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Abstract

This report investigates the economic displacement effects of tobacco consumption in Bulgaria, using anonymised Household Budget Survey data from nearly 26,500 households in the 2015-2024 period. The analysis confirms a substantial crowding-out effect, whereby tobacco spending reduces household expenditures on key components of human capital (i.e. health care, education, housing, clothing, recreation, sports and culture) while simultaneously crowding in additional spending on food, alcohol, transport and hospitality services. The study also documents a notable rise in household-level tobacco prevalence, increasing by more than 10 percentage points over the past decade, alongside real growth in tobacco expenditures per smoking household. These patterns exacerbate poverty risks, weaken human capital formation, and pose broader macroeconomic challenges. The findings underscore the urgent need for more ambitious tobacco control policies in Bulgaria, grounded not only in public health objectives but also in economic and social welfare considerations.

Keywords: Crowding-out effect, tobacco consumption, household expenditure, human capital

JEL classification: I12, D12, H31, C33

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1. Introduction

It is a well-established fact that tobacco consumption, aside from its detrimental health effects, has a broad negative economic influence on both the macro and micro levels (NCI and WHO 2016). One of the most pronounced economic impacts of tobacco consumption is its crowding-out effect – that is, tobacco expenditures supplant outlays on other consumer goods, including on products that directly contribute to human development. This issue concerns not only socioeconomic efficiency but also intergenerational and gender justice, since in many cases the family income is apportioned in a way that satisfies the tobacco consumption needs of the dominant adults at the expense of providing healthy food, a decent education, or access to culture and sports for the dependent family members (John 2008; Swarnata et al. 2024; Nguyen and Nguyen 2020).

This report utilises Household Budget Survey (HBS) data to examine the crowding-out effect of tobacco consumption in Bulgaria. It primarily follows the methodology outlined in the toolkit of the *Tobacconomics* project, which was specifically designed to use household budget surveys for estimating various aspects of tobacco economics (John et al. 2023). The quantitative research compiled anonymised data of nearly 26,500 Bulgarian households from 2015 to 2024. Within this dataset, the existence of a significant crowding-out effect of tobacco expenditures in Bulgaria has been confirmed. Tobacco consumption in Bulgaria is associated with decreasing expenditures on education, health care, housing, clothing, recreation, sports and culture. At the same time, tobacco 'crowds in' additional expenditures on food, transport and alcohol as well as hospitality services (e.g. bars, hotels and restaurants).

While working with consumption data spanning the past decade, we discovered a fact that is not central to the research agenda but still deserves explicit attention: that the national household-level tobacco prevalence increased by more than 10 percentage points (pp) during this period. In 2015, the share of households with positive tobacco expenditures stood at 42.1%. It rose to 52.3% by 2024, while tobacco expenditures per smoking household also grew during this period by 7.4% in real terms. The HBS is not the perfect tool for measuring tobacco prevalence; moreover, part of the mentioned increase may be due to structural factors, such as changes in household size and composition. Still, this upward trend, which is most pronounced among middle-income households (see Figure A1), likely corresponds to a genuine rise in tobacco consumption.

These results further confirm what was already known: that Bulgaria has a serious public health problem in terms of elevated and still-rising tobacco use. The main finding of this report (i.e. the existence of a significant crowding-out effect of tobacco consumption, mainly on expenditures that are important for the development of human capital) may serve as another argument in support of more ambitious measures addressing the unusually high national tobacco prevalence.

2. Data and main variables

This study used anonymised records of households included in the Bulgarian HBS for the years 2015-2019 and 2021-2024 (due to the pandemic restrictions, 2020 was a gap year for the survey). The National Statistical Institute (NSI) is responsible for carrying out the HBS in the field and processing the raw data.

The Bulgarian HBS uses a two-stage stratified sample to provide nationally representative data on household consumption expenditures. It is executed in three waves throughout the year, and the NSI recalculates expenditures on an annual basis. By design, the Bulgarian HBS consists of 3,060 households per year, but some households included in the sample do not complete the survey. In addition, during the data clearing procedures, we intentionally omitted those households consisting only of individuals below the age of 15. There were also cases of households with overlapping survey IDs that were dropped from the dataset. Thus, in the end, we came up with 26,473 separate household records, or an average of roughly 2,940 households per year. The number of individuals within the studied household sample is 57,364.

We obtained data from the NSI on household expenditures divided into broad and mutually exclusive consumption categories according to the COICOP classification (UN 2023: p. 37). These are: food and non-alcoholic beverages; alcoholic beverages and tobacco; clothing and footwear; housing, water, electricity, gas and other fuels; furnishings, household equipment and routine household maintenance; health; transport; information and communication; recreation, sport and culture; education services; restaurants and accommodation services; and miscellaneous goods and services. In the text below, we use widely understandable shortened denominations of these basic expenditure groups. Another expenditure category, ‘Alcohol’, was created by subtracting expenditures on tobacco from the second category according to the COICOP classification.

At the core of this research are household expenditures on tobacco products. We constructed a joint variable <*tob_exp*> by combining expenditures on ‘cigarettes’ and ‘other tobacco products’. The latter subgroup consists of various items, such as pipe tobacco, chewing tobacco, rolling tobacco, cigarette papers and single-use filters.

Various household characteristics have been derived about individual household members. They include household size (the average number of members per household); residence (city, town or village); household type according to the economic activity of its members (employed, unemployed, pensioner); ratio of adults to all household members; ratio of adult females to all adult household members; and maximum level of education attained by a household member.

All descriptive statistics reported here are weighted by using survey weights provided by NSI records.

3. Research methods

3.1. LITERATURE REVIEW AND RESEARCH STRATEGY

The discussion on the crowding-out effect of tobacco consumption dates back to the beginning of the 2000s. The first research paper to apply an econometric approach to the topic was published in 2004 based on consumer data from the United States (Busch et al. 2004). An important update to the methodology was made in 2008, when a study on the crowding-out effect of tobacco consumption in India raised the issue of the endogeneity of the studied factors, which was overcome via instrumental variables (John 2008). In subsequent years, separate studies on the tobacco crowding-out effect have been carried out in more than 20 countries, predominantly in Southeast Asia, sub-Saharan Africa, Latin America and the Balkans. Most of these studies follow the methodology of John (2008), although other methods are also being applied (e.g. in Colombia and South Africa).

This study on the tobacco crowding-out effect in Bulgaria likewise follows Rijo John's research strategy, thus providing comparable national results for a universalised research procedure. It also adds to the better understanding of regional tobacco consumption patterns, along with previously published studies on tobacco crowding-out in Turkey (San and Chaloupka 2016), Serbia (Vladisavljevic et al. 2023), Montenegro (Mugosa et al. 2023) and, most recently, North Macedonia (Spasova et al. 2024) and Albania (Merkai et al. 2025).

We conducted this research in three main methodological steps. First, we calculated the budget shares of the major expenditure groups for households with and without tobacco consumption (introducing the binary variable for tobacco use <*d*>), estimating whether the differences were statistically significant. Second, we estimated the crowding-out effects of tobacco expenditures by applying instrumental variables to overcome the endogeneity emerging due to simultaneity. Third, we followed the crowding-out effects within three additionally constructed income groups. We accompanied our research with a series of statistical tests explained in the sections below and in Appendix.

3.2. ESTIMATING BUDGET SHARES

When estimating the budget shares of different expenditure groups for tobacco-consuming and non-consuming households, we discovered that, although important, this descriptive statistic is insufficient to reveal the substitution effect of tobacco. This is quite evident when analysing expenditures on education (see Table 1). The average tobacco-consuming household dedicates 3.3% of its total budget to education, compared to only 2.2% for households without tobacco expenditures. Yet it would be incorrect to infer that smoking families are more concerned about education: households consisting only of pensioners have much lower smoking prevalence, and they understandably also have lower education expenditures. This simple example indicates the importance of accounting for household characteristics when comparing consumption patterns.

Nevertheless, estimating the budget shares of different product categories for tobacco-consuming and non-consuming households is an important analytical starting point. First, we applied a Student's t-test with analytical weights, comparing the mean values of tobacco-using and non-using subpopulations under the null hypothesis of no significant difference. While the t-test has been utilised in many published studies on tobacco crowding-out, the methodological challenge of the normality of distribution has yet to be addressed. Consumer expenditures are not normally distributed as a rule. Nearest to the normal distribution in Bulgaria are expenditures on food and non-alcoholic beverages (as shown in Figure A2), but even this category did not pass the Shapiro-Wilk normality test. Other consumer groups, such as clothing and footwear (as shown in Figure A3), reveal large deviations from the normal distribution, and this may disturb the t-test estimations (see Edgell and Noon 1984). Therefore, we additionally applied a Wald test, which does not have normality restrictions. However, as evident from Table 1, there were very close outputs for both of the methods used.

3.3. METHODOLOGY OF THE CROWDING-OUT ESTIMATION

Following the research approach codified in John et al. (2023), we assumed that households tend to maximise the utility of their consumption of a set of different goods and services under conditions of budgetary constraint:

$$q_i = f^i(p_1, p_2, \ldots, p_n, Y;\ h)\ for\ every\ i\ =\ 1\ to\ n, \tag{1}$$

where q_i is the quantity of the $i-th$ good, Y is the disposable budget (here approximated by the total expenditures), $p_2, \ldots, p_n$ are the prices of the goods in the individual utility function, and h is the vector of household characteristics.

The underlying assumption regarding tobacco consumption is that tobacco demand is predetermined. In other words, households (or, rather, their dominant members) first apportion a certain part of their budget to tobacco, and then they distribute the remaining part to various goods and services. Denoting tobacco as the $n-th$ good in the above function, and with the budget remaining after tobacco consumption as $M = Y - tob\_exp$, the new utility function is:

$$q_i = f^i(p_1, p_2, \ldots, p_{n-1}, d, M; q_{n,}\ h)\ for\ every\ i \neq n. \tag{2}$$

Due to the lack of precise information about the prices of different goods, we cannot estimate this equation directly. However, since we do know the expenditures apportioned to different commodity groups, we can estimate a system of Engel curves to answer the question of how budget shares spent on certain goods change as disposable income changes. An influential approach to this is the QAIDS model of Banks et al. (1997), which updates the 'Almost Ideal Demand System' first developed by Angus Deaton. The advantage of QAIDS is the inclusion of income in the equation both in level and quadratic terms, which 'permits goods to be luxuries at some income levels and necessities at others' (p. 528). The resulting specification is:

$$w_{ij} = \beta_{0i} + \beta_{1i}.tob\_exp_j + \beta_{2i} InM_j + \beta_{3i}\ (InM^2) + \delta_i h_j + U_{ij}, \tag{3}$$

Where w_{ij} is the share of the budget M (that remains after deducting tobacco expenditures) allocated by the $j-\text{th}$ household to the $i-\text{th}$ commodity group. Further, InM and InM^2 are the natural logs of the non-tobacco budget, h_j is the vector of household characteristics, and u_{ij} is the random error term. The coefficient β_{1i} is of central interest for the present study because it indicates the crowding-out (or crowding-in) effect of tobacco expenses.

The above equation can be augmented with the inclusion of the binary variable *d* indicating tobacco consumption status (1 for tobacco spenders and 0 for non-spenders):

$$w_{ij} = \beta_{0i} + \beta_{0di}d_j + \beta_{1i}tob\_exp_j + (\beta_{2i} + \beta_{2di}d_j)InM_j + (\beta_{3i} + \beta_{3di}d_j)(InM^2) + \delta_i h_j + u_{ij}. \quad (4)$$

The criterion for choosing whether to estimate equation (3) or (4) is answering the question of whether households without tobacco expenditures avoid tobacco due to their lack of purchasing power (the so-called 'corner solution') or due to abstention. The Wald test for the heterogeneity of preferences answers it using the parameters of equation (4). The null hypothesis of the test is that preferences among households with and without tobacco expenditures are homogenous. A significant test statistic means the rejection of H_0:

$$H_0: \beta_{0di} = \beta_{2di} = \beta_{3di} = 0. \quad (5)$$

Due to the endogeneity of the factors included in equations (3) and (4), one has to resort to instrumental variables to obtain consistent estimates. Many studies (see Swarnata et al. 2024) have shown that the logarithmic value of total expenditures and its square (InY and InY^2) are proper instruments for the budget remaining after subtracting tobacco expenditures (InM and InM^2). The literature recommends using the male or female ratio (i.e. the ratio of adult women or men to the number of all adults in the household) as the instrument variable for tobacco expenditures.[1] We have also included additional instrumental variables that are expected to be exogenous (i.e. household size, maximum education, adult ratio) and dummy variables representing socioeconomic status.

The econometric technique used for estimating the crowding-out effect via the above variables is called GMM 3SLS – a modern version of the three-stage least squares approach. GMM 3SLS and the traditional 3SLS technique produce identical coefficients but differ in the estimated values of their standard errors and, thus, in the potential significance of the crowding-out effects. According to Wooldridge (2010, p. 196), the Generalised Method of Moments estimator is 'never worse, asymptotically, than 3SLS, and in some important cases is strictly better', as it uses a heteroscedasticity-consistent weighting matrix.

[1] Due to the lack of significant difference between male and female smoking in Serbia, Vladisavljevic et al. (2023) applied an imputed instrument for tobacco expenditures.

3.4. ANALYSIS WITHIN INCOME GROUPS

Aiming at deeper insight into the effects of income distribution on tobacco consumption, and still more into the effects of tobacco use on the consumption patterns at different income strata, we constructed three subgroups within our sample: low-, middle- and high-income. The criterion for dividing the sample are expenditures per household member within a given year. In other words, for each year, we divided the sample into three categories according to the expenditures per household member, and then we merged these categories for the entire sample. Interestingly, due to the rapid growth of real incomes over the studied period, accompanied by an almost 50% increase in the general Consumer Price Index (CPI) level, the mean value of nominal expenditures for the high-income group in 2015 is only marginally higher than the mean expenditures for the low-income group in 2024.[2]

Since the procedure of dividing households into three broad income groups used survey weights, the exact number of households within each group differs. The low-income group includes 9,485 households, the middle-income group 8,934 households, and the high-income group 8,054 households. Table A6 provides further information on the characteristics of the households within the studied subgroups.

[2] Since estimations via QAIDS are based on budget shares rather than prices, we did not adjust our variables for CPI – not least because the period between 2015 and 2024 saw a sharp rearrangement in the relative prices of goods.

4. Results for the entire HBS sample

4.1. BUDGET SHARES

The first three columns in Table 1 show how two categories of Bulgarian households (i.e. those with and without tobacco expenditures) tend to apportion their consumer budgets. The next four columns indicate significance tests of the differences between them. The rule of thumb is that t-statistics higher than 2 denote a significant difference. Thus, all of the estimated differences are significant except for durable goods and other goods. The data initially suggest that tobacco-consuming households in Bulgaria spend considerably less on food, health care and housing while spending more on transport and clothing. However, as already noted in Section 3.2, relying solely on simple mean comparisons and t-tests can be misleading because these results do not account for differences in household characteristics. Once all the relevant covariates are included in the regression models, some effects appear to be reversed (e.g. tobacco use is associated with a relative increase, rather than a decrease, in food expenditure). This highlights the importance of using more complex regression models to properly isolate crowding-out effects rather than drawing conclusions based only on unadjusted mean differences.

Table 1 / Expenditures of tobacco-consuming and non-consuming households: budget shares in % and statistical tests of significance

	Expenditures, %		Difference,				
	Non-smoking households	Smoking households	percentage points	T-test (lincom)	Significance	Wald test	Significance
Tobacco	0	7.6	7.6	-120.29	0.000	19536.9	0.000
Food	39.1	32.7	-6.4	44.44	0.000	1914.4	0.000
Clothing	3.1	3.8	0.7	-14.37	0.000	207.3	0.000
Alcohol	1	1.6	0.6	-31.94	0.000	1049.1	0.000
Housing	19.4	16.2	-3.2	28.72	0.000	803.3	0.000
Durable goods	4.6	4.5	-0.1	1.52	0.130	2.3	0.129
Health	9.8	6.2	-3.6	38.53	0.000	1388.9	0.000
Transport	5.7	7.8	2.1	-23.28	0.000	547.5	0.000
Communication	5	5.6	0.6	-14.01	0.000	196.2	0.000
Recreation & culture	4.2	4.6	0.4	-6.25	0.000	39.6	0.000
Education	2.2	3.3	1.1	-5.37	0.000	29.9	0.000
Hotels & restaurants	3.5	4.6	1.1	-15.59	0.000	244.5	0.000
Other goods	4.4	4.5	0.1	-1.39	0.164	1.87	0.179

Notes: Since these estimations use analytical weights, the sum of all expenditure shares is not 100% (103% for tobacco-consuming and 102% for non-consuming households).
Source: authors' calculations

4.2. CROWDING-OUT EFFECT

As explained in Section 3.3, in order to determine which equation to estimate, we first applied a Wald test for the heterogeneity of preferences among households with and without tobacco expenditures. In the case of the Bulgarian HBS, the Wald test proved that household preferences are mostly heterogeneous (see Table A1). Only in the case of education was there an insignificant result for budgetary share, indicating homogeneous preferences. Therefore, we proceeded with estimating equation (4).[3] The results are shown in Table 2.

Table 2 / The quadratic conditional Engel curves for the entire household sample

Variable	Tob_exp	lnM	lnM^2	D	dlnM	$dlnM^2$	Constant
Food	0.000007***	0.272***	-0.020***	1.014***	-0.214***	0.011***	-0.426***
	(0.000)	(0.030)	(0.002)	(0.214)	(0.046)	(0.002)	(0.138)
Health	-0.000003***	0.011	-0.0003	-0.170	0.024	-0.0007	0.013
	(0.000)	(0.040)	(0.002)	(0.237)	(0.052)	(0.003)	(0.179)
Education	-0.000001***	-0.029***	0.002***	-0.020	0.004	-0.0002	0.125***
	(0.000)	(0.005)	(0.000)	(0.034)	(0.008)	(0.000)	(0.023)
Housing	-0.000003***	0.072***	-0.006***	0.248	-0.055	0.003	0.054
	(0.000)	(0.026)	(0.001)	(0.193)	(0.042)	(0.002)	(0.119)
Clothing	-0.000004***	0.012	-6.58E-05	-0.111	0.019	-0.0007	-0.0705*
	(0.000)	(0.009)	(0.0005)	(0.068)	(0.015)	(0.0008)	(0.041)
Recreation	-0.000004***	-0.301***	0.018***	-0.084	0.022	-0.001	1.298***
	(0.000)	(0.024)	(0.001)	(0.161)	(0.036)	(0.002)	(0.105)
Transport	0.000004***	-0.099***	0.008***	-0.582**	0.129**	-0.007**	0.330**
	(0.000)	(0.031)	(0.002)	(0.231)	(0.051)	(0.003)	(0.136)
Restaurants	0.000006***	-0.082***	0.005***	-0.158	0.035	-0.002	0.337***
	(0.000)	(0.017)	(0.001)	(0.124)	(0.027)	(0.002)	(0.077)
Alcohol	0.000003***	0.048***	-0.02***	0.070*	-0.009	0.0002	-0.226***
	(0.000)	(0.005)	(0.000)	(0.041)	(0.009)	(0.0005)	(0.021)

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Given that the study focuses on the effects of tobacco use on consumer expenditures, the coefficients of household characteristics are not reported.
Source: authors' calculations

In short, the results in Column 1 of the above table indicate that tobacco expenditures in Bulgaria crowd out expenditures on health, education, housing, clothing and recreation (with the latter group including culture and sport). In turn, tobacco expenditures crowd in expenditures on food, alcohol, transport, and restaurants and hotels. Below, we give an interpretation of the results in each of the estimated expenditure groups. Table A2 summarises the results of 15 studies on tobacco crowding-out from around the world, which allows for comparisons and a better understanding of tobacco consumption patterns in Bulgaria.

Food. This is a very broad product category, as it comprises not only food items but also beverages (e.g. coffee and sugary drinks) as well as ready-made foods. The literature shows that the effects of tobacco expenditures on food expenditures are ambiguous. In countries like Mexico and Bangladesh, tobacco crowds in more food expenditures (see Husain et al. 2018); we discovered a similar effect in

[3] Of the 12 expenditure groups, 'Other goods' were excluded to ensure the adding-up restriction in the system of equations. We also excluded 'Durables' due to the insignificant t-test result. 'Communication' is a smaller and less important consumer group; we did not estimate it, as it took approx. 26 hours for the GMM to converge, even with only nine equations.

Bulgaria. It is important to note that tobacco expenditures affect not only the quantity but also the quality of the food consumed. We have already confirmed that Bulgarian tobacco-consuming households spend considerably less of their budgets on food (33% vs. 39%; see Table 1). The positive crowding-in coefficient therefore may be partially explained by additional outlays on food items that are complementary to cigarettes. To gain better insight into these diverging effects, we need data on disaggregated food groups (e.g. coffee, sugary drinks, dairy products, vegetables and fruits, and ready-made foods).

Health. Tobacco spending is associated with significantly lower health expenditures among Bulgarian households. This is a typical example of a crowding-out effect after deducting tobacco outlays from the limited household budget. Although individual health status tends to deteriorate for tobacco consumers, which in turn creates a need for higher health-related expenses, these have to be forgone 'to make ends meet'. This conclusion is still more important given the bigger size of tobacco-consuming households (2.5 members vs. 1.9 members for non-consuming households).

Education. Tobacco expenditures in Bulgaria are connected with diminished expenditures on education. This is a universal trait associated with tobacco crowding-out around the world (see John et al. 2012 and other studies, as indicated in Table A2), and the estimations for Bulgaria attest the same. Education is the main vehicle for advancement of human capital, so this finding is disturbing in light of the unusually high tobacco prevalence and expenditures in Bulgaria. This is a strong argument supporting the need for a stricter national tobacco control policy.

Housing. Lower expenditures on housing due to tobacco expenditures further confirm the detrimental effects of tobacco use on human development. The big 'Housing' expenditure group includes expenses like heating in winter, having additional room(s) for children, or living closer to central cultural and sports facilities or schools.

Clothing. Tobacco spending is associated with lower expenditures on clothes and footwear in Bulgaria. Principally, this is one of the most neglected product categories in Bulgaria (see Figure A3). Families with stressed incomes largely exclude such expenses from their utility function, or they may purchase second-hand items instead of new ones. Diminished expenditures on clothes and footwear may indicate reduced social opportunities and lower sociability among tobacco users in general.

The same explanation holds for another major expenditure group: ***Recreation, Sports, and Culture*** (the 9th COICOP group). It turns out that some social activities in Bulgaria have to be limited due to tobacco consumption in the presence of budgetary constraints.

Transport and ***Alcohol*** are two product groups that are typically associated positively with tobacco expenditures. For the 'Transport' category, part of the explanation may be the general smoking prohibition in closed public places and the consumer's choice to switch to more expensive private modes of transportation, mostly cars, where tobacco can be used freely. In the case of alcohol, the results for Bulgaria are consistent with estimations across the world: tobacco and alcohol are complementary goods.

The alcohol statistics may partially explain the crowding-in effect in the product category ***Restaurants and Accommodation***, which also includes expenditures in drinking establishments. Yet the insignificant coefficient of the binary variable *d* indicates that households with tobacco expenditures are not necessarily more frequent restaurant-goers.

4.3. MONETARY DIMENSIONS OF THE CROWDING-OUT EFFECT

Albeit statistically significant at the 1% level, the estimated coefficients of the crowding-out effect shown in Table 2 are very small numbers. This is mainly due to their specific form: they answer the question of how the annual expenses on food, clothing etc. – measured in percentage points of the total consumer budget (M) – would change if tobacco expenditures were increased by one Bulgarian lev (BGN; roughly EUR 0.51). One should also take into consideration the rapid increase in disposable income over the last decade in Bulgaria. Real expenditures grew by 45% between 2015 and 2024, which is equal to an additional BGN[4] 6,000 (of 2024 purchasing power) per average household; such an income boost ought to lessen the magnitude of the tobacco crowding-out effect. Nevertheless, the estimated redistributive effect of tobacco on household consumption habits remains considerable.

Let us assume that a certain household increases its cigarette consumption by one pack a day. In 2024 prices, this will be equal to BGN 6 per pack, or BGN 2,190 per annum. The average annual household budget for 2024 was BGN 18,822 (the sum designated by 'M' in the above text). Using the coefficients estimated in Table 2, smoking one more pack of cigarettes per day would mean foregoing BGN 113 on health, BGN 25 on education, BGN 125 on housing, BGN 150 on recreation, and BGN 175 on clothes and footwear. These are no trivial sums given the total budget apportioned by Bulgarian households on these expenditure groups. For instance, a household consuming one more pack of cigarettes per day will have to forgo almost a quarter of its annual clothing and footwear expenditures as well as 14% of its budget for recreation and sport. The consumption effects are even bigger, since tobacco 'crowds in' more money on hotels, restaurants and bars (28% of the average budget for this product category in 2024) as well as alcohol (46%). Table 3 presents these estimations.

Table 3 / Monetary dimensions of the crowding-out and crowding-in effects of tobacco use in 2024

	Food	Health	Education	Housing	Clothing	Recreation	Transport	Restaurants	Alcohol
Estimated coefficient	0.00000735	-0.0000027	-0.0000006	-0.0000031	-0.0000042	-0.0000036	0.00000395	0.00000644	0.00000284
Annual budget for 2024 /M/, BGN	18822	18822	18822	18822	18822	18822	18822	18822	18822
Effect of 1 BGN spent on tobacco, BGN	0.14	-0.05	-0.01	-0.06	-0.08	-0.07	0.07	0.12	0.05
Annual effect when smoking one additional pack per day, BGN	302.97	-112.94	-24.61	-125.72	-174.36	-149.63	162.82	265.46	117.07
Annual effect on the expenditure group, %	4.45	-6.78	-4.64	-4.35	-23.88	-13.66	12.13	28.32	45.73

Source: authors' calculations

[4] As of 1 January 2026, Bulgaria will adopt the euro, and all prices of goods and services will be denominated in EUR rather than BGN. Nevertheless, we conducted our estimations using the Bulgarian currency to avoid further currency adjustments that could distort the general proportions of the studied crowding-out effect.

The above estimations are valid under the assumption of 'all other things being equal'. It is important to repeat here that tobacco consumption has a diverging effect on different goods and services, increasing the demand for certain consumer products while decreasing the demand for others.

There is another important remark to be made concerning the magnitude of the coefficients. Following John et al. (2023), we estimated the crowding-out coefficients based on equation (4) in Section 3.3. That is, in the list of variables that determine the crowding-out effect, we also included the binary variable *d* and its interactions with income ($d\#c.InM$ and $d\#c.InM^2$). One of the consequences of this approach was the substantial decrease in the coefficients of the variable tob_exp. This is an expected outcome in applied econometrics, as factor coefficients tend to decrease when including new significant variables into the equation. This also means that our estimations are conservatively based: by increasing the methodological precision of our estimations, we gained strictly conservative results. If estimating equation (3) instead of equation (4), the coefficients would be higher by roughly one magnitude, while the direction of the crowding-out and crowding-in effects would basically be the same (excluding the ambiguous category 'Food'). Table A5 presents estimations of equation (3), within the same dataset, for the entire sample and the different income groups.

5. Crowding-out effects within different income groups

Following the methods described in Section 3.4, we divided the household sample into three parts according to the average expenditures per household member within a given year. Table 4 presents descriptive statistics of the real expenditures and budget shares allocated to tobacco within each income group over the studied period.

The table reveals relatively stable budget shares dedicated to tobacco products across all income groups, although these shares have been declining since 2022. Nevertheless, the total amount of money spent on tobacco rose substantially over the studied period: between 2015 and 2024, there was real growth in tobacco spending of 62% among low-income households, nearly 45% for the middle-income group, and 8% for the high-income group. The main factor behind this growth in tobacco expenditures is the general increase in the affordability of tobacco products in Bulgaria in recent years. The declining real prices of cigarettes over the last decade, which have determined their increase in affordability – together with growing incomes – are shown in Column 2 of Table 4. Table A6 gives additional details about the characteristics of Bulgarian households at different income levels.

Table 4 / Real tobacco expenditures and budget shares of tobacco within income groups

		All households		Low-income		Middle-income		High-income	
	Real price per pack, BGN	Real tobacco expenditures, BGN	Budget share on tobacco, %	Real tobacco expenditures, BGN	Budget share on tobacco, %	Real tobacco expenditures, BGN	Budget share on tobacco, %	Real tobacco expenditures, BGN	Budget share on tobacco, %
2015	6.91	510.7	7.8	381.0	8.4	486.5	7.7	664.8	7.4
2016	7.23	535.7	8.1	383.3	8.4	460.9	8.1	763.2	7.9
2017	7.30	543.7	7.6	371.7	7.6	486.0	7.6	773.6	7.6
2018	7.37	549.7	8.1	371.9	8.4	489.6	7.9	787.6	8.0
2019	7.27	581.4	8.3	411.9	8.8	524.4	8.4	808.2	8.0
2021	7.00	568.0	7.8	442.6	8.7	519.9	7.7	742.3	7.2
2022	6.07	584.4	7.3	595.4	8.6	582.4	7.4	575.5	6.1
2023	5.77	598.0	6.9	565.9	7.4	542.8	7.0	685.4	6.2
2024	6.11	680.5	6.6	616.8	7.5	703.8	7.1	720.9	5.3

Notes: Only households with positive expenditures on tobacco are included. All monetary values have been deflated with the CPI index using 2024 as the base year.
Source: authors' calculations

Table 5 summarises the crowding-out coefficients of tobacco expenditures for the three income groups.

Table 5 / Tobacco crowding-out coefficients among three income groups

	Low-income	P>|z|	Middle-income	P>|z|	High-income	P>|z|
Food	0.00000945	0.000	0.00000796	0.000	0.00000795	0.000
Health	-0.00000328	0.001	-0.00000241	0.030	-0.00000295	0.005
Education	-0.00000036	0.069	-0.00000064	0.007	-0.00000077	0.000
Housing	-0.00000238	0.117	-0.00000205	0.153	-0.00000418	0.001
Clothing	-0.00000532	0.000	-0.00000447	0.000	-0.00000280	0.000
Recreation	-0.00000163	0.025	-0.00000498	0.000	-0.00000491	0.000
Transport	0.00000332	0.005	0.00000348	0.004	0.00000287	0.028
Restaurants	0.00000422	0.000	0.00000657	0.000	0.00000753	0.000

Note: All coefficients significant at the 1% or 5% level except those marked in gold.
Source: authors' calculations.

On the subgroup level, we included only eight equations in the GMM estimations and did not estimate coefficients for communication, durable household goods or alcohol. The reasons behind this were the lower shares of omitted product categories from the total budget and an insignificant t-test for 'Durable goods'. Nevertheless, the results presented in Table 5 indicate that the crowding-out effect across different income groups is generally consistent in the entire sample. Only in the low-income group were the coefficients for education and housing statistically insignificant (also negative and significant at 10% in the case of education). Part of the explanation for the insignificant crowding-out coefficient for education may be its small budget share (less than 1.9% of the 'M' budget among low-income households).

For some expenditure categories, the crowding-out effect is stronger within the low-income group; such is the case with health care and, in particular, clothing. When it comes to recreation, the inverse is true, possibly explained by the nature of this expenditure category, which also includes sports. If such is the case, the reason behind this is likely rather cultural and behavioural than budget-related. Interestingly, the crowding-in effect of tobacco consumption also differs within the income groups. Among high-income households, tobacco crowding-in is considerably stronger in terms of restaurants and accommodation, whereas it has the same effect on food expenses among low-income households.

6. Limitations and Conclusion

By applying an econometric approach, which is widely used in the modern tobacco control literature, the existence of a significant tobacco crowding-out effect has been confirmed for Bulgaria. Nevertheless, this study has certain limitations. First, we have been working with data on very broad product categories, which only allows for general conclusions to be drawn about changing consumption patterns due to tobacco use. This limitation is most visible within the 'Food' product category. Detailed data is needed about the consumption of sub-categories (e.g. vegetables and fruits, meat, cereals, sugary beverages or ready-made foods) to derive conclusions about the general impact of tobacco use on the quantity and, in particular, the quality of the food consumed.

Second, the Bulgarian HBS is biased in some respects. Within the sample, pensioners are overrepresented and high-income households are underrepresented (as is typical for many other HBSs). Information on the number of cigarettes purchased per tobacco-consuming household (and, thus, the 'unit price' of tobacco products) also raises questions (Sabev and Petkov 2024). In general, an analysis of HBS data of such quality may only elucidate the general patterns and relationships. But to gain precise estimations concerning tobacco economics and public health, purpose-made surveys are required.

A third limitation of the study is inherent in the very design of the constructed dataset and concerns its static nature. By merging household expenditure data spanning 10 years, we tried to create a pseudo-panel that partially reflects the evolution of the studied traits. It also resolves some survey deficiencies thanks to the greater number of observations. In this way, we managed to overcome some annual fluctuations influenced not by changing consumption patterns but, rather, by the survey implementation itself (e.g. the 22% drop in real tobacco expenditures for the high-income group registered in 2022, followed by a 19% jump in 2023). However, this approach does not account for the changing macroeconomic conditions in Bulgaria between 2015 and 2024 that may have directly affected consumer choices. Moreover, even when merging data for 10 years, our estimation approach remains static, as argued by Gallego et al. (2024).[5]

Nevertheless, by applying an econometric approach that (i) uses robust standard errors, (ii) accounts for important household characteristics, and (iii) controls for the heterogeneous preferences of tobacco-consuming and non-consuming households, we confirmed the existence of a tobacco crowding-out effect in Bulgaria. More importantly, we confirmed that tobacco crowding-out occurs mostly within the expenditure groups that directly influence the availability and quality of human capital in Bulgaria: health, housing, education and recreation. Tobacco expenditures also 'eat up' households' available clothing budgets. These detrimental crowding-out effects are exacerbated by a parallel 'crowding-in' process that enhances expenditures on alcohol and drinking establishments. Based on findings in the global and regional literature (see Chelwa and Koch 2019; Mugosa et al. 2023), we expect that the higher outlays for food associated with tobacco expenditures in Bulgaria mostly concern unhealthy food at the expense

[5] 'Most of the literature is based on the comparison of budget shares between smokers and non-smokers in a static context. While [some] studies (…) consider several years of information, the treatment of information is still static' (p. 10).

of items that constitute the basis of a healthy diet (e.g. dairy products, vegetables and fruits), especially for children and adolescents.

These results warrant public and political attention as well as a structured policy response. The interference of the tobacco industry in Bulgaria's public policies has been substantial (Assunta 2023), with many political proposals for stricter national tobacco control being watered down or rejected outright in recent years. In this respect, the increased tobacco use prevalence on a household level – by 10 percentage points over 10 years – is telling enough. However, the results of the present study might contribute to redressing this unfavourable 'power imbalance'.

This study's findings indicate that tobacco expenditures in Bulgaria are rapidly growing among low-income households, while high-income households retain their elevated tobacco consumption. Tobacco expenditures are depriving low-income households of resources vital for their development while decreasing their capacity to climb out of the poverty trap. Strikingly, tobacco-consuming Bulgarian households in the low-income group spend on average four times more on tobacco products than on education, and their average tobacco expenditures are 30% higher than the potential family contribution to health.

In addition to these negative micro-effects, the negative crowding-out effect of tobacco expenditures in Bulgaria also manifests itself on the macroeconomic level. Devoid of adequate funds for education, health, recreation and housing, there is a failure to develop human capital among Bulgaria's tobacco-consuming population, especially in the lower-income stratum. This directly worsens social mobility prospects and creates ossified enclaves of poverty and underdevelopment, even when general socioeconomic conditions feature rapid betterment and growth. Given the need to constantly build up new skills and competences in response to technological advancements, Bulgaria's labour resources may fall behind, not least because of the elevated national tobacco consumption and its crowding-out nature.

The advice given by Pu et al. (2008) calling for governments to tackle the problem of tobacco consumption 'outside of the realm of public health' warrants attention. Indeed, there are plenty of economic reasons – both on the macroeconomic and microeconomic levels – for Bulgaria to adopt a stricter tobacco control policy.

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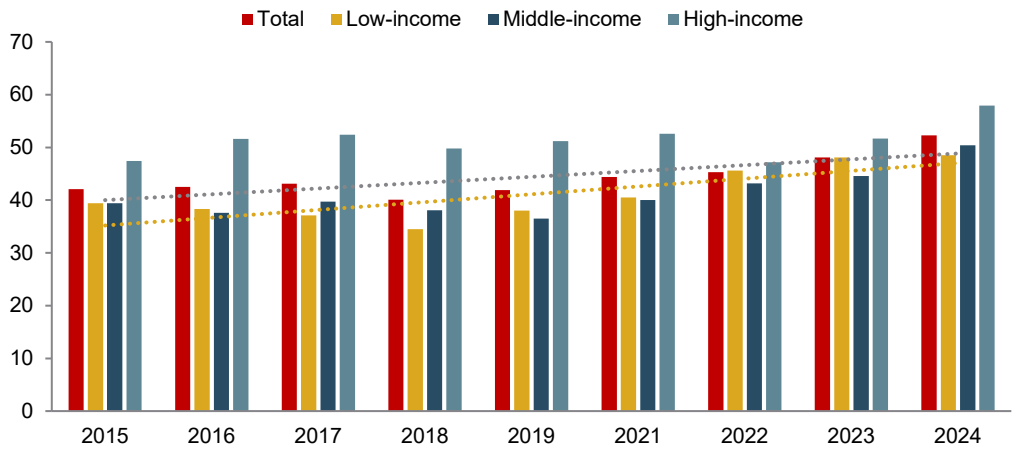
Appendix

Figure A1 / Tobacco prevalence at household level, 2015-2024, %



Source: authors' calculations based on Household Budget Survey

Figure A2 / Histogram of the budget shares spent on food and non-alcoholic beverages, theoretical normal distribution curve

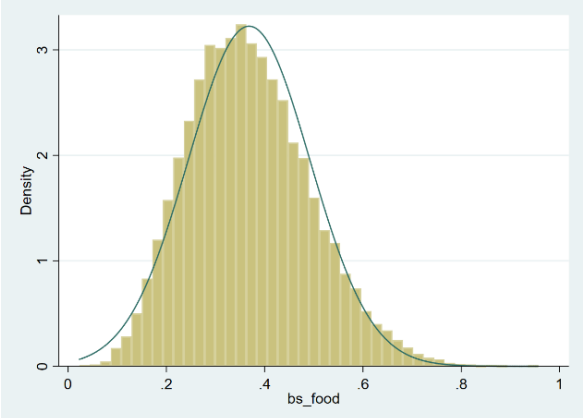


Figure A3 / Histogram of budget shares spent on clothing and footwear

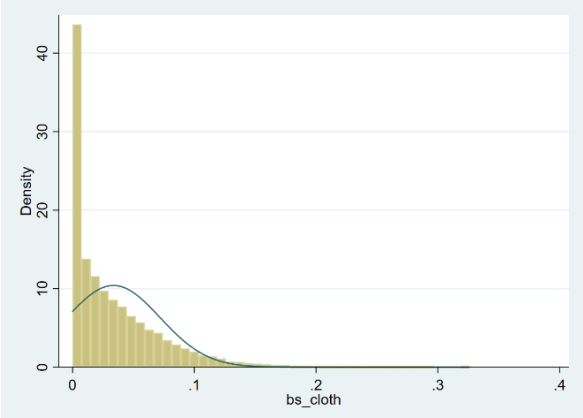


Table A1 / Wald test results on homogeneity of preferences, households with and without tobacco expenditures

Expenditure	Wald test p-value
Food	0.0002
Alcohol	0.0095
Clothing	0.0019
Housing	0.0493
Durables	0.0409
Health	0.0110
Transport	0.0363
Communication	0.0006
Recreation	0.0012
Education	0.3498
Restaurants	0.0371

Note: The Wald test was applied to the budget shares within M (the budget after deducting tobacco expenditures)
Source: authors' calculations

Table A2 / Estimations of crowding-out effects in selected studies

Source	Country	Food	Clothes	Alcohol	Housing	Durables	Health	Transport	Leisure & Culture	Education	Hotels & Restaurants
John 2008	Rural India	-	+				+		-	-	
John 2008	Urban India	-					+	+	-	-	
Sanchez & Gomez 2024	Mexico	+		+	-	+	-	+	+	-	
Nguyen & Nguyen 2020	Vietnam			+		+				-	
Swaranta et al. 2024	Indonesia	-	-		-	-	-	+	-	-	
Husain et al. 2018	Bangladesh	+	-		-		+	-		-	
Gallego et al. 2024	Colombia 2011			+	-					-	
Vladisavljevic et al. 2023	Serbia	-	-	+			-			-	+
Mugosa et al. 2023	Montenegro		-	+	-	-				-	+
San & Chaloupka 2016	Turkey 2011		-	+	-	-	-	+	+	-	
Merkaj et al. 2025	Albania	+	-	+	-				+	-	-
Pu et al. 2008	Taiwan	+	-			-	-	-	-	+	
Ross et al. 2017	Mauritius	+		+	+		-	-		-	+
John et al. 2012	Cambodia		-							-	
Spasova et al. 2025	North Macedonia		-	+		-	-				+
Current study 2025	Bulgaria	+	-	+	-		-	+	-	-	+

Note: '-' indicates a crowding-out effect significant for the whole sample; '+' indicates a significant crowding-in effect.
Source: authors' research.

PRE- AND POST-ESTIMATION TESTS

The amount of non-tobacco expenditures ('M') determines, and is determined by, the budget shares of different product categories. This principally means that including both variables in a regression equation would yield biased results; therefore, a different estimation technique needed to be applied when calculating the crowding-out effect – namely, instrumental variables. In the context of this study, the endogeneity of variables is obvious, yet it was prudent to first test this assumption.

The Durbin-Wu-Hausman test using robust standard errors indeed proved the endogeneity of regressors (tob_exp, InM and InM^2) for all expenditure groups. The null hypothesis of this test was that there were exogenous variables: a significant statistic here implies the rejection of H_0. Results shown in the first two columns of Table A3 indicate that the application of the instrumental variables approach was justified.

Next, we checked the presence of heteroscedasticity in the dataset. As explained in John et al. (2023, p. 70), 'heteroscedasticity is the norm rather than exception [in household budget surveys].' Results from the Pagan-Hall homoscedasticity test within the Bulgarian HBS sample revealed mixed results: of the 11 tested expenditure groups, five indicate a heteroscedastic disturbance (those with a significant value of the Pagan-Hall test; see columns 3 and 4 in Table A3). This fact suggests the need to apply the GMM estimator recommended by Wooldridge and discussed in the last paragraph of Section 3.3 here.

Finally, we checked the validity of the instruments used in the estimations. The F-statistic of the first-stage regression (regressing the instrumental variables on the instruments and other exogenous variables) indicates the strength of the instruments used. Higher F-statistics suggest stronger instruments, while F-statistics below 10 reveal the presence of weaker instruments. Table A4 summarises the results for the three endogenous variables used in this research. Given the high estimated F-values, we may conclude that weak instruments were absent in the structural equation. We have not reported the values of Shea's statistics because there is no consensus on their interpretation.

Since our model is just identified (i.e. the number of instruments is equal to the number of endogenous variables), it was not possible to test the so-called exclusion restriction via Hansen's J-statistic or other methods.

Table A3 / Endogeneity and homoscedasticity tests

	Durbin-Wu-Hausman Exogeneity Test		Heteroscedasticity Test	
Expenditure groups	**Test result**	**p-value**	**Pagan-Hall**	**p-value**
Food	15.1951	0.0017	412.754	0.0000
Alcohol	795.681	0.0000	3.241	0.9752
Clothing	22.4468	0.0001	68.574	0.0000
Housing	75.9208	0.0000	3.172	0.9771
Durables	142.188	0.0000	4.242	0.9358
Health	231.715	0.0000	3.129	0.9782
Transport	764.923	0.0000	3.393	0.9706
Communication	15.1911	0.0017	197.684	0.0000
Recreation	15.1078	0.0017	967.788	0.0000
Education	12.5223	0.0058	147.165	0.0000
Restaurants	190.494	0.0000	4.301	0.9327

Source: authors' calculations

Table A4 / F-statistics of the first regression

Variable	R-sq.	Adjusted R-sq.	F (3, 26462)	Prob > F
tob_exp	0.4598	0.4596	108.919	0.0000
lnM	0.9942	0.9942	599932	0.0000
lnM^2	0.9943	0.9943	598075	0.0000

Source: authors' calculations

Table A5 / Crowding-out coefficients when estimating equation (3)

	All households	Low-income	Middle-income	High-income
Food	-0.0000663***	-0.000061**	-0.0000218	-0.0000786***
Health	-0.0000376***	-0.0000265***	-0.0000422***	-0.0000429***
Education	-0.0000059***	-0.0000067**	-0.0000077**	-0.0000038
Housing	-0.0001366***	-0.0001164***	-0.0001471***	-0.0001324***
Clothing	-0.0000376***	-0.0000265***	-0.0000422***	-0.0000429***
Recreation	-0.0000248***	-0.0000157	-0.000029**	-0.0000342**
Durables	-0.0000861***	-0.0000619***	-0.0000879***	-0.0001***
Transport	0.0002667***	0.0001395***	0.0002526***	0.0003462***
Communication	-0.0000116***	-0.0000232**	-0.0000142**	0.0000001
Restaurants	0.0001091***	0.0000684***	0.0000503***	0.0001691***
Alcohol	0.0000996***	0.0000959***	0.0001043***	0.0000936***

Source: authors' calculations. Note: *** p<0.01, ** p<0.05

Table A6 / Selected characteristics of Bulgarian households at different income levels

	Low-income	Middle-income	High-income
Household size, members	2.54	2.07	1.89
Female ratio (women to all adults)	0.54	0.59	0.53
Total expenditures in 2024, BGN	15,400	18,207	24,903
Real growth in expenditures, 2024/2015, %	56.5	42.4	39.5
Maximum education (1-6)*	3.18	3.67	4.38
Intensity of cigarette consumption, packs**	172	197	210
Budget share spent on tobacco**	8.2	7.6	7.1
Budget share spent on food	41.5	36.9	30.3
Budget share spent on clothing	2.9	3.2	4.2
Budget share spent on education	1.8	2.6	3.6
Budget share spent on health	8.5	9.2	7
Budget share spent on recreation	3.1	4	6
Budget share spent on restaurants	2.3	3.4	6.3
Budget share spent on housing	19.4	18.5	16.1

Notes: * maximum educational level attained by a household member (3 = finished secondary education; 4 = vocational education after secondary level; 5 = bachelor's degree; 6 = master's degree or Ph.D.). ** only for households with positive tobacco expenditures
Source: authors' calculations.

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