wiiw HEPA
HEALTH ECONOMICS AND POLICY ANALYSIS

1958
INSTITUTE OF ECONOMIC SCIENCES
COGNOSCERE EST MUTARE

NOVEMBER 2024
wiiw HEPA Research Study 5

Time-varying elasticities of demand for cigarettes in Serbia

Aleksandar Zdravković, Jovan Zubović and Boban Nedeljković

The Vienna Institute for International Economic Studies
Wiener Institut für Internationale Wirtschaftsvergleiche

Time-varying elasticities of demand for cigarettes in Serbia

ALEKSANDAR ZDRAVKOVIĆ
JOVAN ZUBOVIĆ
BOBAN NEDELJKOVIĆ

Aleksandar Zdravković is Senior Research Associate at the Institute of Economic Sciences in Belgrade. Jovan Zubović is Principal Research Fellow at the Institute of Economic Sciences (IES). Boban Nedeljković is Research Associate at Institute of Economic Sciences in Serbia.

This research was funded by the Vienna Institute for International Economic Studies (wiiw). Wiiw is a partner of the Bloomberg Philanthropies' Initiative to Reduce Tobacco Use. The views expressed do not necessarily reflect the views of wiiw or Bloomberg Philanthropies.

The authors are grateful for comments from wiiw.

Abstract

This study challenges the conventional assumption of constant price elasticity of cigarette demand by demonstrating that taxation and pricing practices can induce structural changes in consumption behaviour. The results reveal that larger, unexpected price increases lead to stronger demand responses, whereas predictable, moderate tax hikes – like those currently applied in Serbia – make demand more inelastic, especially regarding smoking intensity. Consequently, the study concludes that tobacco control policies based on regular, predictable tax adjustments are less effective and instead recommends introducing less predictable, larger tax increases to achieve stronger public health impacts.

Keywords: time-varying elasticity, tobacco taxation, cigarette prices, household budget survey, Serbia

JEL classification: I18, D12, H21

CONTENTS

TABLES AND FIGURES

Executive summary

Background

This study examines the time-varying relationship between cigarette demand and its key determinants in Serbia. Understanding how price elasticity of demand evolves over time provides important insights for designing effective fiscal and health policies. Given the high prevalence of smoking in Serbia despite frequent increases in tobacco taxes under the excise calendar, analysing how consumers' sensitivity to price changes develops across different periods is crucial for evaluating the sustainability and effectiveness of tobacco taxation policy.

Methodology

The study employs an econometric framework based on a rolling regression approach to estimate price and income elasticities of cigarette demand using data from Serbian household budget surveys. Assuming that elasticities vary over time, a two-part model is employed to separately estimate the prevalence and intensity components of price and income elasticities across five-year rolling subperiods from 2006 to 2022, resulting in a total of 12 estimation windows.

Results

The empirical analysis shows that both the prevalence and intensity components of cigarette price elasticity tend to fluctuate over time. Changes in the magnitude of total price elasticity appear to be closely linked to variations in the size of price adjustments. Although the prevalence component varies across periods, no evidence is found in support of the hardening hypothesis. The intensity component tends to decline during periods of small and predictable price increases. On the other hand, income elasticity exhibits a steady upward trend throughout the observed period.

Conclusion

This study challenges the conventional assumption of constant price elasticity of cigarette demand by demonstrating that taxation and pricing practices can induce structural changes in consumption behaviour. The results reveal that larger, unexpected price increases lead to stronger demand responses, whereas predictable, moderate tax hikes – like those currently applied in Serbia – make demand more inelastic, especially regarding smoking intensity. Consequently, the study concludes that tobacco control policies based on regular, predictable tax adjustments are less effective and instead recommends introducing less predictable, larger tax increases to achieve stronger public health impacts.

1. Introduction

Despite the many efforts made in previous decades to minimise its harm, tobacco use remains one of the greatest threats to public health. According to estimations of the World Health Organization (WHO 2023), the use of tobacco is directly responsible for over 8 million deaths each year around the world, whereby this risk is unevenly distributed, as 80% of smokers reside in low- and middle-income countries (LMICs). Serbia, a middle-income country, ratified the WHO's Framework Convention on Tobacco Control (FCTC) in 2006. In the following years, it enacted multiple related laws, launched several public health strategies and started to implement tobacco control measures, including the introduction of a so-called 'excise calendar' pursuant to the 2007 Law on Excises, which stipulates increases in specific taxes. Beginning in 2012, amendments to this law established a practice of semi-annual growth of the specific excise predefined over the five-year period. Over time, industry has responded to the excise calendar by increasing the retail price of tobacco products – by 10 Serbian dinars (RSD), or approximately EUR 0.08 – on a semi-annual basis regardless of the growth of the specific excise, which eventually resulted in highly predictable dynamics and size of changes in retail prices. Amendments to the Law on Excises have also stipulated that the specific excise is occasionally subject to indexation for inflation. More specifically, legislation prescribes indexation of cigarette prices if inflation is above 2%, which was the case in 2023 and 2024.

The initial effects of the introduction of tobacco control measures and the excise calendar in Serbia were quite successful. A study by Zubović et al. (2019) covering the 2006-2017 period shows that smoking prevalence (cigarettes) in Serbia sharply declined, from around 49.7% in 2006 to 34.4% in 2014, followed by the respective drop in the monthly average of cigarette packs smoked per household. However, the same study indicates that the prevalence and intensity of smoking stagnated over the 2015-2017 period. According to more recent data (WHO 2023), in 2021, Serbia was the European country with the highest percentage of daily smokers among the adult population (33%), which indicates that the pace of decline in smoking prevalence substantially slowed down.

One of the likely reasons for the recent failure of efforts to reduce smoking in Serbia is an increase in the affordability of cigarettes that has been observed in the last couple of years. According to the latest edition of Cigarette Tax Scorecard (Drope et al. 2024), Serbia received an overall score of 2.5 (out of 5) in 2022, which is comparably lower compared to 2020 (3.25) and 2018 (3.88), indicating reversed progress on tobacco taxes (i.e. that income growth likely exceeded the effect of taxation increase). This difference can primarily be attributed to a decrease in the affordability change score, which was 5 in 2018, 3 in 2020, and 0 in 2022, while the remaining three components of the overall score (i.e. absolute price, tax share and tax structure) received the same ratings in 2022 as in 2020 (3, 4 and 3, respectively), which were highly similar to the ratings of 2018 (2, 4.5 and 3, respectively). In this study, we analyse whether the substantial slowing down in smoking reduction observed since 2015 can be solely attributed to the increasing affordability of cigarettes vis-à-vis the hypothesis that implementation of control measures (in particular, the excise calendar) has resulted in structural changes in consumer demand that have reduced the effectiveness of tobacco taxation over time.

Within a microeconomic analytical framework, structural changes in consumer behaviour are observed through changes in price and income elasticities estimated from consumer demand equations. In other words, switching between different regimes of consumer behaviour imposes the concept of elasticity that varies over time in line with regime-switching dynamics. While studies on varying elasticities of demand for some other goods that are subject to regulated pricing are quite common in the literature – such as demand for electricity (Chern and Bouis 1988; Inglesi-Lotz 2011; Liddle and Hasanov 2023) and demand for gasoline (Mikayilov et al. 2020; Kilian and Zhou, 2024) – the studies of varying elasticities of demand for tobacco products are extremely rare. Nevertheless, a few existing studies on the subject indicate that these elasticities may indeed vary (Huang et al. 2004; Dautzenberg and Dautzenberg 2019; Olesiński et al. 2020).

Traditional studies on tobacco demand often assume that price elasticity is constant, using historical data to predict how tax-driven price changes affect public revenue. However, this approach overlooks broader shifts in taxation policies and industry pricing strategies that may influence consumer behaviour. This study challenges the assumption of constant price elasticity by analysing Serbian household budget data from 2006 to 2022.

The main objective of this study is to examine whether the price and income elasticities of demand for cigarettes did vary over time and, if so, to examine the following research questions:

1. Does the size of a price change affect the size of the respective response of demand for cigarettes, as suggested by Dautzenberg and Dautzenberg (2019)?
2. Does the price elasticity of smoking prevalence decline over time, as suggested by the ‘hardening hypothesis’?
3. Do the predictable dynamics and size of price changes affect the respective response of demand for cigarettes?

The starting point of our analysis is the study by Vladisavljević et al. (2021) estimating the price and income elasticity of demand for cigarettes in Serbia over the 2006-2017 period (at -0.659 and 1.058, respectively), using data from Serbian household budget surveys. We extended this analysis with more recent data and applied two-part model to estimate variations in prevalence and intensity elasticities of demand for cigarettes over the 2006-2022 period, using data from Serbian household budget surveys.

The rest of the paper is organised as follows. Section 2 summarises the findings from the few studies on this issue in the existing literature. Section 3, on data and methods, discusses the sources and features of the data used as well as the empirical strategy of estimation. Section 4, on stylised facts, provides insight into the dynamics of cigarette prices and affordability as well as households’ use of tobacco products. Section 5 presents and discusses key outcomes from the empirical estimates. Lastly, Section 6 summarises the key findings and limitations of the research before providing policy recommendations and possible directions for future research.

2. Literature Review

While variations in elasticity of demand for cigarettes within one country have rarely been the subject of research, the vast majority of studies examine aggregate price and income elasticities of demand for tobacco products. Before presenting the findings of the studies that focused on time variations in elasticity, we briefly introduce general findings on tobacco price (and income) elasticities from the overall estimations and aggregate data based on different data sources. Using the Global Adult Tobacco Survey (GATS) data from 13 LMICs surveyed between 2008 and 2011, Kostova et al. (2014) estimated the total price elasticity of cigarette demand of approximately -0.53 (-0.36 for smoking prevalence and -0.17 for smoking intensity). Nargis et al. (2021) have made separate estimations for 45 high-income countries (HICs) and 124 LMICs using 2007-2016 data from various sources (e.g. Euromonitor International, the International Monetary Fund and the World Bank). Their analysis showed comparable price elasticities (-0.21 for LMICs and -0.36 for HICs) but different income elasticities (-0.16 for HICs and 0.32 for LMICs). This may indicate that cigarettes are perceived as inferior products in HICs, where consumption tends to decrease with income growth, whereas it tends to increase with income growth in LMICs, suggesting that cigarettes are perceived as a normal good in these countries. Similar estimates can be found for individual LMICs in the region. For instance, in the case of Bosnia and Herzegovina (Gligorić et al. 2022), where Household Budget Survey (HBS) data from 2007, 2011 and 2015 were used, the estimations were -1.01 for price elasticity and 0.81 for income elasticity. For Albania, Gjika et al. (2020), using Living Standard Measurement Survey (LSMS) data from 2012, estimated a price elasticity of -0.57 and an income elasticity of 0.24. Taken together, these data are in line with meta-analytic estimates from the early 2000s (Gallet and List 2003), which showed an average price elasticity of -0.48 (with estimates ranging between -3.12 and 1.41) and an average income elasticity of 0.42 (with estimates ranging between -0.80 and 3.03), indicating differences between studies and countries.

Previous studies that tracked the changes in elasticity over time have produced valuable insights. Using cigarette market data from 1961 to 2002 from 42 US states and Washington, D.C., Huang et al. (2004) have estimated a price elasticity of -0.41 and an income elasticity of 0.06. In addition, they observed some specific trends and sharp changes that are worthy of attention. In general, the magnitude of price elasticity appeared to decline (in terms of absolute value) over time, indicating that as more people quit smoking, the remaining (‘hardcore’) smokers become less sensitive to price changes. The sharp decline in the magnitude of price elasticity around 1992 is considered to be the consequence of the tax share reaching a bottom value of about 25% of the price. On the other hand, income elasticity was continuously declining (but staying positive), especially since early 1990s, with some differences in the pace of decline depending on the type of income. The fast decline (in terms of absolute value) after 1992 was observed for dividend income elasticity (with slightly negative values after 1996, reaching -0.03 in 2022), suggesting that higher-income individuals with dividend income were quitting or reducing smoking, with anti-smoking campaigns being one of the possible reasons. Similarly, transfer income (i.e. pensions and welfare payments) elasticity also noticeably declined after 1990 (reaching negative values of around -0.03 in 2001 and 2002), probably because the elderly and the poor faced limitations when it came to affording more cigarette consumption once prices rose. The decline in earning income elasticity was the slowest compared to the other two components, with a mild increase as of 2000, which the authors regarded as the possible counter-cyclical character of tobacco consumption during periods of recession.

Meta-analysis of the several studies from South Africa indicated that price elasticity varies over time. Using data from 1970 to 1989, van Walbeek (1996) estimated that price elasticity ranges between -0.53 and -1.52. Two subsequent studies (Van der Merwe and Annett 1998; van Walbeek 2000, as cited in Mukong and Tingum 2020), which used 1970 as the starting point and 1995 and 1998 as the endpoints, estimated price elasticities of -0.69 and -0.60, respectively. Unlike these studies, which are characterised by substantial overlap in the observed period, Boshoff (2008) used quarterly data from 1996 to 2006 and estimated price elasticity between -0.5 and -0.7. On the other hand, using data from 2008 to 2014, Mukong and Tingum (2020) found that elasticity is -0.43 for economy-price cigarettes and -0.69 for mid-price brands. Altogether, these studies show not only that price elasticity tends to vary, but also that it tends to exhibit a mild decrease (in terms of absolute value) over time.

The observed trend might seem to provide some support for the hardening hypothesis, which suggests that once smoking prevalence declines due to 'light' smokers quitting, then the remaining 'hardcore' smokers tend to be less sensitive to price measures and to intensify their smoking instead. Still, it is important to note that many studies have rejected this hypothesis. For example, using the data from 18 European countries, Fernández et al. (2015) showed that country-level prevalence tends to relate positively to the proportion of highly dependent smokers. Although the correlation was not significant, this indicated a 'softening' trend (as opposed to the hardening hypothesis), meaning that the share of highly dependent smokers tends to be lower when the smoking prevalence is lower in the population. Kulik and Glantz (2016) provided additional support for the 'softening' alternative using data from 51 US states and 31 European countries. Their study showed that for every 1% decrease in smoking prevalence, quit attempts increased by 0.55% in the US and remained stable in Europe, while the individual-level consumption decreased in both the US and the European countries, by 0.32 and 0.22 cigarettes per day, respectively. Similar results were reported for Australia and South Korea, where quit attempts and quit ratios tend to increase when smoking prevalence declines, while the share of 'hardcore' smokers tends to decrease (Brennan et al. 2020; Jung et al. 2024).

Even though a different type of data was used, findings from Poland also indicated time-varying price elasticity. Olesiński et al. (2020) analysed the 2005-2014 period using retail sales volume and retail prices of the low- and high-price segments of the cigarette market. The price elasticity of demand for both of these segments was estimated to be around -0.5 in 2008, ending up at around -1.0 in 2014. However, the hump-shaped pattern of fluctuation was observed for both segments: low-price-segment elasticity started declining (in terms of absolute value) in 2010, when it reached the value of around -0.18, while high-price-segment elasticity achieved the lowest level (in terms of absolute value), of approximately -0.18, in 2012. The authors hypothesised that the changes in elasticity in both segments were likely due to market circumstances (e.g. an increase in the popularity of e-cigarettes and the rise of shadow market products).

The very important findings on the dynamic response in demand for cigarettes to changes in price are also provided by the analysis of Dautzenberg and Dautzenberg (2019). They investigated the association between magnitude of change in price and change in sales of cigarettes in France in the 2008-2018 period, concluding that this relation is not proportional: a higher increase in prices leads to a more elastic respond in cigarette sales. More specifically, they figured out that an increase of more than 6% of the price of cigarettes produces a significant fall in sales (elasticity above -0.8), while an increase in the price of less than 5% is ineffective, as it leads to a very inelastic response in demand for cigarettes (elasticity below -0.5).

While the increase in tobacco taxes stands out as the long-term goal of national fiscal and health policies all over the world, fiscal authorities in most of the countries make ad hoc decisions on the exact size of increases in excises on an annual basis. The public announcement of the multiannual schedule of tobacco taxation, which stipulates the exact dates and amounts of increases in tobacco excises a couple of years ahead of time (which was implemented in Serbia by the introduction of an excise calendar), is not commonly applied in practice. Some other notable examples of pre-announced multiannual schedules of increases in tobacco taxes can be found in Bulgaria, New Zealand and Poland. In 2010, the government of New Zealand adopted a plan to implement a 10% annual increase in the excise on cigarettes between 2010-2017 (Li et al. 2017). More recent cases include the 2022-2027 excise road map in Poland and the 2023-2026 excise calendar in Bulgaria. In 2023, Bulgaria adopted a four-year excise calendar that prescribes a 5% annual increase in the excise on manufactured cigarettes (Sabev et al. 2023). The excise road map 2022-2027 that was adopted by the Polish government initially envisaged an 10% annual increase in the excise on cigarettes, but the plan was changed in 2024 to increase excise taxes on cigarettes by 25%, 20% and 15%, respectively, over the next three years (Government of Poland 2025).

Serbia's multiannual schedule of tobacco taxation is distinctive from other similar cases in at least two aspects. First, due to the practice of biannual changes in excises, the trend in the increases of tobacco taxation appears to be very smooth. Second, regardless of the size of the excise increase, the industry in Serbia responds by raising the price of a pack of all brands of cigarettes by RSD 10, whereas the industry in other countries adjusts prices based on the size of the increase of the excise and manipulates prices across market segments.

Since the practice of the pre-announced multiannual scheduling of tobacco taxation is rarely implemented, the possible association between the predictability of an increase in tobacco taxes/prices and demand for tobacco products is not frequently explored. One of the rare studies on this subject is that of Li et al. (2017), who explored the short-term behavioural response to the fifth (2014) and sixth (2015) rounds of New Zealand's series of annual pre-announced tobacco excise increases. Using self-reported data collected in the three months before and after each increase, the authors find no statistically significant change in smoking- or product-related behaviours immediately following those two increases, although overall cessation-related activity in the sample was high over the course of the entire period of observation. On the other hand, findings of a similar study (Hanewinkel and Isensee 2007), which examined a series of uneven tobacco excise increases in Germany between 2002 and 2005, indicate behavioural changes of smokers and significant associations between the magnitude of the price increase and the intentions of smokers to reduce or quit smoking.

In recent years, there have been several studies attempting to estimate elasticities of demand for cigarettes in Serbia. Applying the Engle-Granger cointegration method to 2002-2016 macroeconomic data, Jovanovic et al. (2018) provided price-elasticity estimates between -0.76 and -0.62 and income-elasticity estimates between 0.34 and 0.39. In a subsequent study (Vladisavljević et al. 2020), Deaton's model was applied to 2006-2017 HBS data, producing an estimated price elasticity of -0.639. Vladisavljević et al. (2021) subsequently combined methods of two-part modelling and Deaton's model to re-estimate both price elasticity and income elasticity, including separate estimations for three income groups (i.e. low, middle and high). Nevertheless, none of those studies have attempted to examine whether the elasticity of demand for cigarettes varies (i.e. to see if some structural change in demand for cigarettes occurred over time).

3. Data and Methods

3.1. DATA

The data used to estimate the demand elasticity for cigarettes comes from the Household Budget Survey (HBS), a nationally representative survey on the income and consumption of households that is conducted as a repeated cross-section. It is implemented by national statistical offices in all European countries under the methodological guidance of Eurostat. The Statistical Office of the Republic of Serbia (SORS) has been conducting a HBS annually since 2006, with the exemption of 2020, when it was cancelled out due to COVID-19 pandemic. Therefore, our sample consists of 16 annual HBSs covering the period 2006-2022 period and comprising a total of 86,768 observations.

It is important to mention that the HBSs record consumed quantities of goods and the respective value of expenditures, meaning that the prices of cigarettes are computed in two steps. First, prices at the level of households are proxied by the unit costs of a pack of cigarettes, calculated as the ratio between total household expenditure on cigarettes and quantities of cigarette packs consumed (Data on the consumption of individual household members are not available in Serbian HBSs). In the second step, prices at the level of municipality are computed as the average unit cost (if at least three smoking households are recorded within the municipality) and imputed to all households within the municipality in order to mitigate the possible issue of endogeneity stemming from the simultaneous determination of demand for cigarettes and cigarette prices.

3.2. EMPIRICAL STRATEGY

The empirical strategy of this study revolves around the idea that structural changes in smoking behaviour over time impose varying elasticities of demand for cigarettes following the respective changes in the parameters describing the cigarette demand function. In order to model these variations, the empirical strategy applied in this paper utilises three building blocks. The first block is a general approach to setting up the model to estimate the demand elasticity for cigarettes in Serbia. The second block boils down the general approach to estimating demand elasticity to a specific approach to estimate time-varying elasticities, with the goal being to analyse covariations between estimated elasticities and changes in prices/income over time. Lastly, the third block deals with empirical specifications of the regression model.

General specification of the varying-parameter model

The central assumption of the varying-parameter linear models is that regression coefficients depend on some covariates. In other words, varying-parameter models are linear in regressors, but their coefficients are changing with the value of other variables. The general specification of the varying-parameter linear regression, simplified to only one explanatory variable and only one covariate-modifying regression coefficient, reads as follows (Park et al. 2013):

$$E(Y|X = x, Z = z) = xf(z) \quad (1.1)$$

where Y is a dependent variable, X is an explanatory variable, f is a coefficient function, and Z is the covariate-affecting value of the coefficient function. The dependence of the regression coefficient on covariate Z implies a special sort of interaction between Z and X: in some cases, Z is indistinguishable from X, while in other cases Z can be a special variable, such as time (Hastie and Tibshirani 1993). For instance, in the literature dealing with modelling variations in demand for energy, factors such as changes in the structure and development level of an economy, behavioural changes of consumers, and new socioeconomic or energy-related policies are considered covariates that may modify response of demand for energy to changes in energy prices. In a similar manner, socioeconomic changes and changes in tobacco-control and -taxation policies can be considered a possible factor that may induce structural changes in demand for cigarettes with respect to prices.

The major issue with varying-parameter models is the complexity of their econometric estimation, which usually relies on non-standard numeric estimation methods. However, in this study, we utilise a simple approach of rolling regressions, which are regressions applied to rolling subperiods ('windows') within the total period, similar to what was done in Chern and Bouis (1988), Huang et al. (2004), and Kilian and Zhou (2024). The direct benefit of this simplified approach is that it makes it possible to apply standard econometric methods to estimate demand functions (e.g. two-part modelling), resulting in time series of estimated elasticity that may be very useful to detect structural changes in consumer behaviour (Chern and Bouis 1988). More specifically, the pattern of variations in elasticity over time may reveal if there was some break point in time in which structural change occurred. Subsequently, any detected break point can be used to partition the sample into subperiods, estimate regressions for subperiods, and test the hypothesis that a difference in responses of demand to a variable of interest is indeed statistically significant with respect to the break point. We adopted this approach in the context of our study to examine the third research question (i.e. whether the predictability of cigarette pricing led to any change in demand for cigarettes). In addition, the declining trend of estimated prevalence elasticities can be considered preliminary evidence in support of the hardening hypothesis before it is further scrutinised using statistical tests. Regarding the first research question (i.e. whether the predictable dynamics and size of price changes affect the respective response of demand for cigarettes), we simply associate time series of price changes with time series of estimated price elasticities to gauge the level of correlation (as described latter in this section).

Two-part modelling

The first block relies on the general setup of the two-part model (Belotti et al. 2015), which was further adjusted to model demand elasticity for cigarettes (John et al. 2023). Basically, two-part modelling is an approach to regression analysis that can be applied to random variables with mixed discrete-continuous distribution (Belotti et al. 2015). More specifically, if random variable y produces two outcomes ($y_i = 0$ and $y_i \geq 0$) frequently enough to plausibly indicate that there are substantial reasons to separately model those two outcomes, the two-part model provides a general framework for how to perform it.

In the first part, a binary choice model is utilised to fit probability of observing a positive-versus-zero outcome:

$$\pi(y > 0) = Pr(y > 0|x) = F(x\delta) \tag{1.2}$$

where x is a vector of explanatory variables, δ is the corresponding vector of parameters to be estimated, and F is the cumulative distribution function of the error term.

In the second part, an appropriate regression model is utilised to fit positive outcome with respect to explanatory variables, conditional on a probability of having positive outcome:

$$\pi(y|y > 0, x) = g(x\gamma) \tag{1.3}$$

where g is a density function for $y|y > 0$. Subsequently, overall mean reads as the product of expectations from both parts of the model:

$$E(y|x) = Pr(y > 0|x) \text{ x } E(y|y > 0, x) \tag{1.4}$$

In recent years, many empirical studies have applied two-part modelling to estimate demand elasticity for cigarettes with respect to price and income, using data from HBSs (Zubović et al. 2019; Vladisavljević et al. 2020; Vladisavljević et al. 2021; Gligorić et al. 2022; Lichner and Ostrihoň 2024). The empirical strategy based on a two-part model to fit demand for cigarettes using HBS data is described in detail in the *Updated Toolkit on Using Household Expenditure Surveys for Research in the Economics of Tobacco Control* (John et al. 2023). The main idea behind this empirical strategy is to use two-part modelling to model the probability of smoking prevalence for a household (h) in the first part, and then to model intensity of smoking in the second part if this household is a smoking one. The key points in this modelling are:

a) Total sample of n households is divided into subsamples of smoking households n^s and non-smoking households n^{ns}, so that prevalence indicator I_h has two possible outcomes:
   - $I_h = 1, \;\; h \in n^s$ or
   - $I_h = 0, \;\; h \in n^{ns}$

b) The first part of the two-part model uses the full sample n to estimate the probability of prevalence, meaning the probability of observing a positive outcome (i.e. a smoking household) versus a zero outcome (i.e. a non-smoking household). More specifically, the following model is estimated:

$$Pr(I_h = 1|x) = F(x_h\delta), \;\; x_h = \{p_h, m_h, x_h^c\} \tag{1.5}$$

   assuming that F takes the form of logit function $f(z) = e^z/(1 + e^z)$, $z = x\delta$. The vector of explanatory variables (x_h) is assumed to contain price p_h and income m_h as key explanatory variables, thus segregated from the control variables:

$$x_h^c \tag{1.6}$$

c) Once the probability of prevalence is modelled, the elasticity of prevalence $(\varepsilon_I^{x_j})$ with respect to price or income is estimated using marginal effects at the average as:

$$\varepsilon_I^{x_j} = ME_I^{x_j}(\bar{x}_j/\bar{I}), \;\; x_j = \{p, m\} \tag{1.7}$$

where marginal effects $ME_I^{x_j}$ measure the change in the probability of being a smoking household for the unit change in key explanatory variable x_j:

$$ME_I^{x_j} = \partial Pr(I_h = 1|x)/\partial x_j \quad (1.8)$$

d) The second part of the two-part model uses only a subsample of smoking households (n^s) to model the intensity of smoking based on a probability that household h is smoking:

$$E(y_h|y_h > 0, x) = x_h\gamma \quad (1.9)$$

where y_h denotes demand for cigarettes of household h. The conditional demand for cigarettes can be further estimated using Deaton's model (Vladisavljević et al. 2020; Vladisavljević et al. 2021; Gligorić et al. 2022) or a generalised linear model (GLM; Zubović et al. 2019; Lichner and Ostrihoň 2024). This study adopted the latter approach.

e) Similar to the case of prevalence, intensity elasticity $\varepsilon_y^{x_j}$ can be computed via marginal effects (Zubović et al. 2019):

$$\varepsilon_y^{x_j} = ME_y^{x_j}(\bar{x}_j/\bar{y}), \;\; x_j = \{p, m\} \quad (1.10)$$

while marginal effects in this case will be equal to γ_j, following the linear specification of the model.

d) Eventually, total elasticity of demand for cigarettes (ε^{x_j}) with respect to price or income will be approximately equal to:

$$\varepsilon^{x_j} = \varepsilon_I^{x_j} + \left(1 + \varepsilon_I^{x_j}\right)\varepsilon_y^{x_j} \approx \varepsilon_I^{x_j} + \varepsilon_y^{x_j} \quad (1.11)$$

Time-varying rolling-window elasticities

The second block mainly relies on the work of Huang et al. (2004), who analysed dynamics of elasticity in the United States over the 1961-2002 period by estimating elasticity for rolling windows of 15, 20 and 25 years, respectively. Assuming that total sample n comprises the HBSs covering the period of T years, setting the rolling-window subsamples at length L can be formulated as:

$$n_1^L, \;\; 1, \dots L; \quad (1.12)$$

$$n_2^L, \;\; 2, \dots L + 1;$$

$$\dots$$

$$n_l^L, \;\; l, \dots L + l - 1;$$

$$\dots$$

$$n_{T-(L-1)}^L, \;\; T - (L - 1), \dots, T$$

where l denotes subperiod $l, \dots L + l - 1$ covered by the respective rolling window. The total number of subsamples (n_l^L) will be equal to $T - (L - 1)$. For instance, if the period covers 20 years and the length of the rolling window is five years, the total number of subsamples (n_l^L) will be 16. Estimation of the total elasticity $\varepsilon_l^{x_j}$ for each rolling-window subsample results in a time series that provides insights into the variation of elasticities over considered period T.

Furthermore, if the annualised rate of change in average price or income $agr_l(\bar{x}_j)$ over subperiods l is calculated, simple correlation coefficients between elasticities and the corresponding rates of change in prices or income, $\rho^{\varepsilon^{x_j}, \bar{x}_j} = corr\left(\varepsilon_l^{x_j}, agr_l(\bar{x}_j)\right)$, will provide insights into whether time variation in elasticities are associated with the magnitude of changes in key explanatory variables.

Model specification

Apart from the key explanatory variables (i.e. price and income), proper empirical estimation of models (1.5) and (1.9) requires the set of adequate control variables (x_h^c) to be selected. To do so, the previous study by Zubović et al. (2019), which estimates demand elasticity for cigarettes in Serbia (using a two-part model with GLM-based estimation of intensity), was utilised. This study opted to use various specifications of the prevalence and demand models (including non-linear specification with squared prices and income) in the belief that these are the most suitable statistical features regarding issues of multicollinearity, goodness of fit, and heteroskedasticity. Subsequently, the study comes up with the optimal specification of the prevalence and demand empirical models as follows:

$$Pr(I_h = 1|x) = f(\beta_1^I p_h + \beta_2^I m_h + \beta_3^I m_h^2 + x_h^c \delta^c)$$

$$E(y_h|y_h > 0, x) = \beta_1^y p_h + \beta_2^y m_h + \beta_3^y m_h^2 + x_h^c \gamma^c$$

where the set of control variables x_h^c includes the following socio-demographic variables:

- Household size
- Male ratio
- Adult ratio
- Educational attainment
- Region
- Activity status
- Advertising ban (relevant only in estimating aggregate elasticity)

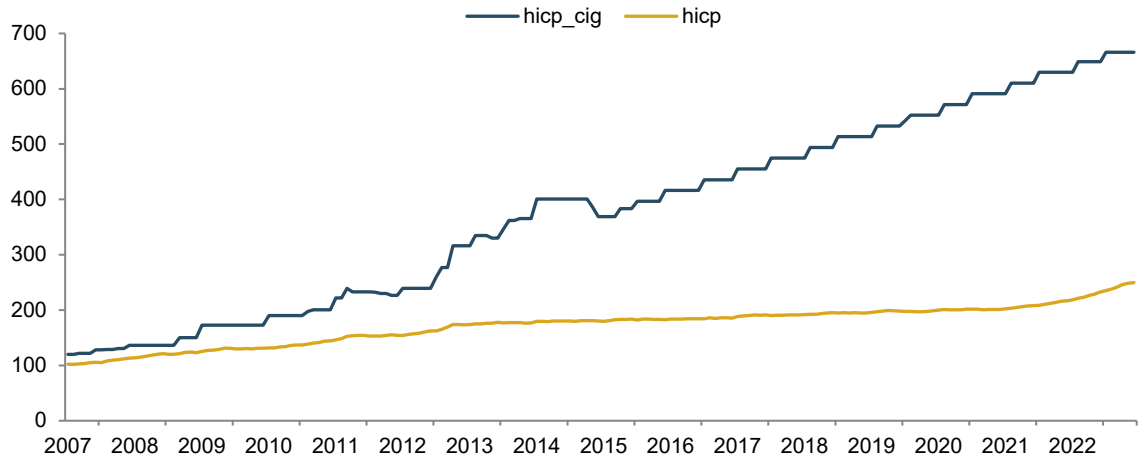
A description of each of the control variables is provided in the Appendix (Table A1). Squared prices are not included in the model specification, as they do not appear to be significant in any of the specifications considered.

4. Stylised facts

4.1. MACROECONOMIC DATA

According to the data from SORS, the price of cigarettes considerably increased over the 2006-2022 period (Figure 1). The cumulative inflation rate of cigarette prices over this period was around 556%, or roughly four times higher than the overall inflation rate (134%). The trend in cigarette prices reveals one very important insight. As shown in Figure 1, the 2006-2014 period was characterised by discretionary changes in prices. Since 2015, changes in prices have been driven by the rules stipulated by the excise calendar, which lead to regular and highly predictable changes in cigarette prices. Additionally, it can be noticed that the increase in the price of cigarettes relative to the overall level of prices was more dynamic in the first years of the period considered. More specifically, over the 2006-2016 period, the cumulative increase in prices was 326%, or around 3.85 times higher than increase in overall prices (85%). On the other hand, the cumulative increase in cigarette prices over the 2017-2022 period was only 41%, or just 1.8 times higher than the increase in overall prices (23%).

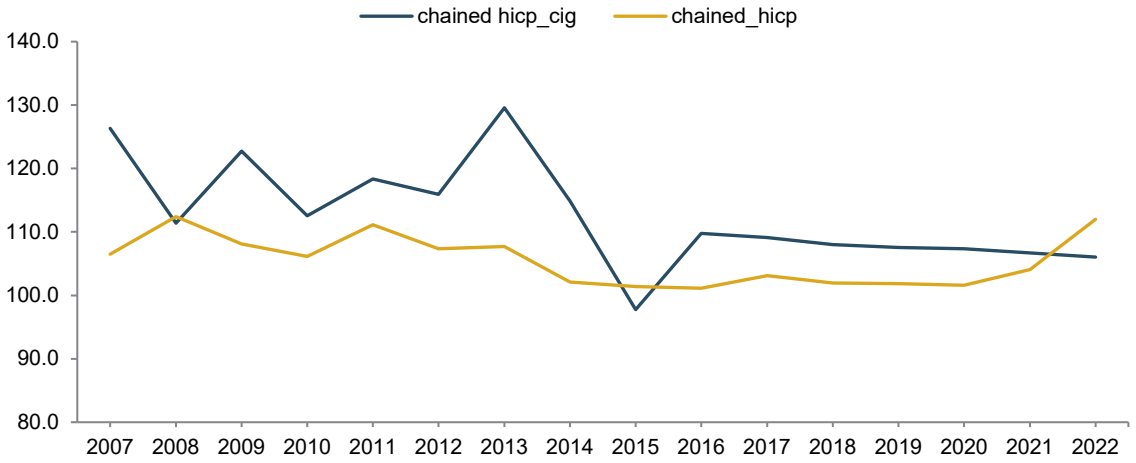
Figure 1 / Indices of overall consumer prices vis-à-vis cigarette prices, 2007-2022 (2006=100)



Note: hicp – overall index of consumer prices; hicp_cig – index of consumer prices of tobacco products
Source: SORS

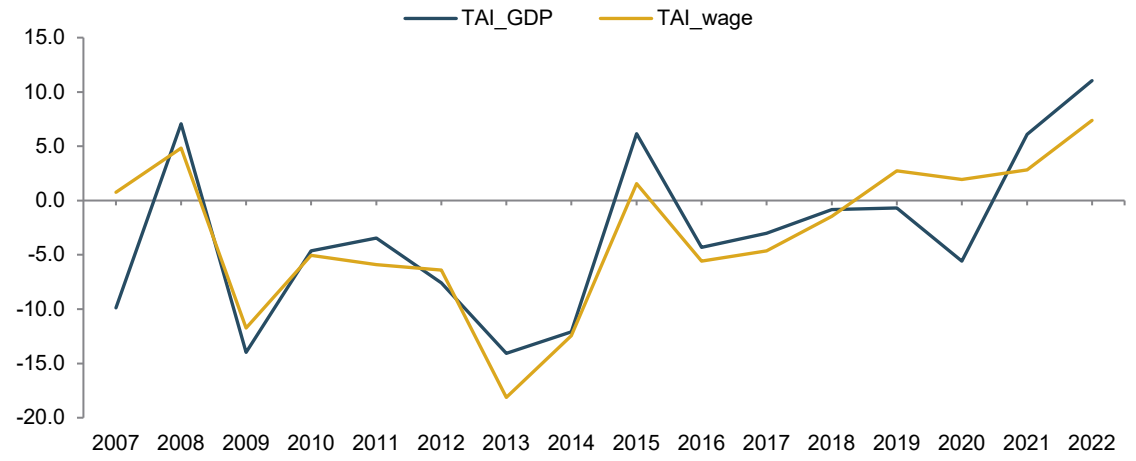
While the cumulative change in cigarette prices considerably exceeded the overall level of prices, the annual changes in cigarette prices were not always correlated with annual changes in overall prices. This is illustrated in Figure 2, which displays chained indices at the annual level (previous year=100). Until 2014, annual changes in cigarette prices were firmly correlated with and highly above the change in overall prices. In 2015, when fiscal consolidation was implemented at the national level in Serbia, cigarette prices temporarily declined before bouncing back in 2016. Since 2016, annual changes in cigarette prices have been smoothed by the excise calendar, allowing for price predictability and for the prices to be detached from overall inflation. Following the sharp increase in inflation in the post-pandemic period, the annual change in cigarette prices eventually equalised with annual inflation by 2022.

Figure 2 / Chained indices of overall consumer prices vis-à-vis cigarette prices, 2007-2022



Note: hicp – overall index of consumer prices; hicp_cig – index of consumer prices of tobacco products
Source: authors' calculations based on SORS data

Figure 3 / Tobacco affordability index, 2007-2022



Note: TAI_GDP – affordability measured by GDP per capita; TAI_wage – affordability measured by average wage.
Source: authors' calculations based on SORS data

As mentioned earlier, an increase in cigarette prices does not always mean that tobacco products have become less affordable, as an increase in income can offset the increase in prices. The affordability of cigarettes over the 2007-2022 period, measured by the tobacco affordability index (TAI), is displayed in Figure 3. The TAI is calculated as the real annual change in GDP or real annual change in average wage, adjusted by the ratio of inflation in tobacco prices to the overall inflation rate (Zubović et al. 2024). Therefore, a decreasing value in the TAI means that cigarettes become less affordable. As shown in Figure 3, the affordability of cigarettes was very volatile regardless of which TAI measure was used. Nevertheless, it can be noticed that, on average, affordability was declining until 2014, but it has been rising since 2015, especially in 2021 and 2022.

4.2. HBS DATA

Data from HBSs were used to produce descriptives describing trends in the use of cigarettes in Serbia over the 2006-2022 period (Table 1). Smoking prevalence, defined as the share of households that reported cigarette expenditures, has significantly declined over the observed period (from 49.7% in 2006 to 30.3% in 2022), resulting in a cumulative decline of19.4 percentage points (pp). However, the long-term decline in prevalence reversed itself in 2022, which corresponds to the increase in affordability observed in Figure 3.

Table 1 / Cigarette use in Serbia, weighted descriptives, 2006-2022

Year	Prevalence (% of smoking households)	Average real price (RSD) of cig. pack, 2006=100	Average number of cigarettes smoked (in packs) per household	Average real expenditure on cigarettes per household		Average share of expenditure on cigarettes in smoking households' budget	
				smoking	all	smoking	all
2006	49.75%	51.93	39.11	1,988	989	5.83%	2.90%
2007	47.93%	58.68	39.22	2,279	1,092	6.63%	3.18%
2008	44.13%	59.05	39.02	2,268	1,001	6.53%	2.88%
2009	42.00%	63.22	37.87	2,353	988	7.01%	2.94%
2010	38.82%	65.84	36.99	2,440	947	7.15%	2.77%
2011	38.42%	68.77	36.17	2,486	955	7.53%	2.89%
2012	38.03%	75.90	34.31	2,607	992	7.86%	2.99%
2013	35.06%	92.81	29.56	2,758	967	8.44%	2.96%
2014	34.44%	105.43	27.69	2,922	1,006	8.84%	3.04%
2015	36.28%	103.45	28.91	2,985	1,083	8.85%	3.21%
2016	33.81%	110.44	29.21	3,234	1,093	9.42%	3.17%
2017	34.24%	117.70	27.24	3,241	1,110	9.33%	3.19%
2018	32.23%	123.02	28.84	3,581	1,154	10.04%	3.24%
2019	31.65%	129.18	31.36	3,737	1,183	10.37%	3.28%
2021	28.96%	142.79	28.15	4,034	1,169	10.46%	3.03%
2022	30.31%	140.47	26.94	3,785	1,147	10.31%	3.13%

Source: authors' calculations based on HBS data

As mentioned before, HBSs do not collect data on prices, so real prices are proxied by the average unit costs of cigarettes reported by households within one municipality, adjusted for overall inflation. The average real price of cigarettes increased from RSD 52 in 2006 to RSD 140.5 in 2022 (in 2006 RSD), indicating that the real price of cigarettes cumulatively increased by around 2.7 times. Besides the decline in prevalence, households have also decreased smoking intensity, from 39 packs monthly on average in 2006 to 27 packs per household in 2022 (cumulative decline: 31%). Nevertheless, stagnation in smoking intensity can be observed since 2013.

The increase in cigarette prices at a higher pace than the decline in smoking intensity resulted in a gradual increase in average real expenditure on cigarettes per smoking household, which almost doubled between 2006 and 2022, from around RSD 2,000 to RSD 3,785 (in 2006 RSD). On the other hand, the increase in average real expenditure on cigarettes was at a higher pace than the real increase in disposable income, resulting in an increased share of expenditure on cigarettes in the budget of smoking households, from 5.8% to 10.3%.

5. Results

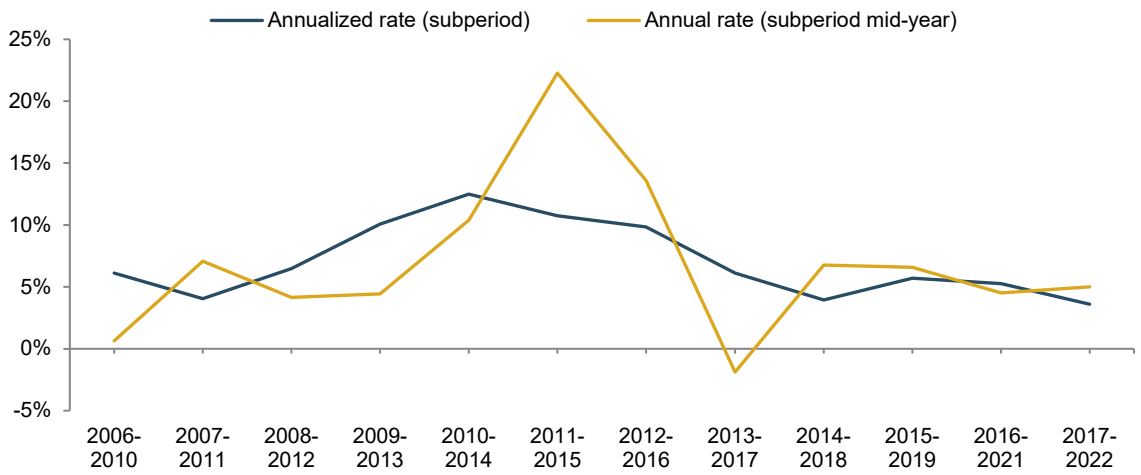
5.1. ROLLING WINDOWS

The first issue that arises in estimating the time-varying elasticities is how to select the proper length of the rolling window. After testing several lengths (ranging from three to seven years), we concluded that a five-year rolling window is the optimal choice. While the three- and four-year rolling windows produce instable elasticity estimates due to an insufficient number of observations, the six- and seven-year rolling windows produce oversmoothed elasticity estimates given that the total sample covers 16 annual HBSs.

Following (1.12), selecting a five-year rolling window results in 12 subsamples n_l^5. The number of observations covered by subsamples n_l^5 vary from 22,832 for the 2009-2013 subperiod to 32,041 for the 2015-2019 subperiod. This is the consequence of the change in the number of observations covered by the HBS, which varies from around 4,500 until 2014 (when coverage was increased) to 6,000-6,500 observations thereafter. Keeping in mind that the HBS was not conducted in 2020, the last two rolling windows actually covered the six-year periods 2016-2021 and 2017-2022, but they effectively comprise observations from five annual HBSs, as in the case of the other rolling windows.

The reason for using rolling windows was that they make it possible to 'smooth' volatile growth rates and observe trends in price changes more clearly than when simply using annual growth rates. Additionally, assuming that the magnitude of demand elasticity covaries with recent price changes, elasticity computed over the longer periods of time may diverge from the recently observed elasticity by giving too much significance to the 'old' observations. Both points are illustrated in Figure 4, which shows a comparison between the annualised rate of change in cigarette prices over the rolling subperiods and the annual rates from the subperiod mid-year (e.g. if the subperiod is 2007-2011, the mid-year is 2009).

Figure 4 / Real changes in cigarette prices, annualised subperiod rates vis-à-vis subperiod mid-year rates



Source: authors' calculations based on HBS data

5.2. AGGREGATE ELASTICITY ESTIMATES

Table 2 shows aggregated estimates of the elasticity of demand for cigarettes over the 2006-2022 period using two-part modelling with GLM estimation of intensity model.

Table 2 / Estimates of aggregate demand elasticities in Serbia using two-part modelling

	Elasticity component	GLM, log 2006-2022	GLM, level 2006-2022	GLM, log 2006-2017	Deaton 2006-2017
Total	Price	-0.686	-0.706	-0.714	-0.659
	Income	1.133	0.864	1.024	1.058
Prevalence	Price	-0.310	-0.311	-0.265	
	Income	0.647	0.475	0.609	
Intensity	Price	-0.374	-0.345	-0.450	-0.395
	Income	0.449	0.416	0.413	0.447

Source: Zubović et al. (2019); authors' calculations

The primary model is specified with price and income in log terms, while a model with price and income in levels is applied for the sake of testing the robustness of the estimates. Estimation details of the log model are presented in Table 3, while estimation of the model in levels is provided in the Appendix (Table A2). Additionally, the robustness of the estimates is assessed by comparing them with those found in Zubović et al. (2019), who estimated elasticities for the 2006-2017 period using two-part modelling in two versions (i.e. with GLM and Deaton modelling of intensity elasticity).

Table 3 / Aggregate elasticities' estimates, two-part model in logs, 2006-2022

Variables	Prevalence		Intensity	
	Coeff.	Std. error	Coeff.	Std. error
Real cigarette price	-0.495**	(0.063)	-0.374***	(0.030)
Real monthly household income	1.404***	(0.055)	0.587***	(0.026)
Real monthly household income squared	-0.224***	(0.022)	-0.056***	(0.010)
Household size	0.060***	(0.008)	0.035***	(0.003)
Male ratio	0.548***	(0.035)	0.173***	(0.016)
Adult ratio	0.526***	(0.061)	0.276***	(0.029)
Education (Referent – Incomplete primary)				
Primary	0.510***	(0.049)	-0.008	(0.025)
Tertiary 2 years	0.564***	(0.049)	-0.034	(0.024)
Secondary 4 years	0.294***	(0.050)	-0.126***	(0.026)
Tertiary 2 years	0.044	(0.055)	-0.176***	(0.027)
Tertiary 3+ years	-0.240***	(0.054)	-0.238***	(0.027)
Region (Referent – Belgrade region)				
Vojvodina	0.079*	(0.044)	0.059**	(0.026)
Šumadija and Western Serbia	0.321***	(0.044)	0.097***	(0.018)
Eastern and Southern Serbia	0.078*	(0.046)	0.155***	(0.019)
Activity status (Referent – Employed)				
Unemployed HH	0.119**	(0.047)	0.074***	(0.023)
Pensioner HH	-0.618***	(0.025)	0.010	(0.028)
Self-employed HH	-0.182***	(0.030)	-0.008	(0.012)
Advertising ban	-0.170***	(0.049)	-0.033*	(0.018)
Constant	-0.371	(0.277)	4.104***	(0.153)
Observations	86,736		86,736	

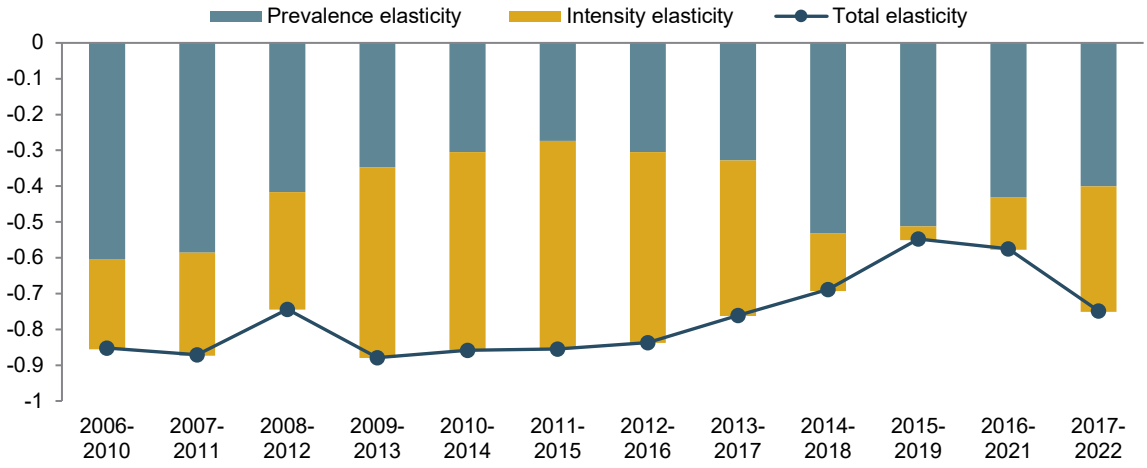
Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: authors' calculations based on HBS data

Estimates from Table 2 indicate that aggregate elasticities are quite stable in the long run. Estimated price elasticity of demand for cigarettes is inelastic, ranging between -0.66 and -0.71. On the other hand, estimates indicate that income elasticity is close to unit value. Regarding components, results indicate a slight change in composition of price elasticity in favour of prevalence elasticity over the last couple of years.

5.3. ROLLING WINDOWS ELASTICITY ESTIMATES

Figure 5 presents a summary of the estimates of the time-varying price elasticities of demand for cigarettes from the log model. Variations in estimated elasticities imply two important findings. First, since the 2009-2013 subperiod, total elasticity steadily declined until the 2016-2021 subperiod, while total elasticity considerably increased in the 2017-2022 subperiod. Second, prevalence and intensity elasticity seem to vary in opposite directions given that the positive co-movement (meaning that both elasticities increased or declined during the same subperiod) is not observed in any of the subperiods. In any case, the overall trend in total price elasticity is decreasing despite volatility, which indicates that demand for cigarettes becomes more inelastic over time.

Figure 5 / Time-varying price elasticity of demand for cigarettes, log model



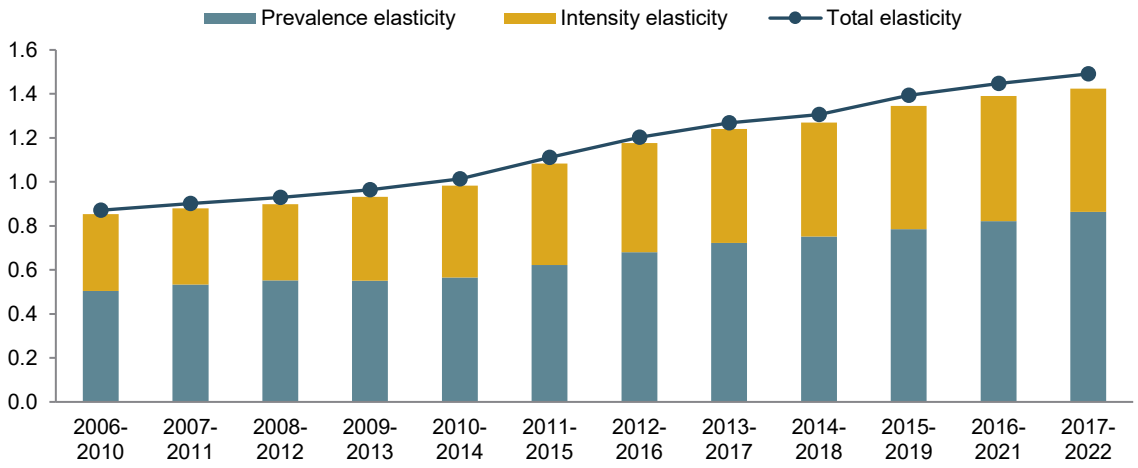
Source: authors' calculations based on HBS data

On the other hand, income elasticity shows a clear increasing trend over the 2006-2022 period (Figure 6). The estimated elasticity increased slightly until the 2010-2014 subperiod, when the pace of increase accelerated. The period of more dynamic increase in income elasticity roughly corresponds to the period of continuous increases in real income that followed the turbulent period in the aftermath of the global crisis.

The variations in elasticity indicated in Figures 5 and 6 are further scrutinised using statistical indicators. More specifically, we consider the statistical significance of the estimated elasticities, the span of confidence intervals, and the size of differences between coefficients. The statistical significance of the estimated elasticities for the rolling subperiods (based on a z-test) is displayed in Table 4. In the case of income, all estimated elasticities (including prevalence and intensity elasticities) are significant at the

0.01 level. Regarding price, all total and prevalence elasticities are significant at least at the 0.05 level. Intensity elasticities appear significant in most of the subperiods, except in the 2014-2018, 2015-2019 and 2016-2021 subperiods, when they correspond with the lowest values of intensity elasticity estimates observed in Figure 5. In other words, statistical tests suggest that, in the above-mentioned subperiods, total elasticity may be fully driven by the prevalence elasticity.

Figure 6 / Time-varying income elasticity of demand for cigarettes, log model



Source: authors' calculations based on HBS data

Table 4 / Statistical significance of the estimated elasticities from log model, rolling subperiods

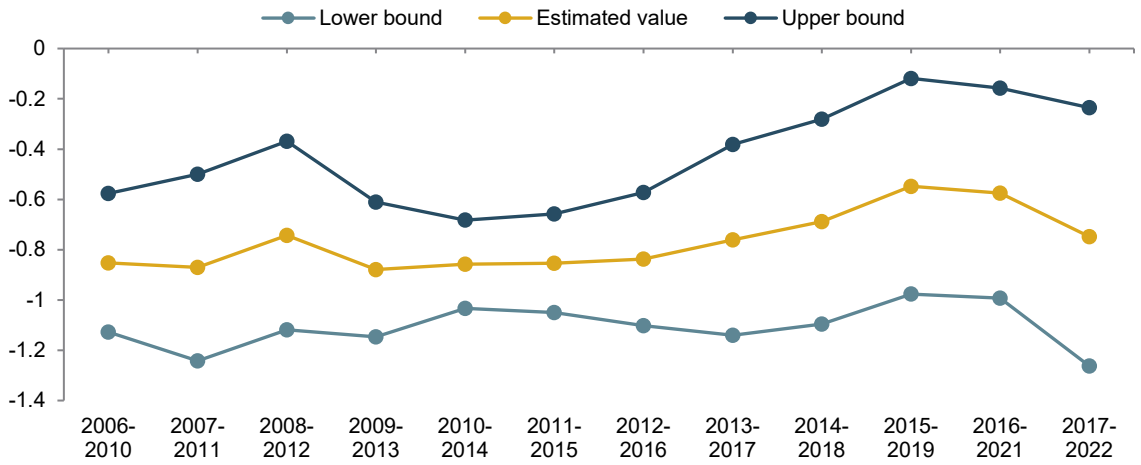
	Price			Income		
Subperiod	Prevalence	Intensity	Total	Prevalence	Intensity	Total
2006-2010	-0.6035***	-0.2521***	-0.8524***	0.5046***	0.3493***	0.8712***
2007-2011	-0.5857***	-0.2875***	-0.8706***	0.5337***	0.3468***	0.9022***
2008-2012	-0.4163**	-0.3287***	-0.7437***	0.5531***	0.3458***	0.9288***
2009-2013	-0.3472***	-0.5325***	-0.8790***	0.5508***	0.3816***	0.9638***
2010-2014	-0.3049***	-0.5532***	-0.8581***	0.5649***	0.4187***	1.0137***
2011-2015	-0.2733***	-0.5812***	-0.8544***	0.6223***	0.4607***	1.1112***
2012-2016	-0.3048***	-0.5330***	-0.8369***	0.6800***	0.4964***	1.2026***
2013-2017	-0.3282**	-0.4348***	-0.7611***	0.7225***	0.5188***	1.2687***
2014-2018	-0.5311***	-0.1618	-0.6886***	0.7512***	0.5187***	1.3058***
2015-2019	-0.5124***	-0.0388	-0.5477**	0.7846***	0.5604***	1.3936***
2016-2021	-0.4319**	-0.1458	-0.5751***	0.8220***	0.5686***	1.4476***
2017-2022	-0.4003**	-0.3509**	-0.7488***	0.8633***	0.5609***	1.4909***

Note: * for p<0.1, ** for p<0.05, *** for p<0.01
Source: authors' calculations based on HBS data

The volatility of total price elasticity is also reflected in the volatile span of confidence intervals, as illustrated by Figure 7. The span of confidence intervals seems to be increasing in the last few subperiods (and particularly in the 2013-2017 subperiod), implying that the estimated values of total price elasticity in these subperiods are less reliable. Additionally, wide confidence intervals provide inconclusive evidence about the significance of differences between estimated elasticities. A similar

pattern of variations in confidence intervals is also observed in the cases of price prevalence and intensity elasticities, as can be seen in Figures A3 and A4 in the Appendix.

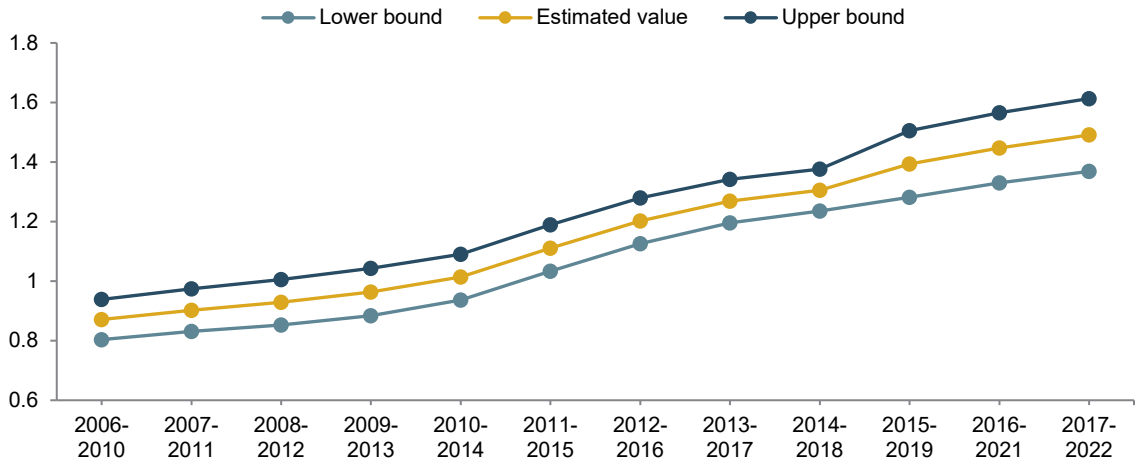
Figure 7 / Confidence intervals of the estimated total price elasticities from the log model, rolling subperiods



Source: authors' calculations based on HBS data

Opposite to those for price elasticity, the span of confidence intervals for total income elasticity is mostly stable, and a slight increase is only observed in the most recent subperiods (as illustrated in Figure 7). While a similar pattern is also observed for the income-intensity elasticity, the span of confidence intervals for income-prevalence elasticity appears stable throughout all subperiods. The lower bounds of confidence intervals for the recent subperiods exceed the upper bounds of intervals for the earlier subperiods, indicating that estimated elasticities indeed vary over time.

Figure 8 / Confidence intervals of the estimated income elasticities from the log model, rolling subperiods



Source: authors' calculations based on HBS data

As previously mentioned, the span and patterns of confidence intervals in the case of income elasticity indicate significant variations, while evidence on the significance of variations are inconclusive in the case of price elasticity. For this reason, we looked for a way to apply more formal testing. We were not aware of any statistical inference method that allows testing the joint null that all elasticities are equal when regression estimates are obtained from overlapping samples. We therefore used a simplified approach to check whether there is any formal evidence regarding the significance of variations. In particular, we looked for the highest and lowest estimates for each elasticity type to check whether these estimates do not come from overlapping subperiods. Since the latter turned out to be true, we applied a standard z-test for independent samples to test whether the difference between the highest and lowest estimates is different than zero, which resembles the standard joint alternative hypothesis (i.e. that at least one pair of estimates is different).

The results of our testing are displayed in Table 5. Statistical significance between the highest and lowest estimates of income elasticity is straightforwardly confirmed as expected. On the other hand, findings on price elasticities are vague. The highest and the lowest estimates do not seem to be significantly different, which indicates that variations in total price elasticity might not be statistically significant. Nevertheless, z-tests suggest that the highest and lowest estimates of prevalence and, in particular, of intensity elasticities differ. This finding provides strong indications that even when total elasticity does not significantly vary over time, the structure of the total elasticity does.

Table 5 / Statistical significance of differences between the highest and lowest estimates of elasticity, according to elasticity types

	Price		Income	
	Highest estimate	**Lowest estimate**	**Highest estimate**	**Lowest estimate**
Total				
Subperiod	2015-2019	2009-2013	2017-2022	2006-2010
Estimated value	-0.5477	-0.879	1.4909	0.8712
Difference	-0.3313		0.6197***	
Prevalence				
Subperiod	2011-2015	2006-2010	2017-2022	2006-2010
Estimated value	-0.2733	-0.6035	0.8633	0.5046
Difference	-0.3302**		0.3587***	
Intensity				
Subperiod	2015-2019	2011-2015	2016-2021	2008-2012
Estimated value	-0.0388	-0.5812	0.5686	0.3458
Difference	-0.5424***		0.2228***	

Source: authors' calculations based on HBS data

6. Discussion

Research question 1: Does the size of a price change affect the size of the respective response of demand for cigarettes?

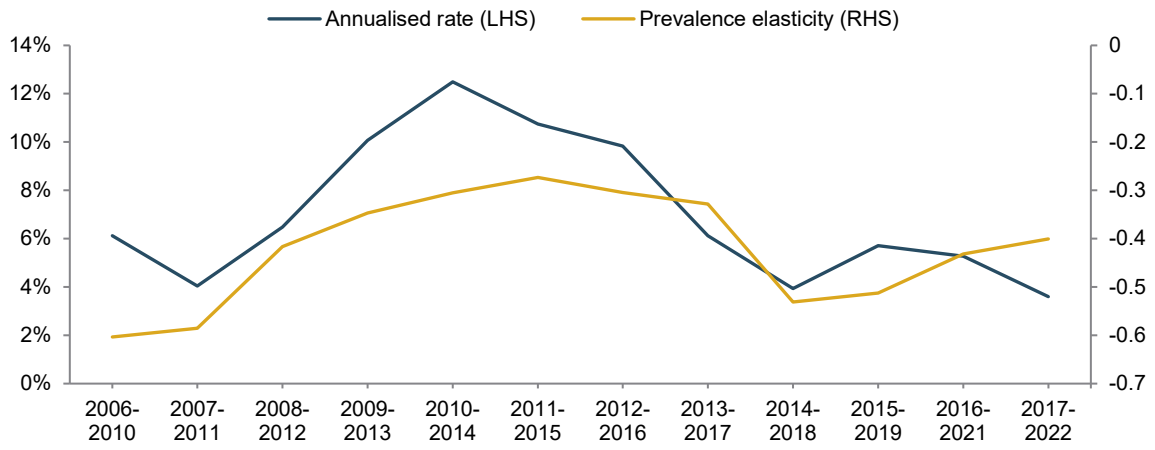
The overall associations between elasticities and price and income are examined using simple correlations between elasticity estimates and the respective annualised subperiod rates of change in price and income, $\rho_{\varepsilon^{x_j},\bar{x}_j} = corr\left(\varepsilon_l^{x_j}, agr_l(\bar{x}_j)\right)$. Table 6 summarises these correlations for both log and level models. The positive association between income elasticity and change in income is very high: an increase in income leads to positive responses of both the prevalence and intensity components and thereby to the positive response of the total income elasticity.

Table 6 / Correlation coefficients between variations in price elasticity and change in prices, and income elasticity and change in income

	Elasticity component	Log model		Level model	
		Change in prices	Change in income	Change in prices	Change in income
Total	Price	-0.51		-0.63	
	Income		0.85		0.88
Prevalence	Price	0.72		0.65	
	Income		0.83		0.87
Intensity	Price	-0.78		-0.78	
	Income		0.88		0.89

Note: Annualised subperiod rates of change in price/income
Source: authors' calculations

Figure 9 / Correlation between prevalence elasticity (log model) and annualised changes in price

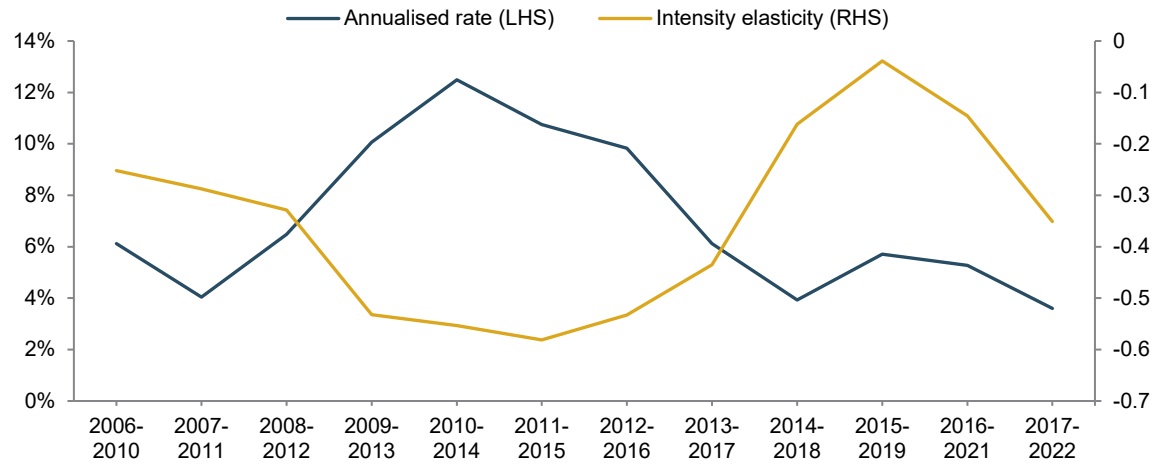


Note: Annualised subperiod rates of change in price
Source: authors' calculations

The correlation between prevalence elasticity and change in prices is positive, indicating that the higher the price change, the less price-responsive the prevalence is, as illustrated in Figure 9.

Conversely, intensity elasticity and price tend to move in opposite directions: the higher the price increase, the more responsive the demand in terms of smoking intensity (Figure 10). Overall, the correlation between total elasticity and price is negative: the higher the price, the stronger the negative response of the demand to price, indicating that variations in the intensity component dominate variations in prevalence in the structure of variations in total elasticity. This is in line with the expectation that the overall volatility of the sum of two random variables will primarily be driven by variations in the variable that is more volatile, which in this case is intensity elasticity.

Figure 10 / Correlation between intensity elasticity (log model) and annualised changes in price



Note: Annualised subperiod rates of change in price
Source: authors' calculations

The correlation analysis confirms that the variations in the size of elasticity are very likely associated with variations in the size of price changes, which is in line with the previously mentioned study of Dautzenberg and Dautzenberg (2019). In addition, some of the aforementioned studies on the elasticity of demand for energy come to a similar conclusion, namely, that a higher increase in energy prices leads to a higher sensitivity of demand (Inglesi-Lotz 2011; Mikayilov et al. 2020).

Research question 2: Does the price elasticity of smoking prevalence decline over time?

The second research question is closely related to the hardening hypothesis, which proposes that the proportion of 'hardcore' smokers will increase as smoking prevalence declines. Accordingly, prevalence elasticity is expected to increase (i.e. decrease in absolute size), as smokers heavily addicted to nicotine become less responsive to the change in price or income. Figure 5 already indicates that despite volatility in size, no trend of increase in price prevalence elasticity is observed.

Nevertheless, we ran formal tests to check whether the latter finding can be statistically confirmed. To this end, we adopted an approach from Chern and Bouis (1988), who estimated whether changes in

electricity prices caused structural changes in consumer behaviour over time. The rationale of this approach is to split the sample into two non-overlapping subperiods before rolling subsample regressions by shifting the year of split. Following their approach, we started with a division total sample on two subperiods (i.e. 2006-2010 and 2011-2022) and ran regressions by shifting the year of split until 2006-2016 and 2017-2022 to ensure that each subperiod covers at least five years, which (as discussed above) is the minimum for obtaining stable estimates.

The results of the estimation presented in Table 7 do not indicate that some structural changes occur when the total 2006-2022 period is considered. By moving the splitting year towards a more recent period, the prevalence-elasticity estimate in the first subperiod does in fact decline, but it is quite stable in the second subperiod, with the difference seeming to be insignificant for each set of regressions apart from the first one.

Table 7 / Price prevalence elasticity estimated, log model, non-overlapping subperiods

Subperiod I	Subperiod II	Subperiod I estimate	Subperiod II estimate	Difference	P-value
2006-2010	2011-2022	-0.6035	-0.3257	-0.2778	0.0342
2006-2011	2012-2022	-0.5634	-0.3441	-0.2194	0.1070
2006-2012	2013-2022	-0.4950	-0.3910	-0.1040	0.4641
2006-2013	2014-2022	-0.4111	-0.4387	0.0276	0.8375
2006-2014	2015-2022	-0.3728	-0.4398	0.0670	0.6186
2006-2015	2016-2022	-0.3100	-0.3261	0.0161	0.9204
2006-2016	2017-2022	-0.3031	-0.4003	0.0972	0.6313

Source: authors' calculations

At first glance, the findings from Table 7 may seem to contradict the findings from Table 5, wherein the difference between the highest and lowest price-prevalence elasticity appears significant. However, it should be noted that both the highest and lowest estimates coming from the pre-2016 subperiod, so it is possible that some structural changes in smokers behaviour regarding prevalence actually did happen in the first 10 years, but that prevalence elasticity has stabilised over the long run. This lends support to rejecting the hardening hypotheses in keeping with other findings on the subject, as discussed in the Literature Review section above (Brennan et al. 2020; Kulik and Glantz 2016).

Research question 3: Do the predictable dynamics and size of price changes affect the respective response of demand for cigarettes?

As previously mentioned, following Serbia's introduction of an excise calendar that established a practice of semi-annual growth of specific excise predefined over a five-year period, industry responded by regularly (i.e. semi-annually) increasing the retail price of a pack of cigarettes by RSD 10 (approximately EUR 0.08) regardless of the growth in specific excise. Since 2015, this has resulted in highly predictable dynamics and size of the change in retail prices, as can be clearly seen in Figure 1. The estimates of price elasticity presented in Table 4 and Figure 5 suggest that the decline in price elasticity roughly corresponds to the period in which the dynamics and size of changes in the retail prices of cigarettes became highly predictable.

Given these circumstances, it is legitimate to raise the question of whether price predictability can have a structural impact on demand for cigarettes. To examine this issue more deeply, we estimated price elasticities for the 2006-2014 and 2015-2022 subperiods and tested whether there was a difference among estimates. The results are shown in Table 8. While the size of total price elasticity in the subperiod of non-predictable price increases is indeed larger, there is no statistical evidence to support that this difference is significant. The estimated prevalence elasticity does not differ, as already indicated in Table 7. The most intriguing result is the statistically significant difference of intensity elasticity (at the 0.05 level), which indicates that smoking intensity was two times higher in the first subperiod than in the subperiod of high pricing predictability. This is in line with findings (from Table 4) that estimated price-intensity elasticity is not significant at all in the three rolling subperiods covering the 2014-2021 period.

Table 8 / Price elasticity estimated, log model, 2006-2014 vis-à-vis 2005-2022

	2006-2014	2015-2022	Difference	P-value
Total	-0.8339	-0.6837	-0.1502	0.3528
Prevalence	-0.3728	-0.4398	0.0670	0.6186
Intensity	-0.4609	-0.2471	-0.2138	0.0182

Source: authors' calculations

As underlined by Li et al. (2017), 'little is known about the impact of small, persistent, predictable tobacco tax increases on smoking behaviour.' This led us to hypothesise that the price elasticity of demand for cigarettes consists of (i) a certain basis level common for all countries and (ii) a country-specific component that can vary over time depending primarily on the specific tobacco control measures and their implementation, but also on the country's stage of economic and social development. In this study, we actually examined whether the dynamics of a country-specific component of elasticities is driven by two factors related to cigarette prices: one observable (i.e. the size of the variation in prices) and one unobservable (i.e. the effects that having predictable cigarette prices since 2015 has had on smokers' behaviour). Additionally, we recognise that there are some other non-price factors that affect elasticity (e.g. changes in tobacco control legislation and changes in how rigorously these laws are implemented and enforced). However, for technical reasons, we were unable to include them in our analysis given the short time spans of our rolling windows. The latter can be illustrated by using the advertising ban introduced in 2010 as a dummy, which works on the total-sample level of total sample but did not have any variations in the 2011-2015 subperiod.

For this period, we hypothesise that smoking households gradually factored the predictable increases in expenditures on cigarettes into their budget planning and crowded out some other goods and services (as demonstrated by Vladisavljević et al. 2024). As a result, intensity elasticity plunged to the levels of statistical insignificance observed in the 2014-2018, 2015-2019 and 2016-2021 subperiods. Nevertheless, total elasticity did not fall very sharply due to the recovery of the prevalence elasticity. While the latter is admittedly tricky to explain, it is likely the consequence of the fact that a certain proportion of smokers stopped smoking because they were discouraged by the continuous and substantial increases in the price of smoking.

Our findings on declining intensity elasticity and steady prevalence elasticity observed in the period of high predictability of the increases in cigarette taxes and prices are comparable to those of Li et al. (2017), who found that smokers did not significantly change their behaviour following two small and

predictable increases of the excise in New Zealand, although overall cessation-related activity was high before and after the increases in taxation. The authors discuss two possible interpretations: first, that smokers adapted to the regular small increases in tobacco price and lost motivation to change their behaviour and, second, that the persistent and predictable nature of the tax increases allows industry to implement strategies that dilute the impact of the tax increases on tobacco consumption (which, in the case of Serbia, would be the industry's unusual strategy of increasing prices in the fixed nominal amount of RSD 10).

Eventually, intensity elasticity bounced back at the very end of the period analysed, making demand for cigarettes more elastic during the 2017-2022 period. Nevertheless, it should be noted that the last two subperiods comprise 2020, in which a HBS was not carried out due to the COVID-19 pandemic, which may influence the reliability of the estimates. For this reason, further extension of the analysis in the upcoming years is needed to figure out whether the increase in price elasticity in the 2017-2022 subperiod becomes a steady trend or is a consequence of some data distortion.

To examine the robustness of our estimates, we also extended the model specification to include some additional variables that arguably affect demand for cigarettes. In particular, we used the share of expenditures for alcohol and horeca (e.g. hotels, restaurants, coffee bars) in household budgets, following the findings of Vladisavljević et al. (2024) that these groups of expenditures have a 'crowding-in' effect being positively associated with the consumption of cigarettes. The results of additional estimation confirm a positive impact on cigarette consumption (especially the impact of share of expenditures on alcohol on prevalence of smoking), but the pattern of estimated elasticities over time does not substantially differ from this baseline estimation.

7. Conclusions

In recent decades, the number of studies estimating price and income elasticity of demand for tobacco have proliferated. Typically, such a study assumes that price elasticity is constant, then estimates price elasticity based on historical data, and then projects a change in public revenues for an arbitrary change in price (imposed by an arbitrary change in taxation), regardless of the broader context of tobacco-taxation practices of policy makers and tobacco-pricing practices of the industry.

In this study, we have challenged the view that price elasticity of demand for cigarettes is constant by hypothesising that broader changes in tobacco taxation and pricing practices may result in structural changes in demand for tobacco, which in turn leads to varying price elasticity. We examined the variations in elasticities of household demand for cigarettes using data from Serbian household budget surveys (HBSs) and found mixed evidence that price elasticity varied over the 2006-2022 period. More specifically, we found that estimates of price prevalence and intensity elasticities were significantly different in some subperiods, but due to their co-movements in opposite directions, no evidence indicates that total elasticity changed over time. On the other hand, estimates of income elasticity strongly indicate that sensitivity of demand for cigarettes has increased over time. In addition, price elasticity appears to be considerably more volatile (relative to the overall trend) than income elasticity. The latter holds true not only for total price elasticity, but also for the prevalence and intensity components of total price elasticity.

Furthermore, we focused on the more specific research questions of whether variations in estimated price elasticities will match some expectations that we formed based on the stylised facts and previous work, including associations with magnitude of change in prices, associations with retail pricing practices, and compliance with the hardening hypothesis. Our findings suggest a negative correlation between total price elasticity (in absolute value) and price change, which means that a larger increase in price leads to a larger fall in demand for cigarettes (relative to small changes in price), which is primarily driven by negative correlation between change in prices and price-intensity elasticity. Examination of the patterns of variations in price-prevalence elasticities suggest that prevalence elasticity significantly varied at some points in time, but a declining trend is not confirmed, and the hardening hypothesis has been rejected. The most intriguing finding from our research is that over the period in which dynamics and size changes in retail prices became very predictable, intensity elasticity decreased to such a low level that statistical tests could not even reject the hypothesis that intensity of smoking reacts to price changes at all.

Based on the stylised facts, we hypothesised that higher magnitudes of change in prices lead to more elastic responses in demand for cigarettes, while higher predictability of change in prices makes the response of demand more inelastic. An unanticipated sharp increase in cigarette prices seems to shock smokers, whose intensity of smoking declines unproportionally higher relative to a moderate increase in prices. On the other hand, anticipated price changes lead to predictable cigarette expenditures, which are most likely incorporated into the budget planning of smoking households through the ‘crowding out’ of other goods and services. This, in turn, results in an exceptionally inelastic response of demand for cigarettes by

the smoking households, especially in terms of intensity of smoking. Unfortunately, the lack of previous research on this subject limits our ability to interpret the results or critically appraise our reasoning.

The main policy recommendation that can be derived from this study's findings is that policy makers should avoid moderate and predictable increases in tobacco taxes, as they lead to high predictivity of increase in retail prices and eventually to ineffective outcomes in terms of reductions in demand for cigarettes. Serbia is currently running the policy of highly predictable and regular moderate changes in tobacco taxation, and the ineffectiveness of this kind of policy becomes evident as a result of recent stagnation in the rates of smoking prevalence and intensity.

This study's main limitation is the fact that it was restricted to using rolling windows of five-year subperiods, which was imposed because only 16 annual HBSs had been conducted in Serbia by 2023. Although the number of observations is still considerable (around 25,000 on average per five-year rolling window), when it comes to subsamples, the estimates of elasticities are still likely to be less reliable relative to aggregate estimates utilising the total sample. The other limitations related to the sample include concerns deriving from the fact that data from the Serbian HBSs do not have a longitudinal structure, so that variations in elasticities may come from the variations in the scope of the sample. In addition, the fact that an HBS was not carried out in 2020 may affect the reliability of the elasticity estimates in the last two subperiods.

The main topic for the further research that has been raised by this study is the association between the predictability of cigarette prices and the elasticity of demand for cigarettes, as we are not aware of any empirical work that deals with this subject. The other possible directions for future research include estimating time-varying income elasticities with respect to income components (e.g. earned and transferred income), which were found to be relevant by the literature, or extending the regional scope of the research to enrich the diversity of government policies and practices in tobacco taxation comprised by the analysis.

References

Belotti, F., Deb, P., Manning, W. & Norton, E. (2015). twopm: Two-part models. *Stata Journal*, 15(1), 3–20. https://journals.sagepub.com/doi/pdf/10.1177/1536867X1501500102

Boshoff, W. H. (2008). Cigarette demand in South Africa over 1996-2006: the role of price, income and health awareness. *South African Journal of Economics*, 76(1), 118–131.

Brennan, E., Greenhalgh, E. M., Durkin, S. J., Scollo, M. M., Hayes, L. & Wakefield, M. A. (2020). Hardening or softening? An observational study of changes to the prevalence of hardening indicators in Victoria, Australia, 2001-2016. *Tobacco Control*, 29(3). doi.org/10.1136/tobaccocontrol-2019-054937

Chern, W. S. & Bouis, H. E. (1988). Structural changes in residential electricity demand. *Energy Economics*, 10(3), 213–222. doi:10.1016/0140-9883(88)90005-9

Dautzenberg, B. & Dautzenberg, M. (2019). Increasing tobacco taxes by less than 5% is ineffective: lessons from 2000-2018 surveys in France. *Tobacco Prevention & Cessation*, 5 (Supplement), A79. doi:10.18332/tpc/105195.

Drope, J., Oo, S., Lee, H., Dorokhina, M, Guerrero-López, C., Rodriguez-Iglesias G., Mugoša, A., Mirza, M., Bontu, A. & Chaloupka, F. (2024). Tobacconomics Cigarette Tax Scorecard (3rd ed.). Baltimore, MD: Bloomberg School of Public Health, Johns Hopkins University.

Fernández, E., Lugo, A., Clancy, L., Matsuo, K., La Vecchia, C. & Gallus, S. (2015). Smoking dependence in 18 European countries: hard to maintain the hardening hypothesis. *Preventive Medicine*, 81, 314–319.

Gallet, C. A. & List, J. A. (2003). Cigarette demand: a meta-analysis of elasticities. *Health Economics*, 12(10), 821–835.

Gjika, A., Zhllima, E., Rama, K. & Imami, D. (2020). Analysis of tobacco price elasticity in Albania using household level data. *International Journal of Environmental Research and Public Health*, 17(2), 432.

Gligorić, D., Kulovac, D. P., Mićić, L. & Pepić, A. (2022). Price and income elasticity of cigarette demand in Bosnia and Herzegovina by different socioeconomic groups. *Tobacco Control*, 31(2), 101–109. doi:10.1136/tobaccocontrol-2021-056881

Government of Poland (2025). Annual progress report on the implementation of the medium-term fiscal-structural plan for 2025-2028. www.gov.pl/attachment/8ccc8d43-7200-4031-a039-42afe49ac246

Hanewinkel, R. & Isensee, B. (2007). Five in a row – reactions of smokers to tobacco tax increases: population-based cross-sectional studies in Germany 2001-2006. *Tobacco Control*, 16(1), 34–37. https://doi.org/10.1136/tc.2006.017236

Hastie, T. & Tibshirani, R. (1993). Varying-coefficient models. *Journal of the Royal Statistical Society. Series B (Methodological)*, 55(4), 757–796.

Huang, B., Yang C. & Hwang, M. (2004). New evidence on demand for cigarettes: A panel data approach. *International Journal of Applied Economics*, 1(1), 81–97.

Inglesi-Lotz, R. (2011). The evolution of price elasticity of electricity demand in South Africa: a Kalman filter application. *Energy Policy* 39(6), 3690–3696.

John, R. M., Chelwa, G., Vulovic, V. & Chaloupka, F.J. (2023). Updated toolkit on using household expenditure surveys for research in the economics of tobacco control. Tobacconomics. www.economicsforhealth.org/files/research/856/tobacconomics-updated-hes-tool-kit-2nd-ed-eng-v2.1.pdf

Jovanovic, O., Zubović, J., Vladisavljević, M., Bodrož, D., Ljumović, I., Domazet, I. & Đukić, M. (2018). Estimation of tobacco products price and income elasticity using aggregate data. *Economic Analysis*, 51(3-4), 81–94.

Jung, B., Lee, J. A., Kim, Y. J. & Cho, H. J. (2024). The smoking population is not hardening in South Korea: a study using the Korea Community Health Survey from 2010 to 2018. *Tobacco Control*, 33(2), 171–177.

Kilian, L. & Zhou, X. (2024). Heterogeneity in the pass-through from oil to gasoline prices: a new instrument for estimating the price elasticity of gasoline demand. *Journal of Public Economics*, 232, 105099.

Kostova, D., Tesche, J., Perucic, A. M., Yurekli, A., Asma, S. & GATS Collaborative Group (2014). Exploring the relationship between cigarette prices and smoking among adults: a cross-country study of low-and middle-income nations. *Nicotine & Tobacco Research*, 16(Suppl. 1), S10-S15.

Kulik, M. C. & Glantz, S. A. (2016). The smoking population in the USA and EU is softening not hardening. *Tobacco Control*, 25(4), 470–475. https://doi.org/10.1136/tobaccocontrol-2015-052329

Li, J., Newcombe, R., Guiney, H. & Walton, D. (2017). Impact on smoking behavior of the New Zealand annual increase in tobacco tax: data for the fifth and sixth year of increases. *Nicotine & Tobacco Research*, 19(12), 1491–1498. https://doi.org/10.1093/ntr/ntw233

Lichner, I. & Ostrihoň, F. (2024). Estimation of price and income elasticity of demand for tobacco cigarettes in Slovakia. Tobacconomics Working Series. Institute of Economic Research SAS in Slovakia. https://tobacconomics.org/research/estimation-of-price-and-income-elasticity-of-demand-for-tobacco-cigarettes-in-slovakia-working-paper-series/

Liddle, B. & Hasanov, F. (2023). Are the income and price elasticities of economy-wide electricity demand in middle-income countries time-varying? Evidence from panels and individual countries. *Environmental and Ecological Statistic*, 30, 827–849. https://doi.org/10.1007/s10651-023-00585-4

Mikayilov, J., Joutz, F. & Hasanov, F. (2020). Gasoline demand in Saudi Arabia: Are the price and income elasticities constant? *Energy Sources, Part B: Economics, Planning, and Policy*, 15(4), 211–229. https://doi.org/10.1080/15567249.2020.1775325

Mukong, A. K. & Tingum, E. N. (2020). The demand for cigarettes: new evidence from South Africa. *Development Southern Africa*, 37(1), 40–54.

Nargis, N., Stoklosa, M., Shang, C. & Drope, J. (2021). Price, income, and affordability as the determinants of tobacco consumption: a practitioner's guide to tobacco taxation. *Nicotine and Tobacco Research,* 23(1), 40–47.

Olesiński, B., Rozkrut, M. & Torój, A. (2020). How time-varying elasticities of demand translate into the excise related laffer surface. *Argumenta Oeconomica*, 1(44), 259–299.

Park, B. U., Mammen, E., Lee, Y. K. & Lee, E. R. (2013). Varying coefficient regression models: A review and new developments. *International Statistical Review*, 83(1), 36–64. doi:10.1111/insr.12029

Sabev, D., Antonov, P., Naseva, E., Geshanova, G. & Gavrilova, M. (2023). Economics of tobacco and tobacco taxation: National study – Bulgaria. https://doi.org/10.13140/RG.2.2.21331.35369

Van der Merwe, R. & Annett, N. (1998). Chapter 4: The effects of taxation on consumption in South Africa. The Economics of Tobacco Control Project, in: The economics of tobacco control in South Africa, report submitted to International Tobacco Initiative, School of Economics, University of Cape Town.

van Walbeek, C. P. (1996). Excise taxes on tobacco: how much scope does the government have? *South African Journal of Economics*, 64(1), 20–42.

Vladisavljevic, M., Zubović, J., Đukić, M. & Jovanović, O. (2020). Tobacco price elasticity in Serbia: evidence from a middle-income country with high prevalence and low tobacco prices. *Tobacco Control,* 29(5), 331–336.

Vladisavljević, M., Zubović, J., Đukić, M. & Jovanović, O. (2021). Inequality-reducing effects of tobacco tax increase: accounting for behavioral response of low-, middle-, and high-income households in Serbia. *International Journal of Environmental Research and Public Health,* 18(18), 9494.

Vladisavljević, M., Zubović, J., Jovanović, O. & Đukić, M. (2024). Crowding-out effect of tobacco consumption in Serbia. *Tobacco Control*, 33(Suppl. 2), 88–94.

WHO – World Health Organization (2023). WHO report on the global tobacco epidemic, 2023: protect people from tobacco smoke. https://iris.who.int/server/api/core/bitstreams/2b09f8b0-08f3-4bef-b8a5-8c4b4e1a95ad/content

Zubović, J., Vladisavljević, M., Gjika, A., Zhllima, E., Imami, D., Gligorić, D., Mićić, L., Preradović, D., Pepić, A., Prekazi, B., Pula, E., Najdovska, N.T., Mugoša, A., Čizmović, M., Laković, T., Popović, M., Đukić, M. & Jovanović, O. (2019). Impacts of tobacco excise increases on cigarette consumption and government revenues in Southeastern European Countries [Report]. IES. www.tobacconomics.org/files/research/561/Regional-report-2019.pdf

Zubović, J., Zdravković, A., Jovanović, O., Djukić, M. & Vladisavljević, M. (2024). Affordability of cigarettes in ten Southeastern European countries between 2008 and 2019. *Tobacco Control,* 33 (Suppl. 2), 59–67. https://doi.org/10.1136/tc-2022-057716

Appendix

Table A1 / Definition of variables

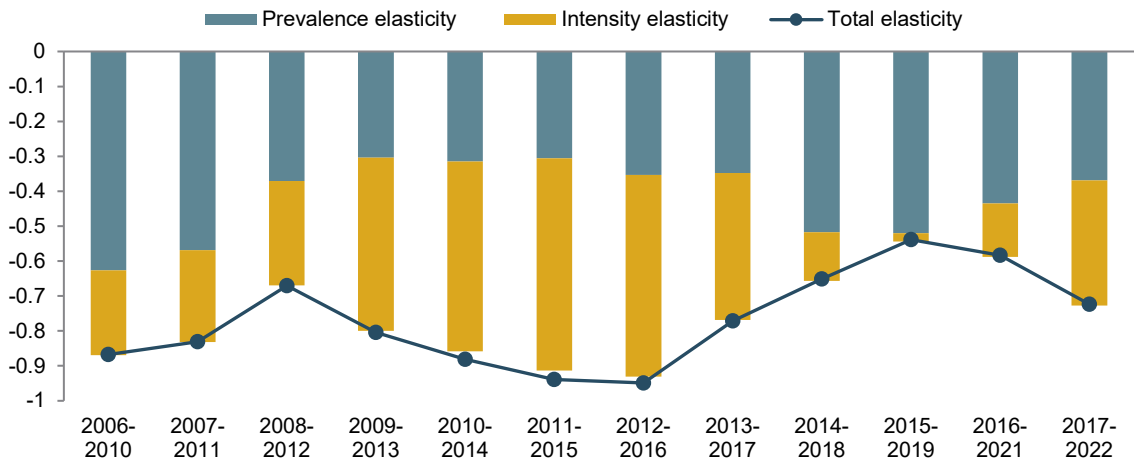
Variable	Description	Measure
Prevalence indicator	Equals one when a household (HH) has positive expenditure on cigarettes and zero otherwise.	Indicator
Number of cigarettes	Consumption of cigarettes by smoking household	Number of packs
Real cigarette price	Average unit cost of a cigarette pack at the municipality level (if at least three households reported cigarette expenditures within the municipality), adjusted by overall harmonised index of consumer prices (HICP) for the respective month in which household consumption was reported	Real RSD (2006=100)
Real monthly household income	Approximated by total monthly household expenditures adjusted by overall HICP for the respective month in which household consumption was reported	Real RSD (2006=100)
Household size	Total members of household	Number
Male ratio	Share of male household members	Percentage
Adult ratio	Share of household members older than 14 years	Percentage
Education	Maximum level of education achieved by household members, categorised as follows: incomplete primary (less than 8 years of schooling), primary (8 years), secondary up to 3 years, secondary 4 years, tertiary 2 years, tertiary 3+ years	Categories; referent – Incomplete primary
Region	Household location with respect to NUTS 2 regional classification: Belgrade, Vojvodina, Šumadija and Western Serbia, Eastern and Southern Serbia.	Categories; referent – Belgrade
Activity status	Maximum level of activity achieved by household members, categorised as follows: unemployed HH, pensioner HH, self-employed HH, employed HH.	Categories; referent – Employed
Advertising ban	0 till 2009, 1 since 2010	Dummy

Table A2 / Aggregate elasticities estimates, two-part model in levels, 2006-2022

Variables	Prevalence		Intensity	
	Coeff.	Std. error	Coeff.	Std. error
Real cigarette price	-0.005***	(0.001)	-0.004***	(0.000)
Real monthly household income	0.513***	(0.018)	0.225***	(0.015)
Real monthly household income squared	-0.029***	(0.001)	-0.011***	(0.001)
Household size	0.066***	(0.008)	0.036***	(0.003)
Male ratio	0.555***	(0.034)	0.167***	(0.016)
Adult ratio	0.528***	(0.062)	0.265***	(0.028)
Education (Referent – Incomplete primary)				
Primary	0.630***	(0.047)	0.037	(0.026)
Tertiary 2 years	0.742***	(0.047)	0.026	(0.024)
Secondary 4 years	0.494***	(0.048)	-0.060**	(0.026)
Tertiary 2 years	0.241***	(0.054)	-0.111***	(0.027)
Tertiary 3+ years	-0.061	(0.053)	-0.174***	(0.028)
Region (Referent – Belgrade region)				
Vojvodina	0.077*	(0.043)	0.069***	(0.025)
Šumadija and Western Serbia	0.327***	(0.044)	0.108***	(0.018)
Eastern and Southern Serbia	0.070	(0.045)	0.165***	(0.018)
Activity status (Referent – Employed)				
Unemployed HH	-0.013	(0.045)	0.037	(0.023)
Pensioner HH	-0.639***	(0.025)	0.001	(0.028)
Self-employed HH	-0.174***	(0.030)	-0.009	-0.012
Advertising ban	-0.208***	(0.045)	-0.062***	(0.016)
Constant	-2.394***	(0.104)	2.719***	(0.074)
Observations	86,736		86,736	

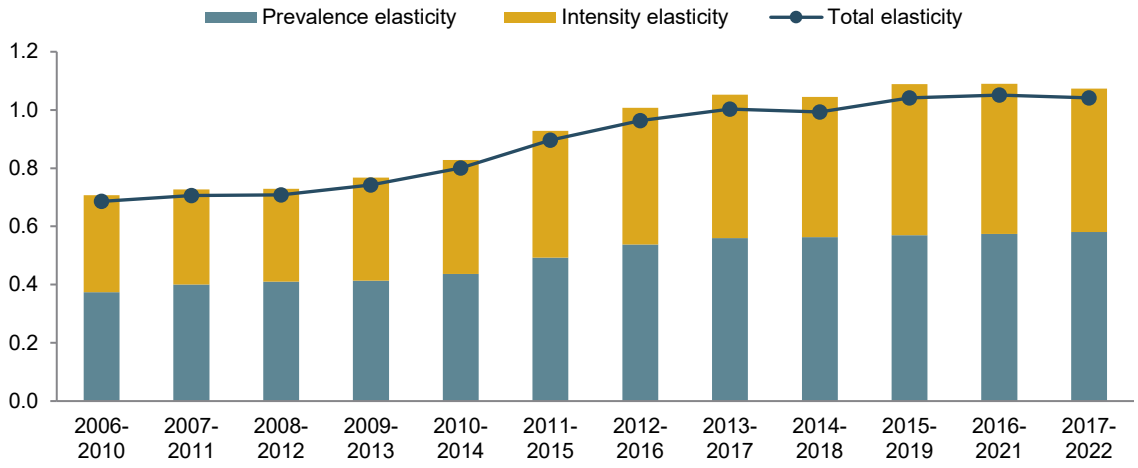
Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Figure A1 / Time-varying price elasticity of demand for cigarettes, level model



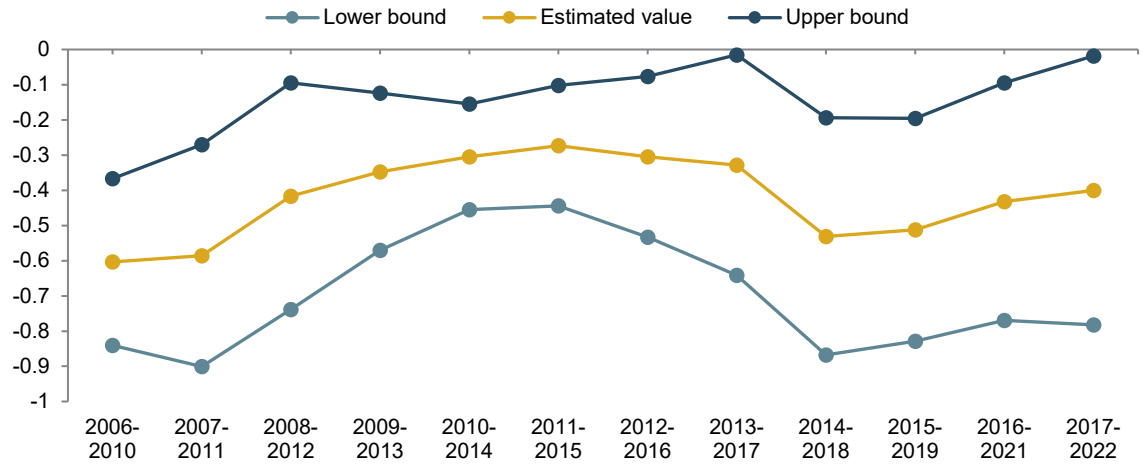
Source: authors' calculations based on HBS data

Figure A2 / Time-varying income elasticity of demand for cigarettes, level model



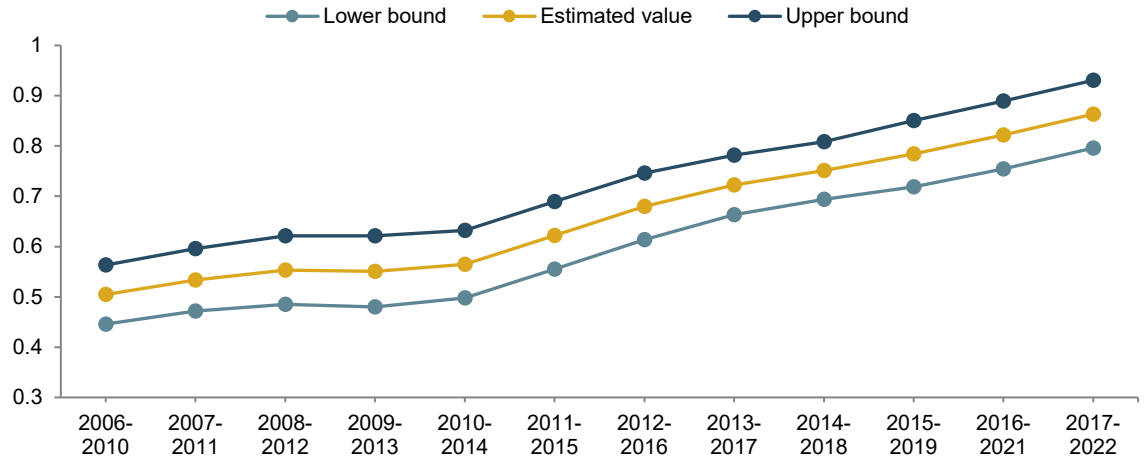
Source: authors' calculations based on HBS data

Figure A3 / Confidence intervals of the estimated price prevalence elasticities from the log model, rolling subperiods



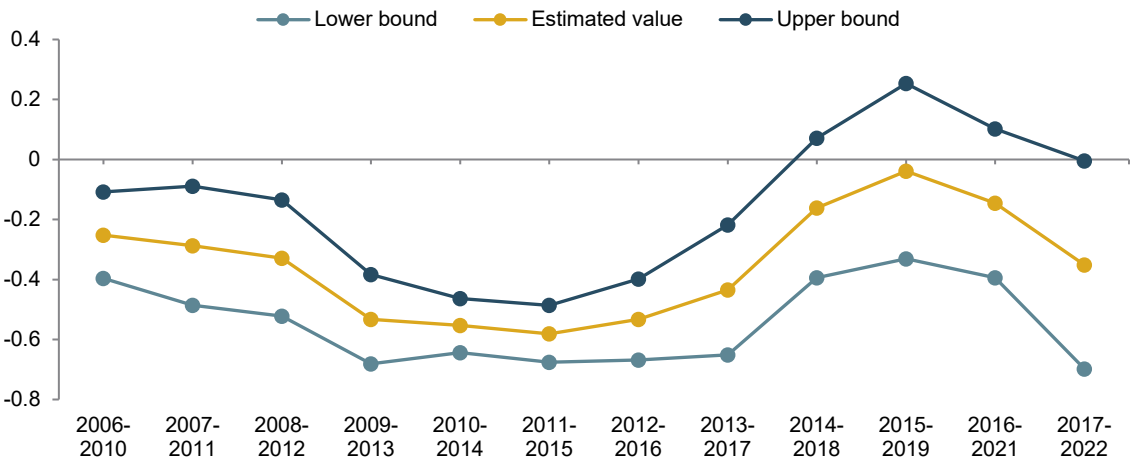
Source: authors' calculations based on HBS data

Figure A4 / Confidence intervals of the estimated income prevalence elasticities from the log model, rolling subperiods



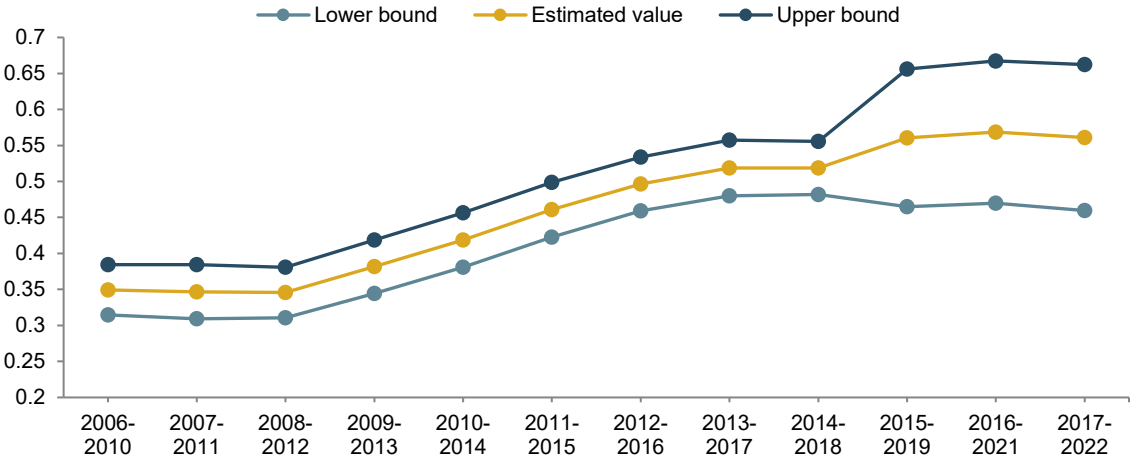
Source: authors' calculations based on HBS data

Figure A5 / Confidence intervals of the estimated price intensity elasticities from the log model, rolling subperiods



Source: authors' calculations based on HBS data

Figure A6 / Confidence intervals of the estimated income intensity elasticities from the log model, rolling subperiods



Source: authors' calculations based on HBS data

IMPRESSUM

Herausgeber, Verleger, Eigentümer und Hersteller:
Verein „Wiener Institut für Internationale Wirtschaftsvergleiche“ (wiiw),
Wien 6, Rahlgasse 3

ZVR-Zahl: 329995655

Postanschrift: A 1060 Wien, Rahlgasse 3, Tel: [+431] 533 66 10, Telefax: [+431] 533 66 10 50
Internet Homepage: www.wiiw.ac.at

Offenlegung nach § 25 Mediengesetz: Medieninhaber (Verleger): Verein "Wiener Institut für Internationale Wirtschaftsvergleiche", A 1060 Wien, Rahlgasse 3. Vereinszweck: Analyse der wirtschaftlichen Entwicklung der zentral- und osteuropäischen Länder sowie anderer Transformationswirtschaften sowohl mittels empirischer als auch theoretischer Studien und ihre Veröffentlichung; Erbringung von Beratungsleistungen für Regierungs- und Verwaltungsstellen, Firmen und Institutionen.

wiiw HEPA

wiiw.ac.at