that income will grow with the forecasted real GDP growth rate (World Economic Outlook Database). The results are given in Table 1.

Table 1. Effects of increase in cigarette price and income to consumption of cigarettes and tax revenues

	Price of Boss cigarettes, per pack, in denars	**Effective excise, in denars, per pack** (0.9% from the retail price + per cigarette excise)	**Average income,** assumed to grow with the forecasted rate of GDP, in denars	**Decline in consumption because of price increase, in %** (calculated by using estimated long-run price easticity of -0.375)	**Decline in consumption because of income increase, in %** (calculated by using estimated long-run income easticity of -0.158)	**Consumption of cigarettes**, per capita	**Excise tax revenues** (million of denars)
2017	82	48	22925			2,704	11,011
Scenario 1	91	57	23567	-3.7	-0.4	2,591	12,518
Scenario 2	107	75	23567	-11.2	-0.4	2,388	15,148
Scenario 3	124	93	23567	-18.7	-0.4	2,185	17,165
increase in %							
Scenario 1	10.0					-4.2	13.7
Scenario 2	30.0					-11.7	37.6
Scenario 3	50.0					-19.2	55.9

The decline in consumption is higher because the income coefficient was estimated negative (decline in the range of 4.2% to 19.2%). As in the first simulation, because of increase in tax rates, government excise revenues will increase with a similar rate as in the first simulation (increase in the range of 13.7% to 55.9% or 24.5 to 100 million of Euros).