The differential effects of tobacco taxation across educational groups: evidence from Poland[*]

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Abstract

Objective Assessing the impact of the recent excise hike in Poland, with particular attention to differences between tertiary- and non-tertiary-educated populations.

Methods We use the nationally representative Household Budget Survey data from 2010 to 2022 to estimate changes in smoking behaviour in response to cigarette affordability at both the extensive and intensive margins. Combining these estimates with European Health Interview Survey data, we simulate the effects of excise hikes for smoking prevalence and consumption in 2025–2027.

Results We find that the less-educated population exhibits a higher smoking prevalence but is more responsive to cigarette affordability. For the non-tertiary-educated population, a 10% increase in the ratio of cigarette price to income, i.e., a 9.1% reduction in affordability, lowers the probability of households buying cigarettes by 0.61 percentage points (pp), translating into 2.2% fewer smokers. For the tertiary-educated population, such a decline in affordability reduces the probability of buying cigarettes by 0.24 pp and the number of smokers by 1.1%. The reduction of consumption volume among continuing smokers is also larger among the non-tertiary-educated population. We estimate that the excise tax roadmap adopted in 2024, securing a 21% tax increase by 2027, will reduce the number of smokers in Poland by about 250,000, reduce overall cigarette consumption by 8.4%, and increase excise revenue by 10.9%.

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Conclusions In Poland, increases in the cigarette excise tax will reduce smoking prevalence and consumption volume mainly among the non-tertiary-educated population. Non-economic factors appear to primarily drive the decline in smoking prevalence among tertiary-educated people.

Summary box

What is already known on this topic

- Cigarette consumption among less-educated people is more sensitive to cigarette affordability.

What this study adds

- We use panel household budget data to estimate smoking responses to changes in cigarette affordability.
- We show that the decrease in smoking prevalence among the tertiary-educated population is linked to non-economic factors.
- We quantify the expected effects of excise hikes across educational groups, showing that these effects are concentrated among the less-educated population.

How this study might affect research, practice or policy

- The findings highlight that excise hikes are an effective tool for reducing cigarette consumption among the non-tertiary-educated population.

1. Introduction

Little is known about smoking disparities by education and the price responsiveness of tobacco demand across education levels, especially in Europe. A 1990 study of twelve European countries found that lower-educated individuals smoke generally more, although not necessarily in Southern European countries [1]. In Western European countries and in Hungary, education level is a stronger predictor of smoking than income, which seems to be linked to higher maturity of the smoking epidemic [2]. Unobserved factors, rather than health-related knowledge, likely explain such an educational gap. In Germany, for example, up to 90% of educational differences in smoking had formed before the age of 16, i.e., before compulsory schooling was completed, and this gap persisted into adulthood [3].

Studies of price elasticity of cigarette demand across educational attainment in the USA and Canada concluded that those with higher education are less price sensitive compared to lower-educated groups (4–6). Studies in Spain reached similar findings (7,8). A recent US study concluded that educational disparities in smoking are increasing over time [9], agreeing with the Hungarian study [2], and pointing to the relevance of the stage of the smoking epidemic. Thus, it is important to revisit the educational difference in smoking patterns in Europe and to study the role of tobacco tax policy in addressing this gap.

We contribute to the literature by examining the case of Poland, which, like other Central and Eastern European (CEE) countries, displays significant educational disparities in smoking patterns. We show that the recent decline in smoking prevalence among the tertiary-educated population was driven by non-economic factors such as social norms and health awareness. In contrast, the less-educated population seems to be more responsive to economic factors such as changes in cigarette affordability, suggesting that excise tax policy may be particularly effective

in reducing high smoking prevalence among this group. To illustrate the differing policy impacts across educational groups, we evaluate the scheduled excise tax increase for 2025–2027.

2. Background

The smoking prevalence in Poland and other CEE countries declined significantly since joining the European Union, primarily due to tax increases needed to comply with the EU Tobacco Tax Directive [10]. As a result, the current smoking prevalence in the CEE countries is on par with the EU average. According to the most recent data from the European Health Interview Survey (EHIS), in 2019, 20.9% of adult Poles smoked tobacco products daily, slightly below the EU average (21.4%). Similar shares of daily smokers are observed in other CEE countries: Czechia (21.2%), Lithuania (20.9%), and Romania (20.7%).

However, a large difference between non-tertiary-educated and tertiary-educated populations remains, with the difference being exceptionally high in Poland and other CEE countries (Figure 1). Taking into account both daily and occasional smokers, the educational difference in smoking prevalence in 2019 amounted to 15.9 percentage points (pp) in Poland, noticeably above those in Western European countries, such as France (-0.3 pp) and Italy (5.3 pp). While the share of smokers among the tertiary-educated population in Poland is low – in 2019, it was the third lowest in the EU at 12.5% – the prevalence among the less educated population is rather high – in 2019, it amounted to 28.4%. Moreover, in Poland and other CEE countries, except for Slovenia and Estonia, the educational gap in prevalence widened between 2009-2019.

Figure 1 Difference between smoking prevalence among non-tertiary-educated and tertiary-educated people, 2019 (pp)
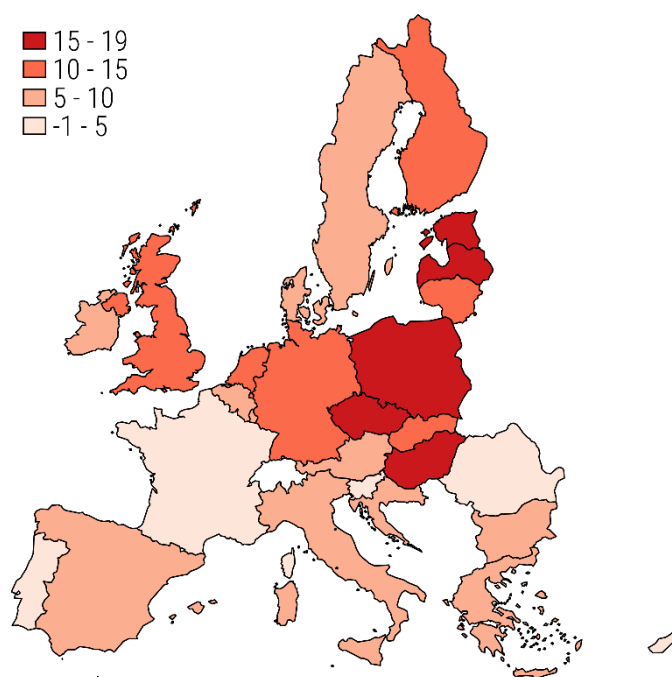

Source: own calculations based on the 2019 EHIS data, 2014 EHIS for France and the UK.

An annual measure of smoking prevalence is provided by the Polish Household Budget Survey (HBS). The HBS data allows identifying households consuming cigarettes rather than individual smokers. In 2019, the share of such households stood at 28.1%, slightly above 24.3% of individual smokers according to the EHIS data. The HBS data show that in the early 2010s, smoking prevalence was declining among both tertiary and non-tertiary-educated populations. However, since 2015, it has rebounded among the latter. Among the non-tertiary-educated population, the share of households buying cigarettes increased from 25.4% in 2015 to 32.9% in 2022. Importantly, the average cigarette price to wage ratio, a measure of cigarette affordability, started to decline in 2014 (Figure 2), suggesting its potentially critical role for smoking patterns among the less-educated population. On average over the 2010-2022 period, households with tertiary-educated members had an equivalised income 60.5% higher than those without tertiary-educated members. However, this gap steadily declined—from 77.5% in 2010 to 48.1% in 2022.

As taxes constitute the main component of cigarette price in Poland, excise policy has shaped the evolution of cigarette price relative to income. In 2010-2022, excise constituted, on average, 60.8% of the retail price, and VAT a further 18.7%. The excise duty on tobacco rose in the early 2010s, motivated by the EU Tobacco Tax Directives and revenue needs, but remained flat in 2015-2022, except for a single 10% hike in 2020. Moreover, high inflation substantially reduced the real value of excise in 2020-2023. As a result, between 2014 and 2024, the ratio of the average cigarette price to the average wage decreased by 35% (Figure 2).

In 2023, the government implemented a roadmap for increasing the excise in line with inflation until 2027. This roadmap was updated in 2024 with a more ambitious plan aimed at bringing the average cigarette price to wage ratio back to the 2021 level by 2027 (Figure 2).

Figure 2 The ratio of average cigarette price to average wage
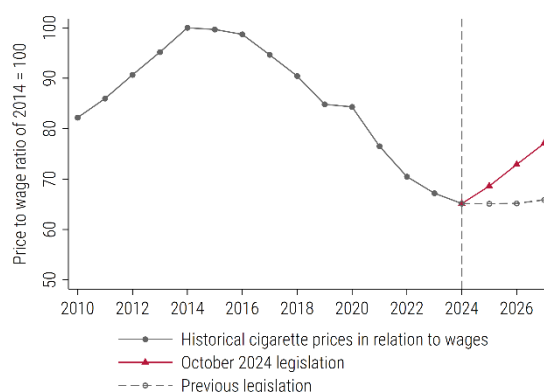
Source: own figure based on data from Statistics Poland and the Ministry of Finance

3. Data and methodology

We use the HBS data 2010-2022 to estimate the effects of changes in cigarette prices and households' incomes on the probability of smoking (extensive margin effects), and on the quantity of cigarettes bought (intensive margin effects). HBS is a rich microdataset containing information on a household's members (including age, educational attainment, and income sources) and detailed information on household expenditures within one month, including spending on three categories of tobacco products: i) cigarettes, ii) cigars, and iii) other tobacco items. Purchased quantities, for example, the number of cigarettes, are also reported. Even though neither expenditure nor consumption are attributed to individual members, such microdata are often used to study the impact of price/tax on tobacco use (11,12).

The key advantage of the Polish HBS data is the yearly panel structure of the survey. We include only households that participated in the survey in two successive years, providing two observations of monthly incomes and expenditures, separated by a year. This allows observing the changes in the consumption of tobacco products and linking them to shifts in prices and household incomes.

The number of households buying cigarettes in our sample is substantial, despite some reduction over time, especially during the 2020-2022 pandemic. It ranges from 2,600 in the most recent period to 3,900 in 2010, allowing a rigorous quantitative analysis. Importantly, we excluded households that changed the number of members to prevent bias in smoking patterns that may result from smokers moving out or in the observed households.

We are primarily interested in the effects of long-term (permanent) changes in cigarette affordability rather than transitory shocks that may barely impact consumption [13]. Among employees and retirees, the annual change in reported income likely reflects the true change in their financial situation. We use reported net income for such households, excluding one-time gains from insurance payouts and the sale of capital or consumption goods. However, among

business owners and the self-employed, changes in monthly income may reflect the volatile nature of economic activity. Indeed, the standard deviation of annual income change among households with revenues from economic activity is 54% larger than in the rest of the sample. Therefore, for households with business incomes, we proxy permanent income with monthly expenditures, excluding tax payments, real estate purchases, investments in economic activity, and costs related to running a farm. To minimise the impact of outliers and reporting errors, we winsorise key variables: household expenditures and incomes at the 1st and 99th percentiles of year-specific distributions, and cigarette consumption at the 99th percentile.

We use a national weighted average price of cigarettes that serves as a basis for calculating the excise tax and is announced annually by the Ministry of Finance. Although we observe unit values paid by households, these are endogenous to income and affected by consumption baskets and measurement errors. Unit values reported by households are highly concentrated. For example, in 2022, 87% of unit values per pack of cigarettes were between 13.75 and 16.75 PLN, while the official average price was 15.17 PLN.

We use Ordinary Least Squares to estimate two types of regressions explaining: i) a binary variable y_i whether a household i has bought cigarettes, and ii) the logarithm of the number of cigarettes bought, z_i:

$$\Delta y_i = \alpha + \beta \times \Delta\ln(RIP_i) + \gamma \times Edu + \zeta \times Age + \epsilon_i \tag{1}$$

$$\Delta\ln(z_i) = \eta + \theta \times \Delta\ln(RIP_i) + \kappa \times Edu + \lambda \times Age + \mu_i \tag{2}$$

Where Δ represents a one-year change, RIP_i captures the logarithm of the relative income price, Edu indicates the maximum educational attainment in the household (non-tertiary or tertiary, taking into account all household members), Age is a vector of indicator variables for the age group (18-39, 40-59, 60+) of household's head, and random errors are represented by ϵ_i and μ_i.

Our main variable of interest is RIP_i, following Nargis et al. [14], defined as the cigarette pack price divided by the disposable income. In model (1), β represents the prevalence semi-elasticity with respect to RIP_i (percentage-point change in smoking probability in response to a 1% RIP change), while in model (2) θ captures the elasticity of the volume purchased with respect to RIP_i.

By including fixed effects for education and age, we control for different trends in smoking prevalence across socio-demographic groups that may be linked to non-economic factors such as differing social norms and health awareness. We also re-estimate our models separately for age and education groups, obtaining coefficients β and θ that differ between them.

To assess the quantitative importance of changes in the excise law, we simulate the share of smokers and the average consumption of cigarettes under different policy scenarios for 2025-2027. We use β-etas and θ-etas estimated for six subgroups defined according to the age of a household head and level of educational attainment. We also estimate the unconditional trends in outcome variables. For the number of cigarettes, it is the constant ($\eta_{a,e}$) estimated for households with age a and education e. For the binary outcome variable, it is further divided by the mean share of smokers in the relevant group, capturing a relative change in the number of smokers that can be attributed to non-economic factors. We denote this unconditional trend as $\phi_{a,e}$.

We consider two scenarios for tobacco excise. The reference scenario follows the 2023 Polish legislation, under which excise would reach 168 EUR in 2027, translating into a 22% cumulative cigarette price increase from 2024 to 2027. The higher excise scenario follows the more ambitious 2024 law (Figure 2), under which excise will reach 204 EUR by 2027 (21.0% above the reference scenario), translating into a 43% cumulative nominal cigarette price increase from 2024 to 2027. We construct relative income prices for each scenario, assuming that households' nominal income will grow as forecasted by the Ministry of Finance.

We derive the share of smokers, $S_{a,e,t}^s$ for age group a, educational group e, in year t and scenario s as:

$$S_{a,e,t}^s = \left(1 + \phi_{a,e}\right) \times S_{a,e,t-1}^s + \beta_{a,e} \times \Delta\ln(RIP)_t^s \qquad (3)$$

And the average quantity of cigarettes per smoker, $Q_{a,e,t}^s$, is derived as:

$$Q_{a,e,t}^s = \left(1 + \eta_{a,e}\right) \times Q_{a,e,t-1}^s + \theta_{a,e} \times \Delta\ln(RIP)_t^s \times Q_{a,e,t-1}^s \qquad (4)$$

To ensure that our simulation of smoking prevalence represents the shares of individuals (rather than households), we calculate the starting points of outcome variables, $S_{a,e,t}^s$ and $Q_{a,e,t}^s$, using the EHIS data. Since the latest data point from this survey is from 2019, we extrapolate it to 2022 using the change from 2019 to 2022 observed in the HBS data for households of given characteristics. 2023 is the first year of simulation obtained with equations (3) and (4). The population shares of socio-demographic groups are also derived from the 2019 EHIS data.

4. Results

We find a significant link between the affordability of cigarettes and smoking prevalence. A 10% increase in the relative income price of cigarettes translates into a 0.47 pp decrease in the probability of households buying cigarettes (semi-elasticity of -0.047, column 1 of Table 1). At the mean level of smoking prevalence in the sample, this estimate implies the elasticity of -0.18. Hence, a 10% increase in RIP is associated with a 1.8% decrease in the number of households purchasing cigarettes. Importantly, the impact of relative prices on smoking prevalence is noticeably higher among people without tertiary education (semi-elasticity of -0.061 pp, elasticity at the mean of -0.22, column 2 of Table 1) than among tertiary-educated individuals (semi-elasticity of -0.024 pp, elasticity at the mean of -0.11, column 3 of Table 1).

The estimated constant term and the fixed effects for tertiary education and for age groups capture trends in smoking prevalence unrelated to changes in RIP. We observe significant educational

differences in these trends. The estimated constant (-0.001, column 1 of Table 1) is not significant and therefore implies no systematic change in the probability of smoking among those without tertiary education. As the fixed effect for the tertiary-educated population is much larger in absolute terms (-0.007), it indicates an annual decrease of 0.8 percentage points in this group. This difference between more and less educated subpopulations can be likely attributed to non-economic factors, such as health awareness and social norms that may play a more important role for tertiary-educated households.

Table 1 Main estimation results

Dep. variable	(1)	(2)	(3)	(4)	(5)	(6)
	One-year change in smoking status			One-year change in log(cigarettes)		
Sample	All	Non-tertiary educated	Tertiary educated	All	Non-tertiary educated	Tertiary educated
$\Delta \ln(\text{RIP})$	-0.047***	-0.061***	-0.024***	-0.282***	-0.307***	-0.218***
	(0.004)	(0.005)	(0.006)	(0.021)	(0.025)	(0.040)
Tertiary educated	-0.007***			0.026*		
	(0.002)			(0.015)		
Age: 18-39	-0.006*	-0.012***	0.003	-0.018	-0.027	0.003
	(0.003)	(0.005)	(0.004)	(0.018)	(0.022)	(0.030)
Age: 60+	0.002	0.001	0.004	0.001	-0.003	0.012
	(0.002)	(0.003)	(0.004)	(0.015)	(0.017)	(0.030)
Constant	-0.001	0.000	-0.011***	-0.021*	-0.018	-0.003
	(0.002)	(0.002)	(0.003)	(0.011)	(0.012)	(0.019)
Implied elasticity	-0.182	-0.219	-0.112			
R-squared	0.002	0.002	0.001	0.009	0.010	0.006
Observations	155,713	108,429	47,284	26,858	20,139	6,719

Note: In columns 1-3, the dependent variable is a one-year change in a binary variable denoting the presence of expenditures on cigarettes. In columns 4-6, the dependent variable is a one-year change in the logarithm of the number of cigarettes bought. The main explanatory variable is the one-year difference in the logarithm of the relative income price (RIP), defined as the price of a cigarette pack divided by the household's income. In columns 1 and 4, we include all households. In columns 2-3 and 5-6, the sample is split by the maximum educational attainment in a household. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' calculations based on the household budget survey.

The response in terms of cigarette consumption volume is also significant and differs between educational groups. On average, a 10% increase in RIP translates into a 2.8% lower quantity of cigarettes consumed (column 4 of Table 1), but the effect is stronger among the non-tertiary-

educated households (-3.1%, column 5 of Table 1) than among tertiary-educated households (-2.2%, column 6 of Table 1).

We also consider a specification with year fixed effects that effectively controls for price and other, regulatory or policy related factors which might have affected the cigarette consumption in a given year. In this alternative, more restrictive specification, the estimation of the RIP coefficient is based only on variation in household income changes. The results obtained resemble those in Table 1. The prevalence semi-elasticities with respect to RIP are estimated at -0.041 for the whole sample, -0.054 for the non-tertiary-educated population, and -0.020 for the tertiary-educated population. Estimates for intensive margin elasticities are -0.264, -0.284, and -0.212, respectively (full estimation results are available upon request).

Next, we turn to simulating the effects of excise scenarios on smoking prevalence and cigarette consumption. Table 2 summarises the parameters used, highlighting differences between educational groups, both in the elasticities and the unconditional trends in the smoking prevalence. In particular, we find a significant negative trend in smoking prevalence among the tertiary-educated population, which can be related, for example, to social norms and increasing health awareness. For the non-tertiary-educated population, such a trend exists only among people aged 18–39.

Table 2 Parameters used in simulations

Education level	Primary, lower secondary, and upper secondary			Tertiary		
Age group	18-39	40-59	60+	18-39	40-59	60+
Share in population, %	22.5%	24.8%	27.1%	13.4%	8.1%	4.0%
Smoking prevalence in 2022, %	30.7%	31.6%	21.0%	10.9%	11.5%	12.6%
Semi-elasticity, extensive margin	-0.075	-0.067	-0.043	-0.016	-0.033	-0.018
Unconditional trend, % of smokers	-3.5%	0.0%	0.6%	-3.9%	-4.9%	-3.5%
Average number of cigarettes per day among smokers	13.0	14.9	14.1	6.9	9.7	11.2
Elasticity, intensive margin	-0.338	-0.296	-0.296	-0.176	-0.258	-0.213
Unconditional trend, % of the number of cigarettes per smoker	-4.6%	-1.8%	-2.1%	0.1%	-0.4%	0.9%

Note: The average number of daily cigarettes accounts for both daily and occasional smokers. For occasional smokers, we assume that their number of daily cigarettes amounts to 0. Source: Authors' calculations based on the EHIS data and the household budget survey

In the reference scenario, the smoking prevalence in Poland would decrease from 23.1% (7.21 million smokers) in 2024 to 22.1% (6.88 million smokers) in 2027 (Table 3). In contrast, the 2024 policy of more ambitious hikes will likely lower smoking prevalence to 21.3% (6.63 million smokers) in 2027. Hence, the differential impact of the more ambitious policy amounts to 250,000 fewer smokers. As medical research indicates 30-50 fewer premature deaths per 100 people who abstain from smoking [15], the policy could reduce premature deaths by at least 75,000.

The expected reduction in cigarette consumption is even stronger than that of smoking prevalence. In the reference scenario, consumption would fall from 34.4 billion sticks in 2024 to 30.6 billion sticks in 2027 (Table 3). Due to higher excise, we expect the consumption to fall to 28.0 billion sticks in 2027, 8.4% below the reference scenario. However, the excise revenues are expected to be 10.9% higher than in the reference scenario. Importantly, our simulation refers to declared consumption by the domestic adult population. It is, therefore, lower than actual cigarette sales, which also include consumption of foreigners, immigrants not covered in the survey, as well as domestic minors.

The excise-related reduction in smoking prevalence and consumption is concentrated among less-educated people. As background, let us first describe the reference scenario with lower excise hikes. In 2024, there were 6,371,000 non-tertiary-educated smokers, and this figure would decrease to 6,147,000 (by 3.5%) by 2027. In contrast, the number of tertiary-educated smokers would drop from 838,000 to 731,000 (by 12.8%), with the difference reflecting the important role of non-economic factors among the tertiary-educated population. Now we turn to the differences between the higher-excise scenario and the reference scenario as of 2027. As a result of higher excise, both educational groups show the same percentage (3.6%) reduction in smoker numbers, which is a coincidence. This happens because the semi-elasticities used in the simulations (see equation 3) are applied to the entire adult population (smokers and non-smokers alike), while the relative change in smoker numbers depends on the initial size of the smoking group (larger for the non-tertiary educated population). Still, the effects of higher excise are concentrated among less-educated people. Although non-tertiary-educated individuals make up 74.4% of the adult Polish population, 89.3% of the reduction in smoking incidence due to higher excise can be attributed to this group.

Furthermore, out of the 2.56 billion-stick policy-related reduction in consumption, 2.39 billion (93.6%) is projected to occur among non-tertiary-educated people, and only 164 million (6.4%) among the tertiary-educated population. The relatively small contribution of the latter group can be explained by its lower smoking prevalence and lower sensitivity to changes in cigarette affordability. Consequently, the rate of increase in excise paid by tertiary-educated individuals will be higher than that of non-tertiary-educated individuals (12.5% vs. 10.8%, Table 3).

Table 3 Simulation of the number of smokers and cigarette consumption under alternative excise path scenarios for 2027

		2024 values	Reference scenario, 2027	Higher excise, 2027	Difference between scenarios	Difference in %
Number of smokers (thousands)	Total	7,208	6,878	6,628	-250	-3.6%
	Non-tertiary educated	6,371	6,147	5,924	-223	-3.6%
	Tertiary educated	838	731	705	-27	-3.6%
Number of consumed cigarettes (billion)	Total	34.4	30.6	28.0	-2.6	-8.4%
	Non-tertiary educated	31.7	28.3	25.9	-2.4	-8.5%
	Tertiary educated	2.7	2.3	2.2	-0.2	-7.0%
Excise paid (billion PLN)	Total	18.9	21.6	24.0	2.4	10.9%
	Non-tertiary educated	17.4	20.0	22.2	2.2	10.8%
	Tertiary educated	1.5	1.7	1.9	0.2	12.5%

Source: Authors' calculations based on the household budget survey and the European Health Interview Survey.

5. Concluding remarks

In this paper, we have studied the impact of tobacco excise taxes on smoking patterns in Poland. While smoking has become less popular among tertiary-educated individuals in recent years, its prevalence remains high among the non-tertiary-educated population. Such divergent trends are common in Central and Eastern Europe.

We used historical changes in cigarette prices relative to income to estimate smoking elasticities at both the extensive and the intensive margins. The early 2010s saw a series of excise hikes that decreased the affordability of cigarettes. However, after 2014, affordability systematically increased, and the average wage in 2024 allowed for the purchase of 54% more cigarettes compared to 2014. This increase in cigarette affordability coincided with the rising cigarette consumption among the less educated population.

We found significant relative income price elasticities of both smoking prevalence and consumption volume among those who continue smoking. Importantly, these elasticities are

noticeably higher among the non-tertiary-educated population than among the tertiary-educated one. We used these estimates to study two alternative excise paths for 2025-2027. Our simulations show that the effects on smoking, and therefore the health benefits of the new excise roadmap with more ambitious excise hikes, will be concentrated among non-tertiary-educated people. At the same time, the increase in excise paid will be relatively higher among the tertiary-educated people. Our findings imply that higher cigarette excise taxes in Poland will reduce the educational disparity in smoking.

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