Accelerating Progress on Effective Tobacco Tax Policies in Low- and Middle-Income Countries

Price and Income Elasticity of Cigarette Demand in Bulgaria and the Impact of Changing Excises on Government Tax Revenues

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Contents

Executive Summary

Bulgaria has the highest mortality rate attributable to tobacco consumption and exposure globally, and it is the European Union (EU) member state with the highest tobacco prevalence. It is also the EU member state with the lowest excise rates on cigarettes. These facts stand in close connection, underlining the urgent need for effective national tobacco control measures.

This study, authored by the research team from the Smoke-free Life Bulgaria Coalition, has two main objectives. First, to provide independent and reliable estimations of the national price and income elasticity of cigarette demand. Second, to develop scenarios about the expected cigarette demand and budget revenues when imposing higher excise rates. The quantitative research utilizes the Household Budget Survey data for 2015–2019 and 2021.

Following the established methodology of the two-part models, we initially estimated the prevalence elasticity of cigarette demand (elasticity on the extensive margin) and then the intensity elasticity. The total elasticity is equal to the sum of these two coefficients. The first part applied a logit model, which did not find statistical association between the price of cigarettes and the prevalence of smoking. Yet the income elasticity of cigarette demand on the extensive margin is positive, significant at the 0.01 level, and amounts to roughly 0.5. This means that a 10-percent increase in household incomes will result in a five-percent greater probability that someone from the household would buy cigarettes.

In the second part, the intensity elasticity coefficients were calculated by using two different methods, Angus Deaton's and the generalized linear model (GLM). Both methods returned very close results: price elasticity in the range of -1.4 to -1.49 and income elasticity of around 0.8. Thus, by summing up the coefficients, we estimated a total price elasticity of -1.49 and a total income elasticity of 1.32. These results are considerably higher than previous estimates—for Bulgaria and for other countries in the Balkan region—and also higher than the price elasticity coefficients calculated during the first year of this project with Bulgarian macrodata from 2004–2021. Therefore, the new estimations should be interpreted with caution.

When following the second objective—to develop scenarios of expected demanded quantities and budget revenues with different excise increases—we found that a 7.25-percent increase in the specific excise duty would bring an additional BGN 31 million in tobacco tax revenues along with more than a five-percent reduction in cigarette consumption. Given the estimated elasticity of cigarette demand, fiscal neutrality (same level of budget revenues) may be retained by a roughly 10-percent specific excise increase leading to eight percent lower tobacco consumption.

The overall conclusion from this study is that there is room for more ambitious tobacco taxation policies in Bulgaria. In general, current research results are in line with similar research in other countries from the region. However, there are peculiarities in Bulgarian tobacco demand and thus a need for further detailed and thorough tobacco elasticity studies based on bigger and more reliable data sets.

1. Introduction

Tobacco consumption, according to the Global Burden of Disease database, is responsible for more than eight million premature deaths per year (including 1.3 million non-smokers), and the World Health Organization decries tobacco as "one of the biggest public health threats the world has ever faced." Amidst this pandemic, Bulgaria is the nation with the highest death rate attributable to tobacco use and exposure: 328.5 deaths per 100,000 people as of 2019.[1] The toll that tobacco consumption takes on Bulgaria amounted to 22,750 deaths in 2019 (18,189 to 28,030 confidence interval), which corresponds to 18.3 percent of all deaths in the country. Tobacco—both smoking and exposure to second-hand smoke—is the second-most significant national health risk factor, thus a major contributor to the astounding mortality rate.[2]

In addition to its detrimental health aspects, tobacco consumption has widespread negative economic impacts globally. The total economic cost of smoking (which includes both health expenditures and productivity losses due to tobacco use and exposure) has been estimated at 1.8 percent of the world's gross domestic product;[3] for the Balkan region, this number may even be twice as high.[4] Tobacco consumption burdens disproportionately poorer households by reducing their disposable incomes available for staple goods and education and increasing their health care costs, thus doubly exacerbating poverty.[5] Bulgaria, being a middle-income country with a high inequality rate and high tobacco consumption, is largely susceptible to these negative economic impacts. According to the European Health Interview Survey, the share of daily smokers in Bulgaria was 28.7 percent in 2019, which is the highest number in the EU, 55 percent above the average.

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[1] Global Burden of Disease [database]. (2019). Washington, DC: Institute for Health Metrics and Evaluation.
[2] The World Bank. Death rate, crude (per 1,000 people). [indicator]. Available: https://data.worldbank.org/indicator/SP.DYN.CDRT.IN?locations=BG Bulgarian mortality rate was the highest in the world for seven consecutive years since 2015.
[3] Goodchild, M., Nargis, N., & Tursan d'Espaignet, E. (2018). Global economic cost of smoking-attributable diseases. *Tobacco Control,* 27(1):58-64.
[4] Gligoric, D., Kulovac, D., Micic, L., & Vulovic, V. (2023). Economic cost of cigarette smoking in Bosnia and Herzegovina. *Tobacco Control,* 0:1-6.
[5] World Health Organization. (2021). *Global report on trends in prevalence of tobacco use 2000-2025.* Geneva.

Tobacco tax increases are "the single most consistently effective tool for reducing tobacco use,"[6] therefore their proper design and implementation is of central importance for Bulgaria. The mechanism by which tobacco taxation lowers consumption is by lowering the affordability of tobacco products. Since tobacco is a highly addictive product and its demand is principally inelastic, there is room for sustaining and even increasing tobacco tax revenues while decreasing total tobacco consumption—as confirmed by numerous studies in different countries.[7] This guarantees stable budget revenues while the nation reaps the health, social, and economic benefits from lowering tobacco use such as lower public and personal healthcare expenditures, higher productivity, lower absenteeism, and household resources remaining for personal development.

Yet this typical win-win scenario (both higher budget revenues and public health benefits) has its detractors. First, in countries like Bulgaria, where the VAT and excise on tobacco products turned into a substantial fiscal source during the last 15 years, it is impossible to sustain tobacco-related revenue growth *ad infinitum*. For instance, in the peak year of 2020, indirect tobacco taxation in Bulgaria brought in 14 percent of all tax revenues (direct and indirect taxes) and 7.7 percent of total general government revenues—a disturbingly high share revealing a generally unbalanced tax structure. Second, and more substantially, tobacco's fiscal importance lessens the government's willingness to adopt more vigorous tobacco control measures. The lowest excise rates on cigarettes in the EU are the corollary of this disputable prudence.

Thus, in extreme cases like Bulgaria, where tobacco taxation has historically been used to raise revenues and not as a means to lower tobacco consumption, there is a need for a new policy prioritizing public health over short-term budget revenues. The possibility of retaining the same level of tobacco tax revenues with lower levels of tobacco consumption has to be explored and implemented to its end.

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[6] See discussion in Chaloupka, F. (2017). *Tobacco Tax Increases Remain Most Effective Policy for Reducing Tobacco Use*. A Tobacconomics Research Brief. Chicago: Institute for Health Research and Policy, University of Illinois at Chicago. https ://tobacconomics.org/uploads/misc/2017/11/effectiveness-of-tobacco-taxes_brief.pdf

[7] See for example Cizimovic, M., Mugosa, A., Kovacevic, M., & Lakovic, T. (2022). Effectiveness of tax policy changes in Montenegro: Smoking behavior by socio-economic status. *Tobacco Control*, 31, s124-s132.

The growing incomes of the Bulgarian population are constantly making tobacco products more affordable, while the tobacco industry devises newer and more potent marketing signals. In this dynamic and complex situation, it is of central importance to have proper estimations of the elasticity of tobacco consumption that will inform authorities of the possible effects (in terms of tobacco demand and public revenues) of raising tobacco taxes.

Mainly due to the character of the available data, the present research did not achieve comprehensive results on all tested hypotheses. Nevertheless, it provides important inferences regarding national cigarette consumption and the possible optimal tobacco tax policies for Bulgaria.

2. Methodology of Elasticity of Demand Estimations

2.1 Two-part model

In the last decades, the two-part model found widespread use in the domain of health economics.[8] Based on the basic rule of probability theory, it represents the total elasticity of demand as a sum of two independently calculated elasticity coefficients: the *prevalence elasticity* and the *conditional elasticity.* Basically, "elasticity of demand" is the rate of change of demanded quantity resulting from the change in some underlying factor, most often price or income.

Narrowing the focus to tobacco economics, prevalence elasticity—also called elasticity on the extensive margin—answers the question to smoke or not to smoke. The probability of this decision is estimated via binary regression models. Conditional elasticity, on its part, relates only to tobacco consumers and represents expectations of change in the demanded quantity resulting from changes in cigarette price, disposable incomes, or some other underlying factor. Conditional elasticity is widely understood as elasticity on the intensive margin. When estimating it using household expenditures surveys, typically Deaton's method is applied. Alternatively, conditional elasticity might be calculated directly with a regression model, for instance, OLS or GLM.

[8] Belotti, F., Deb, P., Manning, W., & Norton, E. (2015). Twopm: Two-part models. *The Stata Journal, 15*(1), 3-20.

This research attempts to estimate the total price and income elasticity of tobacco demand in Bulgaria by, first, estimating prevalence elasticity via a logit model and, second, by estimating intensity elasticity following Deaton's method. GLM is used as a robustness check for the estimated elasticity coefficients on the intensive margin. Elasticity coefficients on the extensive margin are attained after comparing different model specifications on the basis of their pseudo-R^2 values, AIC, BIC, and correctly specified results.

2.2 Estimating prevalence elasticity of cigarette demand

Even in a country with high tobacco prevalence, the majority of the population usually does not consume cigarettes—that is, for most households' tobacco consumption, y = 0. In order to model the probability of a household having positive consumption, y = 1, different regression models for binary outcomes might be employed.[9] In this research, a logit model is employed. Formally, it may be represented in the following way:

$$P(y = 1) = \phi(\beta_0 + \beta_1 * p_i + \beta_2 * i_i + \beta_3 * Z) \qquad (1)$$

where p_i and i_i are respectively cigarette prices and disposable income faced by household *i*, and Z is the vector of the covariates used in the analysis. It is important that the regression coefficients β in the above equation do not represent marginal effects and have no clear interpretation. In order to estimate the marginal effects (for instance, of price) one has to calculate:

$$ME_p = \Delta P(y > 1) / \Delta P_i = f(z) * \beta_1 \qquad (2)$$

with *z* being the linear combination of the independent variables. Marginal effects are interpreted as the probability of households having positive spending on tobacco products depending on a unit increase in price. Price elasticity is derived directly from this with the formula:

[9] Long, J., & Freese, J. (2014). *Regression models for categorical dependent variables using Stata.* College Station: Stata Press.

$$\xi_{p1} = ME_p\,(\overline{pi}\,/\,Y) = \frac{dP(Y=1)}{dpi} * \frac{\overline{pi}}{Y} \qquad (3)$$

where $\overline{pi}$ and Y are the average prices and smoking prevalence before the price increase.

Estimations via logit models require the application of at least two post-estimation tests. The *linktest* aims to detect a possible specification error, and the Hosmer-Lemeshow *goodness-of-fit test*[10] is a test of the observed against the expected value across the whole distribution of the outcomes, by grouping them within usually 10 categories of equal size.

2.3 Estimating intensity elasticity of cigarette demand

Theoretically, Deaton's method is the preferred option to estimate the intensity elasticity of cigarette demand since it was developed especially for applications in HBS when there is no explicit information on the prices of goods.

A. Deaton's method

The initial prerequisite for applying Deaton's method is that all households of a given cluster face the same price of a given good, namely cigarettes, whereas there is a significant variation in prices between separate clusters. In addition, prices are not directly observable but only the "unit values"—the ratio of the household's expenditure on a given good and the physical quantity of this good. Unit values are not prices since they reflect the possibility of consumers switching to lower-quality products in order to retain the quantity of consumption. Therefore, unit values unlike market prices are to a certain extent a matter of consumer choice. As Deaton points out,

> There is a risk of simultaneity bias in any attempt to use them to "explain" the patterns of demand… Instead of explaining the demand for rice by the price of rice, we are in effect regressing two aspects of the demand for rice on one another…[11]

Deaton's method of calculating price elasticities from HBS data—without knowing the exact prices—consists of several steps. (The formulas will not be repeated here. An accessible summary

[10] Archer, K., Lemeshow, S. (2006). Goodness-of-fit test for a logistic regression model fitted using survey sample data. *The Stata Journal,* 6, Number 1, pp.97-105.
[11] Deaton, A. (2018). *The analysis of household surveys.* p. 288.

of the method is provided in the *Updated Tobacconomics Toolkit on Using Household Expenditure Surveys for Research in the Economics of Tobacco Control*. See section 3.3 on pages 30–45.[12]) Step 1 is to calculate the unit values at the household level. Step 2 is to test whether unit values vary between different clusters by using ANOVA. A significant F-statistic and R^2 around 0.5 (that is, cluster dummies explaining at least half of the total variation of unit values) mean that the unit values can be used for estimating price elasticities. Step 3 is to estimate the within-cluster regressions of unit values (presented on the left side of the equation in logarithmic form) and budget shares (shares of tobacco expenditures in the total household expenditures). The unobserved prices are not included in this calculation; their coefficients are recovered at Step 6.

Step 4 consists of preparing data for between-cluster regression. It aims to obtain cluster-level demand and unit values by "purging" them from any household-specific characteristics different from price information and measurement errors. In addition, two other variables are estimated: the average cluster size for all households and the average cluster size for households reporting a purchase of tobacco products. Step 5 involves regressing cluster-level demand on cluster-level unit values, and this yields the ratio between the unobserved prices introduced in Step 3. Lastly, in Step 6, an estimation of the price elasticity of demand is obtained by applying quality correction. The income elasticity of demand is calculated by only first-stage coefficients and is derived already in Step 3. The standard errors for both price elasticity and expenditure elasticity of demand have to be additionally obtained by a bootstrap procedure with 1,000 replications.

B. Generalized linear model

In the two-part models, positive outcomes are often modeled by a regression framework for continuous outcomes. In many cases, GLM models are preferred since they do not require assumptions of homoscedasticity or normality.[13] Moreover, GLM lessens the risk of prediction bias in the process of retransformation of coefficients. Formally, GLM is:

[12] John, R., Vulovic, V., Chelwa, G., & Chaloupka, F. (2023). *Updated toolkit on using household expenditure surveys for research in the economics of tobacco control.* A Tobacconomics Toolkit. Chicago: Tobacconomics, Institute for Health Research and Policy, University of Illinois Chicago.

[13] Zubovic, J., & Vladisavljevic, M. (eds.). (2019). *Impacts of tobacco excise increases on cigarette consumption and government revenues in Southeastern European countries. Regional study*. Belgrade: Institute of Economic Sciences.

$$g\{E(y)\} = x\beta, \; y \sim F \qquad (4)$$

where g(.) is called a link function, and F is the distributional family. GLM is a generalization of non-linear least squares and represents the expected value in the form of a function. A standard practice in health economics is to use GLM with gamma family and a log link function. Still, the type of link function that should be used in GLM has to be tested via the Box-Cox test. The best approximation for the distributional family is determined via the modified Park test.

After the model estimation, the intensity elasticity is calculated with the formula:

$$\xi_p = ME_p\left(\bar{p} / \bar{y}\right) \qquad (5)$$

where $\bar{p}$ and $\bar{y}$ are the averages of the price and the quantity of cigarettes consumed by households with positive consumption. The elasticity coefficient is interpreted in the following way: if the price (or income) changes by one percent, cigarette consumption (of households with positive cigarette consumption) will change by ξ_p percent, all other things being equal.

2.4 Estimating total price and income elasticity

Total price elasticity is calculated by summing up the estimated conditional elasticity ξ_{p1} and intensity elasticity ξ_{p2}. There is a reasonable argument that the total elasticity coefficient differs from the straightforward sum, since a change in the smoking prevalence would influence the intensity elasticity (Zubovic & Vadisavljevic, 2019). Because the estimated difference in the straightforward and the corrected sum is not significant, a simple summing up was used here.

A specific problem arises when one part of the two-part model estimates non-significant elasticity coefficients, and the other part produces significant results—this is the case here with the estimated price elasticity in Bulgaria. A similar situation was observed for instance in Kosovo[14]: the first part of the model (logit) did not reach statistically significant results, but Deaton's method in the second part produced significant results. In such cases, the logical interpretation is that, given the available data, the observed changes in cigarette prices do not

[14] See Prekazi, B. (2019). Kosovo. (Country Chapter). In: Zubovic, J., Vladisavljevic, M. (eds.). Impacts of Tobacco Excise Increases on Cigarette Consumption and Government Revenues in Southeastern European Countries.

impact the decision to smoke or not to smoke, yet price still determines the decision of how much to smoke. Therefore, the total price elasticity of cigarette demand is equal to the price elasticity on the intensive margin.

2.5 Dividing the sample into three income groups

As evident from Table 2 (on page 14), cigarette demand in Bulgaria is unevenly distributed among income groups, with the highest tobacco prevalence and intensity in the highest income group—an atypical situation, at least for the EU.[15] Here, the method used for dividing the sample into income groups will be outlined. First, a new variable "income per household member" was created. Then, based on this variable and using weights, the HBS sample was divided into three categories for each separate year. Third, households were grouped according to their belonging to a certain category in a given year. Since the incomes of the population grew during the studied period, the minimum income values of a higher income group in a previous year may be below the maximum income values of a lower income group in a later year.

Divided in this way, the first group comprises of 6,338 households, the second group of 5,944, and the third group of 5,450. Data in columns 3 and 6 in Table 2 are derived from this sample (columns 4 and 5 in Table 2 exclude non-smoking households).

3. Data, Descriptive Statistics, and Main Variables

3.1 Data used in the analysis

This research utilizes anonymized individual household data from the Bulgarian Household Budget Survey (HBS) for the years 2015–2019 and 2021, with a gap year in 2020 due to the COVID-19 pandemic. The data were obtained from the Bulgarian National Statistical Institute

[15] This unusual result finds its confirmation in the European Health Interview Surveys (EHIS): for 2019, the share of the non-smokers in the first income quintile in Bulgaria was 69.2%, which is slightly below the EU average. For the fifth quintile, the share of non-smokers was only 57.9%, which is by far the lowest value across all countries covered by EHIS. See Eurostat, "Smoking of tobacco products by sex, age and income quintile" (indicator).

(NSI). According to NSI, in 2015 a major update in the HBS methodology was introduced which does not allow for reliable merging with HBS entries from previous years.

The total number of Bulgarian households covered by HBS during these six years is 17,732, which makes an average of 2,955 per year. The annual quota of the HBS for Bulgaria is 3,060 households, but roughly a hundred of them usually leave the survey each year before it is completed (Bulgarian HBS is conducted in three waves and each household included has to participate for four months in a year). The recall period is 30 days, and NSI annualizes the results in its HBS reports.

In addition to the data on cigarette consumption and cigarette expenditures, NSI also follows expenditures on other tobacco products. This indicator was omitted from the analysis here since as of 2021 only three percent of all covered Bulgarian households had such expenditures.

3.2 Descriptive statistics

As a first step, all monetary values from the HBS—household incomes, household total expenditures, and expenditures on cigarettes—were adjusted with the national Consumer Price Index, with 2021 as the base year. The main indicators of cigarette consumption in Bulgaria are summarized in Table 1.

Table 1. Cigarette demand in Bulgaria according to HBS, 2015–2021

	Smoking prevalence *%*	**Average cig. consumption** *20-sticks packs per household per year*	**Real cig. expenditure,** *BGN*	**Avg. real price per pack** *BGN*	**Avg. real income,** *BGN*
2015	41.63	182.57	936.93	5.13	11,754
2016	41.75	179.81	974.98	5.42	11,998
2017	42.5	178.63	972.49	5.44	12,565
2018	39.98	189.17	1038.1	5.52	12,772

2019	41.18	196.09	1067.47	5.48	13,300
2021	43.91	188.24	989.8	5.27	16,133

Notes: All numbers represent weighted means. Monetary values corrected for inflation. Data on consumption, expenditures, and price pertain only to households reporting cigarette expenditures. "Average real price" is an approximation for the average unit value of cigarettes (Avg. expenditure / Avg. consumption) and is different from the price variable used in elasticity estimations (Sec. 3.3).
Source: Bulgarian HBS, Authors' calculations.

The most pronounced development evident from the table is households' 37-percent income growth[16] in the studied six-year period (and 21 percent in only two years, 2019 to 2021). On the backdrop of mostly stagnant real prices of cigarettes, the rising incomes largely increased the affordability of cigarettes in Bulgaria—which inevitably affected tobacco demand. During the period covered by the HBS data, the average weighted price of cigarettes moved in two opposite directions: first, it rose by 7.6 percent between 2015 and 2018, and then it declined by 4.5 percent until 2021. The year with highest growth (5.7 percent) of the real price of cigarettes was 2016, while in the second part of the studied period, real prices went down due to the inflation effect.

In regards to the quantity of cigarettes consumed, the development is mixed: it declined by four percent per cigarette-consuming household in 2021—but prior to this between 2017 and 2019 there was an almost 10-percent increase (up to 196 standard packs of cigarettes per household). The average Bulgarian household with positive cigarette expenditures consumed 10.3 cigarettes per day, or 15.5 packs per month, in 2021. As for cigarette prevalence, it rose by 6.6 percent between 2019 and 2021; in the same time, the average real price of cigarettes fell by 3.8 percent.

Albeit mixed, data in Table 1 indicate an important development: **the major increase in cigarette prevalence (by almost 10 percent) occurred** during the years of 2018–2021—**exactly when the cigarette prices entered a negative trend**, as real prices per pack dropped from 5.52 to 5.27 BGN. The case of declining real cigarette prices is atypical, and unwanted, for a country applying tobacco control measures.

[16] According to the World Bank data on the per capita gross domestic product between 2015 and 2021 (measured in constant PPP terms), there was a 22% growth in Bulgaria—still considerable but below the HBS very high estimations.

Table 2 sums up the cigarette demand in the low-, middle-, and high-income population groups.

Table 2. Cigarette demand in Bulgaria among low-, middle-, and high-income groups

		Prevalence, %	Consumption, packs	Avg. expenditure (BGN)	Average price (BGN)
2015	Low	38.75	150.18	747.24	4.99
	Medium	39.04	184.62	948.53	5.15
	High	47.11	207.52	1,083.41	5.22
2016	Low	36.88	146.55	779.82	5.30
	Medium	37.03	176.06	948.98	5.40
	High	51.35	206.44	1,134.12	5.52
2017	Low	36.48	145.58	772.48	5.35
	Medium	39.28	172.34	939.33	5.42
	High	51.74	206.73	1,138.82	5.52
2018	Low	33.33	155.86	832.98	5.46
	Medium	37.38	180.48	992.62	5.51
	High	49.25	218.33	1,211.57	5.56
2019	Low	36.94	155.93	841.92	5.45
	Medium	35.6	206.19	1,114.47	5.44
	High	50.99	218.13	1,198.14	5.53
2021	Low	40.36	162.41	841.40	5.22
	Medium	39.62	192.26	1,007.64	5.25
	High	51.75	206.34	1,091.95	5.32

Note: All numbers represent weighted means.

Source: HBS, Authors' calculations.

It is noteworthy that **the highest-income group in Bulgaria also has the highest cigarette prevalence**—unlike most other EU member states where higher-income groups have lower smoking rates.[17] According to the sample utilized in this research, the prevalence of cigarette consumption of the higher-income group in Bulgaria in 2021 was more than 11 percentage points (or 28 percent) higher than that of the lower-income group.

In addition, the average annual consumption measured in packs per household for the high-income group was nearly 27 percent larger than that of the lower-income group. Evidently, the cigarette unit values ("real prices") for the lower- and higher-income groups are quite close—as shown in column 6 in Table 2. The latter fact is due mainly to a specific tobacco industry strategy (a low pricing strategy aimed at high sales volumes) provoked by the relatively lower purchasing power of Bulgarian households, even in the higher income brackets—yet this might be regarded as a positive trait from the tobacco control point of view.

In regards to the **middle-income group, it is closer to the lower-income group in terms of cigarette prevalence, whereas in terms of intensity of consumption, it stands somewhere in the middle between the highest and the lowest income groups**. Among other things, this indicates that smoking initiation (participation) is being influenced by a different set of factors than smoking intensity, the latter being determined predominantly by budgetary restraints.

An interesting development took place in the last three years covered by the data set: whereas until 2018 the middle-income group had a higher cigarette prevalence than the lower-income group, since 2019 the lower-income group overtook the middle-income group in this respect. Still, the intensity of cigarette consumption in the middle-income group remained substantially higher than in the low-income group. The highest intensity of cigarette demand is in the high-income group: the average smoking high-income household consumed 11.3 cigarettes daily in 2021 (or 17 packs monthly) while the average smoking household from the lower-income group consumed less than nine cigarettes daily.

[17] Eurostat. (2021). *Smoking of tobacco products by sex, age and income quintile*. [indicator]. Online data code: HLTH_EHIS_SK1I__custom_7348665.

In short, the distribution of cigarette consumption in Bulgaria is skewed towards the higher income group—although the lower income group is catching up in more recent years.

3.3 Main variables used in the analysis

HBS provides annualized data on a household level about cigarette expenditures and the number of purchased cigarettes. Based on the incidence of cigarette expenditures, a binary variable "consuming—non-consuming households" was created. The main variables in the elasticity of demand analysis are the price of cigarettes and the disposable income of households.

There is a high correlation (r=0.7848) between households' incomes and their consumer expenditures, but these indicators are not identical. Since self-reported records on general household incomes in the HBS are typically less reliable than records on expenditures with a possibility of very high underreporting, in all models employed below we used the total household expenditures as an approximation for the real disposable incomes of households.

Constructing the price variable required a series of additional transformations. As a preliminary step, using the unique household ID that contains a code for the (unspecified) geographical areas of the surveyed households, two territorial levels were created: "district" (there are 28 districts in Bulgaria) and the much smaller "cluster," or primary sampling unit (PSU).

In the Bulgarian HBS, there are no records of prices of consumed cigarettes, but it is easy to construct a unit value of cigarettes equal to total cigarette expenditures divided by the number of the consumed cigarettes. In order to address the issue of endogeneity that may distort the logit regression in the first part of the model,[18] instead of individual unit values an imputed variable was created, equal to the mean unit value of cigarettes in each PSU, for each year.[19] To this end, first we created mean unit values on a district level, for each year—having in this way

[18] Deaton's method does not apply this transformation: it bypasses the endogeneity issue by not resorting to cluster price levels.

[19] Endogeneity problem might be overcome by "developing average measures of price from the prices reported by individuals residing in the same geographic area…": U.S. National Cancer Institute and WHO. (2021). *The Economics of Tobacco and Tobacco Control.* Bethesda: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute; and Geneva: WHO.

168 unique "district-year" means. Second, we created mean unit values on a PSU level, for each year (the total number of "PSU-years" is 3,059). Third, for each "PSU-year" with no cigarette expenditures, or only one household with cigarette expenditures, we imputed the corresponding "district-year" unit value—that is, the mean price for the higher geographical aggregation. The so-described price variable comprises of 2,204 unique values.

In addition to the price and income variables, the quantitative research utilized a series of covariates: the available sociodemographic characteristics of the households. They included male ratio (number of males/household size), adult ratio (number of adults/household size), maximum education (the highest education level attained by a member of a household, in the range 1–6), household type (based on the employment status: only pensioners, households with at least one employed, and households with only unemployed/other), and household size.

In the process of model fitting, some variables were transformed into quadratic or logarithmic forms in order to find the best specification of the demand model.

4. Total Elasticity of Cigarette Demand in Bulgaria: Results

4.1 Prevalence elasticity of cigarette demand

The prevalence elasticity of cigarette demand in Bulgaria is estimated via a logit model, with "price" and "income" being the main independent variables, and the set of covariates mentioned above.

A major prerequisite for applying the logit function is the correct specification of variables in the model, which is tested via Pregibon's specification test (linktest). In order to pass the linktest, a model specification has to have a statistically insignificant value of the _hatsq[20]. In addition, after estimating the model, the Hosmer-Lemeshow test assesses whether the observed values match the expected values in the subgroups of the model populations, typically dividing it into 10 groups. A number of model specifications with the available variables were tested yet only a

[20] _hatsq represents the leverage of each observation in the model—that is, it indicates how much influence each data point has on the estimated coefficients in the logit.

fraction of them passed the linktest. Table 3 lists prevalence elasticity coefficients for ten model specifications that have passed both tests. Appendix A describes these specifications and also lists the information criteria that informed our selection of the preferred model.

Table 3. Estimations of prevalence elasticity of cigarette demand across different models

	Price		**Income**	
Logit	**elasticity**	**S.E.**	**elasticity**	**S.E.**
Model4	-0.0411	(0.1859)	0.5598 ***	(0.0277)
Model5	-0.1109	(0.1867)	0.5799 ***	(0.0290)
Model6	0.0377	(0.1947)	0.5268 ***	(0.0279)
Model7	-0.0326	(0.1889)	0.5446 ***	(0.0266)
Model8	-0.0643	(0.1866)	0.5443 ***	(0.0266)
Model9	-0.0049	(0.1913)	0.5263 ***	(0.0279)
Model10	-0.0191	(0.1875)	0.5064 ***	(0.0283)
Model11	-0.0042	(0.1881)	0.5108 ***	(0.0283)
Model12	-0.0227	(0.1882)	0.5276 ***	(0.0281)
Model13	-0.0291	(0.1878)	0.5289 ***	(0.0282)

Legend: Standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Authors' calculations

It is evident from the table that none of the estimated price elasticity coefficients on the extensive margin is statistically significant, and the calculated standard errors are quite large. All of the tested logit model specifications (including those that did not pass the linktest) returned the same result. A negative association between price and prevalence is observed—yet it is statistically not significant. Therefore, we have to conclude that the **price variable had no statistically significant effect on the Bulgarian households' decision "to smoke or not to smoke" in the period of 2015–2021.**

This lack of statistical significance of the price variable in the logit model might find several explanations. First, as evident from Table 1, during the studied period of 2015–2021 there were

no large movements in the real cigarette prices—a fact that diminished the variability of the variable. In addition, from the reported in Appendix A Pseudo-R^2 values, one may deduce that the decision "to smoke or not to smoke" is rather weakly explained by the available variables. Obviously, other factors unaccounted here also play a role for this decision: background, milieu, psychological type, public narrative, exposure to tobacco advertising, etc. Third, as evident from the sub-group descriptive statistics in Table 2, and also from Appendix C, there is a big difference in the price elasticity of demand across different income groups in Bulgaria that likely has a large effect on the size of the standard error of the total coefficient.

In regards to the income elasticity of cigarette demand, all of the tested model specifications produced results significant at the 0.01 level, in the relatively close range of 0.5–0.58. Based on the information criteria (AIC, BIC, Pseudo-R2, and the percentage of correctly specified results), we selected Model10 as our preferred model. It consists of log of price, square of the log of income, a factorial of the adult ratio and male ratio within the household, the square of the maximum education attained by a household member, and factorial of the household size and household type. The value of the income elasticity coefficient is 0.506, therefore, **with every 10 percent increase in their disposable incomes, the probability of Bulgarian households to have positive cigarette expenditures increases by roughly 5.1 percent, all other things being constant**.

4.2 Intensity elasticity of cigarette demand

The intensity elasticity of cigarette demand in Bulgaria was estimated first via Deaton's method[21] based on 6,798 observations (after dropping households with no cigarette expenditures and these from PSUs with less than two households reporting cigarette expenditures). Deaton's method was applied with the same variables as those used in the logit model. That is, expenditures were used as the more realistic approximation of disposable incomes, and the mean unit value of cigarettes within the clusters was imputed to every household there. The

[21] Using the Stata code published in Appendices 1 and 2 of the *Updated Tobacconomics Toolkit* (pp. 105-112).

latter follows the methodological requirement that all households in one cluster face the same price, and all price variations happen only between the clusters.[22]

Table 4 lists the coefficients calculated via Deaton's method. Appendix B lists the results of the ANOVA and the first-stage regressions.

Table 4. The intensity elasticity of cigarette demand in Bulgaria, calculated via Deaton's method

		Observed coeff.	Bootstrap std. err.	P >|z|	95% CI	
Deaton 1	**Price elasticity**	-1.4897 ***	(0.4171)	0.000	-2.3072	-0.6722
	Expenditure elasticity	0.8131 ***	(0.0390)	0.000	0.7367	0.8895

Legend: Standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Authors' calculations

Evidently, the calculated elasticity coefficients are significant at the 0.01 level. The price elasticity of cigarette consumption at the intensive margin is around -1.5, which is substantially higher than in other countries from the Western Balkan region where they range between -0.232 and -0.458.[23] Such high coefficient as the estimated from the Bulgarian HBS means that for cigarette-consuming households, every increase in the price of cigarettes by 10 percent will lead to an almost 15-percent reduction in the number of consumed cigarettes, all other things being equal. Every increase in the consumer budgets by 10 percent will lead to a more than eight-percent parallel increase in the number of smoked cigarettes, all other things being equal.

Standard errors both for price and income elasticity were obtained by a bootstrap procedure. The calculated standard error for the income elasticity is low and the confidence interval of the predicted value is narrow. Noteworthy, albeit statistically significant at the 0.01 level, the

[22] Deaton, A. (2018). *The Analysis of Household Surveys. A Microeconometric Approach to Development Policy.* Reissue Edition. Washington: World Bank.

[23] See Zubovic et al. (2019) p. 71

calculated standard error for the price elasticity is considerable, and this leads to a wider confidence interval between -0.67 and -2.3. This implies that **the intensity elasticity of cigarette demand in Bulgaria might vary between inelastic (as usual in most countries in the world) and strictly elastic within the noted significance level**.

Since the estimated price elasticity coefficient on the intensive margin is unusually high, we applied also an alternative estimation method—GLM with link Log and the gamma family. The ten model specifications from the logit model (see Table 3 and Appendix A) were used here.

Table 5. Intensity elasticity of cigarette demand in Bulgaria calculated via GLM

	Price elasticity	Std. err.	Income elasticity	Std. err
Model4	-1.4987***	(0.3628)	0.7968 ***	(0.0344)
Model 5	-1.4952 ***	(0.3581)	0.8244***	(0.0348)
Model 6	-1.4923 ***	(0.3289)	0.7900 ***	(0.0329)
Model 7	-1.4329 ***	(0.3393)	0.7815***	(0.0277)
Model 8	-1.3967 ***	(0.3541)	0.7808***	(0.0276)
Model 9	-1.4520 ***	(0.3483)	0.7894 ***	(0.0329)
Model10	-1.4120 ***	(0.3591)	0.7933 ***	(0.0331)
Model11	-1.4183 ***	(0.3602)	0.7996 ***	(0.0336)
Model12	-1.4062 ***	(0.3547)	0.8064 ***	(0.0331)
Model13	-1.4074 ***	(0.3561)	0.8056 ***	(0.0329)

Legend: Standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Authors' calculations

Albeit diverging from the empirical results across the region, **estimations via GLM specifications presented in Table 5 reveal similarities to the estimations via Deaton's method**: coefficients of intensity elasticity of price between -1.4 and -1.49, and coefficients of income elasticity around 0.8. This proximity of estimated results is still more remarkable since both methods follow

different approaches—GLM utilizes unit value as a price variable, and Deaton's method uses the households' budget shares of cigarette expenditures.

All of the estimated GLM specifications passed the Pregibon's linktest, with insignificant values of _hatsq ranging from 0.124 to 0.498. The modified Park test was applied to the preferred Model10 specification, and it turned out that gamma is indeed the correct distributional family of the model (having the lowest Chi2 value).

4.3 Total elasticity of cigarette demand

By summing up the significant elasticity coefficients on extensive and intensive margins of the preferred models, one attains the total elasticity coefficients. Since the logit model did not produce statistically significant price elasticity coefficients, we assume that total price elasticity is equal to the price elasticity on the intensive margin. According to the estimations via Deaton's model, it is roughly -1.49. For the income elasticity of cigarette demand, we sum up estimations via logit Model10 and Deaton's method to equal 1.3195.

The alternative estimation equals the intensity elasticity to the coefficient calculated via GLM: -1.412. Estimations via logit and GLM of the preferred Model10 give the alternative income elasticity coefficient. For further tobacco tax simulations, we use the estimations produced via Deaton's method both for price and income elasticity.

Table 6. Total price and income elasticity of cigarette demand

	Price elasticity	**Income elasticity**
Model10 + Deaton	-1.4897	1.3195
Model10 + GLM	-1.4120	1.2997

Source: Authors' calculations

These results are interpreted in the following way: all other things being equal, a 10-percent increase in the price of cigarettes will lead to a 14.9-percent decline in cigarette demand. A 10-

percent increase in disposable income, all other things being equal, will lead to a 13.25-percent increase in cigarette demand.

5. Simulations of the Expected Effects of Potential Tobacco Tax Increases on Cigarette Demand and Tobacco Tax Revenues

In 2021, Bulgarian Customs Authorities released for consumption 760.265 million packs of cigarettes. The collected excise duties amounted to BGN 2.843 billion, and the VAT revenues on cigarettes added another BGN 683 million. Total tax revenues from cigarettes were equal to 2.15 percent of the national GDP, or 10.4 percent of all tax revenues for the year. This makes the national tobacco tax policy of special importance, and the calculated elasticity coefficients of tobacco demand may shed light on the possible outcomes of prospective tobacco tax raises in terms of cigarettes consumed and public revenues collected.

Five scenarios of alternative price increases were developed in this report: five-percent, 10-percent, 15-percent, 20-percent, and 25-percent increases in average weighted cigarette prices. Assuming a full tax pass-through, this may be achieved with a 7.24 percent, 14.47 percent, 21.71 percent, 28.95 percent, and 36.19 percent increase, respectively, in the specific excise duty on cigarettes. For these simulations, the estimated coefficients presented in Table 6 were used.

As a first step, the new expected cigarette demand was calculated following the formula:

$$D_{t+1} = D_t\,(1 + \xi_p * \Delta p[\%] + \xi_i * \Delta i[\%]) \qquad (6)$$

D_{t+1} is the new expected cigarette demand (in packs), D_t stands for the baseline demand (in the year 2021), ξ_p and ξ_i are the estimated price and income elasticity coefficients, Δp is the simulated price increase of the cigarettes, and Δi is the expected change in households' incomes.

When determining the value of Δi, there are different methodological possibilities. One is to use the rate of change in the period *t+1* compared to *t*.[24] In other words, to use the mean annual

[24] Zubovic, J., & Vladisavljevic, M. (eds.). (2019). *Impacts of Tobacco Excise Increases on Cigarette Consumption and Government Revenues in Southeastern European Countries*.

growth rate of Bulgarian households' incomes in 2022. Yet 2022 was an atypical year due to the war in Ukraine and the inflation spike co-provoked by an energy crisis; when accounting for CPI the average income of Bulgarian households remained flat during that year. Therefore, the income growth in the period *t+1* has been modeled on the basis of the historical average annual rates in the studied period of 2015–2021, or 1.8 percent per annum. The results of these calculations are presented in the second row of Table 7.

Second, the new values of tobacco taxes per pack (specific and ad valorem excise and VAT) are calculated for every price increase scenario. Third, the expected tobacco tax revenues are estimated—based on the price and demand elasticities, and the new tax rates.

Table 7. Simulations with different price increases of cigarettes via specific excise increase

Price change	**Baseline /2021/**	**5%**	**10%**	**15%**	**20%**	**25%**
Consumed packs (millions)	760.265	721.693	665.065	608.437	551.809	495.180
Price (BGN)	5.41	5.68	5.95	6.22	6.49	6.76
Specific excise (BGN)	2.18	2.34	2.5	2.65	2.81	2.97
Ad valorem excise (BGN)	1.35	1.42	1.49	1.56	1.62	1.69
VAT (BGN)	0.9	0.95	0.99	1.04	1.08	1.13
Tax (excises + VAT) (BGN)	4.43	4.71	4.98	5.25	5.51	5.79
Budget revenues (billion BGN)	3.368	3.399	3.312	3.194	3.040	2,876
Revenues to baseline (million BGN)		31	-56	-174	-328	-492
Revenues to baseline (%)		0.9	-1.7	-5.2	-9.7	-14.6
Consumption to baseline (%)		-5.1	-12.5	-20.0	-27.4	-34.9

Source: Authors' calculations

As already noted, the estimated total elasticity coefficients of cigarette demand based on the Bulgarian HBS are elevated in comparison to other countries in the region and fall into the elastic segment of the demand curve—whereas the typical cigarette demand across the world is price inelastic. Thus, revenue and demand simulations based on these coefficients have to be interpreted with caution. Still, the estimations summed up in Table 7 offer certain insights that deserve certain consideration.

First, the only scenario allowing for a simultaneous growth in tax revenues and decline in the consumed quantity is the lowest, five-percent price increase (through 7.24 percent specific excise increase). This is exactly the policy of several consecutive Bulgarian governments: **miniscule excise increases that inadvertently help collect more taxes yet fall behind the increased affordability of cigarettes**. In December 2022, Bulgaria introduced a new excise calendar that envisions a stepwise and modest increase in tobacco excise rates until 2026, leading to only three-to-four percent annual price increases. According to the interim reports of the Ministry of Finance, as of October 2023, the collected excises on tobacco products were 11.7 percent higher on an annual basis, in nominal terms. The effect on cigarette consumption is still to be recorded in the annual data of the Custom Authority. Yet, according to the simulation in Table 7, even in this most conservative approach a not negligible reduction of five percent in cigarette consumption might be expected.

Further calculations showed that a 10-percent increase in the specific excise (leading to a 6.9-percent increase of the average retail price, assuming a full pass-through) will retain the 2021 levels of tobacco tax revenues and simultaneously decrease tobacco consumption by 8.05 percent.

Second, and in broader connection to the above, the **approach that sees in tobacco taxation a means for tobacco control and, simultaneously, a means for collecting higher budget revenues** in middle-income countries might face its natural limits in extreme cases like Bulgaria. As already stated in the Introduction, in the peak year of 2020 indirect taxation of tobacco products was responsible for 14 percent of all tax revenues of the Bulgarian government. This number is more

than three times higher than the EU average.[25] Still more important is that Bulgarian population is rapidly decreasing and ageing—both facts will naturally lower the number of the consumed cigarettes. The Bulgarian government needs a middle-term strategy for finding fiscal substitutes to tobacco tax revenues—albeit these revenues still grow in the short term. This important development requires further research, and scrutiny from the authorities.

Third, simulations based on the high price elasticity coefficient of cigarette consumption in Bulgaria estimated here indicate that **tobacco taxation is indeed a powerful tool for tobacco control**. Less than a 22-percent increase in specific excise would decrease annual cigarette consumption by more than 150 million packs per annum, or by 20 percent—and this will cost the government budget only five percent of its tobacco tax revenues. When accounting for the full economic cost of tobacco use this decision would still be fully cost-effective.

To substantiate these broader conclusions additional research is needed based on bigger and more reliable samples.

Regarding the expected developments across the income groups in their consumed quantities and collected budget revenues along with cigarette price increases, as already stated, the estimated coefficients lack the consistency needed for submitting policy proposals based on simulations. However, the results achieved clearly indicate that low-income households show a considerably higher price elasticity of cigarette demand. Therefore, any cigarette excise increases in Bulgaria should have a progressive tax effect,[26] redistributing the tax burden to higher-income groups and at the same time freeing the lower-income group of tobacco-related expenditures.

[25] European Commission. (2020). Evaluation of the Council Directive 2011/64/EU on the structure and rates of excise duty applied to manufactured tobacco. Brussels : Commission staff working document, p. 19. As of 2016, the average share of tobacco taxation in the total tax revenues of the EU member states was 4.4 percent, whereas for Bulgaria this number was 14.5 percent. See also Cristina Enache. (2022). Cigarette taxes in Europe. May 2022. *Tax foundation.* Available: https://taxfoundation.org/data/all/eu/cigarette-tax-europe-2022/.

[26] Verguet, S., Kearns, P., Rees, V. (2021). Questioning the regressivity of tobacco taxes: A distributional accounting impact model of increased tobacco taxation. *Tobacco Control* 2021; Vol 30, pp. 245-257.

6. Conclusion and Recommendations

This research on the price and income elasticity of cigarette demand in Bulgaria applied consequentially the two-part method by first estimating the prevalence elasticity, then the intensity elasticity, and finally summing up both coefficients. The underlying data for this quantitative research are the Bulgarian HBS for years 2015–2019 and 2021. Estimated coefficients—total price elasticity of -1.4897 and total income elasticity of 1.3195—are considerably higher than those calculated in the first year of this project with macrodata from 2004 to 2021: -0.827 price elasticity and 0.618 income elasticity (*National Study Bulgaria,* p. 18). These results are also higher than the corresponding coefficients from other countries in the Balkan region. An earlier study by a World Bank research team estimated for Bulgaria a total price elasticity coefficient of -0.8, with -1.33 for the low and lower-middle income group, -1.02 for the upper-middle income group, and -0.52 for the high-income groups (Sayginsoy et al., 2002). Therefore, the newer estimations diverge from the existing estimations produced by three independent sources—and have to be accepted with caution.

Nevertheless, these results should be considered seriously because of the recent history of a sharp decline in cigarette demand after excise tax increases. The Bulgarian Ministry of Finance, evidently miscalculating the price elasticity of cigarette demand in the economic slump of 2009/10, missed by almost BGN 0.5 billion its plans for tobacco tax revenues the year after imposing excise increases leading to a 40-percent jump in cigarette prices.[27] According to the scenarios developed in Table 7, a 25-percent cigarette price increase would indeed lead to a drop by BGN 0.5 billion (with 2021 purchasing power) of the tobacco tax revenues—along with a substantial reduction in the number of consumed cigarettes.

If anything, one sees the need for further research on the elasticity of tobacco demand in Bulgaria. First, because of the highly elevated tobacco-provoked mortality rate in the country. Second, because Bulgaria still lags behind the other EU member states in adopting more ambitious tobacco control measures. And third, because the most reliable estimation on the price

[27] See details in Sabev, D., Nasseva, E., Antonov, P., Gavrilova, M. & Geshanova, G. (2023). Accelerating progress on effective tax policies in low- and middle-income countries: Bulgaria. SFLC. Available:

elasticity of cigarette demand in Bulgaria was published more than two decades ago—based on an LSMS Household Survey conducted in 1995, a year when the inflation rate in Bulgaria was around 100 percent.[28]

Yet one has to conclude realistically that even with more reliable and extended data sets, it will be rather impossible to obtain the "perfect" quantitative estimation of the price elasticity of cigarette demand in Bulgaria. The elasticity of demand is dynamic in its nature[29] and depends on a multitude of varying factors, including economic growth rates, public narratives, rational expectations, demand control measures, and availability of substitutes.

***

Based on the research and analysis carried out during the second year of the project Accelerating Progress on Effective Tobacco Tax Policies in Low- and Middle-Income Countries, the following recommendations focused on Bulgaria may be given:

- To publicize the fact that the tobacco-provoked mortality rate in Bulgaria is the highest in the world, and to demand a list of countermeasures from authorities.
- Since tobacco excise increases in Bulgaria currently serve as a means for raising budget revenues and not so much for tobacco control, shift the tobacco taxation narrative to advance the message of the need for steeper excise hikes that provide the same level of revenues with lower tobacco consumption.
- The above entails revamping of the current excise calendar which is in force until 2026. The corresponding legislative effort might be justified by the growing tobacco prevalence among the low-income group and the higher tobacco demand in the high-income group.
- To confront the issue that fiscal authorities openly cooperate with the tobacco industry in determining "mutually beneficial" tobacco excise levels.
- Bulgaria is a historical tobacco-producing country—yet the availability of comprehensive microdata on national tobacco demand is limited. Therefore, to design and implement

[28] Sayginsoy, O., Yurekli, A. A, & de Beyer, J. (2002). Cigarette demand, taxation, and the poor: A case study of Bulgaria. UCSF: Center for Tobacco Control Research and Education: https://escholarship.org/uc/item/35g997q4
[29] Field, M., Pagoulatos, E. (1997). The Cyclical Behavior of Price Elasticity of Demand. *Southern Economic Journal,* Vol. 64, No. 1, pp. 118-129.

thorough research on the tobacco consumption of Bulgarians focused not only on monetary aspects but also on behavioral and cultural factors.

- The high prevalence and intensity of cigarette consumption among the Bulgarian high-income group might indicate that cigarettes in Bulgaria have turned into a kind of pseudo-Veblen good. Therefore, it is recommended to engage publicity to attack the presumed "prestige" of smoking.

Tobacco taxation is the most potent single tool for fighting tobacco epidemics. Yet Bulgarian authorities have found how to use it not for tobacco control but for continuous expansion of the budget revenues. In order to lessen the burden of tobacco consumption on the Bulgarian economy and household budgets, and to provide positive outcomes for the deteriorated public health system, one needs more ambitious and comprehensive measures for tobacco control.

Appendix A. Logit model specifications

A. Logit 0models specifications

	Coef P	Coef Exp	AIC	BIC	Corr. Specif %	Specification	linktest	Pseudo R2
Model1	-0.0097	0.3015				prcig exp educc maleratio adultratio htype	NO	0.0958
Model2	-0.0985	0.4195				c.prcig##c.prcig c.exp##c.exp educc maleratio adultratio htype	NO	0.1035
Model3	-0.1386	0.5297				lnpr lne educc maleratio adultratio htype	NO	0.106
Model4	-0.041	0.5598	21,515	21,585	66.91	lnpr c.lne##c.lne educc maleratio adultratio htype hsize	YES / 0.134	0.1076
Model5	-0.1109	0.5799	21,467	21,584	67.06	lnpr c.lne##c.lne i.educc c.maleratio##c.maleratio c.adultratio##c.adultratio htype hsize	YES / 0.790	0.1101
Model6	0.0377	0.5268	21,214	21,331	67.29	c.lnpr c.lnpr##c.lnpr c.lne c.lne##c.lne i.educc i.htype c.maleratio c.adultratio hsize	YES / 0.075	0.1206
Model7	0.0059	0.5271	21,214	21,331	67.26	prcig c.prcig##c.prcig c.lne c.lne##c.lne i.educc i.htype c.maleratio c.adultratio	YES / 0.079	0.1206
Model8	-0.0643	0.5443	21,215	21,317	67.41	lnpr c.lne##c.lne maleratio adultratio i.htype i.educc	YES / 0.081	0.1204
Model9	-0.049	0.5263	21,215	21,332	67.34	prcig c.lne##c.lne c.maleratio c.adultratio##c.adultratio i.htype i.educc c.hsize	YES / 0.071	0.1206
Mod.10	***-0.0191***	***0.5063***	***21,204***	***21,336***	***67.51***	***lnpr c.lne##c.lne c.maleratio##c.adultratio i.educc##i.educc i.htype##c.hsize***	***YES / 0.402***	***0.1212***
Mod.11	-0.0042	0.5108	21,206	21,532	67.57	lnpr c.lne##c.lne c.maleratio##c.adultratio i.educc##i.htype##c.hsize	YES / 0.155	0.1232
Mod.12	-0.0227	0.5273	21,180	21,398	67.44	lnpr c.lne##c.lne c.maleratio##c.adultratio##c.hsize i.educc##i.htype	YES / 0.089	0.1231

Mod.13	-0.0291	0.5289	21,196	21,336	67.34	lnpr c.lne##c.lne c.adultratio##c.maleratio##c.hsize i.htype i.educc##i.educc	YES / 0.250	0.1216

Legend: All price elasticity coefficients insignificant, all income elasticity coefficients significant at p=0.01

Variables used in the logit specifications and in the Deaton's part

Logit:

prcig / lnpr – imputed cigarette "price" (level and log)

exp / lne – household real expenditures (level and log)

htype – household's type (employed, pensioners, other)

educc – maximum attained education

adultratio – the share of adults in the household

maleratio – the share of adult males in the household

hsize – household size

Deaton:

luvcig – log of cigarette unit value

lexp – log of household expenditures (=lne)

lhsize – log of hsize

maleratio

adultratio

maxedu = educc

bscig = ecig/exp

ecig – expenditures on cigarettes

sgp1-sgp3 – the three household types

Appendix B. Interim results in Deaton's method

ANOVA

```
      Number of obs =      6,798    R-squared     =  0.4959
      Root MSE      =    .067896    Adj R-squared =  0.2627
```

Source	Partial SS	df	MS	F	Prob>F
Model	21.072712	2,150	.00980126	2.13	0.0000
clust	21.072712	2,150	.00980126	2.13	0.0000
Residual	21.421805	4,647	.00460981		
Total	42.494517	6,797	.00625195		

First-stage regressions

	(1)	(2)
VARIABLES	Unit value Regression	Budget share Regression
Lexp	0.0262***	-0.0130***
	(0.00290)	(0.00265)
Lhsize	-0.0131***	-0.0122***
	(0.00288)	(0.00263)
Maleratio	-0.00239	0.0273***
	(0.00384)	(0.00351)
Adultratio	-0.00990	0.00161
	(0.00758)	(0.00693)
Maxedu	0.00100	-0.00424***
	(0.000860)	(0.000786)
sgp1	0.00580	0.00891
	(0.00629)	(0.00575)
sgp2	-0.00809***	-0.0194***
	(0.00277)	(0.00254)

o.sgp3	-	-
Constant	1.453***	0.219***
	(0.0263)	(0.0241)
Observations	6,798	6,798
R-squared	0.512	0.493

Legend: Standard errors in parentheses. *** p < 0.01

Appendix C. Elasticity of cigarette demand across different income groups

Current research also tried to estimate the price and income elasticity coefficients across different income groups. Due to several limitations (smaller subgroup samples, concerns about weaknesses in the HBS data collection, etc.), we did not incorporate these estimations in the main report and instead included them in the Appendix. The estimated coefficients lack the consistency needed for developing of reliable consumption and revenue scenarios, and corresponding policy measures. Nevertheless, these estimations bear certain information about some general trends in the tobacco consumption of Bulgarians and might be useful to future subgroup studies on the elasticity of tobacco consumption.

For the first part of the two-part model, Model10 has been selected as the preferred specification of the logit function (see Table 3 and Appendix A). Nevertheless, in Table C1, we present the prevalence elasticity coefficients of all "short-listed" models for the three income groups.

Table C1. Price and income elasticity on the extensive margin in three income groups

	Price elasticity			**Income elasticity**		
	Low-income	*Middle-income*	*High-income*	*Low-income*	*Middle-income*	*High-income*
Model4	-0.9848***	0.1909	0.7275 **	0.5057 ***	0.7446 ***	0.3438 ***
Model5	-1.058 ***	0.1382	0.6815 **	0.5688 ***	0.7695 ***	0.3691 ***
Model6	-0.8775***	0.1946	0.7374 **	0.5192 ***	0.6777 ***	0.3187 ***
Model7	-0.9121***	0.2076	0.6734 **	0.5614 ***	0.6859 ***	0.3548 ***
Model8	-0.9934***	0.2122	0.6616 **	0.5610 ***	0.6862 ***	0.3545 ***
Model9	-0.9406***	0.2083	0.7231 **	0.5189 ***	0.6786 ***	0.3188 ***
Model10	-0.9408***	0.2499	0.7156 **	0.5025 ***	0.6380 ***	0.3156 ***
Model11	-0.9272***	0.2585	0.7199 **	0.5110 ***	0.6452 ***	0.3205 ***
Model12	-0.9353***	0.2143	0.7035 **	0.5267 ***	0.6667 ***	0.3246 ***
Model13	-0.9416***	0.2222	0.7096 **	0.5274 ***	0.6739 ***	0.3197 ***

Legend: Standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Authors' calculations

First, we see statistically significant price elasticity coefficients for the low- and high-income groups—although the total price elasticity coefficient on the extensive margin is strictly insignificant. For the mid-income group, price elasticity coefficients are insignificant, yet all of them positive and fall in a close range. For the low-income group the price elasticity coefficients are negative, in the range of -0.9 to -1, whereas for the-high income group the coefficients are positive and equal to roughly 0.7. One might assume that exactly this divergence in the price effects on cigarette prevalence between different income groups explains the lack of statistical significance in the total price elasticity coefficient (see Table 3).

As for the conditional income elasticity of cigarette demand, all estimated coefficients within the income groups are significant at the 0.01 level and amount to roughly 0.5 for the low-income group, 0.65 for the mid-income group, and 0.3 for the high-income group. The lowest income elasticity for the high-income group is an expected result; the higher income elasticity of the mid-income group versus the low-income group deserves closer attention. It might be assumed that for the low-income group, tobacco expenditures are a rather "high hurdle" and at the current price levels, certain income increases are not sufficient to provoke smoking initiation in the absence of additional non-income factors. Whereas households from the mid-income group with generally higher purchasing power are more inclined to return to (or initiate) tobacco consumption when facing higher incomes—especially when the higher-income group uses smoking as a status symbol.

An important and atypical trait of the estimated results is the positive—and substantial—price elasticity coefficient for the high-income group. It implies that with every 10-percent increase in cigarette prices, Bulgarian households from the high-income group would increase their probability of smoking by more than seven percent. Several explanations might be given for this surprising result, including the very low (in relative terms) price levels of cigarettes in Bulgaria, and the substantial income growth of the high earners during the studied period. Yet the reason

for the positive price elasticity coefficients might alternatively be the inherent flaws in the Bulgarian HBS data collection. Therefore, we leave this result without further elaboration.

Based on the data in Table C1, one may infer with a high level of generalization that, all other things being equal, one-third of the Bulgarian population with the lowest incomes will decrease its probability of consuming cigarettes by 9.5 percent when cigarette prices rise by 10 percent. As for the mid- and high-income groups, we see no clear statistical association between cigarette prevalence and cigarette prices during the studied period.

Intensity elasticity for cigarette-consuming households across the three income groups has been estimated via the two outlined in the report methods, Deaton's and GLM, with results shown in Table C2.

Table C2. Intensity elasticity across three income groups

	Price elasticity			**Income elasticity**		
	Low-income	*Middle-income*	*High-income*	*Low-income*	*Middle-income*	*High-income*
Deaton	-2.7466	-0.3187	-0.2515	0.9475***	1.0813***	0.6276 ***
	(22.1959)	(0.9389)	(17.6522)	(0.1116)	(0.1400)	(0.0999)
GLM						
(Model10)	-1.5650***	-1.095***	-1.5762***	0.9381***	0.8822 ***	0.6369 ***
	(0.3486)	(0.3646)	(0.3130)	(0.0516)	(0.0625)	(0.0459)

Legend: Std. errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1

Source: Authors' calculations

Deaton's method produced significant results for income elasticity on the intensive margin, which are generally consistent with the parallel GLM estimations. As with the logit model, the high-income group has the lowest coefficient, and the middle-income group has the highest. One might assume that low-income tobacco consumers already forego substantial amounts of goods and services when dedicating their budgets to smoking, and when their incomes increase, they

are less likely to transfer this new purchasing power entirely to tobacco. Whereas tobacco consumers from the middle-income group are more likely to overreact in their tobacco consumption to increases in income. Yet this tentative conclusion finds no support in the GLM results on income elasticity on the intensive margin for the mid- and low-income groups.

As regards price elasticity, the results derived by Deaton's method are statistically insignificant, whereas the GLM estimations returned coefficients significant at the 0.01 level. Yet the GLM estimations also raise concerns, with the price elasticity coefficient within the high-income group higher than in the low-income group—which contradicts not only the theory but also the conclusions derived so far from Tables 2 and C2. We concur that this discrepancy in the price elasticity coefficient of the high-income group may be due to the relatively small sample size in the subgroup analysis—and is counterweighted by the positive coefficient on the extensive margin.

Based on estimations in tables C1 and C2, by summing up the statistically significant prevalence and intensity elasticity coefficients one may calculate the total price elasticity coefficient for the three income groups.

Table C3. Total elasticity of cigarette demand within the three income groups

Price elasticity			**Income elasticity**		
Low-income	*Middle-income*	*High-income*	*Low-income*	*Middle-income*	*High-income*
-2.5058	-1.1096	-0.8606	1.4500	1.7193	0.9432

Source: Authors' calculations

The total price elasticity coefficients are equal to Model10 logit estimations in the first part plus Model10 GLM estimations in the second part (since Deaton's method did not provide significant price elasticity coefficients on the intensive margin). Income elasticity coefficients are equal to Model10 logit estimations in the first part plus Deaton's method estimations in the second part.

When analyzing these results, one might assume that in general they correspond to the calculated total elasticity coefficients. Barring the elevated price elasticity coefficient in the low-income group, the results for Bulgaria are also generally consistent with the corresponding estimations from other countries in the Western Balkans.[30] Still, certain irregularities like positive price elasticity on the extensive margin for the high-income group, elevated price elasticity derived with GLM for the high-income group, and others, deter us from accepting these coefficients as "final results." They might be indicative for further studies on the elasticity of tobacco demand in Bulgaria based on bigger and more reliable samples yet do not have the necessary consistency to serve for policy purposes.

[30] See Table 9.6 on p. 73 in Zubovic et al. (2019).

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