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Youth smoking initiation in CESEE:

A comparative analysis of 10 selected countries

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Abstract

Youth smoking initiation remains a critical public health challenge in Central, Eastern and South-Eastern Europe (CESEE), where early onset of tobacco use contributes to long-term nicotine dependence and chronic disease risk. Understanding the determinants of smoking initiation is essential for designing effective strategy for tobacco control. The aim of this study is to examine the timing and determinants of smoking initiation among adolescents aged 13-15 in 10 CESEE countries, comparing EU and non-EU member countries to identify policy and behavioural factors influencing early uptake. The study uses data from the Global Youth Tobacco Survey (GYTS). Survival analysis techniques were applied to estimate the age of initiation and assess the impact of cigarette prices, non-price tobacco control measures, parental smoking behaviour, peer behaviour and risk perception. The findings indicate that higher cigarette prices significantly delay smoking initiation, particularly in non-EU countries, where price sensitivity is greater. Non-price policies, especially the combined implementation of advertising bans and indoor smoking restrictions, also contribute to postponing onset. EU membership, measured through mandatory adoption of the Tobacco Products Directive, has a positive effect on delaying initiation. However, social factors remain dominant: peer behaviour is the strongest predictor of early smoking, followed by parental smoking behaviour. Gender differences were observed, with girls initiating later than boys. These results underscore the need for comprehensive strategies combining fiscal and regulatory measures with interventions targeting the social drivers of youth smoking.

Keywords: Youth smoking initiation, cigarette prices, tobacco control, peer behaviour, survival analysis

JEL classification: I12, I18, C41

CONTENTS

TABLES AND FIGURES

1. Introduction

Interventions to prevent tobacco use among young people require careful planning and an approach that takes into account the broader social, cultural and economic context while also addressing the specific characteristics of this population group. In modern society, where the rapid flow of information, digital media and the global connectivity of young people enable a rapid exchange of trends, attitudes and behaviours, the risk of tobacco use is growing. Such an environment can lead young people to be directly or indirectly exposed to advertising content, increasing the likelihood of early initiation of tobacco use. Well-designed prevention strategies that successfully delay the onset of smoking among youth can have a long-term and far-reaching impact on public health. A regional approach is essential, as neighbouring countries share similar cultural patterns, economic challenges and legal frameworks, allowing for the exchange of best practices as well as action. Indeed, actions that are coordinated and supported at the regional level can significantly contribute to reducing nicotine use among young people, delaying the development of dependence and consequently reducing the prevalence of smoking in the adult population in the future.

This study builds on the existing literature on smoking initiation while focusing on youth in 10 selected countries. The results of this study can contribute to gaining a deeper understanding of youth smoking behaviour in Central, Eastern and South-Eastern Europe (CESEE) and provide valuable insights for policy makers and public health organisations in their efforts to formulate effective strategies to address the tobacco epidemic in the region. The evidence-based policy recommendations can improve the development of new policy documents, highlighting the positive impact of both pricing and non-pricing tobacco control measures as well as fostering their implementation and harmonisation with European Union (EU) legislation.

The *Literature Review* section provides a comprehensive overview of existing research on youth smoking initiation (both nationally and regionally), analysing price and non-price interventions and their impact on youth smoking prevalence and initiation. The *Data and Methodology* section is divided into two subsections: *Data* (inputs to the study) and *Methodology* (a theoretical approach to survival analysis). An overview of youth smoking behaviour in the CESEE countries can be found in section *Regional Context: Youth and Smoking in CESEE Europe*. The section *Tobacco Control Environment* provides a brief overview of current tobacco control policies. The results are presented in the *Quantitative and Qualitative Insights*. Finally, the *Conclusions* section summarises the key findings on youth smoking initiation in the region, while the *Policy Recommendations and Key Messages* section provide evidence-based policy suggestions suitable for advocacy and inclusion in national strategic documents.

2. Literature review

Youth smoking initiation remains a major public health concern due to the early onset of nicotine dependence and its long-term consequences. Nicotine addiction is the key driver behind continued tobacco use and contributes to the burden of chronic diseases later in life (USDHHS 2012). Studies show that symptoms of nicotine dependence can occur soon after the first few smoking experiences, even before regular or daily use begins (DiFranza et al. 2000; DiFranza et al. 2007; Gervais et al. 2006). Adolescents who start smoking early are more likely to become long-term smokers in adulthood, underlining the need for timely prevention measures (Chassin et al. 1990).

The effectiveness of tobacco control strategies also depends on the characteristics of youth behaviour. Previous research has shown that young people respond differently to tobacco control measures (especially price and tax increases) than adults (Chaloupka and Pacula 2001; IARC 2011). Such tailored approaches are crucial for reducing youth tobacco use and smoking initiation as well as for improving public health in general. Understanding youth behaviour and the determinants that shape it is important not only to reduce tobacco consumption among youth but also to prevent the initiation of tobacco use (USDHHS 2012). Chaloupka and Pacula (2001) examined the impact of price on reducing cigarette consumption among adolescents. The results show that adolescents are more sensitive to price changes than adults due to their lower disposable income, weaker addictive behaviour, and higher sensitivity to peer influence. They point out that the long-term effects of cigarette price increases are even larger because price-sensitive behaviour accumulates over time. These findings are consistent with the conclusions presented in the IARC Handbook on Cancer Prevention (IARC 2011; Chapter 6) that macro-level policies which increase the cost of tobacco consumption are effective tools for reducing the youth smoking prevalence (e.g. tax measures combined with consistent implementation of other tobacco control policies).

There are studies in the literature that estimate the determinants of smoking initiation in adolescents at the national level. Such studies can contribute significantly to understanding the specific behaviours of young smokers, how their decision to start smoking may be influenced, and how tobacco taxation policy can impact smoking prevalence and initiation.

The authors of most national studies in low- and middle-income countries investigating the effects of price and non-price policies and other factors on smoking prevalence and initiation among youth aged 13-15 have used comparable methodological approaches relying on survival analysis techniques. Merkaj et al. (2022) find that cigarette price is a significant predictor of smoking initiation among youth in Albania, while non-price tobacco control policies also play an important role in reducing initiation. Their results suggest that further increases in excise taxes could lead to a greater decline in smoking rates among adolescents. Mugoša et al. (2023) confirm that the indirect effect of price on smoking initiation in Montenegro (operating through various demographic factors) is more pronounced than the direct price effect, indicating that price influences variables such as peer and parental behaviour. Using the same methodology, Gligorić et al. (2024) show that there is a negative relationship between cigarette prices and smoking initiation among youth in Bosnia and Herzegovina. Jovanović and Zubović (2024) find that

higher cigarette prices significantly reduce the probability of smoking initiation among students in Serbia. Moreover, non-price measures, such as awareness campaigns and access restrictions, are also effective. Jovanović et al. (2023) show that cigarette prices primarily affect adolescents' smoking behaviour in North Macedonia through indirect mechanisms, such as influence from peers and parents. In addition to these social factors, smoking initiation is also shaped by personal characteristics and broader societal trends. Those country-specific studies contribute to the existing literature on

Despite the works cited above, studies of this kind are scarce in Eastern Europe and in most low- and middle-income countries. This is also the case at the regional level. Schnohr et al. (2008) used the Health Behavior in School-aged Children (HBSC) studies and national-level data to examine how contextual factors influence daily smoking among adolescents in 27 European countries. Since national policies are among the factors influencing smoking behaviour, the authors decided to include three of them in the analysis: (i) prices (and national tobacco taxes), (ii) the age limit to purchase tobacco products, and (iii) smoking bans in schools. Their results confirm the association between the three mandatory bans and the risk of daily smoking, but they also call for a more detailed analysis of voluntary bans to obtain more robust results. Kostova et al. (2010) used data on 349,930 adolescents (mean age 14 years) from 20 low- and middle-income countries obtained from GYTS data between 1999 and 2006. They found that price was an important determinant of both prevalence and intensity of smoking, but they did not analyse smoking initiation.

At the same time, regional studies examining the determinants of smoking initiation among adolescents are even rarer than those looking at the prevalence of smoking. Oh et al. (2010) estimate the determinants of smoking initiation among young women in five European countries (mean age 18 years) and conclude that friends are the most important factor in smoking initiation. Veeranki et al. (2017) identified correlates with the age of smoking initiation among adolescents in Africa and concluded that exposure to parental/peer smoking and industry advertising significantly increase the risk of early smoking initiation among adolescents.

Overall, the findings of the small but growing number of studies from low- and middle-income countries are consistent with studies conducted in high-income countries: price has a negative effect on tobacco use among young people, while the influence on smoking initiation may be a direct or indirect (mostly through peer or parental influence) factor. As youth smoking rates in South-Eastern Europe remain alarmingly high and policies are often inconsistent, there is growing interest in understanding the determinants of smoking initiation across specific regions (Nadasan et al. 2016). This study uses a survival analysis approach to fill this gap by examining the determinants of smoking initiation among adolescents aged 13-15 years in both EU and non-EU countries while also identifying similarities/differences between countries with a common historical and geographical background and accounting for contextual factors.

3. Data and methodology

3.1. DATA

Large-scale survey datasets – and especially those collected through complex survey designs, such as the Global Youth Tobacco Survey (GYTS), the Health Behaviour in School-aged Children (HBSC) survey, the European School Survey Project on Alcohol and Other Drugs (ESPAD) survey, and the Youth Risk Behavior Surveillance System (YRBSS) survey – are a valuable resource for researchers studying youth health behaviours. These datasets allow for the analysis of heterogeneity at the individual level as well as behavioural patterns over time. However, outcome measures in such studies are often categorical (e.g. whether a respondent has ever smoked), which can pose a challenge in econometric modelling. Thanks to improved statistical methods and data processing, researchers can now use techniques like duration or survival analysis to better understand when events of interest (e.g. smoking initiation) occur and what factors influence their timing.

In this regional study, survival analysis was used to examine the determinants and timing of smoking initiation among adolescents aged 13-15 years in selected CESEE countries. We used datasets from the GYTS, which employs a globally standardised methodology that includes a two-stage sampling design in which schools are selected with probability proportional to the number of students. Classes within the selected schools are randomly selected. All students in the selected classes are eligible to participate in the survey. The sample includes young people aged 13-15 and covers both EU and non-EU countries in the study. The GYTS datasets are public and can be used by third parties. They follow the same methodology in all countries and are therefore best suited for this study. To ensure comparability, only countries and GYTS waves with complete information relevant to our analysis were included.[1] Because Serbia has one of the highest prevalence rates of smoking in Europe, an increasing prevalence among adolescents, and an increasing use of new tobacco and nicotine products (Vladisavljević et al. 2023; IOPHOS 2024), the need for a comprehensive regional study becomes clear. Rather than being unique to Serbia, high smoking rates among adolescents are a general problem in the Western Balkans, where early initiation and social acceptance of tobacco use remain widespread.

In order to understand patterns of tobacco use among youth in Serbia and other countries in the region, the broader regional context must be taken into account, especially given the historical, cultural and socio-political similarities with neighbouring countries. The rationale of this study is to identify similarities and differences in youth tobacco use and the impact of legal frameworks and determinants in countries with a common historical heritage and geographical location. These findings are essential for the development of effective and evidence-based tobacco control strategies. Therefore, in addition to Serbia, the study also includes Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Hungary, Montenegro, North Macedonia and Romania. Slovenia is also included due to its common historical background as a former republic of the Socialist Federal Republic of Yugoslavia (SFRY). This country selection allows for a unique regional analysis of youth smoking initiation and provides a valuable basis for increased regional cooperation in tobacco control. As Serbia is not a member of the EU, like several other neighbouring countries, the regional analysis is also based on EU membership. The process of country selection selects five EU

[1] The data cleaning process can be found in Appendix C.

member countries (Bulgaria, Croatia, Hungary, Romania and Slovenia) and five non-EU member countries (Albania, Bosnia and Herzegovina, Montenegro, North Macedonia and Serbia).

After selecting the countries, the next step was to select variables. Although the GYTS surveys were conducted using a standardised methodology, each country had the option to adapt the questionnaire to its specific needs. As a result, certain variables were not available in all survey waves for all countries. This led to the selection of variables that were comparable across countries and present in all GYTS datasets. The final dataset for this study has more than 120,000 individual records with harmonised variables for all survey waves and countries. All data were cleaned and restructured to allow modelling of time to event, with the outcome of interest being the age at which smoking started.

Table 1 presents the timeline of the GYTS conducted across selected countries included in this study, divided into EU and non-EU member states. The survey was conducted in multiple waves (I–IV) from the early 2000s. In non-EU countries, the GYTS was conducted with wider time gaps between survey waves. Bosnia and Herzegovina has the highest number of conducted waves due to country-specific context, while the latest data available for Serbia are from 2017. In EU countries, the GYTS was conducted more often. Croatia, Romania and Slovenia conducted four waves at relatively regular intervals, while Hungary completed only two waves with no available data beyond 2008. This distribution of survey waves reflects differences in monitoring the continuity of youth tobacco use, potentially indicating varying institutional capacities, public health priorities, and levels of support for international research frameworks.

Table 1 / GYTS databases included in the analysis, by country

Country/Waves	I	II	III	IV
Non-EU countries				
Albania	2004	2009	2015	
Bosnia and Herzegovina	2003	2008	2013	2018 2019
North Macedonia	2003	2008	2016	
Montenegro	2004	2008	2014	2018
Serbia		2008	2013	2017
EU countries				
Croatia	2003	2007	2011	2016
Romania	2004	2009	2013	2017
Bulgaria	2002	2008	2015	
Slovenia	2003	2007	2011	2017
Hungary	2003	2008		

Source: authors' calculations

Table 2 presents the number of surveyed students per wave. While the sample sizes vary across countries and waves, most national surveys included between 2,000 and 4,500 students, with Bosnia and Herzegovina reporting the highest participation – over 9,000 students in Wave III.[2]

Table 3 shows the number of GYTS respondents aged 13-15 across the survey years in five non-EU countries. The largest share is made up of 14-year-old students, especially in Bosnia and Herzegovina

[2] One possible explanation for the large sample sizes in Bosnia and Herzegovina lies in the country's administrative structure. Due to the decentralised government system, in which education is the responsibility of several entities and cantons, parallel sampling in several sub-national regions may have been necessary when surveying in order to ensure representativeness. This often leads to larger overall samples, as each administrative unit is treated as a separate sampling frame.

and Serbia. The structure of the sample in Albania fluctuated. Montenegro and North Macedonia have a more balanced age distribution.

Table 2 / GYTS databases included in the analysis, by the number of respondents, unweighted

Country/Waves	I	II	III	IV
Non-EU countries				
Albania	2,954	3,452	3,251	
Bosnia and Herzegovina	6,263	8,658	9,422	3,971 3,791
North Macedonia	2,669	3,950	4,498	
Montenegro	1,267	3,118	3,412	3,627
Serbia		2,976	2,922	3,197
EU countries				
Croatia	3,083	3,381	3,416	2,806
Romania	2,403	2,843	3,074	4,015
Bulgaria	1,629	3,062	3,306	
Slovenia	3,666	2,409	1,365	1,910
Hungary	3,098	2,903		

Source: authors' calculations

Table 3 / The structure of the respondents in the non-EU countries, by age*

Year/Age	13	14	15
Albania			
2004	1,123	1,015	816
2009	415	1,420	1,617
2015	1,026	1,136	1,089
Total	2,564	3,571	3,522
Bosnia and Herzegovina			
2003	1,776	2,277	2,210
2008	2,734	3,353	2,571
2013	3,431	3,474	2,517
2018	640	1,691	1,640
2019	735	1,359	1,697
Total	9,316	12,154	10,635
Montenegro			
2004	619	514	134
2008	1,188	1,068	862
2014	798	1,084	1,530
2018	948	1,160	1,519
Total	3,553	3,826	4,045
North Macedonia			
2003	1,314	901	454
2008	1,468	1,396	1,086
2016	1,361	1,708	1,429
Total	4,143	4,005	2,969
Serbia			
2008	552	1,385	1,039
2013	574	939	1,409
2017	841	1,112	1,244
Total	1,967	3,436	3,692

Note: *unweighted; n=73,398.
Source: authors' calculations

Table 4 shows the age distributions of GYTS respondents across five EU countries. A notable finding is the dominance of 14-year-olds in total numbers, particularly in Romania and Croatia, which recorded over 5,000 and 4,600 respondents in that age group, respectively. While Croatia maintains relatively balanced sampling across all ages and years, Romania shows a sharp age disparity, with 15-year-olds sharply underrepresented in 2013 and 2017. Slovenia, on the other hand, presents an inverse pattern: the highest number of respondents were 15-year-olds, with a consistent drop in younger age groups over time. Hungary, despite conducting only two waves, maintains a stable distribution.

Table 4 / The structure of the respondents in the EU countries, by age*

Year/Age	13	14	15
Bulgaria			
2002	472	640	517
2008	706	1,216	1,140
2015	748	1,259	1,299
Total	1,926	3,115	2,956
Croatia			
2003	1,283	1,198	602
2007	1,045	1,154	1,182
2011	1,010	1,281	1,125
2016	843	969	994
Total	4,181	4,602	3,903
Hungary			
2003	1,002	1,192	904
2008	805	1,184	914
Total	1,807	2,376	1,818
Romania			
2004	321	996	1,086
2009	1,170	1,088	576
2013	1,552	1,366	156
2017	1,631	1,669	715
Total	4,674	5,119	2,533
Slovenia			
2003	974	1,224	1,468
2007	493	898	1,018
2011	276	501	588
2017	446	748	716
Total	2,189	3,371	3,790

Note: *unweighted; n=48,360
Source: authors' calculations

Table A1 (Appendix A) shows the gender breakdown of the sample used in this survey. The data shows a slight dominance of female respondents among students aged 13-15 in both the EU and non-EU countries included in the study. On average, girls made up 51.8% of respondents in non-EU countries and 52.7% in EU member states. While the gender distribution is generally balanced, Albania stands out with the highest proportion of female respondents (54.1%), closely followed by Bulgaria and Slovenia (53.6% and 53.1%, respectively). The difference is minimal in North Macedonia. Detailed information on the structure of the sample by gender, age and country is provided in Table A2 (Appendix A).

In the sample, respondents in the non-EU countries are slightly older on average at the time of the interview than those in the EU countries (14.1 and 13.9 years, respectively). Among the countries, Serbia and Bulgaria have the highest average age (14.2 years), while Romania has the lowest (13.8 years). The

standard deviation (SD) values are relatively low and similar in all countries (0.75-0.80), suggesting that the age distribution is narrow and centred around the target age, thereby ensuring sample comparability. Overall, the data confirm that the survey has successfully captured the target age group of young people, with the samples being comparable across all countries. The data is shown in Table 5.

Table 5 / The average age of respondents at the time of the interview

Country	Average Age	Standard Deviation
Overall	**14**	**0.78236**
Non-EU	**14.1**	**0.78604**
Albania	14.1	0.77468
Bosnia and Herzegovina	14.1	0.80217
Montenegro	13.9	0.77929
North Macedonia	13.9	0.79631
Serbia	14.2	0.74924
EU	**13.9**	**0.77928**
Bulgaria	14.2	0.77415
Croatia	14	0.79792
Hungary	14.1	0.80118
Romania	13.8	0.75128
Slovenia	14.1	0.77379

Note: n=121,758
Source: authors' calculations

3.2. METHODOLOGY

The survival methodology enables us to distinguish between respondents who have already started smoking and those who have not, taking into account the exact timing of this behavioural transition. Two main approaches to modelling youth smoking initiation are often used in the literature, especially when one wants to assess the role of taxes on youth smoking initiation and the impact of non-price policies. The first approach is known as *discrete choice models* and treats the initiation of smoking as a binary outcome (i.e. whether smoking occurred or not) without considering the timing. These models are limited because they do not capture the duration until the first cigarette and usually exclude adolescents who had not yet started smoking at the time of the survey. The second approach is *survival models (or duration models),* which take into account the time of initiation. These models consider the fact that a significant number of adolescents may never start smoking during the observation period. The greatest strength of this approach is that it handles right-censored data[3] properly and allows for the inclusion of individuals who are at risk of starting to smoke but have not yet done so.

We start our analysis by estimating non-parametric functions, using Kaplan-Meier and Nelson-Aalen estimators, to examine the shape of the hazard and survivor curves. Based on the observed patterns and model fit (exponential, Weibull, Log-Normal, Log-Logistic), we then proceed with the Weibull parametric model, which offers flexibility in capturing increasing or decreasing hazard rates over time and is commonly used in studies of smoking behaviour. The Weibull hazard function is a key tool in

[3] Right-censored data refer to individuals for whom the event of interest (e.g. starting to smoke) has not occurred by the end of the observation period. We only know that it has not occurred up to a certain point in time, but we do not know whether or when it might occur later. The inclusion of such data in the survival analysis is essential, as their exclusion can distort the results.

survival analysis because it allows the modelling of a wide range of hazard rate patterns, unlike simpler models, such as the exponential distribution, which only assumes a constant hazard.

The formula for the hazard function of the Weibull distribution is as follows (Kleinbaum and Klein 2012):

$$h(t) = \lambda p t^{p-1}$$

where *h(t)* is the hazard function, *λ* is the scale parameter in the Weibull distribution, and *p* is the shape parameter in the Weibull distribution.

In parametric survival models like the Weibull one, the scale parameter is typically reparameterised as a function of individual characteristics. Rather than assuming a constant hazard across individuals, the model allows the hazard rate to vary by expressing the scale parameter λ as an exponential function of a linear combination of covariates. Specifically, this is written as:

$$\lambda_i = exp^{-x_{i\beta}}$$

where x_i denotes the vector of observed characteristics for individual i and β represents the vector of estimated coefficients.

This allows the model to estimate how each factor accelerates or delays the timing of smoking initiation. In the accelerated failure time (AFT) model context, a positive coefficient indicates a delay in initiation (i.e. longer survival time), while a negative coefficient indicates earlier onset. The delay in smoking onset is calculated in number of months after the risk age.[4] According to the Weibull AFT, the regression coefficients refer to proportional changes in survival time for a unit change in a particular regressor with all other characteristics (Jenkins 2005).

As mentioned previously, an increment in smoking onset suggests a delay in the age at which an individual starts smoking. The delay is calculated in 'months after the risk age of 10', which is the (dependent) time variable in the model.

The main variables involved in estimating the timing and determinants of smoking initiation in this study are the following: cigarette price in international dollars (adjusted for purchasing power parity), non-price tobacco control measures (i.e. the number of non-price tobacco control measures implemented in the country), parental smoking behaviour (with the influence being measured separately for mother, father or both parents), and peer influence (measured by whether the respondent would smoke if their best friend offered them tobacco). Risk perception is estimated by a variable indicating whether the respondent

[4] The 'risk age' of 10 years is a threshold frequently used in tobacco research to mark the point at which children are first considered at risk of starting to smoke. It reflects the minimum age at which meaningful differences in smoking initiation can be seen in the survey data. Although some individuals may start smoking even earlier, the use of age 10 provides a standardised baseline for calculating the time to event in survival models. In our study, for example, the estimated mean survival time is 12.6 years. This means that the average delay in smoking onset is 2.6 years after the age at risk of 10 years (i.e. about 31 months). This interpretation provides a clearer understanding of how covariates influence the timing of smoking initiation.
In the Weibull AFT model, the coefficients represent the (log) time relationship. For example, if the coefficient for the variable 'female' is 0.065, the time ratio is exp(0.065) ≈ 1.067. This means that, holding the other variables constant, girls start smoking about 6.7% later than boys, indicating a delayed onset.

considers smoking to be harmful. Gender-, time- and country-fixed effects are included in the analysis as well.

Parental smoking behaviour is estimated using the GYTS questions: 'How often do you see your father (stepfather or mother's partner) smoking in your home?' or 'How often do you see your mother (stepmother or father's partner) smoking in your home?'. We found that these questions best reflect the parental influence on smoking initiation, as opposed to the question 'Do your parents (caregivers) smoke?', which is not included in all GYTS databases.

Since we do not have the question '*Does one of your closest friends smoke cigarettes?'* in all GYTS databases for selected CESEE countries, we used the question '*Does your best friend offer you tobacco*?' as the best approach to estimate the peer effect. Since the literature suggests that this variable may be endogenous, we applied the Wald test for exogeneity, which shows that the null hypothesis of no endogeneity is rejected at the usual statistical significance level (Table A4). The peer effect in the probit model is positive and smaller, but the coefficients between the split-population model and the probit model are not directly comparable. Since the peer variable is an important predictor of smoking initiation, we include it in the final models, but due to endogeneity issues, the magnitude of the effect should be interpreted with some caution (Jovanovic et al. 2023).

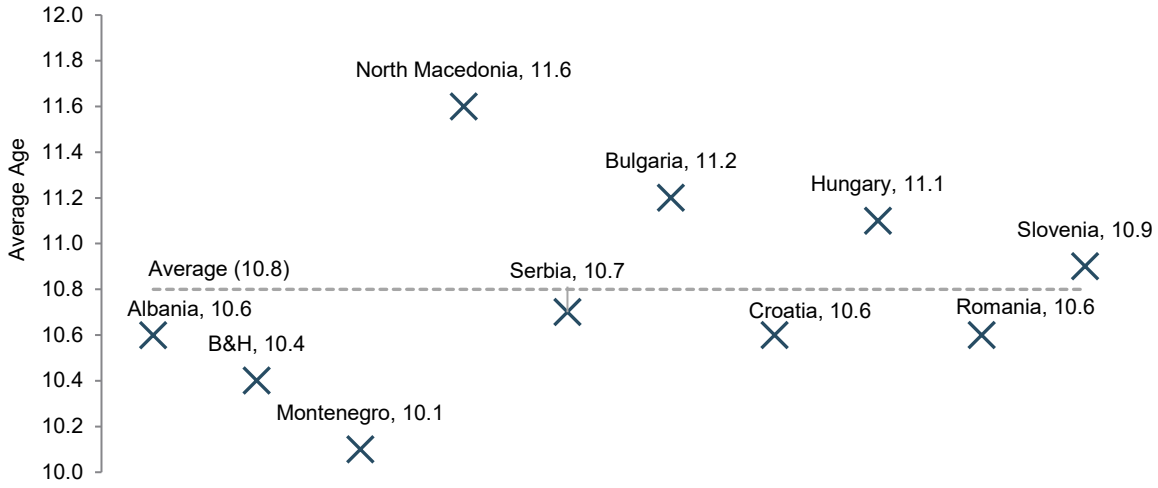
In order to estimate the effects of respondents' perception regarding the dangers of tobacco use, we used the variable (identical in all databases): '*Do you think that tobacco is harmful to your health?*'. As this variable can be potentially endogenous, we applied the Wald test (Table A5). As before, since this is a significant factor in smoking initiation, we included it in the final model. However, due to endogeneity issues, the effects should again be interpreted with caution (Jovanovic and Zubovic 2024).

The limited number of studies that have been conducted to examine the decision to start smoking among adolescents does not provide definitive and unequivocal evidence of the impact of tobacco taxation on smoking initiation. More consistent results are available for smoking prevalence and intensity, while results for smoking initiation show mixed results (IARC 2011). The distinction between the strong direct effect of cigarette prices on smoking initiation versus indirect price effects acting through parental smoking status or peer influence is important in the analysis to provide evidence-based results for tobacco control policy recommendations. In this study, all significant variables are included to estimate the strength of price in selected CESEE countries.

4. Regional context: youth and smoking in CESEE

Figure 1 shows the average age at which an adolescent tried cigarettes for the first time. Overall, the average age is 10.8 years. The data shows that students in Montenegro tried smoking very early, at an average age of 10.1 years – the lowest age among all countries surveyed. Serbia is close to the overall average, while young people in North Macedonia try their first cigarette at almost 12 years – the highest age in the region. Except for North Macedonia, all other non-EU countries are below the overall average in the sample, suggesting that young people in these countries tend to start smoking earlier than their peers in the EU. The rationale for this difference in youth behaviour may lie in several factors. EU countries implement stricter tobacco control policies, conduct more effective public health campaigns raising awareness about the risks of tobacco use, and generally have a higher socioeconomic status. In contrast, non-EU countries often exhibit weaker enforcement of tobacco regulations, lower public health investment, and greater availability and affordability of tobacco products, all of which may contribute to earlier smoking initiation among youth in these countries (Zubović et al. 2023).

Figure 1 / The average age of the respondents when they first tried cigarettes, by country



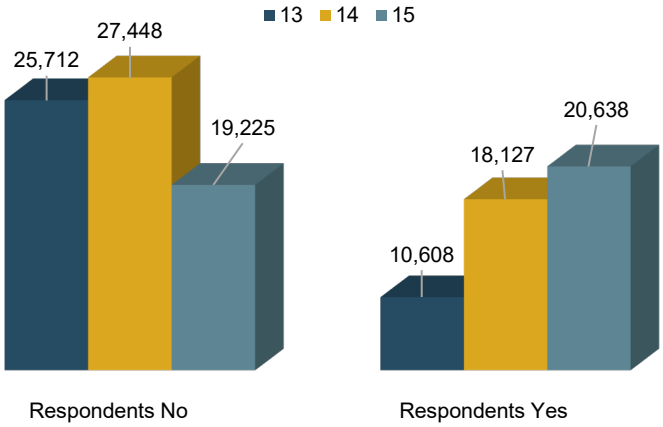
Note: n=49,399
Source: authors' calculations

Important indicators in our survival analysis are the number of adolescents who have tried cigarettes and the number of those who have smoked during the 30-day period before the survey. According to the literature (Willard and Schoenborn 1995; NSDUH 2014; Goodwin et al. 2017), current smokers are those who have consumed at least one cigarette in the last 30 days, whereby a distinction is made between active smokers and social (non-)smokers (Shiffman et al. 2015).[5] The combined consideration of these two indicators provides information about the behavioural characteristics of young smokers. Among

[5] Active smokers are individuals who smoke cigarettes or other tobacco products regularly, typically on a daily basis. Social smokers, on the other hand, are those who smoke primarily or exclusively in social situations, often only when they are with others who are smoking, and they may not consider themselves to be regular smokers.

them, some only have a cigarette once out of curiosity and then never again; some smoke only on special occasions; and some are already 'nicotine addicts' and have smoked in the last 30 days. Considering the age of 13-15 years, it is clear that these are sensitive age categories that should be systematically monitored, which can sometimes seem very complicated in a specific systemic and institutional framework.

Figure 2 / The number of respondents from the sample who had tried cigarettes



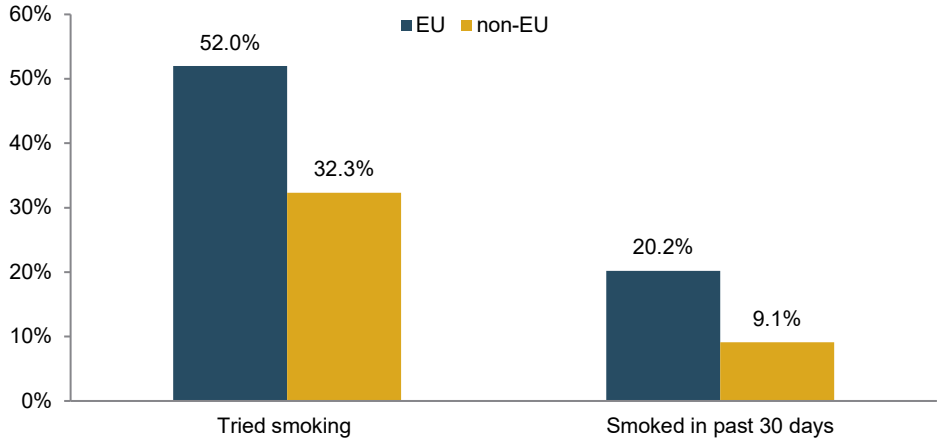
Note: n=121,758
Source: authors' calculations

Our analysis shows a very significant difference between the value of the indicator (absolute and percentage) for 'tried cigarettes' and the indicator for current smoking status. Figure 2 shows a comparative overview of the number of respondents who answered 'yes' to the question '*Have you ever tried cigarettes at least once in your lifetime?'.* This question was the same in all observed GYTS databases, so it was retained in the analysis. The older the respondents, the greater the number of those who have tried cigarettes. However, looking at the percentages shown in Figure 3, one sees that the proportion of those who have tried cigarettes is significantly higher in EU countries than in non-EU countries. In addition, the results shown in Figure 4 provide an opportunity to analyse this indicator by country. In all non-EU countries in the sample, the share of young people who have tried cigarettes is lower than in the EU countries. The reason for this may lie in the social and cultural acceptance of smoking as a lifestyle choice (Bulgaria and Croatia are countries with the highest prevalence in EU) as well as possible underreporting in non-EU countries due to more conservative family environments. The number is lowest in North Macedonia, which complements the high average age at which young Macedonians try their first cigarette.

Figure 3 clearly shows that young people in the EU countries try their first cigarette at a later age, which may indicate the positive impact of parental influence (e.g. having non-smoking parents) and/or of educational programmes implemented in schools in accordance with national strategies. However, the indicator in Figure 3, which shows the percentage of 13- to 15-year-olds who have tried a cigarette, is significantly higher in these countries. Thus, although they are trying cigarettes later, the percentage of those who have tried smoking is higher in the EU countries than in the non-EU ones. At the same time, even though the tried-smoking percentage is very high (52%), the value of the variable measuring smoking

in the last 30 days is significantly lower (20.2%), which shows that although many young people in the EU countries have tried cigarettes, only a small proportion of them can be considered current smokers.

Figure 3 / Percentages of respondents who have tried cigarettes and smoked cigarettes in the last 30 days

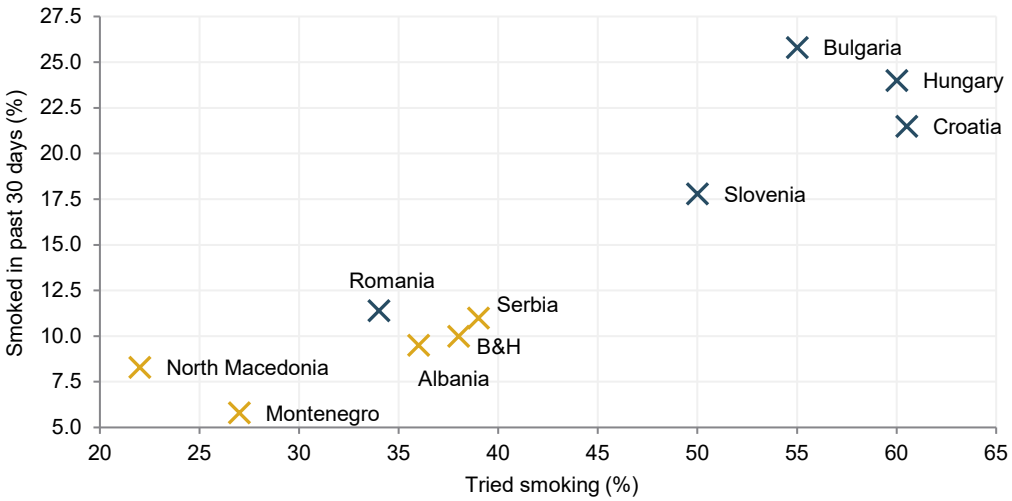


Note: n=121,758
Source: authors' calculations

In non-EU countries, on the other hand, this difference is even more pronounced: although 32.3% of young people stated that they had tried cigarettes at least once in their lives, only 9.1% of young people had smoked at least one cigarette in the last 30 days. Nevertheless, the adult prevalence in the non-EU countries is higher overall, which means later onset.

Figure 4 provides an overview of the countries surveyed. Bulgaria, Hungary and Romania stand out among them, as the values for both indicators are significantly high.

Figure 4 / Smoking behaviour among youth in non-EU and EU countries



Note: n=121,758
Source: authors' calculations

5. Tobacco control environment

The tobacco control framework in the CESEE countries varies considerably between countries, primarily due to the degree of implementation of EU legislation. In addition, the differences may reflect different levels of economic development, political environments, health inequalities and health policies. All 10 countries in this study have ratified the Framework Convention on Tobacco Control (FCTC) of the World Health Organization (WHO), but the degree of implementation of its policy components varies significantly.

In the selected EU countries, most tobacco control measures (e.g. taxation policies, smoke-free laws and advertising bans) were introduced between 2002 and 2010, even before the ratification of the WHO FCTC. Slovenia and Hungary ratified the WHO FCTC in 2005, Bulgaria and Romania in 2006, and Croatia in 2008. The Bulgarian Health Act of 2004 is the main law regulating the health system in **Bulgaria**. Since the Act emphasises the protection of citizens' health as a national priority, it includes provisions for tobacco control, with a focus on promoting health and preventing tobacco-related harm. The Act outlines regulations regarding smoking in public and in workplaces, advertising and promoting tobacco products, and funding for tobacco control programmes. The Excise Duties and Tax Warehouses Act was originally adopted in 2005, and it was later amended multiple times to align with EU directives and to introduce stricter controls on excisable goods, including tobacco products. In **Romania**, the Law on Preventing and Combating the Effects of Tobacco Product Consumption (Law No. 349/2002) prohibits smoking in enclosed public spaces, workplaces and public transportation in addition to restricting the sale of tobacco products to individuals under 18 and regulating the content and labelling of tobacco products. In **Slovenia**, the first Restriction of the Use of Tobacco Products Act was adopted in 1996; at the time, it was one of the most advanced laws in the field of tobacco control in Europe (Koprivnikar et al. 2021). In 2008, the same year it ratified the WHO FCTC, **Croatia** adopted the Law on the Restriction of the Use of Tobacco Products, which defines a smoke-free policy for enclosed public spaces (with exceptions for special areas), restricts advertising, and establishes health warnings on packaging. In **Hungary**, Act XLII of 1999 laid the groundwork for smoke-free environments, but Act CXXXIV of 2012 (on Reducing Smoking Prevalence Among Young People and on the Retail of Tobacco Products), which introduced a full retail monopoly on tobacco, is also very important.

As for the selected non-EU countries, Albania, Serbia and North Macedonia became parties to the WHO FCTC in 2006, Montenegro a year later, and Bosnia and Herzegovina two years later. **Albania** enacted a comprehensive anti-tobacco law through Law No. 9636/2006 (on the Protection of Health from Tobacco Products), which introduced a ban on smoking in public places and on all forms of tobacco advertising. Despite this, effective enforcement has remained a persistent challenge due to limited institutional capacity and monitoring mechanisms (Rama et al. 2019). **Serbia** adopted the Law on the Protection of the Population from Exposure to Tobacco Smoke (Official Gazette No. 30/2010), which regulates where smoking is permitted and where it is not, while the Advertising Law (Official Gazette No. 79/2005) restricts and regulates the advertising of tobacco products to protect public health. **North Macedonia** adopted its core tobacco control measures with the Law on Restriction of Smoking (Official Gazette No. 36/2005), which banned smoking in most public indoor spaces and introduced restrictions on advertising. This legislation has been followed by the Law on Tobacco, Tobacco Products

and Related Products (2019), which aligns the national framework more closely with FCTC recommendations on product packaging, labelling, and the regulation of novel tobacco products. **Montenegro** introduced its foundational tobacco control regulation with the Law on the Restriction of the Use of Tobacco Products (Official Gazette No. 52/2004), which established smoke-free environments and banned tobacco advertising in most media. The law has been amended several times, as many others among EU and non-EU countries, in order to strengthen implementation of the tobacco control measures. **Bosnia and Herzegovina**'s tobacco control efforts are fragmented due to its complex constitutional structure. The Federation of Bosnia and Herzegovina adopted a tobacco control law in 2004, with smoke-free provisions and advertising restrictions, while Republika Srpska and Brčko District implemented separate legal instruments.

In all observed countries, there is a policy prohibiting the sale of tobacco products to minors. Despite several of the most important legal acts mentioned above, many non-EU countries are still facing problems, such as indirect advertising at the point of sale and illegal selling to minors (e.g. selling without age verification).

Tobacco taxation remains one of the most powerful instruments to reduce smoking prevalence. Owing to Council Directive 2011/64/EU (the Tobacco Tax Directive), EU countries operate under a harmonised floor for both specific and ad valorem excise duties: EUR 90 per 1,000 cigarettes and at least 60 % of the weighted average price (WAP). The non-EU countries have country-specific tax architectures, resulting in wider variation in retail prices and tobacco affordability (Drope et al. 2024).

Appendix B of this study presents an overview of tobacco control policies in the 10 observed countries categorised by factors such as: the smoke-free status of indoor public places, workplaces and public transport; the smoke-free status of outdoor places; selling to minors; and tobacco taxation policy.

6. Quantitative and qualitative insights

In our analysis, we used a model to account for heterogeneity between individuals and to capture how various factors (e.g. gender, parental smoking, perceived harm and cigarette prices) influence the timing of smoking initiation. In our study, based on the variables selected to estimate the determinants of smoking initiation, we can write the scale parameter for the Weibull model as follows:

$$\lambda_i = \exp(-\beta o - \beta 1 * price_i - \beta 2 * policy - \beta 3 * parents_i - \beta 4 * friend_i - B5 * harm_i - \beta 6 * male)$$

The main variables used to estimate the timing and determinants of smoking initiation are as follows: price, policy (number of effective non-price policies), parents (parental influence), friend (peer effect) and harm (perception that smoking is harmful). Gender, as well as time- and country-fixed effects, are also included in the analysis, whose results are presented in Table A3.

Our analysis of youth smoking initiation begins with a binary indicator of whether smoking was initiated and is complemented by a duration variable that measures the time until smoking initiation. This indicator is basic and serves as a foundation for duration analysis. Table 6 shows that 40.6% reported having tried smoking (*eversmoker*). Given the young age range in the sample, this data is concerning from a public health perspective and underlines the importance of early preventive interventions.

Table 6 / Youth who have ever tried smoking

ever smoker	Frequency	Percent	Cumulative
no	72,359	59.44	59.44
yes	49,373	40.56	100.00
	121,732	100.00	

Source: authors' calculations

On average, the duration of non-smoking (i.e. the time before starting to smoke) is about 10.7 years, while the median survival time is 12 years, which means that half of the sample had been non-smokers for at least that long. The observed range is from ≤ 7 years (earliest reported age) to 14-15 years (latest reported age). The percentile values indicate an early start, as 10% of respondents stated that they had smoked their first cigarette by the age of seven. By the age of eight, a quarter of smokers had already started smoking, while the median age of initiation is 12, which means that half of the sample started smoking before reaching this age. At the upper end of the scale, the results show that very few start smoking after the age of 14.

For the survival analysis, the time variable *starting* was defined as the duration (in years) until the start of smoking, while the event indicator records whether initiation had occurred. The observation period extends from the starting point (t = 0) up to a maximum of 15 years. Individuals who had not started smoking by the end of the observation period were treated as right-censored. The total person-time

accumulated over all observations exceeds 1.5 million years[6] and provides a solid basis for estimating the time and probability of smoking initiation in adolescence (Table 7).

Table 7 / Survival data setup overview

obs. time interval: (o, starting)		
exit on or before: failure		
121,732	total observations	
0	Exclusion	
121,732	observations remaining, representing	
49,373	failures in single-record/single-failure data	
1,536,946	total analysis time at risk and under observation	
	at risk from t =	0
	earliest observation entry t =	0
	last observed exit t =	15

Source: authors' calculations

Summarising the survival data gives a total of 1,536,946 person-years at risk, cumulated over 121,732 people. The incidence rate of smoking onset is 0.032, which means an average of 3.2 smoking onsets per 100 person-years.[7] The 25th percentile of survival time is 12 years, which means that 25% of respondents started smoking at this age. The median (50%) and upper quartile (75%) survival times are not reported in this summary, probably due to the high proportion of censored observations (i.e. those who had not started smoking by the end of follow-up).

Table 8 / Survival analysis summary

failure_d: start; analysis time_t: starting

				survival time		
	time at risk	**incidence rate**	**no. of subjects**	25%	50%	75%
total	1,536,946	0.0321241	121,732	12	.	.

Source: authors' calculations

In order to prepare the data set for the survival analysis, key components (e.g. *entry time*, *exit time* and the *failure event*) must be defined. In our case, all respondents entered the risk group at time 0. The average exit time (i.e. the time at which the event smoking onset occurs) was about 12.6 years. In other

[6] The total number of 1.5 million person-years represents the sum of all individual periods in which the respondents were exposed to the risk of starting to smoke. For each adolescent, this period begins at the start of the observation (usually age 0 in the dataset) and ends either at the reported age of smoking initiation or at the time of censoring (i.e. the current age if the adolescent has not yet started smoking). For example, if one adolescent started smoking at age 12 and another never smoked and was followed until age 14, they would contribute 12 and 14 person-years, respectively, totalling 26 person-years from just these two individuals. This adds up to a total observation time of more than 1.5 million years for all 121,732 participants. This accumulated person-time forms the temporal basis for estimating patterns of smoking onset using survival analysis.

[7] The incidence rate for smoking initiation is 0.032, which means that, on average, about 3.2 adolescents per 100 years of observation start smoking. In other words, if we observe 100 adolescents for one year, we expect about three to four of them to start smoking. This rate reflects the frequency of new observed cases of smoking in relation to the total time people were exposed to the risk (i.e. before they started smoking).

words, the transition from the initial 'non-smoking' state to the 'smoking initiation' state typically occurs at this age. Of all participants, 40.6% experienced the failure event, which corresponds to the proportion who stated that they had ever tried cigarettes.

Table 9 / Survival analysis – key components

		per subject			
Category/Components	**Total**	**mean**	**min**	**median**	**max**
no. of subjects	121,732				
no. of records	121,732	1	1	1	1
first entry time		0	0	0	0
final exit time		12.62565	7	13	15
subject with gap	0				
time on gap if gap	0				
time at risk	1,536,946	12.62565	7	13	15
failures	49,373	0.405588	0	0	1

Source: authors' calculations

Key survival functions in the analysis are often used in the literature to present the dynamic changes of smoking initiation among adults as well as youth. There are three functions of importance for our analysis:

› *survivor function* – shows the probability that an adolescent remains a non-smoker over time

› *failure function* – the probability that smoking has started by a given age

› *hazard function* – the risk of initiating smoking at a specific age, assuming it has not happened yet

For this purpose, Kaplan-Meier (KM)[8] and Nelson-Aalen's (NA)[9] non-parametric methods are used to analyse the time until the occurrence of an event (i.e. the initiation of smoking). The KM method is used to estimate the survivor and failure functions, while the NA method is used to estimate the hazard function. Since our analysis is significant in looking at young people in the whole sample, but also by EU membership status and gender, we will present both methods (KM and NA) for each of these categories individually.

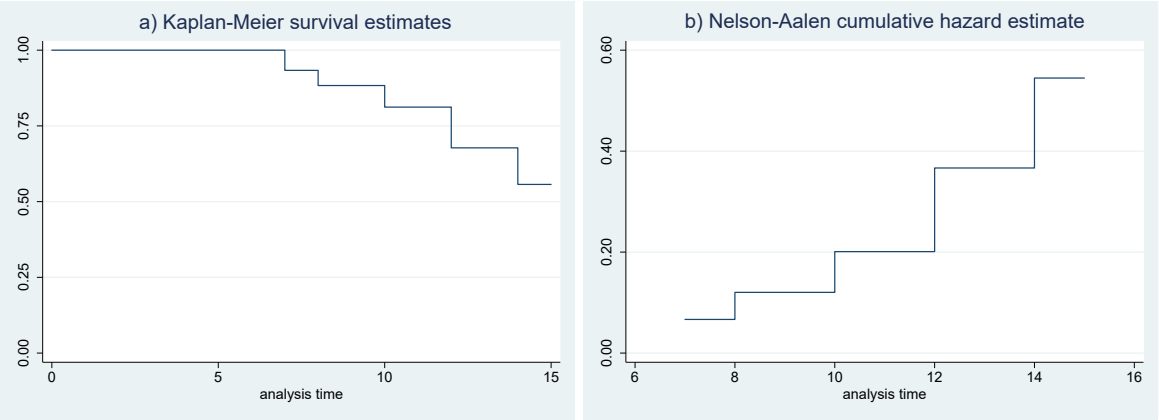
Figure 5a shows the KM survival estimates for the selected CESEE countries in the study, while Figure 5b shows the cumulative risk estimates for smoking initiation. The probability that someone will not become a smoker decreases over time. KM shows decreasing values of the survival function, with the survival rate decreasing more rapidly after 10 years. In other words, the graph shows the probability of the respondent's continued smoking status. The smoking status of the respondent can be positive (i.e. the person is a smoker) or negative (i.e. the person is a non-smoker). The graph on the left shows us the probability of survival (i.e. the probability that a person who is a non-smoker will maintain smoking status over the years). For example, the probability of survival for a person aged 14 is just over 50%. This would mean that people aged 14 and over are 55% likely to remain non-smokers. The second graph offers valuable insights into the cumulative risk associated with smoking initiation. The hazard remains

[8] The Kaplan-Meier estimator has the form S(t)=P(T>t), representing the probability that the event has not occurred by time t. In this analysis, we estimate the probability that a young person has not initiated smoking by a given age (age X).

[9] The Nelson-Aalen estimator is used to estimate the cumulative hazard function, expressed as $H(t) = \sum [d_i / n_i]$ for all $t_i \leq t$, which reflects the accumulated risk of experiencing the event by time t.

low until the age of nine, after which it increases gradually and more sharply around ages 12 to 14, reaching a cumulative hazard of 55% by the end of the period.

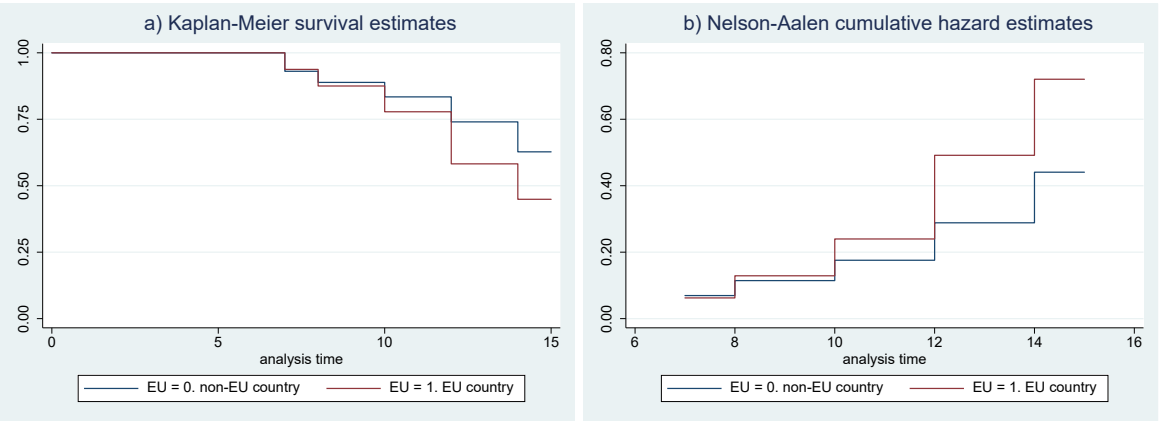
Figure 5 / Non-parametric functions for smoking initiation among youth



Source: authors' calculations

As we want to investigate the similarities and differences in the smoking behaviour of adolescents aged 13-15 in this study, we need to see how these two methods behave in the two groups observed. Figures 6 and 7 show that the probabilities of remaining a non-smoker are different in the EU region than in the non-EU region.

Figure 6 / Non-parametric functions for smoking initiation among youth, by EU membership

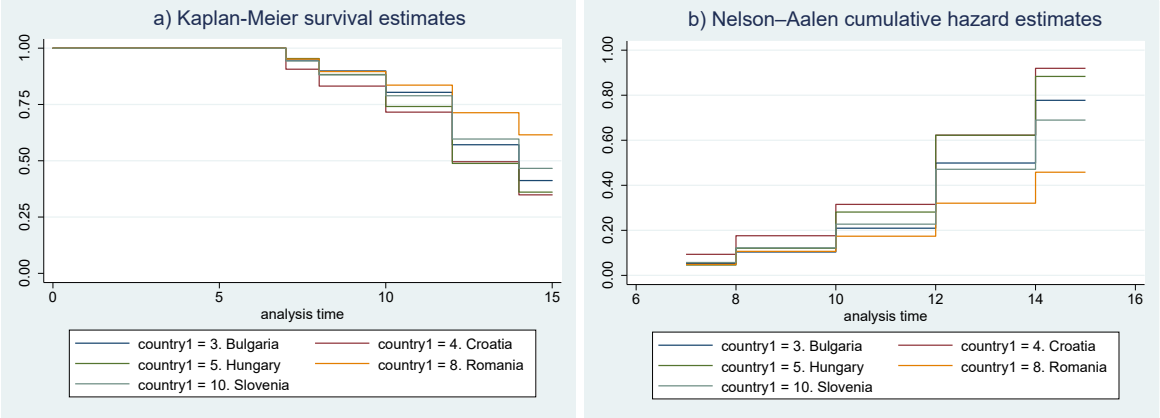


Source: authors' calculations

When we analyse the selected countries in the CESEE region according to membership in the EU, KM and NA show the following results. The KM survival function for both groups of countries starts to decline significantly after 11 years, but it is notable that for all ages, non-EU countries have higher probabilities compared to EU countries. Thus, the probability of survival for people older than 12 years (i.e. the likelihood that they will remain non-smokers) is 80% in non-EU countries, while it is much lower (around 55%) in EU countries. Only for very young people (under the age of eight) is the cumulative hazard

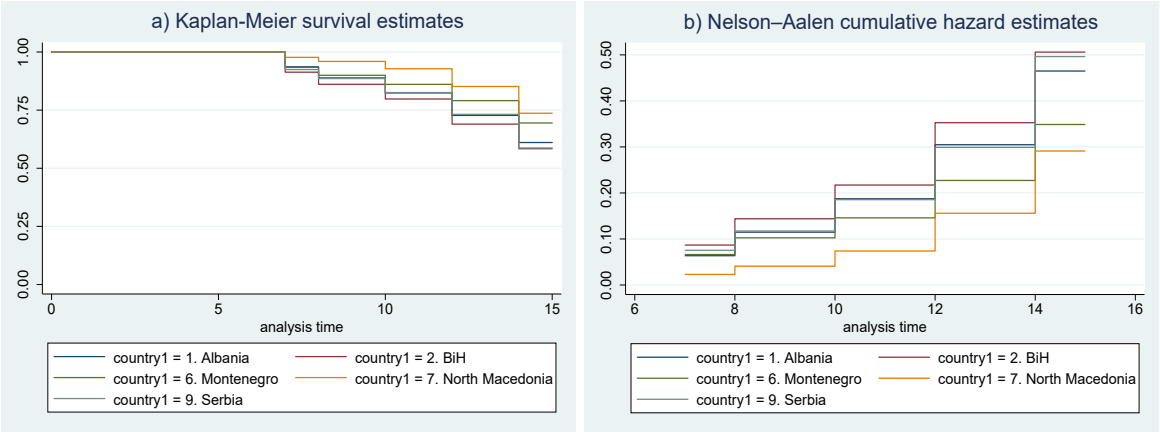
lower for EU countries than for non-EU countries. It begins to rise significantly after 10 years and is always higher for EU countries than for non-EU countries.

Figure 7 / Non-parametric function for smoking initiation among youth, by EU country



Source: authors' calculations

Figure 8 / Non-parametric function for smoking initiation among youth, by non-EU country



Source: authors' calculations

For our survival analysis, it is interesting to observe what happens to the KM and NA survival function by country and to see where the probability of survival for young people is highest and where it is lowest. This information can help to develop interventions specifically for youth. According to our data, the probability of survival is highest for almost all age groups in Romania. On the one side, the probability of maintaining smoking status among young people is highest in Romania compared to the other countries in the group. On the other side, in Croatia, the probability of survival is the lowest almost all the time. The probability of survival for all persons over the age of 12 is slightly less than 50% in Croatia, while it is 70% in Romania. In the group of non-EU countries, the probability of survival is highest in North Macedonia (at 75%) for young people aged 14 and over. It is lowest in Bosnia and Herzegovina (at 60%) for the same age group.

Following the estimation of the non-parametric KM survival function and the NA cumulative hazard function, we proceed with the selection of an appropriate parametric model to further investigate the timing of smoking initiation among youth in South-Eastern Europe. While non-parametric approaches are useful for describing the overall shape of the survivor and hazard functions, parametric survival models allow for more efficient estimation, extrapolation and interpretation of covariate effects. In this study, we consider four commonly used parametric specifications: *Exponential, Weibull, Log-Normal,* and *Log-Logistic*. Their main features are explained in the Methodology section. But, for our study, it is worth noting the following:

› The *Exponential model* assumes a constant hazard over time, offering a simple baseline for comparison.

› The *Weibull model* allows for monotonic increasing or decreasing hazard rates, making it particularly suitable when risk changes with age.

› The *Log-Normal model* captures a non-monotonic hazard pattern, typically increasing to a peak and then declining, which is useful when initiation is most likely in a narrow age range.

› The *Log-Logistic model* offers similar flexibility but with heavier tails, making it suitable when the risk of initiation increases quickly and then decreases gradually.

Each model is estimated and compared in terms of goodness of fit and interpretability to identify the most appropriate structure for analysing smoking initiation in adolescents. Based on the outcomes shown in Table 10 below, the Weibull parameterisation provides the best fit for our data; therefore, we proceed with the analysis using this parametric model. Our choice of Weibull parameterisation is in line with similar research results available in the literature, such as Chen et al. (2001) and Breslau et al. (1993).

Table 10 / Information criteria – smoking initiation

Model	Obs	ll (null)	ll (model	df	AIC	BIC
exp	114,147	-97579.55	-87885.7	32	175835.4	176144.1
weibull	114,147	-66607.66	-52325.08	33	104716.2	105034.5
logN	114,147	-65581.35	-54940.03	33	109946.1	110264.4
logL	114,147	-66429.66	-54392.73	33	108851.5	109169.8

Source: authors' calculations

Based on the previous results, it is obvious that the first model specification (*Exponential*) is not suitable, as the risk function in our data is not constant over time and varies with the age of the respondents. Given the age range covered in the study, it can also be assumed that the Weibull parameterisation would provide the best fit.

Results for the 10 selected CESEE countries show that increasing cigarette prices reduce the probability of smoking and delay smoking initiation among youth (Table 11 and 12). Therefore, a public policy of increasing excise taxes on cigarette consumption that leads to an increase in prices is a relevant strategy to delay the age of smoking initiation. In line with the literature, the examined variables show a statistically significant influence on the delay of smoking initiation. Parental and peer effects have a strong influence on smoking initiation, as young people whose parents are smokers and whose friends offer them tobacco are more likely to start smoking earlier.

Since tobacco control policies play a significant role in delaying smoking initiation among young people, in order to examine in depth the effects of various control measures while also accounting for EU membership, we evaluated Model A, which includes three additional variables comparing to starting ones:

› ***EU_TPD_policy*** – representing the impact of the Tobacco Products Directive (2014/40/EU),

› ***policy_index*** – capturing the composite score of individual non-price tobacco control measures, and

› ***EUacc*** – a dummy variable taking the value 1 if a country is an EU member and 0 otherwise.

All other variables remain the same as in Model C, Table A3. The results are presented in Table 11.

EU membership has a positive and statistically significant effect on delaying the onset of smoking among young people. This result is consistent with the statistical significance of all tobacco control measures implemented in each country, with a focus on the Tobacco Products Directive (TPD), which is mandatory in all EU member states. The positive coefficient for this variable indicates that the application of this policy contributes to delaying the onset of smoking. The inclusion of new variables has not reduced the relevance of the social environment, as the influence of parental and peer behaviour has maintained its statistical significance and negative effect. Peer behaviour has the strongest individual influence in this model.

Since the previous table demonstrated the impact of EU membership on delaying smoking initiation among young people, we extended the analysis to examine the policies implemented in countries that have not yet joined the EU. To this end, a new categorical variable, *all_policy*, was introduced to capture cross-country differences in tobacco control measures. This variable encompasses three categories: (i) indoor smoking bans, (ii) advertising bans combined with indoor smoking bans, and (iii) the joint implementation of advertising bans and indoor smoking bans. The results of this specification are presented in Table 12.

The variable *all_policies* shows very interesting results, indicating a statistically significant effect on delaying the onset of smoking in young people. It can be seen that both indoor smoking bans and advertising bans contribute to delaying smoking initiation, with the coefficient values indicating that the strongest effect is achieved when these policies are implemented together.

These policies were selected because they are applied in all countries observed and have been in place long enough to allow an assessment of their impact within the group of countries included in this study. Similar to the previous model, the influence of peers proves to be the strongest individual factor: friends who offer a cigarette significantly accelerate the onset of smoking and thereby reduce the likelihood of postponement.

Taken together, the findings in Models A and B underscore that restrictive tobacco control measures are effective in postponing smoking initiation in both EU and non-EU countries. However, since peer influence remains the strongest individual determinant of early smoking, the success of such policies ultimately depends on combining regulatory approaches with interventions aimed at reducing social pressures to smoke.

Table 11 / Smoking initiation among youth in CESEE countries – Weibull distribution

Variable	Model A Coef.
price_USD	0.008 (0.001)***
EU_TPD_policy	0.037 (0.001)***
policy_index	0.003 (0.001)***
parents_smoke	
father only	-0.029 (0.001)***
mother only	-0.069 (0.001)***
both	-0.081 (0.001)***
friend_offered	-0.138 (0.001)***
think_harmful	-0.005 (0.001)***
gender	0.064 (0.001)***
time	0.006 (0.001)***
EUacc	0.004 (0.000)***
_cons	2.923 (0.002)***
/ln_p	1.471 (0.000)***
p	4.352 (0.003)
1/p	0.230 (0.001)

Note: Variable p is the shape parameter which indicates whether the hazard rate increases, decreases, or remains constant over time. Standard errors are in parentheses. * p<0.10, **p< 0.05, *** p< 0.01
Source: authors' calculations

Table 12 / Smoking initiation among youth in CESEE countries – Weibull distribution for non-EU countries

Variable	Model B (non EU) Coef.
price_USD	0.029
	(0.015)**
all_policies_cat	
advertising bans	0.112
	(0.008)***
smoking indoor bans	0.044
	(0.005)***
advertising + smoking indoor bans	0.141
	(0.011)***
parents_smoke	
father only	-0.017
	(0.001)
mother only	-0.059
	(0.000)***
both	-0.067
	(0.000)***
friend_offered	-0.133
	(0.000)***
think_harmful	0.005
	(0.000)***
gender	
female	0.071
	(0.000)***
_cons	2.759
	(0.000)***
/ln_p	1.451
	(0.001)***
p	4.266
	(0.003)
1/p	0.234
	(0.000)

Note: Variable p is the shape parameter which indicates whether the hazard rate increases, decreases, or remains constant over time. Standard errors are in parentheses. * p<0.10, **p< 0.05, *** p< 0.01
Source: authors' calculations

7. Conclusion

This study provides empirical evidence on the determinants of smoking initiation among adolescents in 10 selected CESEE countries, representing a continuation of regional research on cigarette affordability in this area (Zubović et al. 2023). This study makes an important contribution to the literature emphasising the role of prices, policies and social factors. Consistent with previous findings, our results confirm that higher cigarette prices are associated with delayed smoking initiation among adolescents, especially in non-EU countries. At the same time, peer effect and parental smoking behaviour continue to emerge as strong and consistent predictors of early smoking initiation, confirming studies highlighting the central role of the social environment in shaping adolescent behaviour (DiFranza et al. 2007; Veeranki et al. 2017).

By examining EU and non-EU countries with a common historical and geographical background, and by introducing policy variables created with novel approach – most notably, the EU Tobacco Products Directive (TPD) and the composite *all_policy* measure – this analysis extends existing national-level evidence to a broader regional framework. The findings demonstrate that EU membership, through the mandatory implementation of the TPD, exerts a positive and statistically significant effect on delaying youth smoking initiation. Moreover, the study shows that a combination of non-price policies (e.g. bans on tobacco advertising and indoor smoking) has the strongest impact, underscoring the importance of sustained and comprehensive tobacco control measures. In this sense, this research represents a step forward compared to earlier regional studies, adding a new dimension by linking EU-level regulations with youth smoking behaviour.

Taken all five models together, the results indicate that while restrictive tobacco control policies are effective in postponing smoking initiation, their success is conditioned by the enduring influence of peers and parents. This suggests that legislative interventions should be complemented with targeted prevention programmes addressing the social drivers of early smoking uptake.

8. Policy recommendation and key messages

The evidence from this survey underscores the need for comprehensive tobacco control strategies:

› Increasing tobacco taxes is essential given the obtained results on how the price of tobacco products impacts smoking initiation in both on the impact of price significance of the price variable for both EU and non-EU countries. It is even more important for non-EU countries, where cigarette affordability remains higher.

› Strict enforcement of advertising bans as well as indoor smoking restrictions should be prioritised to reduce exposure to tobacco products and second-hand smoke among youth.

› Harmonising regulations with EU legislation can accelerate the progress of effective tobacco control policies in countries outside the Union, since EU legislation has a positive impact on delaying initiation among youth.

› Interventions targeting social drivers (e.g. peer influence and parental smoking) are essential. Educational campaigns, school-based programmes and family-oriented initiatives can help to mitigate these risks. A multi-faceted approach combining fiscal, regulatory and behavioural interventions offers the most effective pathway to reducing youth smoking initiation in the CESEE region.

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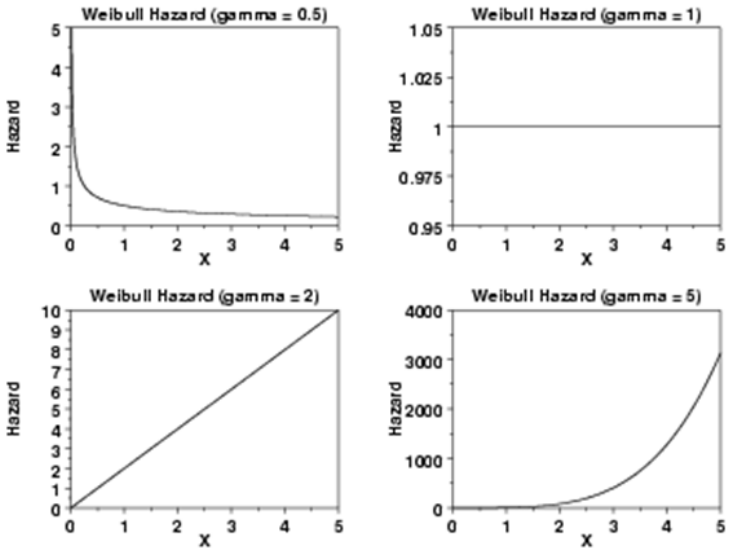
Appendix

APPENDIX A

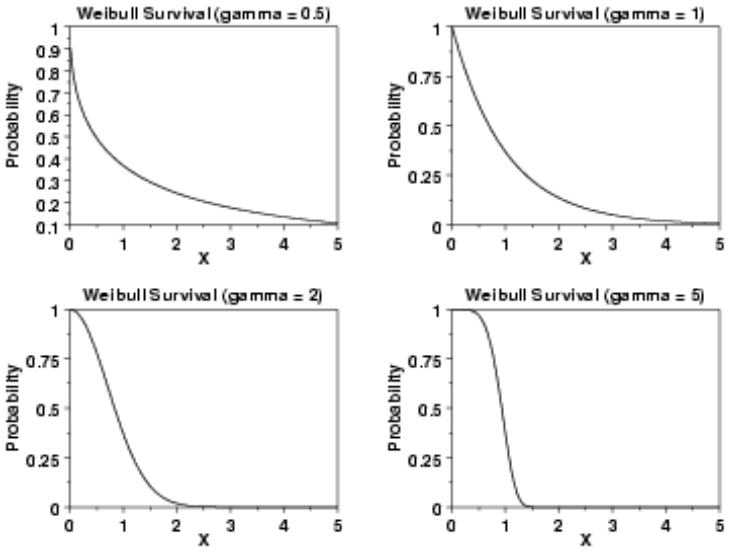
The following plots show the Weibull hazard function by the different values of γ (plot a) and the Weibull survival function by different values of γ (gamma) (plot b):

Graph 1 / Plots for Weibull hazard function and survival function by different values of shape parameter

a)



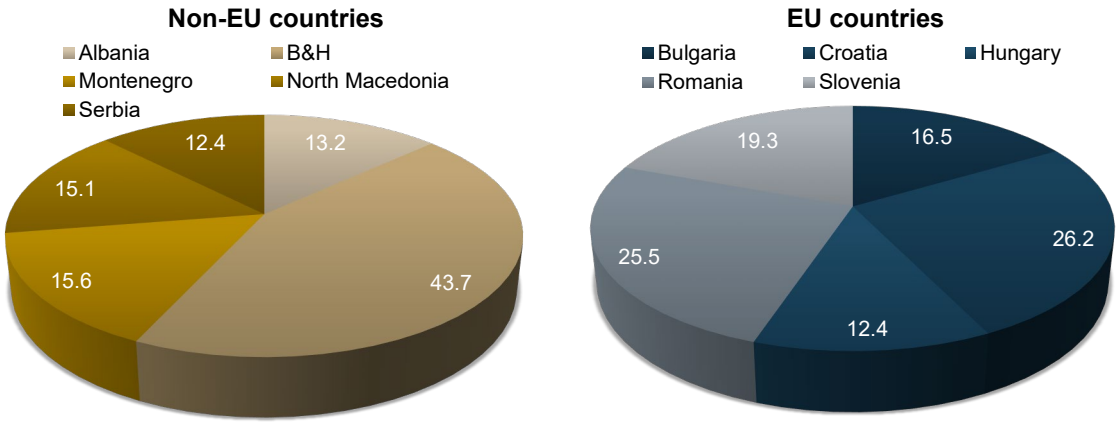
b)



Source: NIST/SEMATECH e-Handbook of Statistical Methods (www.itl.nist.gov/div898/handbook/), 20.06.2025

Figure A1 shows the percentage distribution of respondents by country within EU and non-EU countries. Bosnia and Herzegovina dominates with 43.7 %, which is due to the large sample size in all survey waves. The other countries have lower shares, ranging between 12% and 15%. In contrast, the distribution is more balanced in the observed EU region, with Croatia (26.2%) and Romania (25.5%) having the largest shares, while Hungary has the smallest share (12.4%).

Figure A1 / Total number of respondents, by country and region, in %



Source: authors' calculations

Table A1 / The structure of the respondents, by region, country and gender, %

Country/Gender	Male	Female	Total
Non-EU	**48.2**	**51.8**	**100**
Albania	45.9	54.1	100
Bosnia and Herzegovina	48.6	51.4	100
Montenegro	48.6	51.4	100
North Macedonia	49.5	50.5	100
Serbia	48.2	51.8	100
EU	**47.3**	**52.7**	**100**
Bulgaria	46.4	53.6	100
Croatia	49.0	51.0	100
Hungary	46.9	53.1	100
Romania	47.1	52.5	100
Slovenia	46.9	53.1	100

Note: unweighted; n=120,815
Source: authors' calculations

Table A2 / The structure of the respondents by country, age and gender

Age/Gender	Male	Female	Age/Gender	Male	Female
	Albania			**Bulgaria**	
13	1,147	1,375	13	893	1,026
14	1,660	1,873	14	1,425	1,675
15	1,575	1,922	15	1,372	1,563
Total	**4,382**	**5,170**	**Total**	**3,690**	**4,264**
	Bosnia and Herzegovina			**Croatia**	
13	4,444	4,789	13	1,987	2,142
14	5,901	6,179	14	2,232	2,305
15	5,137	5,434	15	1,920	1,943
Total	**15,482**	**16,402**	**Total**	**6,139**	**6,390**
	Montenegro			**Hungary**	
13	1,756	1,763	13	815	956
14	1,823	1,962	14	1,138	1,207
15	1,933	2,096	15	820	975
Total	**5,512**	**5,821**	**Total**	**2,773**	**3,138**
	North Macedonia			**Romania**	
13	2,006	2,124	13	2,178	2,473
14	1,936	2,058	14	2,408	2,700
15	1,546	1,418	15	1,200	1,328
Total	**5,488**	**5,600**	**Total**	**5,786**	**6,501**
	Serbia			**Slovenia**	
13	961	983	13	1,000	1,151
14	1,608	1,814	14	1,612	1,711
15	1,792	1,890	15	1,719	2,036
Total	**4,361**	**4,687**	**Total**	**4,331**	**4,898**

Note: unweighted; n= 120,815
Source: authors' calculations

Explanation: Model D presents the results of the Weibull AFT regression for non-EU countries and highlights several significant predictors of early smoking initiation among youth aged 13-15. Peer influence (e.g. having a friend offer a cigarette) emerged as the strongest factor accelerating smoking initiation. Parental smoking, especially when both parents smoke, was also strongly associated with earlier initiation. In contrast, higher cigarette prices, stronger tobacco control policies, and the belief that smoking is harmful were associated with delayed onset. The shape parameter (p = 3.67) confirms an increasing hazard over time, suggesting that as adolescents age, the likelihood of starting to smoke rises. The policy variable used for estimation of the effects of tobacco control policies (*policy_turnover*) has a positive coefficient, meaning that a maximum of two non-price tobacco control policies implemented at the same time would encourage young people to postpone smoking initiation.

The results of the Weibull AFT model for EU countries are presented in Model E. The strongest effect in the model is the influence of peers. If a friend has offered a cigarette, the probability of starting smoking earlier increases significantly. Parental smoking is a strong predictor of earlier initiation. The effect is strongest in households where both parents smoke, but smoking by only the father or only the mother also accelerates the transition to smoking behaviour. These results confirm that parental behaviour serves as an important model for young people. Regarding gender, the results show that girls tend to start smoking later than boys, as the positive coefficient indicates a delayed initiation of smoking among female adolescents. It is notable that (compared with non-EU countries) the perception that smoking is harmful to health is not a significant predictor of behaviour in EU countries. This suggests that knowledge alone is not sufficient to delay or prevent smoking initiation in adolescents. Even if the

increase in prices delays the smoking onset, it shows no statistically significant effect. The estimated shape parameter (p = 4.70) indicates an increasing hazard function, which means that the risk of smoking initiation increases rapidly with age.

Table A3 / Smoking initiation among youth in CESEE countries – Weibull distribution

Variable	Model C (all)	Model D (non-EU)	Model E (EU)
price_USD	0.027 (0.007)***	0.055 (0.029)**	0.002 (0.024)
policy_turnover			
less than 2 policies	0.007 (0.015)	0.073 (0.011)***	-0.020 (0.030)
2 policies	0.033 (0.012)***	0.107 (0.026)***	-0.026 (0.027)
parents_smoke			
father only	-0.034 (0.003)***	- 0.034 (0.005)***	-0.039 (0.004)***
mother only	-0.059 (0.003)***	-0.062 (0.006)***	-0.058 (0.004)***
both	-0.071 (0.003)***	-0.073 (0.005)***	-0.070 (0.004)***
friend_offered	-0.153 (0.001)***	-0.189 (0.002)***	-0.125 (0.002)***
think_harmful	0.005 (0.001)***	0.009 (0.002)***	0.001 (0.002)
gender			
2. female	0.053 (0.002)***	0.065 (0.004)***	0.039 (0.003)***
_cons	2.991 (0.021)***	3.075 (0.048)***	2.944 (0.016)***
/ln_p	1.422 (0.004)***	1.300 (0.006)***	1.547 (0.006)***
p	4.144	3.671 (0.022)	4.697 (0.027)
1/p	0.241	0.272 (0.002)	1.547 (0.006)

Note: Variable p is the shape parameter which indicates whether the hazard rate increases, decreases, or remains constant over time. Standard errors are in parentheses. * p<0.10, **p< 0.05, *** p< 0.01

Table A4 / Wald test of exogeneity for variable 'best friend offers tobacco'

Test	χ^2	df	p-value
Wald test of exogeneity	1956.19	1	0.0000

Source: authors' calculations

Table A5 / Wald test of exogeneity for variable 'think tobacco is harmful'

Test	χ^2	df	p-value
Wald test of exogeneity	1994.18	1	0.0000

Source: authors' calculations

APPENDIX B

Table B1 / Tobacco control laws in 10 selected countries

Country	Year	Law	Policy Description (EN)	Policy Type
EU				
Bulgaria	2004	Decree No. 329	Indoor smoking regulation	NP
Bulgaria	2004	Health Act	Education and smoking prevention	NP
Bulgaria	2006	FCTC	WHO FCTC accession – MPOWER implementation	NP
Bulgaria	2010	Excise Duties and Tax Warehouses Act	Tax regulation of tobacco	P
Bulgaria	2013	Law on Labelling Tobacco Products	Labelling standards for tar/nicotine/CO	NP
Bulgaria	2016	Law on Tobacco, Tobacco Products and Associated Products	Comprehensive regulation, includes e-cigarettes	NP
Bulgaria	2019	Health Act amendments	Funding local prevention programmes	NP
Romania	2002	Law No. 349	Ban on smoking in public places	NP
Romania	2004	LAW No. 457	Ban on tobacco advertising	NP
Romania	2016	Law No. 201	Packaging warnings and e-cigarette regulation	NP
Croatia	2008	Law on Restricting Tobacco Use	Indoor smoking ban	NP
Croatia	2009	Law on Electronic Media	Ban on advertising in electronic media	NP
Croatia	2017	Law on Restricting Tobacco Products and Tobacco Alternatives	Pictorial warnings, e-cigarette regulation	NP
Hungary	1999	Act XLII	Ban on smoking and sale to minors	NP
Hungary	2012	Act CXXXIV	Regulation of youth sales, state-controlled retail	NP
Hungary	2013	Gov. Decree 39/2013	Pictorial warnings and penalties	NP
Hungary	2016	Regulation 11/2016	Measurement standards for harmful substances	NP
Slovenia	2007	Law on Restriction of Tobacco	Smoking ban and cessation support	NP
Slovenia	2017	ZOUTPI	Ban on advertising, plain packaging, e-cigarettes	NP
Slovenia	2024	ZOUTPI-B	Further amendments – flavour bans for e-cigarettes	NP
NON EU				
Albania	2006	Anti-Tobacco Law 9636	Ban on smoking, advertising and labelling	NP
Albania	2000	Law on Production and Trade	Control of tobacco production and trade	NP
Albania	2013	Audiovisual Media Law	Ban on media advertising	NP
BiH	1998	Law on Limited Use	Ban on advertising and sales	NP
BiH	2004	Law on Smoking Bans and Advertising (Republic of Srpska)	Public smoking ban	NP
BiH	2023	Law in BiH Federation	Control and restriction of tobacco use	NP
Montenegro	2004	Law No. 52/2004	Basic smoking and advertising ban	NP
Montenegro	2019	Law on Restricting Tobacco Use	Extension to new products, detailed regulation	NP
North Macedonia	1995	Law on Protection of Smoking	Indoor smoking ban	NP
North Macedonia	2006	Law on Tobacco and Products	Basic regulation of tobacco	NP
North Macedonia	2019	Law No. 1245	EU harmonisation, includes e-cigarettes	NP
Serbia	2005	Law on Advertising	Ban on media advertising	NP
Serbia	2005	Law on Smoke-free Enclosed Premises	Ban on smoking indoors	NP
Serbia	2007	Law on Excise	Specific and ad valorem excises	P
Serbia	2010	Law on the Protection of the Population from Tobacco Smoke	Public smoking bans	NP
Serbia	2016	Law on Advertising	Advertising bans	NP

Note: NP = non-price policy; P = price policy
Source: Tobacco Control Laws, www.tobaccocontrollaws.org/legislation/

APPENDIX C

Table C1 / GYTS variable evaluation and selection process, EU countries

	Question Codes GYTS Database			
Variable name/Question GYTS	**Bulgaria 2002**	**Bulgaria 2008**	**Bulgaria 2015**	**Bulgaria 2023**
tried smoking	BGR1	CR1	CR5	CR5
age first cigarette	CR2	CR2	CR6	CR6
parents smoke	CR14	CR16	OR45	OR45
best friend offered tobacco	CR15	CR17	CR39	CR39
smoking harmful to health	BGR29	CR26	CR23	OR53
gender	CR55	CR83	CR2	CR2
custom age	CR54	CR82	CR1	CR1
grade	BGR60	BGR79	BGR3	BUR3
closest friend smokes	BGR30	CR31	OR46	OR46

	Croatia 2003	**Croatia 2007**	**Croatia 2011**	**Croatia 2016**
tried smoking	CR1	CR1	CR1	CR5
age first cigarette	CR2	CR2	CR2	CR6
parents smoke	CR20	CR20	CR20	OR45
best friend offered tobacco	CR21	CR21	CR17	CR39
smoking harmful to health	CR30	CR30	CR26	OR53
gender	CR85	CR85	CR83	CR2
custom age	CR84	CR84	CR82	CR1
grade	HRR86		CR84	HRR3
closest friend smokes	CR35	CR35	CR31	

	Hungary 2003	**Hungary 2008**		
tried smoking	CR1	CR1		
age first cigarette	CR2	HUR2		
parents smoke	CR20			
best friend offered tobacco	CR21	CR21		
smoking harmful to health	CR30	CR30		
gender	CR85	CR87		
custom age	CR84	HUR90		
grade	HUR85	HUR93		
closest friend smokes	CR35	CR35		

	Romania 2004	**Romania 2009**	**Romania 2013**	**Romania 2017**
tried smoking	CR1	CR1	CR5	CR5
age first cigarette	CR2	CR2	CR6	CR6
parents smoke	CR20	CR16	OR45	OR45
best friend offered tobacco	CR21	CR17	CR39	CR39
smoking harmful to health	CR30	CR26	OR53	OR53
gender	CR85	CR83	CR2	CR2
custom age	CR84	CR82	CR1	CR1
grade	ROR86	ROR65	ROR3	ROR3
closest friend smokes	ROR35	CR31	OR46	OR46

	Slovenia 2003	**Slovenia 2007**	**Slovenia 2011**	**Slovenia 2017**
tried smoking	CR1	CR1	CR1	CR5
age first cigarette	CR2	CR2	CR2	CR6
parents smoke	CR20	CR20	CR16	OR1
best friend offered tobacco	CR21	CR21	CR17	CR39
smoking harmful to health	CR30	CR30	CR26	CR23
gender	CR85	CR87	CR83	CR2
custom age	CR84	CR86	CR82	CR1
grade	SIR86	SIR86	CR84	SIR3
closest friend smokes	CR35	CR35	CR31	

Legend: variable is included in the final database, but with different codes

Source: Authors

Table C2 / GYTS variable evaluation and selection process, non-EU countries

	Question Codes GYTS Database					
Variable name/Question GYTS	**Albania 2004**	**Albania 2009**	**Albania 2015**	**Albania 2020**		
tried smoking	CR1	CR1	CR5	CR5		
age first cigarette	CR2	CR2	CR6	CR6		
parents smoke	CR20	CR16	OR45	OR45		
best friend offered tobacco	CR21	CR17	CR39	CR39		
smoking harmful to health	CR30		OR53	OR53		
gender	CR85	CR83	CR2	CR2		
custom age	CR84	CR82	CR1	CR1		
grade	ALR86	ALR84	ALR3	ALR3		
closest friend smokes	CR35	CR31	OR46	OR46		
	BiH 2003 Federation	**BiH 2003 RS**	**BiH 2008**	**BiH 2013**	**BiH 2018 Federation**	**BiH 2018 RS**
tried smoking	CR1	CR1	CR1	CR5	CR5	CR5
age first cigarette	CR2	CR2	CR2	CR6	SR2	CR6
parents smoke	CR20	CR20	CR16	OR45	OR45	OR45
best friend offered tobacco	CR21	CR21	CR17	CR39	CR39	CR39
smoking harmful to health	CR30	CR30	CR26	OR53	OR53	OR53
gender	CR85	CR85	CR83	CR2	CR2	CR2
custom age	CR84	CR84	CR82	BAR1	CR1	CR1
grade	BAR86	SPR85	BAR80	BAR3	BAR3	SPR3
closest friend smokes	CR35	CR35	CR31	OR46	OR46	OR46
	Montenegro 2004	**Montenegro 2008**	**Montenegro 2014**	**Montenegro 2018**		
tried smoking	CR1	CR1	CR5	CR5		
age first cigarette	CR2	CR2	CR6	CR6		
parents smoke	CR20	CR16	OR45	OR45		
best friend offered tobacco	CR21	CR17	CR39	CR39		
smoking harmful to health	CR30	CR26	OR53	OR53		
gender	CR85	CR83	CR2	CR2		
custom age	CR84	CR82	CR1	CR1		
grade	MER86	MER84	MER3	MER3		
closest friend smokes	CR35	CR31	OR46	OR46		
	North Macedonia 2003	**North Macedonia 2008**	**North Macedonia 2016**			
tried smoking	CR1	CR1	CR5			
age first cigarette	CR2	CR2	CR6			
parents smoke	CR20	CR16				
best friend offered tobacco	CR21	CR17	CR39			
smoking harmful to health	CR30	CR26	OR53			
gender	CR85	CR83	CR2			
custom age	CR84	CR82	CR1			
grade	MKR86	MKR84	MKR3			
closest friend smokes	CR35	CR31	OR46			

Legend: variable is included in the final database, but with different codes

Source: Authors

IMPRESSUM

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