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Article

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Does Cigarette Taxation Have an Impact on Reducing Their Consumption?[1]

Jarmila ZIMMERMANNOVÁ – Michal KRAJŇÁK** – Jan ŠIROKÝ** – Eva JÍLKOVÁ**

Abstract

This paper presents the evaluation of the impact of cigarette taxation in the Czech Republic, the Slovak Republic, and Poland. Firstly, the authors focus on the issue of cigarette taxation and the European legislation and then they provide an overview of the international scientific research in this area. The main objective of the research is to evaluate the impact of cigarette taxation on cigarette consumption, observing the effect of negative stimulation of this taxation. The authors use the methods of correlation and regression analyses and create three regression models. Focusing on the stimulation effect of cigarette taxation, the results show that cigarette taxation has a negative influence on cigarette consumption, however, the extent of the impact is not the same in all the analyzed countries.

Keywords: *cigarette taxation, tax incidence, negative stimulation effect*

JEL Classification: E62, H22, H31

Introduction

The primary function of taxes is to raise funds for the state and public budget, respectively. Some of the taxes, however, can have the so-called stimulation function (Ministry of Finance of the Czech Republic, 2018). These include, in

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particular, excise duties which are added to commodities, the consumption of which is accompanied by the development of the negative externalities (Kubátová, 2018). This kind of commodities is described in the literature as "sin goods" and the taxation connected with it "sin taxes"; this term is used to identify taxes charged on a class of products and services considered sources of risky behaviours, such as cigarettes and alcoholic beverages (Bella et al., 2019). According to the theory, increasing cigarette taxation, in addition to the fiscal impact, should have also the stimulation effect – the impact on reducing the harmful consumption of cigarettes (Meier and Licari, 1997).

Taking it into account, this paper evaluates the effect of negative stimulation of cigarette taxation in the selected countries – the Czech Republic, the Slovak Republic, and Poland. These countries were chosen mainly due to the availability of the necessary data. At the beginning of the research, the authors focused on all V4 countries (the Czech Republic, the Slovak Republic, Poland, Hungary). Nevertheless, Hungary was not included in the analysis. The main reason was the lack of necessary data; however, the key reason was the decreasing number of inhabitants in selected period, which can influence the results of the regressing analysis, using the consumption of cigarettes per inhabitant as a dependent variable. Moreover, the countries were selected concerning the results of the study by Schafferer et al. (2018). The analysis of panel data from 36 European countries showed a high sensitivity of cigarette consumption to the increase in cigarette prices in the Czech Republic, Latvia, Lithuania, Poland, and Slovakia. Therefore, the authors focused on the Czech Republic, Poland, and Slovakia for evaluation of the separate influence of cigarette taxation on cigarette consumption.

Regarding the period, the authors used data from 2004 to 2017. The year 2017 represents the last year with available data sets. The year 2004 represents the year in which selected states joined the EU and this situation brought with it a requirement to implement EU Directives connected with cigarettes and generally tobacco issues (Shirane et al., 2012). Besides, since they joined the EU, all three countries have failed to meet the minimum rate of excise duty which was set at EUR 60 per 1 000 cigarettes: EUR 27.83 in Poland; EUR 29.52 in the Czech Republic; EUR 34.01 in the Slovak Republic.

Concerning this research background, the key research question is determined: "Does cigarette taxation in the analyzed countries have stimulation effect, i.e. an impact on reducing cigarette consumption in physical units (pieces)?" Based on this research question, the main objective of this paper is to evaluate the impact of cigarette taxation in the Czech Republic, the Slovak Republic, and Poland in the period 2004 – 2017 with the focus on the stimulation function of cigarette taxation.

1. The Legislation and Literature Overview

The legislation on excise duties on cigarettes has been developing since 1972 when an obligation for Member States to adopt a system of excise duties on tobacco products, including cigarettes was established. An atypical way of taxation (unique one within the excise duties in the EU), i.e. a "composite excise duty" was introduced for cigarettes, where the tax is a combination of a specific excise duty calculated per unit of a product, and proportional (ad valorem) excise duty calculated as a percentage of the retail selling price. The turning point for the excise duty harmonization, including excise duty on cigarettes in the EU Member States, was the introduction of the single internal market on 1st January 1993. That day, the framework of Council Directive 92/12/EEC came into effect[2] (Eur-lex, 1992a). This directive was followed by other legislative acts related to specific taxed commodities. Minimum rates of excise duties on cigarettes were established by Council Directive 92/79/EEC (Eur-lex, 1992b). Since 1st January 2014 over the years, the rate of the excise duty on cigarettes in the countries of the European Union has been increasing, which is mainly determined by the EU law (respective directives) which sets out the minimum tax value in EUR per 1 000 cigarettes. In the analyzed period, these minimum values increased from EUR 60 in 2004 to EUR 64 since 2006, and EUR 90 since the year 2014 respectively.

The theory of excise duties (including cigarettes) was developed by Ramsey (1927). However, the history of excise duties is almost identical to the history of the modern taxation itself. It is described in the scientific literature, for example, in the studies by Schultzová and Rabatinová (2008), Starý et al. (2009) and Gál (2010). Both cultivation and consumption of tobacco and tobacco products, including cigarettes, became a suitable subject of taxation. Cigarette taxation and its consequences are described in the key monograph by Cnossen (2005) dealing with excise duties; on the other hand, we can find cigarette taxation issues also in general economic literature, for example in Samuelson and Nordhaus (2013) or James and Nobes (2018). These authors focus on the consequences of cigarette taxation and public finance issues.

Regarding the up-to-date international research in the analyzed area, the authors focused on the impacts of cigarette taxation on consumers' decisions, precisely the substitution and income effects of cigarette tax rates increase; the income effect is represented by the reduction of final consumption of cigarettes, the substitution effect is represented by changing the brand of cigarettes and preferring the cheaper ones (Liu et al., 2013; Chen et al., 2014; Chiou and

[2] With effect from 14. 1. 2009 it was replaced by Council Directive 2008/118/EC of 16 December 2008 concerning the general arrangements for excise duty and repealing Directive 92/12/EEC (Eur-lex, 2008).

Muehlegger, 2014). Bishop (2018) analyzed the cigarette taxation impact in the United States, dealing with a specific impact of cigarette taxation in a state where a tax increase can deter some residents from smoking, but other residents can avoid the higher tax by purchasing cigarettes from another state. Bishop (2018) measured how border-crossing opportunities affect smoking deterrence achieved by a cigarette tax increase. The new study by David (2018) evaluated the average tax rate imposed on tobacco products in the European Union in comparison with the social costs of smoking. The research shows that the tax imposed on tobacco products fails to cover the social costs of tobacco consumption both in the V4 countries and in the EU on average in the period of 2008 – 2015. David (2010) also analyzed excise duty on cigarettes as a tool of anti-tobacco policy, including the analyses of medical costs of cigarette consumption, and determined the global basic economic gap between tobacco tax receipts and the economic costs of smoking-attributable diseases (David, 2019). Svátková (2009) analyzed the impact of the European legislation on cigarette tax rates, Zimmermannová and Široký (2016) analyzed the cigarette taxation impacts on expenses of selected types of households on consumption of tobacco products. The microeconomic impacts of cigarette taxation, mainly the impact on cigarette consumption, were analyzed also by Lanoie and Leclair (1998) and Mcnaughton and Mawani (2005). Cullis and Jones focused on the positive and negative impacts of frequent tax rate increase (Cullis and Jones, 2009).

Schafferer et al. (2018) assessed the impact of a simulated 10% tax-induced cigarette price increase on licit and illicit consumption and tax revenues in 36 European countries. The research team found that annual illicit cigarette consumption increased, while annual licit cigarette consumption decreased in the analyzed countries. What is the most interesting is that the Czech Republic, Latvia, Lithuania, Poland, and the Slovak Republic were affected the most by the increase in price. Therefore, the Czech Republic, Poland, and the Slovak Republic were selected for the research presented in this paper.

2. Materials and Methods

2.1. Methods

The correlation analysis (Pearson's correlation coefficient) and regression analysis were carried out, where the possible links and connections between the variables were evaluated. The potential impact of the selected economic indicators on the cigarette consumption in the Czech Republic, the Slovak Republic, and Poland was examined. For this purpose, the linear regression method was

used and separate regression models were created. The authors use the linear regression models based on the methodological approach of scientific studies focusing on taxation and evaluation of particular aspects of the cigarette tax impacts. For example, Wasserman et al. (1991), Showalter (1998) or Harding, Leibtag and Lovenheim (2012) employed also generalized linear models for cigarette tax analysis.

Table 1 shows the overview of all variables and their expected/theoretical effect on cigarette consumption.

T a b l e 1

List of Variables

Variable	Abbreviation	Units	Role	Expected/theoretical effect on cigarette consumption
Annual cigarette consumption/capita	CONSUM	Pieces per capita	Dependent	–
Minimum tax rate	TAX	EUR per 1 000 cigarettes	Key explanatory	Negative
GDP/capita	GDP	mil. EUR per capita	Control explanatory	Positive
Inflation rate	INFL	%	Control explanatory	Rather positive
Average wage	WAGE	EUR	Control explanatory	Rather positive
Unemployment rate	UNEMPL	%	Control explanatory	Positive
Time period 2004 – 2017	TIME	Year	Control explanatory	Rather negative

Source: Authors.

For each of the analyzed countries, three partial regression models were created. The first one is the simplest regression model MOD1 which counts only the relation between the excise duty on cigarettes and their consumption. The regression equation is as follows:

$$Y = \beta_0 + \beta_1 X_1 + u \tag{1}$$

In this equation, parameters β_0 and β_1 represent regression coefficients that reflect the impact of the independent variable on the dependent variable. The dependent variable *Y* represents annual cigarette consumption in the individually analyzed countries (the Czech Republic, the Slovak Republic, and Poland) per capita in pieces (CONSUM). The parameter *u* represents a random element of the model. The independent variable X_1 in the regression equation is the minimum tax rate in EUR per 1 000 cigarettes, applied in a given country in a given year (TAX). The second regression model MOD2 is extended by the GDP variable. Based on previous research, the growth in consumption can be expected with the GDP growth on a reciprocal basis (Zimmermannová, Skaličková and Široký, 2016). The equation is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + u \quad (2)$$

In this equation, parameters $\beta_0 - \beta_2$ likewise represent regression coefficients that reflect the impact of the independent variable on the dependent variable. The dependent variable *Y* represents annual cigarette consumption in the individually analyzed countries (the Czech Republic, the Slovak Republic, and Poland) per capita in pieces (CONSUM). The parameter *u* represents a random element of the model. The independent variables in the regression equation MOD2 are as follows: X_1 – min. tax rate in EUR/1 000 cigarettes in a given country in a given year (TAX); X_2 – GDP mil. EUR/capita in a given country in a given year (GDP). The third and the most complex regression model MOD3 contains the basic macroeconomic indicators which can affect consumption and the control variable which is included here is time. The equation is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + u \quad (3)$$

In this equation, parameters β_0 ... β_6 represent regression coefficients that reflect the effect of the independent variable on the dependent variable. The dependent variable *Y* represents annual cigarette consumption in the individually observed countries (the Czech Republic, the Slovak Republic, and Poland) per capita in pieces (CONSUM). Parameter *u* represents the random element of the model. The independent variables in the regression equation are as follows: X_1 – min. tax rate in EUR/1 000 cigarettes in a given country in a given year (TAX); X_2 – GDP in million EUR/capita in a given country in a given year (GDP); X_3 – inflation rate in a given country in a given year (INFL); X_4 – average wage in EUR in a given country in a given year (WAGE); X_5 – unemployment rate in a given country in a given year (UNEMPL); X_6 – time represented by the period 2004 – 2017 (TIME).

Based on the previous research, the growth in consumption can be expected with the increase in inflation rate, because temporarily higher inflation expectations of the economic subjects can stir consumption expenditures (D'Acunto, Hoang and Weber, 2015). Regarding average wage, we can expect a rather positive relationship with the cigarette consumption, since the real per capita personal income of the population plays a significant role for the cigarettes consumption as people who have ensured their basic needs, can consume more money for other activities as for cigarettes (Rigas et al., 2018). Focusing on the unemployment rate, we can expect a stronger positive relationship with cigarette consumption, because unemployed people have higher cigarette consumption (Rigas et al., 2018). The last control variable, time, represents the variable with rather negative relationship with the cigarette consumption, based on statistical data "Cigarette consumption per capita" (see Figure 2).

2.2. Data

The following data sources were used:

- Tax rates in national currencies were taken from the relevant national laws and their amendments (Czech Republic, 2018; Slovak Republic, 2018), and the database of the European Commission (European Commission, 2018).
- Tax revenue – from the official websites of the competent authorities of finance ministries (Customs Administration of the Czech Republic, 2018; Financial Administration of the Slovak Republic, 2018; National Revenue Administration of Poland, 2018); interviews with officers, if necessary.[3]
- Exchange rate – concerning the research subject and the provision of the article 18 of Council Directive 2011/64/EU (Eur-lex, 2011), the exchange rate established from the first working day of October of the previous year was used for the relevant year.[4]
- Cigarette consumption values per capita in the analyzed countries are taken from the WHO database (World Health Organization, 2018) and Eurostat (Eurostat, 2018).[5]
- GDP in million EUR per capita (Eurostat, 2018).
- Inflation rate, the average wage in EUR, unemployment rate – data from individual national and international statistics (Eurostat, 2018; Statistics Poland, 2018; Statistical Office of the Slovak Republic, 2018; Czech Statistical Office, 2018).

3. Results

For the analysis of the stimulation impact of cigarette taxation, we will firstly present the selected characteristics for each of the used variables. The following Tables 2, 3, and 4 summarize parameters of each of the variables in the analyzed countries.

For each of the variables the minimum and maximum values, the mean and the median, are indicated.

[3] In case of the Czech Republic, it is a qualified estimation performed by the Ministry of Finance officers, since tobacco taxation is included into the value of tobacco tax stamp.

[4] Specifically, the exchange rate published in the Official Journal of the EU on 1st October in the period 2003 – 2005, 2008 – 2011, 2013 – 2016, the exchange rate of 2nd October in the years 2007 and 2012, and the exchange rate of 3rd October 2006.

[5] Levels of cigarette consumption per capita in different sources vary considerably, therefore the referred databases were used: WHO for the period 2004 – 2010, and EUROSTAT for the period 2011 – 2017. Two databases were used to preserve the whole analyzed period; the methodology did not change during the period.

T a b l e 2

Overview of the Data Used in the Regression Analysis – the Czech Republic

Variable	Minimum	Maximum	Mean	Median
Y – CONSUM	1 901	2 345	2 066.9	2 019
X_1 – TAX	29.5	95.1	72.4	81.1
X_2 – GDP	9 404	18 130	14 416.5	14 954.5
X_3 – INFL	0.3	6.3	2.1	1.9
X_4 – WAGE	548.5	1 091.6	880.8	957.6
X_5 – UNEMPL	2.9	8.3	6.1	6.7
X_6 – TIME	2004	2017	2010	2010

Source: Eurostat (2018); own processing.

T a b l e 3

Overview of the Data Used in the Regression Analysis – the Slovak Republic

Variable	Minimum	Maximum	Mean	Median
Y – CONSUM	1 312	1 781	1 481	1 410.5
X_1 – TAX	34	91	72.4	85.6
X_2 – GDP	46 110.5	84 985.2	68 183.4	69 559.4
X_3 – INFL	–0.5	7.5	2.3	1.7
X_4 – WAGE	525.3	954	760.6	777.5
X_5 – UNEMPL	9.6	18.1	12.8	13.2
X_6 – TIME	2004	2017	2010	2010

Source: Eurostat (2018); own processing.

T a b l e 4

Overview of the Data Used in the Regression Analysis – Poland

Variable	Minimum	Maximum	Mean	Median
Y – CONSUM	1 211	1 991	1 501.3	1 390.5
X_1 – TAX	27.8	97.8	68.6	71.4
X_2 – GDP	201 843.5	458 899.8	356 320.3	381 556.8
X_3 – INFL	–0.7	4.2	2.1	2.4
X_4 – WAGE	495.3	988.9	794.2	826.3
X_5 – UNEMPL	4.9	19.1	10.2	9.6
X_6 – TIME	2004	2017	2010	2010

Source: Eurostat (2018); own processing.

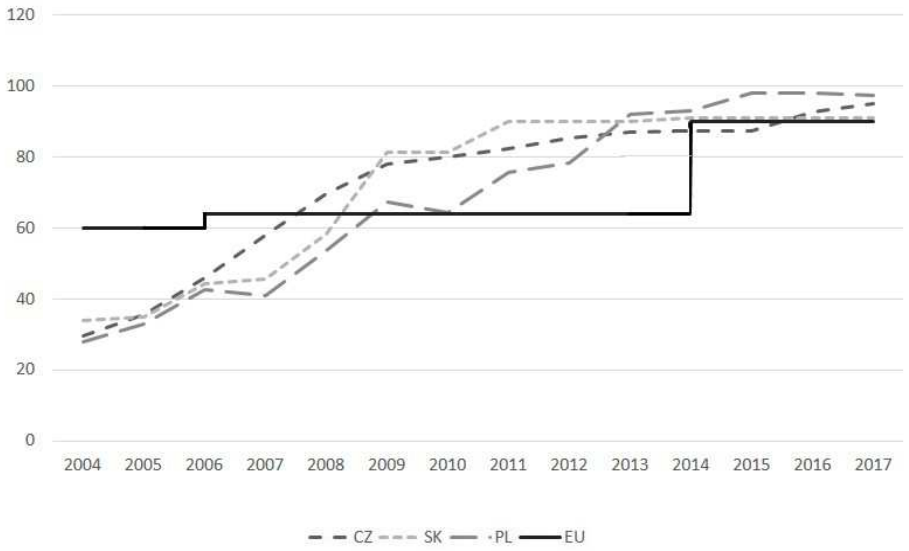
Regarding the development of cigarette tax rates, Figure 1 illustrates how cigarette tax rates in the individual countries gradually approached the EU request according to the relevant directive.

The tax rate in the Czech Republic reached the required minimal tax rate in 2008/2016, in Poland in 2009/2016, and in the Slovak Republic in 2009/2011, respectively. In the analyzed period (2004 – 2017), cigarette taxation in Poland increased by almost 3.5 times, in the Czech Republic by 3.2 times, and in the Slovak Republic by 2.7 times.

Figure 2 shows the development of consumption of cigarettes in pieces in selected countries.

F i g u r e 1

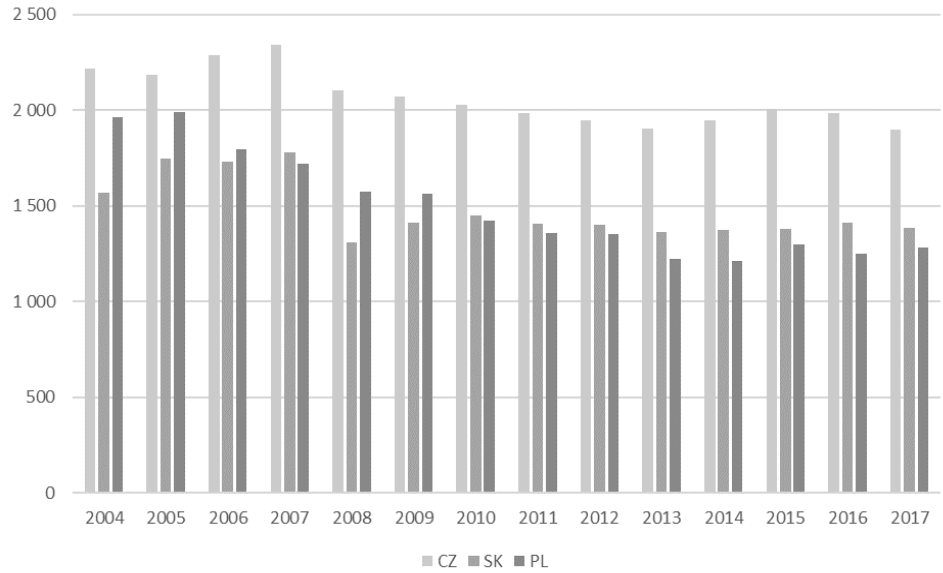
Development of Cigarette Tax Rates (in EUR/1 000 pc)



Source: Czech Republic (2018); Slovak Republic (2018); European Commission (2018); own processing.

F i g u r e 2

Development of Cigarette Consumption per capita (in pieces)



Source: Customs Administration of the Czech Republic (2018); Financial Administration of the Slovak Republic (2018); National Revenue Administration of Poland (2018); own processing.

As regards development in the years 2004 – 2013, a decreasing trend can be observed; during the period 2014 – 2017 the cigarette consumption per capita was slightly fluctuated. Generally, focusing on the whole period, the cigarette consumption per capita decreased. Has the change in the increase of cigarette tax rates led to the reduction of their consumption? What other variables can affect cigarette consumption? The following analysis attempts to answer these questions.

Results from the Czech Republic

Table 5 presents the results of the correlation analysis for the Czech Republic.

T a b l e 5

Correlation Analysis – the Czech Republic

	CONSUM	**GDP**	**TAX**	**INFL**	**WAGE**	**UNEMPL**	**TIME**
CONSUM	1						
GDP	–0.747	1					
TAX	–0.848	0.947	1				
INFL	0.311	–0.104	–0.309	1			
WAGE	–0.873	0.927	0.991	–0.322	1		
UNEMPL	0.308	–0.769	–0.587	–0.118	–0.529	1	
TIME	–0.840	0.892	0.925	–0.425	0.911	–0.657	1

Source: Own processing.

According to the results, a statistically significant negative correlation between cigarette consumption per capita and GDP per capita, the excise tax rate on 1 000 cigarettes, the average wage, and time was indicated. In general, the relation between cigarette taxation and cigarette consumption is rather negative. The regression analysis illustrates the influence of cigarette taxation on reduction of their consumption. Table 6 summarizes the results of regression analysis from the Czech Republic with the use of three models specified in the methodology.

T a b l e 6

Results of Regression Analysis – the Czech Republic

	Model 1		**Model 2**		**Model 3**	
Variable	X_1		X_1, X_2		X_1, X_2, X_3, X_4, X_5, X_6	
	Signif.	Coef.	Signif.	Coef.	Signif.	Coef.
X_1 – TAX	0.000	–5.647	0.014	–9.118	0.627	3.804
X_2 – GDP	X	X	0.265	0.034	0.799	0.126
X_3 – INFL	X	X	X	X	0.091	–34.310
X_4 – WAGE	X	X	X	X	0.407	–0.740
X_5 – UNEMPL	X	X	X	X	0.140	–48.367
X_6 – TIME	X	X	X	X	0.021	–41.791
Constant	0.000	2 475.8	0.000	2 240.9	0.001	86 651.2
Observation	14		14		14	
R^2	0.848		0.867		0.955	
Signif. F	0.000		0.000		0.002	
DW	1.132		1.572		2.137	

Source: Own processing.

The results from Table 6 illustrate that all three models have a high determination index, which means that in the case of Model 1, the general formalization of which is specified (1), it is more than 84% of the variance due to the character of X_1 and less than 16% of random deviations. Under the p-value of 5% there are both the value of the X_1 and and the constant. According to the outcomes of the overall F-test, the estimated regression model of cigarette consumption is statistically significant at 1% level of significance. According to the T-test, the regression coefficient X_1 – excise rate is a statistically significant coefficient which contributes to the explanation of variability of consumption and is justified in the model. The problem with this model is, however, the result of the Durbin-Watson test, where the value of the DW equals 1.132 (more about the Durbin-Watson test in Sawin and White, 1977). This value expresses a tendency to the positive autocorrelation (the value lies within the interval 1.004 to 1.350 of inconclusive zone). According to the results in Table 7, using the Cochrane-Orcutt method (Cochrane and Orcutt, 1949), autocorrelation model is removed, since DW = 1.959. The equation expressing dependency of consumption on the excise duty rate is as follows (4),

$$Y = -7.745\ X_1 + 1548.822 \tag{4}$$

The negative parameter X_1 in equation (4) shows the fact that if the tax burden grows, cigarette consumption decreases. As Table 7 shows, the regression parameter X_1 is statistically significant in the newly created model after removing autocorrelation.

T a b l e 7

Model 1 after Removal of Autocorrelation – the Czech Republic

	Model 1	
Variable	X_1	
	Signif.	Coef.
X_1 – TAX	0.003	–7.745
X_2 – GDP	X	X
X_3 – INFL	X	X
X_4 – WAGE	X	X
X_5 – UNEMPL	X	X
X_6 – TIME	X	X
Constant	0.000	1 548.822
Observation	13	
R^2	0.754	
Signif. F	0.003	
DW	1.959	

Source: Own processing.

The result of the F-test leads to the conclusion that the estimated regression model (4) is statistically significant at the 5% level of significance. Model 2 and Model 3 do not show autocorrelation, the values of F-test are normal as well as

the high index value of determination. In the case of Model 2, the problem is the p-value for the variable X_2. In Model 3, the p-value is over 0.05 for all the X_n variables, except for the variable X_6. Based on these results, it can be concluded that in Model 2, the variable X_2 is not justified, in the Model 3, the same applies to the variables X_2, X_3, X_4, and X_5. Therefore, these variables are removed from the model. Thus, Model 1 was selected as a suitable model for expressing dependencies.

Results from the Slovak Republic

Table 8 presents the results of correlation analysis for the Slovak Republic.

T a b l e 8

Correlation Analysis – the Slovak Republic

	CONSUM	**GDP**	**TAX**	**INFL**	**WAGE**	**UNEMPL**	**TIME**
CONSUM	1						
GDP	–0.709	1					
TAX	–0.802	0.890	1				
INFL	0.324	–0.694	–0.636	1			
WAGE	–0.724	0.989	0.924	–0.726	1		
UNEMPL	0.351	–0.723	–0.422	0.530	–0.668	1	
TIME	–0.691	0.967	0.903	–0.701	0.986	–0.596	1

Source: Own processing.

The results show that cigarette consumption per capita has a statistically significant negative correlation with GDP per capita, the excise tax rate on 1 000 cigarettes and the average wage, similarly as in the case of the Czech Republic. Therefore, it can be assumed that between cigarette taxation and cigarette consumption there will be a rather negative relation.

T a b l e 9

Results of Regression Analysis – the Slovak Republic

	Model 1		**Model 2**		**Model 3**	
Variable	X_1		X_1, X_2		X_1, X_2, X_3, X_4, X_5, X_6	
	Signif.	Coef.	Signif.	Coef.	Signif.	Coef.
X_1 – TAX	0.001	–5.452	0.061	–5.589	0.819	–2.150
X_2 – GDP	X	X	0.955	0.001	0.838	0.005
X_3 – INFL	X	X	X	X	0.224	–31.961
X_4 – WAGE	X	X	X	X	0.586	–3.692
X_5 – UNEMPL	X	X	X	X	0.752	–14.108
X_6 – TIME	X	X	X	X	0.540	63.502
Constant	0.000	1 875.654	0.000	1 863.932	0.266	–123 354
Observation	14		14		14	
R^2	0.802		0.803		0.855	
Signif. F	0.001		0.003		0.079	
DW	2.193		2.205		1.691	

Source: Own processing.

Table 9 shows the results of regression analysis for the Slovak Republic with the use of three models specified in the methodology.

For Model 1, the purpose of which is to illustrate the dependence of cigarette consumption on the excise duty rate on these products, the p-value is 0.001. This value is below the level of significance of 0.05, and the variable is, therefore, justified in the model and affects the explained variable. The results of the overall F-test and Durbin-Watson test are normal. The equation is as follows (5),

$$Y = -5.452\ X_1 + 1875.654 \tag{5}$$

This equation illustrates that with the growth of the minimum rates of excise duties on tobacco products by EUR 1 applied on cigarettes, average cigarette consumption reduces by –5.452 pieces. The equation confirms the result of the correlation analysis between consumption and excise tax rate, which shows a high degree of negative correlation. The index value of R^2 indicates that this model expresses approximately 80% of consumption variability. In the case of Model 2 which assumes that cigarette consumption depends not only on the rate, but also on GDP, the level of significance of both regression parameters is higher than 5%, which illustrates that neither of X_n parameters is statistically significant in this case. The same conclusion is also valid for Model 3, where the value of the test criteria of the overall F-test also acquires more than 5%.

Results from Poland

Table 10 presents the results of correlation analysis for Poland.

T a b l e 10

Correlation Analysis – Poland

	CONSUM	GDP	TAX	INFL	WAGE	UNEMPL	TIME
CONSUM	1						
GDP	–0.929	1					
TAX	–0.961	0.951	1				
INFL	0.445	–0.405	–0.567	1			
WAGE	–0.913	0.997	0.938	–0.395	1		
UNEMPL	0.799	–0.901	–0.767	0.249	–0.905	1	
TIME	–0.930	0.934	0.979	–0.584	0.916	–0.789	1

Source: Own processing.

The results of correlation analysis show that the variable of cigarette consumption per capita correlates statistically significantly negatively with GDP per capita, tax rate on cigarettes, the average wage and, time, as in the case of the Czech Republic, but in the case of Poland, it correlates statistically significantly positively with the level of unemployment. Therefore, the cigarette consumption in Poland can be higher in case of higher unemployment, and, on the other hand, can be lower in case of positive economic growth (GDP and average wage increase).

As with the Czech Republic and the Slovak Republic, we can assume a rather negative relationship between cigarette taxation and cigarette consumption, which will be further examined using regression analysis. Table 11 shows the results of regression analysis from Poland, using the three models specified in the methodology.

T a b l e 11

Results of Regression Analysis – Poland

	Model 1		**Model 2**		**Model 3**	
Variable	X_1		X_1, X_2		X_1, X_2, X_3, X_4, X_5, X_6	
	Signif.	Coef.	Signif.	Coef.	Signif.	Coef.
X_1 – TAX	0.000	–10.238	0.012	–8.570	0.003	–25.893
X_2 – GDP	X	X	0.551	–0.001	0.827	–0.001
X_3 – INFL	X	X	X	X	0.169	–23.388
X_4 – WAGE	X	X	X	X	0.240	2.419
X_5 – UNEMPL	X	X	X	X	0.019	43.770
X_6 – TIME	X	X	X	X	0.049	59.030
Constant	0.000	2 204.2	0.000	2 289.4	0.093	–117 348
Observation	14		14		14	
R^2	0.961		0.962		0.988	
Signif. F	0.000		0.000		0.000	
DW	1.306		1.538		2.479	

Source: Own processing.

In the case of Model 1, the result of Durbin-Watson test is not satisfactory. The value of DW equals 1.306 and lies in the zone of inconclusiveness and, therefore, using the Cochrane-Orcutt method, the model was transformed. The newly created equation is as follows (6),

$$Y = –9.378\ X_1 + 1491.815 \tag{6}$$

The value of DW close to 2 confirms that the autocorrelation in this model does not arise. Table 12 shows the level of significance of the explanatory variables, constants, and the F-test which are normal. Out of the created models, R^2 takes the highest value in this case, and more than 90% of the variation can be explained by the given equation of the regression line. In Model 1, as the Czech Republic or the Slovak Republic, Poland has a negative relation between the excise duty rate and consumption, if one variable increases, the other decreases, as shown by the negative value X_1. At the same time, there is the highest value of the variable X_1 in this model, which leads to the conclusion that it is Poland where cigarette taxation has the largest impact on cigarette consumption (in comparison with the other two analyzed countries). For Models 2 and 3, the explanatory variables are insignificant. For Model 2, it is the variable X_2, and for Model 3 – variables X_2, X_3 a X_4.

T a b l e 12

Model 1 after Removing Autocorrelation – Poland

	Model 1	
	Signif.	Coef.
Variable	X_1	
X_1 – TAX	0.000	–9.378
X_2 – GDP	X	X
X_3 – INFL	X	X
X_4 – WAGE	X	X
X_5 – UNEMPL	X	X
X_6 – TIME	X	X
Constant	0.000	1 491.815
Observation	13	
R^2	0.903	
Signif. F	0.000	
DW	1.836	

Source: Own processing.

Discussion

At the beginning of our analysis, we defined the key research question "Does cigarette taxation in the analyzed countries have stimulation effect, i.e. an impact on reducing cigarette consumption in physical units (pieces)?" Based on the results, it can be concluded that cigarette taxation in the analyzed countries has in fact stimulation effect, i.e. it contributes to reducing cigarette consumption in physical units (pieces). This result was achieved due to regression Model 1. In the case of more complex regression Models 2 and 3 with the use of multiple variables (independent variables), statistically significant coefficients confirming both the suitability and statistical significance of the models have not been detected in any of the analyzed countries. For the comparison of Model 1 results, the obtained regression equations 4, 5, and 6 can be used, as shown in the Table 13.

T a b l e 13

Comparison of Regression Equations for the Analyzed Countries

Country	**Regression equation**
Czech Republic	$Y = 1548.822 – 7.745\ X_1$
Slovak Republic	$Y = 1875.654 – 5.452\ X_1$
Poland	$Y = 1491.815 – 9.378\ X_1$

Source: Own processing.

With great simplification, if there is a tax rate increase in EUR/1 000 cigarettes by EUR 10, it reduces annual cigarette consumption per capita mainly in Poland (according to regression model, approximately by 93 cigarettes), then

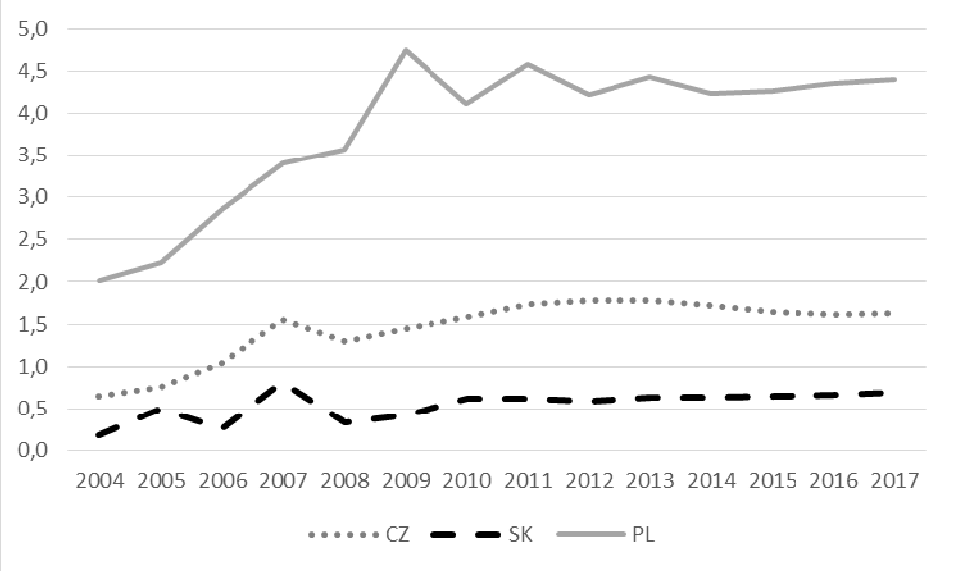
little less in the Czech Republic (according to regression model, approximately by 77 cigarettes) and the least in the Slovak Republic (according to regression model, approximately by 54 cigarettes). However, sin taxes represent only one of the tools causing reduction in cigarette consumption.

The results obtained in this study expand on the previous study by Zimmermannová and Široký (2016). Based on the results of correlation and regression analyses, the authors observed that regardless of the cigarette tax rate increase in the analyzed countries (the Czech Republic and the Slovak Republic), expenditures of households on tobacco products consumption are not decreasing.

Figure 3 shows the development of cigarette taxation revenues in the Czech Republic, the Slovak Republic and Poland in the period 2004 – 2017.

F i g u r e 3

Development of Tax Revenues from Excise Duty on Cigarettes (in billion EUR)



Source: Customs Administration of the Czech Republic (2018); Financial Administration of the Slovak Republic (2018); National Revenue Administration of Poland (2018); own processing.

Despite the increase of cigarette taxation rates, tax revenues were not decreasing. Due to the influence of various factors, there is a considerable fluctuation in the development. Time delays, possibility of frontloading, or introduction of electronic cigarettes in the year 2009 can be considered, among other things, as factors affecting fluctuations. Connecting with the results presented in this paper – cigarette tax rates increase can lead to cigarette consumption decrease. Nevertheless, cigarette taxation revenues will represent an important source of income of the public budgets.

Comparing the results with other studies, Rigas et al. (2018) observed that the countries China, Japan, Russia, USA and Germany present negative cigarette price elasticity, significantly different from zero at the 1% level. This means that a cigarette price increase would cause consumption to fall.

Previous empirical studies underlined the regressivity of cigarette taxation (for example Bella et al., 2019); in case of a tax increase, consumers reacted by switching to cheaper brands (Cnossen, 2005).

The other empirical study (Fidler et al., 2015) identified three key problems connected with cigarette taxation – (i) the tax advantage of cheaper cigarettes, (ii) the tax advantage of cigarette substitutes, and (iii) the possibility of cigarette frontloading. Moreover, as David (2018) states, the excise duty on cigarettes does not cover social costs associated with negative externalities of cigarette consumption. Therefore, the increase of excise duty on cigarette consumption can be expected.

Further research in this area can be focused also on adding other kinds of tobacco products to the analysis (Miltáková and Stavjaňová, 2016), influence of the VAT (Krzikallová and Střílková, 2016) or the overall influence of the cigarette price on the consumption patterns in particular countries.

Regarding the possible additional variables, which can be used in the model, it should be worth to analyze the possible influence of the percentage of university graduates (the knowledge of the negative effects of smoking are more effective to people of high-level education), the influence of advertising in the population (Bella et al., 2019) or age, sex (World Health Organization, 2019) and geographical distribution (Burian et al., 2018).

Conclusion

This paper evaluated the effect of negative stimulation of cigarette taxation in the selected countries: the Czech Republic, the Slovak Republic, and Poland in the period 2004 – 2017. As a methodological approach, the linear regression method was used; separate regression models for particular countries were created. The dependent variable was represented by annual cigarette consumption per capita in pieces, the independent variables in the regression models were represented by minimal tax rate, gross domestic product, inflation rate, average wage, unemployment rate and time, as a control variable.

The authors found out that cigarette taxation in the analyzed countries stimulated consumers to reduce cigarette consumption in the period 2004 – 2017, although there were differences between the countries in the amount of the tax impact.

Regarding economic policy recommendations, further increase of the tax rate on cigarettes can be worth, with regard not only to fiscal and stimulation aspects of cigarettes' taxation, but also concerning the healthcare and social costs related to both active and passive smoking in the society.

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