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# Do cigarette taxes deter youth smoking?

## Evidence from Turkey

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# Abstract

In this paper, we examine how cigarette taxation affects youth smoking initiation in Turkey, using data from the 2017 Global Youth Tobacco Survey (GYTS) to create a pseudo-longitudinal sample of 11- to 17-year-olds. Using Cox proportional hazard models with time-varying covariates for taxes and prices, we find that a higher cigarette tax burden and higher real cigarette prices significantly reduce the risk that an adolescent will start smoking. While social influences, such as parental or teacher smoking, increase the likelihood of smoking initiation, higher parental education lowers it. These results are robust to alternative specifications, including split-population survival models. Our findings indicate that increasing cigarette taxes is effective in curbing youth smoking and that interventions targeting social and educational factors also play important roles.

Keywords: cigarette taxation; youth smoking initiation; tobacco control policy; survival analysis; Turkey

JEL classification: I12, H23, C41, I18



## CONTENTS

Abstract.....	5
1. Introduction.....	9
2. Evolution of cigarette taxes and prices in the 2000s in Turkey.....	11
3. Data, variables, and methodology.....	13
3.1. Model.....	13
3.2. Data.....	14
3.3. Variables.....	15
4. Estimation results.....	19
5. Conclusion and policy implications.....	25
References.....	26
Appendix.....	28

## TABLES AND FIGURES

Table 1 / List of variables .....	16
Table 2 / Descriptive statistics of the study variables.....	18
Table 3 / Extended Cox regression estimates (whole sample).....	20
Table 4 / Extended Cox regression estimates (by gender).....	23
Figure 1 / Real cigarette price index vs. tax burden.....	12
Figure 2 / Kaplan-Meier survival estimation (whole sample).....	19
Figure 3 / Kaplan-Meier survival estimation (by gender).....	22
Table A.1 / Coefficient estimates from logarithmic extended Cox regression models (whole sample)....	28
Table A.2 / Split-population model estimates.....	30
Table A.3 / Cox models with time-varying coefficients for tax and price variables.....	31

# 1. Introduction

The use of tobacco products, particularly cigarettes, dates back centuries, with early consumption often associated with perceived benefits, such as relaxation and stress relief. However, by the mid-twentieth century, a substantial body of scientific evidence had established a clear link between smoking and severe health risks, most notably lung cancer. Subsequent research has further demonstrated associations between smoking and a wide range of diseases, while studies in the social sciences have documented its significant economic and social costs (Reed, 2023). These findings have led to a profound shift in public attitudes towards smoking.

In response to growing evidence on the harms of tobacco use, governments worldwide have implemented a variety of policy measures aimed at reducing smoking prevalence. These include cigarette taxation, smoke-free air laws, restrictions on advertising, and public health campaigns. Among these interventions, taxation has emerged as one of the most effective tools for reducing tobacco consumption, primarily by increasing prices and thereby discouraging use. A large body of empirical research confirms that higher cigarette prices lead to lower smoking rates across different populations and contexts (Gallet & List, 2003; Chaloupka et al., 2010; Bader et al., 2011; Álvarez et al., 2020; Le and Jaffri, 2022).

A particularly important focus of tobacco control policy is adolescents, as smoking behaviour is often initiated at a young age. Evidence suggests that a significant majority of long-term smokers begin before the age of 20, highlighting adolescence as a critical period for intervention (WHO, 2024). Policies that successfully deter smoking initiation among young people can therefore generate substantial long-term public health benefits.

Extensive research has examined the responsiveness of smoking behaviour to price changes, with a strong emphasis on youth populations. Early studies, such as Lewit et al. (1981), found that adolescents are more sensitive to cigarette prices than adults. Subsequent work has reinforced these findings, showing that higher prices and stricter tobacco control policies significantly reduce both smoking participation and initiation among young people (Chaloupka & Wechsler, 1997; Carpenter & Cook, 2008; Huang & Chaloupka, 2012). Estimates of price elasticity among youth tend to be relatively large in magnitude, indicating substantial reductions in smoking initiation in response to price increases.

This evidence is not limited to high-income countries. Studies using international data have reported even larger price responsiveness in low- and middle-income countries (Nikaj & Chaloupka, 2014), with recent research on Africa documenting elasticity estimates for smoking initiation ranging from  $-1.63$  to  $-3.66$  (Asare et al., 2019; Boachie et al., 2022). However, some longitudinal analyses suggest that these effects may diminish when controlling for individual-level characteristics, indicating the importance of unobserved heterogeneity in shaping smoking behaviour (Sen & Wirjanto, 2010).

Despite the breadth of this literature, there remains a notable gap in the case of Turkey. Over the past two decades, Turkey has implemented substantial increases in tobacco taxation alongside broader tobacco control policies. As a middle-income country with domestic tobacco production and evolving

regulatory frameworks, it provides a particularly relevant context for examining the effectiveness of such policies. However, to date, limited empirical research has investigated how these tax increases have affected smoking initiation among adolescents in Turkey.

This study aims to address this gap by examining the impact of cigarette taxes and prices on adolescent smoking initiation in Turkey. Using Cox proportional hazard models with time-varying covariates, we analyse how changes in the tax burden and cigarette prices influence the probability of smoking initiation while controlling for key demographic and social factors. We find consistent evidence that higher taxes and prices significantly reduce the likelihood that adolescents will start to smoke, underscoring the importance of fiscal policy as a tool for tobacco control.

The remainder of the paper proceeds as follows. The next section reviews cigarette taxes and prices in Turkey. Section 3 describes the data and methodology, Section 4 presents the results, and the final section concludes.

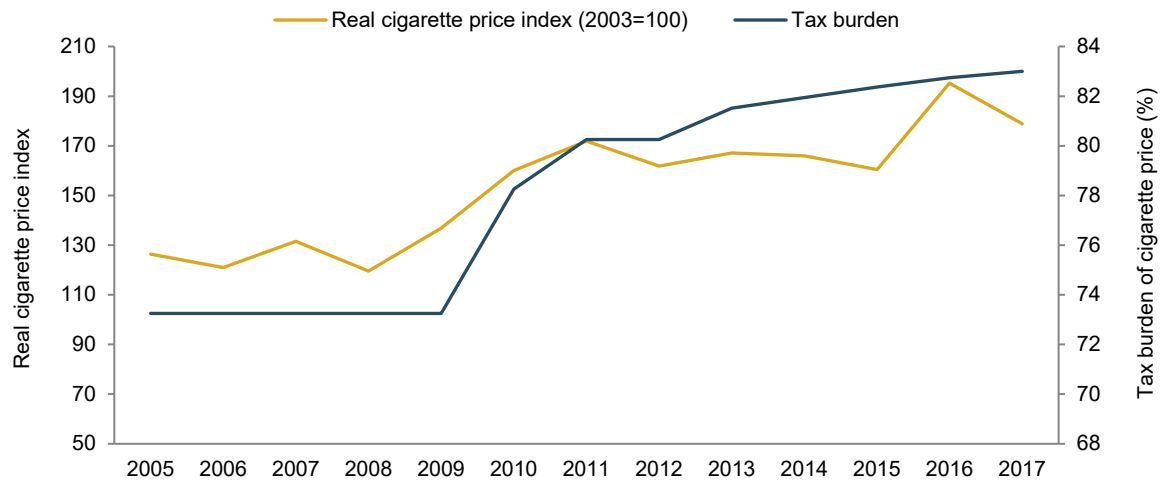
## 2. Evolution of cigarette taxes and prices in the 2000s in Turkey

Like other countries, Turkey has taken important steps to curb tobacco use over the last few decades.<sup>1</sup> The first anti-tobacco law, which banned smoking in public places and advertising of tobacco products, was introduced in 1996. The law also banned the sale of tobacco to minors and introduced health warnings on cigarette packaging. Turkey joined the World Health Organization Framework Convention for Tobacco Control (FCTC) in 2004. A tobacco control programme and action plan were prepared with the participation of both governmental and nongovernmental organisations and institutions. The anti-tobacco law of 3 January 2008 expanded smoke-free areas to include hospitality workplaces, taxis, and open areas of schools in addition to banning tobacco sponsorship.

Tax policy is the most important pillar of tobacco control in Turkey. Until 2002, various types of taxes, mostly ad valorem, were levied on tobacco products sold. In 2002, with the enactment of the Special Consumption Tax Law No. 4760, these different taxes were unified under the name of Special Consumption Tax (SCT). The SCT rate on cigarettes was set at 49.5% in 2002 and increased to 55.3% in 2003. In early 2004, the tax structure was changed again, and a flat tax linked to the retail price was added, although it was discontinued the following year. In mid-2004, the proportional tax rate in the SCT was reduced to 28%, and the lump-sum tax was linked to the amount of oriental tobacco used in cigarette production. In 2005, changes were made again, and the ad valorem tax rate was increased to 58%. At the same time, a minimum lump-sum tax was established to prevent cigarettes from being sold at low prices and applied when the ad valorem tax fell below a certain level. Finally, in 2013, a flat tax was re-introduced alongside the minimum flat tax. Currently, there are three types of excise taxes on tobacco products in Turkey: an ad valorem SCT, a lump-sum SCT, and a value-added tax (VAT). Over time, the ad valorem SCT on tobacco products has fluctuated, while the lump-sum SCT has steadily increased.

Figure 1 illustrates the changes in the tax burden on cigarettes and the real price of cigarettes in Turkey between 2005 and 2017. The graph clearly illustrates the positive correlation between the tax burden and cigarette prices. Between 2005 and 2017, the tax burden on cigarettes increased by approximately 80%, while real cigarette prices increased by approximately 40%. This study focuses on the effects of these tax burdens and price increases resulting from tax policies implemented in the early 2000s on the smoking initiation behaviour of young people.

<sup>1</sup> For a comprehensive analysis of the tobacco market in Turkey, with a focus on the supply chain, consumption patterns and impacts of government policies, including non-price regulations and tax policies, see Balçılar et al. (2025).

**Figure 1 / Real cigarette price index vs. tax burden**

Sources: Real cigarette price index provided by TURKSTAT; tax burden calculated by Çetinkaya and Marquez (2017).

## 3. Data, variables, and methodology

### 3.1. MODEL

This study uses survival analysis to examine the impact of taxes imposed on tobacco products in Turkey since the early 2000s on the smoking habits of Turkish youth. Survival analysis refers to all statistical methods that analyse the time from a well-defined starting point to the observation of the event of interest (Kleinbaum & Klein, 2012; Collett, 2015). The survival function, commonly denoted by  $S(t)$ , represents the probability that a given subject – in our sample, an adolescent – remains event-free (i.e. does not initiate smoking) beyond time  $t$ . Formally, it is defined as:

$$S(t) = P(T > t),$$

where  $T$  denotes the survival time. Thus,  $S(t)$  gives the probability that the time to event exceeds  $t$  (Cox, 1972).

Conditional on survival up to time  $t$ , the instantaneous risk of event occurrence is captured by the hazard function. This function represents the probability that the event occurs in an infinitesimally small interval following  $t$ , given survival up to  $t$ , and is defined as

$$h(t) = \lim_{\Delta t \rightarrow 0} \frac{P(t \leq T < t + \Delta t \mid T \geq t)}{\Delta t}.$$

The relationship between subjects' survival time and the explanatory variables hypothesised to influence this duration is examined using the Cox regression model (CRM), a semi-parametric survival framework introduced by Cox (1972). The model is specified as:

$$h(t, X) = h_0(t) \exp(\beta' X),$$

where  $X = (X_1, X_2, \dots, X_p)'$  denotes the  $p \times 1$  vector of explanatory variables,  $b = (\beta_1, \beta_2, \dots, \beta_p)'$  is the corresponding  $p \times 1$  vector of regression coefficients,  $h(t, X)$  represents the hazard function, and  $h_0(t)$  is the baseline hazard function.

As the CRM does not require specifying the form of the baseline hazard function, it is consequently semi-parametric. It allows for the estimation of hazard ratios, which indicate the relative risk associated with changes in predictor variables (Jenkins, 2005).

The hazard ratio ( $HR$ ), a measure of the association between groups or levels of a predictor variable, was derived using the hazard function defined above.  $HR$  is expressed as (Kleinbaum & Klein, 2012):

$$HR = \frac{\hat{h}(t, X^*)}{\hat{h}(t, X)} = \frac{\hat{h}_0(t) \exp(\beta' X^*)}{\hat{h}_0(t) \exp(\beta' X)} = \frac{\hat{h}_0(t) \exp(\sum_{i=1}^p \beta_i X_i^*)}{\hat{h}_0(t) \exp(\sum_{i=1}^p \beta_i X_i)} = \exp \left[ \sum_{i=1}^p \beta_i (X_i^* - X_i) \right]$$

The hazard ratio represents the relative instantaneous risk of experiencing an event at time  $t$  in the two groups (the group with covariate values  $X^*$  and the group with covariate values  $X$ ). If the hazard ratio is greater than 1, it indicates an increased risk in the first group compared to the second group. If it is less than 1, it suggests a decreased risk in the first group. A hazard ratio of 1 implies no difference in risk between the two groups.

The Cox proportional hazards model assumes that all explanatory variable values are fixed at baseline and do not change during follow-up. However, time-dependent variables can be included in the model, and the CRM can be extended accordingly. When time-dependent variables are included, the CRM is expressed as follows (Collect, 2015):

$$h(t, X(t)) = h_0(t) \exp \left[ \sum_{i=1}^p \beta_i X_i(t) \right]$$

### 3.2. DATA

This study uses data from the most recent survey on Turkey, the 2017 Türkiye Global Youth Tobacco Survey (GYTS).<sup>2</sup> The GYTS is a cross-sectional, nationally representative school-based survey of students aged 11-17 years to systematically monitor youth tobacco use and track key tobacco control indicators. The survey uses a globally standardised methodology involving a two-stage sample design with selected schools. The survey covers a range of topics, including youth tobacco use, cessation, secondhand smoke, access to tobacco products, the role of media and advertising in tobacco use, and knowledge and attitudes towards tobacco use.

The latest GYTS for Turkey, conducted by the Ministry of Health, was administered to 122,040 secondary and high school students aged 11-17 in 2017. Leveraging existing survey questions, we constructed a pseudo-longitudinal dataset to (i) examine the influence of tobacco taxes (whose values change over time) on the likelihood of respondents starting smoking and (ii) determine the time elapsed until students started smoking. This was done by deriving the year of birth and the year in which the participant first tried smoking from their answers to the questions, 'How old are you?' and 'How old were you when you first tried a cigarette?' On the basis of this information, an annual observation was created for each participant from the age of seven (identified as the earliest reported age of smoking initiation) to the year in which they started smoking. This approach enabled tracking each respondent's timeline leading up to smoking initiation and matching it with relevant contextual variables, such as cigarette prices and tax burdens, for each year observed. Participants who did not respond to the question about the age of first smoking were excluded from the sample. The final dataset included 119,261 individuals. As many participants had not started smoking by the end of the observation period (78,145 in total), the data are right-censored.

Using the 2017 GYTS has a clear advantage for this study in estimating the impact of tobacco taxes on adolescent smoking initiation. During the study period (2007-2017), there were no major policy changes other than changes in cigarette tax rates that could affect smoking initiation; therefore, the estimated tax

<sup>2</sup> Data is available at <https://extranet.who.int/ncdsmicrodata/index.php/catalog/477>. Admittedly, the fact that the data set used is relatively dated is a limitation, as it does not capture more recent developments in tobacco use, such as the increasing prevalence of novel products (e.g. e-cigarettes and heated tobacco products).

and price effects are unlikely to be confounded by concurrent policy interventions, thereby strengthening their identification.<sup>3</sup>

### 3.3. VARIABLES

The dependent variable is the time to smoking initiation, defined as the duration an individual remains a non-smoker. This duration is constructed from responses to the question, ‘How old were you when you first tried a cigarette?’ In the GYTS, age at initiation is reported in two-year intervals (e.g. 12-13 years). When a respondent’s current age coincides with the lower bound of the reported interval, that value is assigned as the initiation age. In all other cases, the initiation age is randomly drawn from the lower or upper bound of the reported interval.<sup>4</sup> The year of smoking initiation was assigned a value of 1, and previous years were coded as 0.

The literature associates adolescent smoking initiation with many factors, depending on the researcher’s objectives and data availability. Based on the literature, we consider the variables listed in Table 1 potentially associated with adolescent smoking initiation.

Smoking has long been perceived as a ‘masculine’ activity. Women smoking, especially in public places, was considered by society to be unseemly and even inappropriate. Over time, as women have become more involved in social life, this sexist view of smoking has diminished. However, academic studies still show that smoking prevalence among men is higher than smoking prevalence among women (Chaloupka & Pacula, 1998; Hawkins et al., 2016; Tüzen & Erbaş, 2018; Diaz et al. 2023). To determine the effect of gender on smoking initiation, we added a *Gender* variable to our model and coded male GYTS participants as 1 and female participants as 0.

There is consensus among social scientists that adolescents’ behaviour is influenced by the people they interact with regularly, such as family members, friends, and teachers. This is because, over time, the observed behaviours of these people become social norms that adolescents should (or should not) follow, or they are adopted as models of appropriate behaviour (Biddle et al., 1980). The same is true for adolescent smoking initiation. Academic studies have shown that, in most cases, adolescents whose parents, friends, and/or teachers smoke are more likely to smoke (Chassin et al., 1996; Powell et al., 2005; Hill et al., 2005; Choi et al., 2011). To capture the influence of parents and teachers on adolescents’ smoking initiation, we included the variables *Parents Smoke* and *Teachers Smoke* in our model.

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<sup>3</sup> The Smoke-Free Zones (SFO) law came into effect in 2008. This prevents us from making a robust estimate of the impact of the SFO law because only 0.7% of the observations in our dataset (all of whom were 17 years old in 2017) were exposed to the period before the SFO law.

<sup>4</sup> For example, if the respondent is 12 years old and stated that he/she started smoking within the 12-13 age range, the age of initiation is recorded as 12. However, if the respondent is 13 years old or older and stated that he/she started smoking within the 12-13 age range, the age of initiation is randomly assigned as either 12 or 13.

**Table 1 / List of variables**

Variable name	Variable label	Source
Smoking initiation (dependent variable)	The year the participant started smoking is 1, previous years are 0.	GYTS
Tax burden	Tax on the price of a pack of top-selling brand in the year the respondent started smoking	Çetinkaya & Marquez (2017)
Real price of a premium brand	Price of a pack of Marlboro cigarettes in the year the respondent started smoking (deflated by using consumer price index, CPI)	Authors' compilation from multiple sources
Real cigarette price index	Cigarette price index level in the year the respondent started smoking (deflated by using CPI)	Turkish Statistical Institute
Gender	1 if male, 0 otherwise	GYTS
Teacher smoke	1 if teachers are smoking inside or outside of school buildings	GYTS
Father's education	Categorical variable 1 Illiterate 2 Literate but primary school was not finished 3 Primary school 4 Secondary school 5 High school 6 Higher education	GYTS
Mother's education	Categorical variable 1 Illiterate 2 Literate but primary school was not finished 3 Primary school 4 Secondary school 5 High school 6 Higher education	GYTS
Parents smoke	Categorical variable 1 None/ don't know (reference category) 2 Both 3 Father only 4 Mother only	GYTS
Pocket Money	Categorical variable 1. I usually don't have any spending money (reference category) 2. TRY 1-10 3. TRY 10.1-20 4. TRY 20.1-30 5. TRY 30.1-40 6. TRY 40.1-50 7. More than TRY 50	GYTS

The variable *Parents Smoke* was derived from the question 'Do your parents smoke tobacco?'. For this question, participants were given five options in the survey: 'None', 'Both', 'Father only', 'Mother only', and 'Don't know'. Respondents who answered 'Don't know' were considered to be in the same category

as those who answered 'None', as they were not exposed to this behaviour even if their parents smoked. Thus, four categories were formed, with 'None/Don't know' as the reference category.<sup>5</sup>

For the *Teachers Smoke* variable, the survey questions, 'During school hours, how often do you see teachers smoking in the school building?' and 'During school hours, how often do you see teachers smoking outdoors on school premises?' were used. The response options for both questions were 'About every day', 'Sometimes', 'Never', and 'Don't know'. The variable *Teachers Smoke* was coded as 1 if one of the answers to these two questions is 'About every day' or 'Sometimes' and 0 otherwise.

Parents play a vital role in children's holistic development. We expect educated parents to positively influence their children's development. Researchers who hypothesise that parents' educational attainment level affects their children's decision to start smoking have generally found that children from educated families are less likely to start smoking (Chassin et al., 1992). We also included parents' educational attainment as explanatory variables in our model to test the effect of parents' educational level on the likelihood that their children will start smoking. For these two variables, the two separate questions asking about the educational level of the respondent's father/mother were used. The response options for both questions in the survey were 'illiterate', 'literate but primary school was not finished', 'primary school', 'secondary school', 'high school', and 'higher education', with the last indicating tertiary education. Accordingly, two categorical variables were created for fathers' and mothers' education separately.

Although empirical studies suggest an inverse relationship between income and smoking, this relationship is reversed for adolescents (Casetta et al., 2017). In this study, to capture the impact of income on adolescents' decisions to start smoking, the *Pocket Money* categorical variable was created based on the question 'During an average week, how much money do you have that you can spend on yourself, however you want?' asked to the participants in the GYTS. As information on participants' allowances are only available for 2017, it is assumed that the position of each participant's allowance on the seven-point ordered scale has not changed over time.

The variables *Real Price of a Premium Brand*, *Real Cigarette Price Index*, and *Tax Burden* were added to the model to show the effect of cigarette taxes on adolescents' decisions to start smoking, which is the main objective of our study. As the price of cigarettes is largely determined by cigarette taxes, as in similar studies, we used the real price of a pack of Marlboro cigarettes and the real cigarette price index level provided by the Turkish Statistical Institute (TURKSTAT) in the years of smoking to examine the effect of cigarette taxes on adolescents' decisions to start smoking. In addition, we used tax burden on cigarettes as an alternative variable, which was calculated by Çetinkaya and Marquez (2017). These were the only time-varying independent variables in our study.

Table 2 presents the descriptive statistics of the variables described above. Since the early 2000s, taxes on cigarettes and, consequently, cigarette prices have shown an upward trend. During the analysis period, the average tax burden was 80.4% and the real price of cigarettes increased by approximately 1.5 times. Roughly half of the respondents were men. In addition, 59% of respondents reported having

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<sup>5</sup> As the GYTS does not include a direct measure of peer smoking (e.g., close friends' smoking behaviour), we are unable to include a standard peer effect variable, despite its importance in the literature (Boachie et al., 2022; Biddle et al., 1980). We explored proxy measures based on school-level smoking prevalence; however, these introduced methodological concerns, as they are derived from the same underlying behaviour as the dependent variable and led to unstable estimates. Therefore, they were not included in the final specification.

seen their teachers smoke during school hours, either inside or outside school buildings. While 45% of respondents had parents who did not smoke, 14% had both parents who smoked. While 7% of the participants reported having no money to spend weekly, 35% had money to spend between 1 and 10 Turkish liras (TRY), 20% had between TRY 10.1 and 20, 15% had between TRY 20.1 and 30, 8% had between TRY 30.1 and 40, 7% had between TRY 40.1 and 50, and 7% had more than TRY 50.

**Table 2 / Descriptive statistics of the study variables**

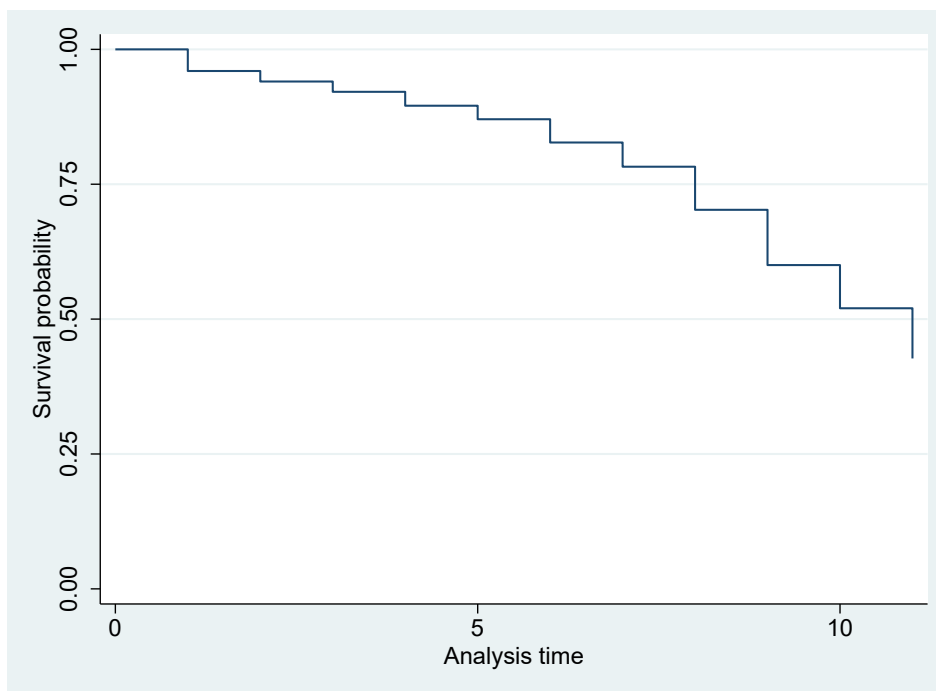
<b>Variable name</b>	<b>Number of observations</b>	<b>Mean / Percentage</b>	<b>Minimum</b>	<b>Maximum</b>
Tax burden	887,808	80.4	73.25	83
Real price of a premium brand	887,808	3.87	2.9	4.4
Real cigarette price index	887,808	165.6	119.6	195.2
Gender	882,106	.48	0	1
Teachers smoke	873,832	.59	0	1
<b>Father's education</b>				
1. Illiterate	836,587	.05	0	1
2. Literate but primary school was not finished	836,587	.05	0	1
3. Primary school	836,587	.25	0	1
4. Secondary school	836,587	.24	0	1
5. High school	836,587	.25	0	1
6. Higher education	836,587	.15	0	1
<b>Mother's education</b>				
1. Illiterate	840,739	.12	0	1
2. Literate but primary school was not finished	840,739	.06	0	1
3. Primary school	840,739	.34	0	1
4. Secondary school	840,739	.23	0	1
5. High school	840,739	.17	0	1
6. Higher education	840,739	.08	0	1
<b>Parents smoke</b>				
1. None / don't know	872,515	.45	0	1
2. Both	872,515	.14	0	1
3. Father only	872,515	.35	0	1
4. Mother only	872,515	.06	0	1
<b>Pocket money</b>				
1. I usually don't have any spending money	884,125	.07	0	1
2. TRY 1-10	884,125	.35	0	1
3. TRY 10.1-20	884,125	.20	0	1
4. TRY 20.1-30	884,125	.15	0	1
5. TRY 30.1-40	884,125	.08	0	1
6. TRY 40.1-50	884,125	.07	0	1
7. More than TRY 50	884,125	.07	0	1

Source: authors' calculations.

## 4. Estimation results

Before examining the impact of the explanatory variables on youth smoking initiation, we first estimate the duration of smoking abstinence using the Kaplan-Meier (KM) method (Figure 2). The estimates indicate that the likelihood of initiating smoking increases with age (year 1 in the figure corresponds to age 7). Up to year 7 (age 13), the probability of initiation remains below 25%; however, after age 13, it rises sharply, reaching 48% at age 16 and nearly 58% at age 17.

**Figure 2 / Kaplan-Meier survival estimation (whole sample)**



Source: authors' calculations.

Second, multivariate extended CRMs were estimated. The estimation results are presented in Table 3. The results show that male students are 54% more likely to start smoking than female students. Students who see their teachers smoking inside or outside school buildings during school hours are 42% more likely to start smoking than those who do not. Children of educated parents (especially those with a high school education or higher) are less likely to start smoking. Students whose parents both smoke are 51% more likely to start smoking than students whose parents do not smoke. Compared with students whose parents do not smoke, those whose father alone smokes are 23% more likely to initiate smoking, while those whose mother alone smokes are approximately 49% more likely to initiate smoking. Finally, compared to students with no money to spend per week, students with a higher amount of money to spend are more likely to start smoking (the opposite result was only found for those with TRY 1-10 to spend). These findings are consistent with previous research discussed in Section 3.3.

**Table 3 / Extended Cox regression estimates (whole sample)**

	(1)	(2)	(3)
Gender	1.542*** (0.0156)	1.542*** (0.0157)	1.541*** (0.0156)
Teacher smokes	1.421*** (0.0155)	1.421*** (0.0155)	1.418*** (0.0155)
<b>Father's education</b>			
1. Illiterate	1	1	1
2. Literate but primary school was not finished	1.171*** (0.0373)	1.172*** (0.0373)	1.172*** (0.0374)
3. Primary school	0.991 (0.0262)	0.991 (0.0263)	0.990 (0.0262)
4. Secondary school	0.979 (0.0262)	0.979 (0.0263)	0.979 (0.0262)
5. High school	0.951* (0.0260)	0.951* (0.0260)	0.952* (0.0260)
6. Higher education	0.898*** (0.0273)	0.898*** (0.0273)	0.899*** (0.0273)
<b>Mother's education</b>			
1. Illiterate	1	1	1
2. Literate but primary school was not finished	1.082*** (0.0278)	1.082*** (0.0278)	1.083*** (0.0278)
3. Primary school	0.971 (0.0186)	0.971 (0.0187)	0.972 (0.0187)
4. Secondary school	0.953** (0.0197)	0.953** (0.0197)	0.955** (0.0197)
5. High school	0.898*** (0.0203)	0.898*** (0.0203)	0.901*** (0.0204)
6. Higher education	0.801*** (0.0233)	0.801*** (0.0233)	0.805*** (0.0234)
<b>Parents smoke</b>			
1. None / don't know	1	1	1
2. Both	1.513*** (0.0217)	1.513*** (0.0217)	1.512*** (0.0217)
3. Father only	1.229*** (0.0145)	1.229*** (0.0145)	1.229*** (0.0145)
4. Mother only	1.490*** (0.0307)	1.490*** (0.0307)	1.490*** (0.0307)
<b>Pocket money</b>			
1. I usually don't have any spending money	1	1	1
2. TRY 1-10	0.880*** (0.0207)	0.880*** (0.0207)	0.880*** (0.0207)
3. TRY 10.1-20	1.075*** (0.0262)	1.076*** (0.0262)	1.072*** (0.0261)
4. TRY 20.1-30	1.228*** (0.0305)	1.229*** (0.0305)	1.221*** (0.0303)
5. TRY 30.1-40	1.333*** (0.0363)	1.334*** (0.0363)	1.323*** (0.0360)
6. TRY 40.1-50	1.350*** (0.0370)	1.352*** (0.0369)	1.337*** (0.0365)
7. More than TRY 50	1.540*** (0.0411)	1.543*** (0.0411)	1.523*** (0.0406)
Tax burden	0.967*** (0.0036)		
Real cigarette price index		0.995*** (0.0004)	
Real price of a premium brand			0.723*** (0.0139)
<i>No. of subjects</i>	106,974	106,974	106,974
<i>No. of obs.</i>	800,924	800,924	800,924

Notes: Estimates reported in the table are hazard ratios rather than regression coefficients. Robust standard errors are shown in parentheses. The Breslow method is used for ties. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5% and 10% levels, respectively.

The three variables used to capture the effect of cigarette taxes on youth smoking initiation were entered separately owing to their high correlation. Column 1 reports results for *Tax Burden*, while columns 2 and 3 use alternative cigarette price measures. All three variables are negatively associated with smoking initiation, indicating that higher taxes and prices reduce the likelihood that adolescents start smoking.

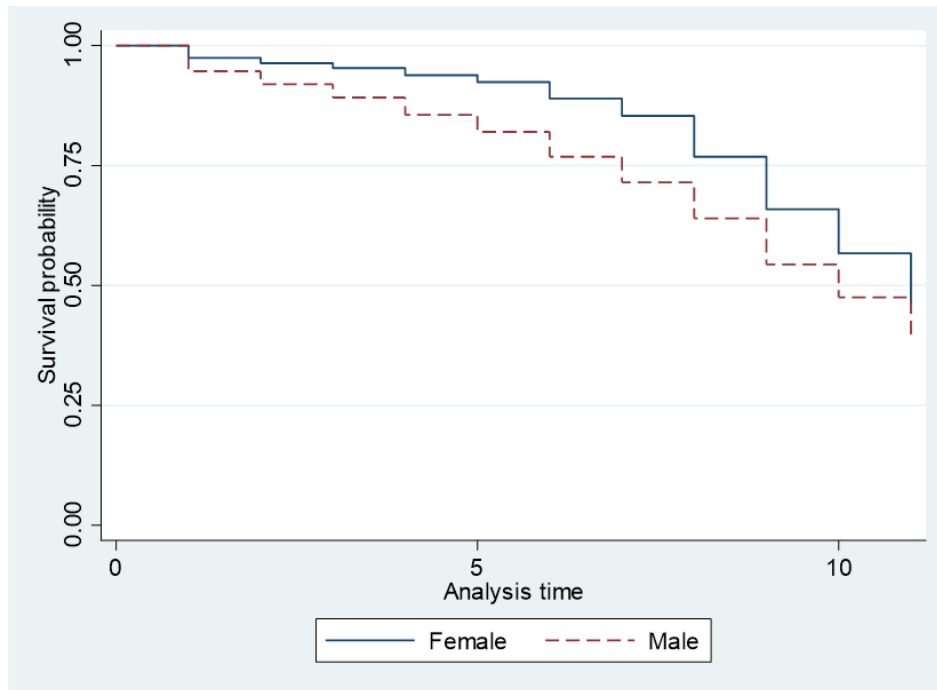
Specifically, a one-unit increase in *Tax Burden* reduces the hazard of smoking initiation by approximately 3.3%. The corresponding effect of a one-unit increase in the *Real Cigarette Price Index* is smaller (about 0.5%), while increases in the *Real Price of a Premium Brand* appear to have a stronger deterrent effect. However, these differences should be interpreted with caution, as they are influenced by the scale of the variables.

As noted earlier, cigarette prices are often used as proxies for cigarette taxes in empirical studies. However, previous research (Kalousova et al., 2020) emphasises that, despite their high correlation with taxes, cigarette prices are also shaped by various market factors, such as production costs and industry pricing strategies. Consequently, estimates based on price measures may either over- or underestimate the true effect of taxes on smoking behaviour. In this study, although all three alternative indicators yield coefficients with consistent signs across estimation methods, their magnitudes differ substantially. This highlights that the estimated effects are sensitive to the specific tax or price measure used and suggests that this issue deserves careful consideration in empirical research. This pattern is also reflected in the elasticity estimates reported below.

To improve interpretation, the models were also re-estimated using logarithmic specifications (Table A.1 in the Appendix). The elasticity estimates imply that a 1% increase in the *Real Cigarette Price Index* reduces the hazard of smoking initiation by approximately 0.74%, while a 1% increase in the *Real Price of a Premium Brand* and *Tax Burden* reduces it by approximately 1.18% and 2.43%, respectively.

To check the robustness of the CRM results, we re-estimate the same models using a split-population survival model (SPSM). Unlike the CRM, which assumes that all subjects (in our case, pupils and students) will experience the event of interest (i.e. initiating smoking), the SPSM assumes that some subjects will never experience the event while simultaneously estimating the probability of experiencing the event and survival time conditional on susceptibility. The estimation results using the SPSM, presented in Table A.2 in the Appendix, confirm the extended CRM results.

Given that smoking behavior often differs by gender, the second stage of the analysis examines whether the effect of cigarette taxes also varies between male and female adolescents. We first estimated Kaplan-Meier survival functions separately by gender. As shown in Figure 3, male adolescents' likelihood of initiating smoking is higher at younger ages, whereas the likelihood increases for females at later ages. By the fifth year (age 11), approximately 18% of males had initiated smoking, compared with less than 8% of females. However, this gap narrows over time, and by age 17 the estimated cumulative initiation rates reach 60% for males and 54% for females.

**Figure 3 / Kaplan-Meier survival estimation (by gender)**

Source: authors' calculations.

Second, we estimated the models separately for male and female adolescents (Table 4). Although the overall results were broadly similar, several gender differences emerged. Male adolescents appear to be more influenced by their mothers' educational level, whereas female adolescents are more affected by parental smoking. In addition, the amount of pocket money received has a stronger effect on smoking initiation among females.

Regarding the tax effect – our main focus – the *Tax Burden* variable was not statistically significant for females. However, the *Real Price of a Premium Brand* had a statistically significant negative effect, although smaller than that observed for males. Using the *Real Cigarette Price Index* variable, a deterrent effect similar to that for males was found. For male adolescents, increases in all three tax-related variables consistently reduced the likelihood of smoking initiation.<sup>6</sup>

We also examined whether the proportional hazards assumption holds for the main policy variables. Schoenfeld residual-based tests indicated evidence of non-proportionality in several specifications. Given the large sample size, however, these tests may detect even small deviations from proportionality. We therefore examined whether the main conclusions remain robust when the effects of the tax and price variables are allowed to vary with log analysis time. The corresponding estimates are reported in Appendix Table A.3.

<sup>6</sup> For male adolescents, the estimated hazard elasticities were  $-1.44$  for the *Real Price of a Premium Brand*,  $-3.21$  for *Tax Burden*, and  $-1.01$  for the *Real Cigarette Price Index*.

**Table 4 / Extended Cox regression estimates (by gender)**

	(1)		(2)		(3)	
	Male	Female	Male	Female	Male	Female
Teachers smoke	1.402*** (0.0202)	1.442*** (0.0239)	1.402*** (0.0202)	1.440*** (0.0239)	1.399*** (0.0201)	1.436*** (0.0238)
<b>Father's education</b>						
1. Illiterate	1	1	1	1	1	1
2. Literate but primary school was not finished	1.223*** (0.0453)	1.069 (0.0635)	1.224*** (0.0454)	1.070 (0.0635)	1.223*** (0.0453)	1.071 (0.0637)
3. Primary school	1.056 (0.0329)	0.893** (0.0439)	1.057* (0.0329)	0.893** (0.0439)	1.055* (0.0329)	0.893** (0.0439)
4. Secondary school	1.008 (0.0321)	0.921* (0.0454)	1.010 (0.0321)	0.921* (0.0454)	1.007 (0.0321)	0.921* (0.0454)
5. High school	0.956 (0.0310)	0.919* (0.0461)	0.957 (0.0310)	0.920* (0.0462)	0.956 (0.0310)	0.922 (0.0461)
6. Higher education	0.920** (0.0338)	0.857*** (0.0465)	0.919** (0.0338)	0.858*** (0.0465)	0.920** (0.0338)	0.860*** (0.0466)
<b>Mother's education</b>						
1. Illiterate	1	1	1	1	1	1
2. Literate but primary school was not finished	1.071** (0.0338)	1.101** (0.0468)	1.070** (0.0339)	1.101** (0.0468)	1.071** (0.0339)	1.101** (0.0468)
3. Primary school	0.964 (0.0232)	0.989 (0.0312)	0.964 (0.0232)	0.990 (0.0312)	0.966 (0.0232)	0.990 (0.0312)
4. Secondary school	0.915*** (0.0239)	1.013 (0.0340)	0.915*** (0.0239)	1.014 (0.0340)	0.917*** (0.0239)	1.016 (0.0341)
5. High school	0.826*** (0.0237)	1.011 (0.0369)	0.826*** (0.0237)	1.011 (0.0369)	0.829*** (0.0238)	1.017 (0.0370)
6. Higher education	0.754*** (0.0280)	0.887*** (0.0410)	0.754*** (0.0280)	0.890** (0.0411)	0.757*** (0.0281)	0.896** (0.0414)
<b>Parents smoke</b>						
1. None / don't know	1	1	1	1	1	1
2. Both	1.353*** (0.0262)	1.730*** (0.0368)	1.353*** (0.0262)	1.729*** (0.0367)	1.353*** (0.0262)	1.727*** (0.0367)
3. Father only	1.219*** (0.0185)	1.246*** (0.0231)	1.219*** (0.0185)	1.246*** (0.0231)	1.219*** (0.0185)	1.245*** (0.0231)
4. Mother only	1.370*** (0.0385)	1.650*** (0.0488)	1.370*** (0.0385)	1.649*** (0.0488)	1.370*** (0.0385)	1.647*** (0.0487)
<b>Pocket money</b>						
1. I usually don't have any spending money	1	1	1	1	1	1
2. TRY 1-10	0.900*** (0.0265)	0.859*** (0.0334)	0.900*** (0.0265)	0.858*** (0.0333)	0.901*** (0.0265)	0.856*** (0.0333)
3. TRY 10.1-20	1.094*** (0.0333)	1.048 (0.0421)	1.095*** (0.0334)	1.044 (0.0419)	1.092*** (0.0333)	1.037 (0.0417)
4. TRY 20.1-30	1.171*** (0.0366)	1.299*** (0.0526)	1.174*** (0.0367)	1.292*** (0.0522)	1.167*** (0.0365)	1.279*** (0.0517)
5. TRY 30.1-40	1.288*** (0.0439)	1.408*** (0.0623)	1.290*** (0.0440)	1.400*** (0.0618)	1.281*** (0.0437)	1.384*** (0.0611)
6. TRY 40.1-50	1.269*** (0.0439)	1.471*** (0.0646)	1.272*** (0.0439)	1.460*** (0.0640)	1.260*** (0.0435)	1.440*** (0.0631)
7. More than TRY 50	1.513*** (0.0497)	1.609*** (0.0713)	1.516*** (0.0497)	1.597*** (0.0706)	1.499*** (0.0492)	1.573*** (0.0696)
Tax burden	0.957*** (0.0043)	0.998 (0.0065)				
Real cigarette price index			0.993*** (0.0005)	0.998*** (0.0006)		
Real price of a premium brand					0.669*** (0.0168)	0.806*** (0.0242)
No. of subjects	52,334	54,640	52,334	54,640	52,334	54,640
No. of obs.	376,539	424,385	376,539	424,385	376,539	424,385

Notes: Standard errors are reported in parentheses, \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5% and 10% levels, respectively.

The interaction terms between the policy variables and log analysis time are consistently below one and statistically significant, indicating that the effects of cigarette taxes and prices are not constant over the risk period. Rather, their deterrent effects become stronger as adolescents move through the risk period. Importantly, this does not contradict the baseline Cox estimates reported in Tables 3 and 4, which reflect average proportional effects over the observation period.

The gender-specific estimates reveal a similar pattern. Among males, all three tax and price measures display statistically significant time-varying deterrent effects. Among females, the interaction terms are also below one, suggesting that the deterrent effects become stronger at later ages, even though the baseline *Tax Burden* coefficient was not statistically significant in the female subsample.

## 5. Conclusion and policy implications

Preventing young people from smoking is one of the two main pillars of anti-smoking policies. Governments adopt a range of anti-smoking measures (e.g. public smoking bans, health warnings, high tobacco taxes, advertising restrictions, and cessation-support programmes) to achieve this goal. Researchers conduct studies to measure the effectiveness of these policies, and the results of these studies guide policy makers in implementing policies.

This study examines how taxes on tobacco products affect youth smoking initiation in Turkey. Using data from the 2017 Türkiye Global Youth Tobacco Survey (GYTS), Cox regression model (CRM) estimates provide insights into the factors associated with smoking initiation among adolescents. The results suggest that young people are negatively influenced by parental and teacher smoking. In addition, adolescents with more educated parents are less likely to initiate smoking, whereas males and those with higher allowances are more likely to do so.

Most importantly, estimations using three alternative tax-related variables (i.e. *Real Price of a Premium Brand*, *Real Cigarette Price Index*, and *Tax Burden*) and two different estimation methods (i.e. extended CRM and split-population survival models) consistently show that increases in cigarette taxes reduce the likelihood of adolescents starting to smoke. Separate estimations by gender further indicate that tax increases have a robust deterrent effect among male adolescents across all specifications, while the effect for females is somewhat weaker but remains evident for key price measures. Additional analyses allowing tax and price effects to vary over time suggest that their deterrent effects become stronger at later ages, indicating that cigarette taxes may play an increasingly important role in preventing smoking initiation as adolescents grow older. The findings also highlight that the estimated magnitude of tax effects is sensitive to the specific tax or price measure used, underscoring the importance of carefully selecting and interpreting these indicators in empirical research.

In line with the study's aim, these results suggest that adolescents are sensitive to price changes, which means that cigarette taxes are an effective policy tool to prevent adolescents from initiating smoking in Turkey. While taxation is an effective tool in reducing smoking prevalence, there are studies (Park et al., 2015) suggesting that this measure should be combined with other policies. Supporting these studies, our results show that tobacco control is not limited to taxation and highlight the importance of other measures, such as parent and teacher education.

While this study provides robust evidence, several limitations have been acknowledged and should be taken into account when interpreting the results. The analysis relies on retrospective information, as the 'year in which the participant first tried smoking' is assumed to correspond to the initiation year, and students' allowance levels are treated as constant over time. In addition, the dataset used is relatively dated and does not capture more recent developments in tobacco use. Finally, the analysis does not include a direct measure of peer effects due to data limitations; although proxy variables were explored, they were not included in the final specification because they introduced methodological concerns.

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# Appendix

**Table A.1 / Coefficient estimates from logarithmic extended Cox regression models (whole sample)**

	(1)	(2)	(3)
Gender	0.434*** (0.0102)	0.434*** (0.0102)	0.433*** (0.0102)
Teachers smoke	0.352*** (0.0110)	0.352*** (0.0109)	0.350*** (0.0109)
<b>Father's education</b>			
1. Illiterate	1	1	1
2. Literate but primary school was not finished	0.159*** (0.0319)	0.159*** (0.0319)	0.159*** (0.0319)
3. Primary school	-0.009 (0.0265)	-0.008 (0.0265)	-0.010 (0.0265)
4. Secondary school	-0.021 (0.0268)	-0.020 (0.0268)	-0.021 (0.0268)
5. High school	-0.050* (0.0273)	-0.049* (0.0273)	-0.049* (0.0273)
6. Higher education	-0.107*** (0.0304)	-0.107*** (0.0304)	-0.106*** (0.0304)
<b>Mother's education</b>			
1. Illiterate	1	1	1
2. Literate but primary school was not finished	0.079*** (0.0257)	0.079*** (0.0257)	0.080*** (0.0257)
3. Primary school	-0.029 (0.0193)	-0.029 (0.0193)	-0.028 (0.0193)
4. Secondary school	-0.048** (0.0207)	-0.048** (0.0207)	-0.046** (0.0207)
5. High school	-0.107*** (0.0227)	-0.107*** (0.0227)	-0.104*** (0.0227)
6. Higher education	-0.222*** (0.0292)	-0.222*** (0.0291)	-0.217*** (0.0291)
<b>Parents smoke</b>			
1. None / don't know	1	1	1
2. Both	0.414*** (0.0144)	0.414*** (0.0144)	0.414*** (0.0144)
3. Father only	0.207*** (0.0118)	0.207*** (0.0118)	0.207*** (0.0118)
4. Mother only	0.399*** (0.0206)	0.399*** (0.0206)	0.399*** (0.0206)

contd.

**Table A.1 / Continued**

	(1)	(2)	(3)
<b>Pocket money</b>			
1. I usually don't have any spending money	1	1	1
2. TRY 1-10	-0.129*** (0.0236)	-0.128*** (0.0236)	-0.128*** (0.0236)
3. TRY 10.1-20	0.074*** (0.0244)	0.074*** (0.0244)	0.070*** (0.0244)
4. TRY 20.1-30	0.206*** (0.0248)	0.207*** (0.0248)	0.200*** (0.0248)
5. TRY 30.1-40	0.289*** (0.0272)	0.289*** (0.0272)	0.281*** (0.0272)
6. TRY 40.1-50	0.302*** (0.0273)	0.302*** (0.0273)	0.292*** (0.0273)
7. More than TRY 50	0.434*** (0.0267)	0.434*** (0.0266)	0.422*** (0.0267)
Tax burden	-2.425*** (0.2897)		
Real cigarette price index		-0.740*** (0.0666)	
Real price of a premium brand			-1.176*** (0.0737)
No. of subjects	106,974	106,974	106,974
No. of obs.	800,924	800,924	800,924

Notes: Standard errors are reported in parentheses, \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5% and 10% levels, respectively.

**Table A.2 / Split-population model estimates**

	(1)	(2)	(3)
Gender	1.568*** (0.019)	1.554*** (0.017)	1.554*** (0.017)
Teachers smoke	1.438*** (0.017)	1.439*** (0.017)	1.438*** (0.016)
<b>Father's education</b>			
1. Illiterate	1	1	1
2. Literate but primary school was not finished	1.184*** (0.038)	1.178*** (0.037)	1.178*** (0.037)
3. Primary school	0.986 (0.027)	0.995 (0.026)	0.995 (0.026)
4. Secondary school	0.974 (0.027)	0.981 (0.026)	0.981 (0.026)
5. High school	0.950* (0.027)	0.951* (0.026)	0.951* (0.026)
6. Higher education	0.895*** (0.028)	0.897*** (0.027)	0.897*** (0.027)
<b>Mother's education</b>			
1. Illiterate	1	1	1
2. Literate but primary school was not finished	1.092*** (0.029)	1.083*** (0.027)	1.083*** (0.027)
3. Primary school	0.973 (0.019)	0.970 (0.019)	0.970 (0.019)
4. Secondary school	0.957** (0.021)	0.950** (0.020)	0.950*** (0.020)
5. High school	0.901*** (0.020)	0.892*** (0.020)	0.892*** (0.020)
6. Higher education	0.803*** (0.024)	0.790*** (0.023)	0.791*** (0.023)
<b>Parents smoke</b>			
1. None / don't know	1	1	1
2. Both	1.549*** (0.025)	1.533*** (0.023)	1.533*** (0.023)
3. Father only	1.242*** (0.016)	1.237*** (0.015)	1.237*** (0.015)
4. Mother only	1.522*** (0.034)	1.508*** (0.032)	1.508*** (0.032)
<b>Pocket money</b>			
1. I usually don't have any spending money	1	1	1
2. TRY 1-10	0.877*** (0.021)	0.878*** (0.021)	0.878*** (0.021)
3. TRY 10.1-20	1.072*** (0.027)	1.093*** (0.027)	1.091*** (0.027)
4. TRY 20.1-30	1.228*** (0.032)	1.263*** (0.031)	1.259*** (0.031)
5. TRY 30.1-40	1.337*** (0.039)	1.377*** (0.038)	1.373*** (0.038)
6. TRY 40.1-50	1.346*** (0.039)	1.406*** (0.043)	1.401*** (0.043)
7. More than TRY 50	1.543*** (0.044)	1.613*** (0.043)	1.606*** (0.043)

contd.

**Table A.2 / Continued**

	(1)	(2)	(3)
Tax burden	0.893*** (0.003)		
Real cigarette price index		0.991*** (0.001)	
Real price of a premium brand			0.658*** (0.013)
No. of obs.	800,924	800,924	800,924

Notes: Standard errors are reported in parentheses, \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5% and 10% levels, respectively.

**Table A.3 / Cox models with time-varying coefficients for tax and price variables**

Variable	Whole sample		Male		Female	
	Main HR	TVC HR	Main HR	TVC HR	Main HR	TVC HR
Tax burden	1.030*** (0.0048)	0.881*** (0.0051)	1.027*** (0.0058)	0.875*** (0.0061)	1.044*** (0.0083)	0.904*** (0.0093)
Real cigarette price index	1.000 (0.0007)	0.996*** (0.0004)	1.000 (0.0009)	0.995*** (0.0006)	1.003** (0.0012)	0.997*** (0.0007)
Real price of a premium brand	1.042 (0.0367)	0.766*** (0.0163)	1.016 (0.0440)	0.720*** (0.0197)	1.183*** (0.0720)	0.775*** (0.0270)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
No. of subjects	106,974	106,974	52,334	52,334	54,640	54,640
No. of obs.	800,924	800,924	376,539	376,539	424,385	424,385

Notes: Estimates are hazard ratios (HR). Robust standard errors clustered at the individual level are reported in parentheses. Each model includes the same control variables as in Tables 3 and 4. 'Main HR' refers to the main component of the relevant tax or price variable in the time-varying coefficient model. 'TVC HR' refers to the time-varying component, specified as the interaction between the relevant tax or price variable and log analysis time, using `tvvc()` and `tevp(ln_t)`. \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels, respectively.



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