Cigarette Affordability in Montenegro

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Mirjana Čizmović,* Anđela Vlahović, Ivana Ivanović,*** Milica Kovačević****

*** Faculty of Business and Economics, Mediterranean University, and Institute for Socio-Economic Analysis, Podgorica, Montenegro**
**** Institute for Socio-Economic Analysis, Podgorica, Montenegro**
***** Institute for Socio-Economic Analysis, Podgorica, Montenegro, and PhD candidate at Faculty of Economics and Business, University of Belgrade**
****** Faculty of Economics, University of Montenegro, and Institute for Socio-Economic Analysis, Podgorica, Montenegro**

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Correspondence to: Mirjana Čizmović, mirjana.cizmovic@unimediteran.net

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Abstract

Background

Cigarette affordability, or the price of cigarettes relative to consumer income, is crucial for understanding the dynamics of tobacco use. When income growth surpasses the increase in cigarette prices, cigarettes become more affordable, potentially boosting consumption. Despite comprehensive tobacco control measures in Montenegro, cigarette use remains high. With significant wage increases in recent years and slow rises in cigarette prices, the risk of increased cigarette affordability—and thus, consumption—becomes pronounced. This study evaluates cigarette affordability trends from 2010 to 2023 and their impact on tobacco consumption, providing policy recommendations to reduce tobacco use.

Methodology

To assess the statistical significance of changes in affordability trends for the entire market and each market segment, a fixed effects regression model is used. This model utilizes an unbalanced panel of macro data with clustered standard errors and time effects. Estimation of the affordability elasticity of cigarette consumption by income groups was done using a two-part model with Household Budget Survey (HBS) data. The first part involved a logit model to assess participation elasticity, while the second part employed generalized linear models (GLM) to estimate conditional elasticity. Additionally, we utilized aggregate data from the Ministry of Finance, applying the autoregressive distributed lag (ARDL) error-correction time series methodology to examine both long-run and short-run affordability elasticity. Various diagnostic tests were conducted to ensure the robustness of our models.

Results

In the period observed from 2010 to 2023, distinct episodes of both increasing and decreasing affordability indicators are evident, largely influenced by changes in income growth that were not adequately addressed by tobacco legislation.

Although findings indicate that cigarettes were nearly 10-percent less affordable in 2023 compared to 2010, periods of economic growth—especially from 2021 to 2023, when expansionary fiscal policies were implemented—led to a significant rise in affordability. This increase contributed to higher cigarette consumption, with annual affordability growth rates of 13 percent, 14 percent, and 7 percent, respectively, during this period. Apart from income growth, pricing strategies of the tobacco industry also contributed to the increased affordability of tobacco products. Empirical results indicate a substantial influence of affordability on cigarette demand in Montenegro. The elasticity coefficient ranges from -0.68 to -0.89, suggesting that demand is highly responsive to changes in affordability.

Conclusions

Our research highlights the significant influence of cigarette affordability on consumption patterns in Montenegro, particularly in the context of recent rapid income growth. While substantial wage increases can improve living standards and reduce poverty, they also present challenges for effective tobacco excise policies. Without adequately considering the rising purchasing power of current and potential smokers, regulations risk making cigarettes more affordable, thereby increasing consumption. To address this, policies aimed at reducing consumption and affordability must consider both price and income effects. Implementing the recommendations of the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) Article 6 and substantial tax increases, in particular, can effectively reduce consumption, especially among lower- and middle-income groups.

JEL Codes: H2, H3, D12, I10, I18, D12, H24

Keywords: affordability, income growth, excise tax, cigarette consumption, affordability elasticity

Introduction

The affordability of cigarettes holds significant importance in public health discussions due to its impact on tobacco use. Cigarette affordability is defined as the price of a product relative to a consumer's income (Blecher & van Walbeek, 2009). When income growth outpaces a proportional increase in real cigarette prices, cigarettes become more affordable, potentially resulting in a rise in consumption. Affordability is a critical metric for tobacco control, offering valuable insights into the effectiveness of raising cigarette prices in curbing consumption.

Although the government has implemented extensive tobacco control measures, general prevalence of cigarette use remains very high in Montenegro (40.7 percent in 2019 (Mugoša et al., 2023) and 38 percent in 2022 (Tobacconomics, 2023)). And despite a noticeable trend of rising cigarette prices over the last 15 years, prices remain low in Montenegro compared to the European Union (EU) level, according to data from the World Health Organization[1] (WHO, 2023). Additionally, the Government of Montenegro initiated economic and fiscal reforms in 2022, nearly doubling minimum net wages (from €250 to €450 as presented in the Montenegro Economic Reform Programme 2022–2024, Government of Montenegro 2022), raising the average wage (by approximately 30 percent in 2022 compared to 2021 (Haan & Traxler, 2023)), and planning for a more expansive fiscal policy in the coming year (starting by increasing the minimal pension by 52 percent, from €296 to €450 in January 2024). With a positive income elasticity observed, coupled with a slow increase in cigarette prices in recent years and a further substantial rise in household income, there is a tangible risk that cigarettes will become more affordable, potentially leading to a rise in tobacco use.

[1] In 2022, the average price of the most-sold cigarette brand in the EU was 9.71 international dollars (PPP) or 6.14 US$ at official exchange rates. In comparison, the corresponding prices in Montenegro were significantly lower, at 7.54 international dollars (PPP) and 2.75 US$.

Montenegro, as a committed signatory to the World Health Organization Framework Convention on Tobacco Control (WHO FCTC), is mandated to employ tax and price policies to curb tobacco use. The primary objective is to progressively reduce the affordability of tobacco products over time, aiming to lower consumption and prevalence rates. Therefore, in terms of Article 6 of the FCTC, it is important to consider Montenegro's specific context when implementing tobacco tax adjustments and to ensure that tax increases are substantial enough to counteract positive trends in income growth. Diverging from prior research that frequently observed price and income effects independently, this paper employs a comprehensive evaluation of cigarette affordability trends from 2010 to 2023 and an estimation of the impacts of affordability on tobacco consumption among adults. Through the findings, the study seeks to provide recommendations to policy makers for public policies that could contribute to reducing tobacco use.

Literature review

Understanding the factors that affect the affordability of cigarettes is crucial for the development of successful tobacco control policies targeting the reduction of tobacco use. There are essentially two categories of research in this context: studies conducting descriptive analysis of cigarette affordability trends across various countries over different time frames and other studies that explore the relationship between tobacco consumption and changes in cigarette affordability. An overview of these studies is presented in tables 1 and 2.

Within the first group of studies, researchers employed various indicators to conduct a descriptive analysis of cigarette affordability across different countries and time periods. The relative income price (RIP) method developed by Blecher and van Walbeek, along with Guindon's minutes of labor (MoL) method, stand out as the two most widely employed standardized approaches for computing cigarette affordability. The first subcategory of these studies focuses on cigarette

affordability analysis utilizing cross-sectional data. Findings from these studies vary, with some suggesting that cigarettes are more affordable in high-income countries (HICs) than in low-income countries (LMICs) (Blecher & van Walbeek, 2004, 2009; He et al., 2018a; Rodríguez-Iglesias et al., 2015). In contrast, other research (Guindon et al., 2002; Blecher & van Walbeek, 2009; Blecher et al., 2013; Blecher, 2020) indicates that over time cigarettes have become more affordable in LMICs compared to HICs.

Table 1. Literature review – Cigarette affordability in HICs and LMICs

Title	Authors	Year	Countries		Time	Data	Indicator	Results
An international analysis of cigarette affordability	Blecher & van Walbeek	2004	28 HICs	42 LMICs	1990 – 2001	EIU World Bank (prices and GDP pc)	RIP	More affordable in HICs than in LMICs
Cigarette affordability trends: An update and some methodological comments	Blecher & van Walbeek	2009	RIP: 32 HICs 45 LMICs	MoL: 29 HICs and 23 LMICs	1990 – 2006	EIU (prices) UBS (MoL)	RIP MoL	More affordable in HICs than in LMICs
Cigarette affordability in Europe	Blecher et al.	2013	EU 15	EU12+	2004 – 2010	EC (prices for EU member countries) EIU (prices for additional 10 non-member countries) Eurostat and World Bank's World Developmen	RIP	Less affordable in most EU member states

						t Indicators (WDI) (GDP pc)		
Affordability of tobacco products: The case of cigarettes	Blecher	2020	41 HICs	47 LMICs	1990 – 2018	EIU Euromonitor International World Bank (GDP pc)	RIP	Less affordable in 32 of 40 HICs Less affordable in 26 of 45 LMICs
Cigarette affordability in China, 2001–2016	Zheng et al.	2016	China		2001 – 2016	Annual Cigarette Price List (prices) National Bureau of Statistics of China (income)	RIP average IPC average CAI average	Less affordable in 2011 and 2015
Real price and affordability as challenges for effective tobacco control policies: An analysis for Argentina	Iglesias et al.	2015	Argentina		2004 – 2014	MINAGRI (prices) INDEC (CPI) EPH survey (income)	RIP	More affordable in 2014 than in 2004
Cigarette affordability in Canadian provinces: A 10-year review	Worrel & Hagen	2021	Canadian provinces		2009 – 2019	Health Canada (prices) Statistics Canada (income)	RIP	Less affordable in 2019 than in 2009
Trends in individualized affordability of factory-made cigarettes: Findings of the 2008–2020 International Tobacco Control	Geboers at al.	2022	the Netherlands		2008 – 2020	International Tobacco Control Netherlands Surveys (self-reported income and prices of the	RIP	Less affordable in 2020 than in 2008

Netherlands Surveys					last tobacco purchase)		
Changes in the affordability of tobacco products in India during 2007/2008 to 2017/2018: a price-relative-to-income analysis	Goodchild et al.	2020	India	2007 / 2008 – 2017 / 2018	Labour Bureau's Consumer Price Index for Industrial Workers (prices) Reserve Bank of India (NSDP/ca-pita)	RIP	National average affordability stayed unchanged

Notes: Economist Intelligence Unit (EIU); Union Bank of Switzerland (UBS); European Commission (EC); National Ministry of Agriculture (MINAGRI); Instituto Nacional de Estadística y Censos (INDEC); Encuesta Permanente de Hogares (EPH) represents a quarterly Permanent Household Survey; Net State Domestic Product per capita (NSDP). Relative Income Price average (RIP average) represents the percentage of nationwide per capita disposable income required to buy 100 packs of weighted average–price cigarettes. In this study, the RIP method was adapted by replacing per capita GDP with nationwide per capita disposable income; IPC (Income Purchasing Capacity) refers to the number of packs of average-price cigarettes that could be purchased with the nationwide per capita disposable income. CAI (Cigarette Affordability Index) measures the magnitude of cigarette affordability change during the whole observed period.

The second group of studies, focused on examining affordability elasticity, describes the percentage change in cigarette consumption in response to a percentage change in the RIP (Blecher & van Walbeek, 2004; Zheng et al., 2016; He et al., 2018a; Nargis et al., 2020; Hu et al., 2019; Đukić et al., 2021) and (Prekazi & Berisha, 2023). Studies from HICs suggest that affordability elasticity is higher, typically ranging from -0.17 to -1.0, compared to most estimates from LMICs (ranging from -0.2 to -0.6). Blecher and van Walbeek (2004) investigated the relationship between cigarette affordability and consumption from 1990 to 2001 using a sample of 28 HICs and 42 LMICs. The analysis, based on cross-

sectional data, revealed that a one-percent increase of RIP would decrease cigarette consumption by 0.49–0.57 percent. They conclude that affordability elasticity of demand did not exhibit significant differences between rich and poor countries.

Zheng et al. (2016) estimated the association between cigarette affordability and cigarette consumption in China from 2001 to 2016. Their analysis was conducted by using two indicators, including RIP and IPC, and they estimated affordability elasticity of demand in China was -0.60. Finally, a panel-data study, comprising 169 countries divided into 45 HICs and 124 LMICs, was conducted by Nargis et al. (2020). Utilizing price, income, and affordability estimates, they performed a policy simulation to analyze the required level of increase in tax and price needed to reduce cigarette consumption by 10 percent in both HICs and LMICs. The affordability elasticity of demand was estimated at -0.171 for HICs and -0.207 for LMICs.

Table 2. Literature review – Affordability elasticity of cigarette demand

Title	Authors	Year	Countries		Time	Data	Indicator	Results
An international analysis of cigarette affordability	Blecher & van Walbeek	2004	28 HICs	42 LMICs	1990 – 2001	EIU (prices)	RIP	Affordability elasticity of demand: -0.53 No significant difference in affordability elasticity of demand between HICs and LMICs
Cigarette affordability	Zheng et al.	2016	China		2001 – 2016	Annual Cigarette	RIP average IPC average CAI average	Affordability elasticity of demand:

in China, 2001–2016					Price List (prices); National Bureau of Statistics of China (per capita disposable income)		-0.60
Cigarette affordability and cigarette consumption among adult and elderly Chinese smokers: Evidence from a longitudinal study	Hu et al.	2019	China	June 2011 – March 2022 2013 July 2015 – January 2016	CHARLS (self-reported cigarette prices and disposable income)	RIP	Affordability elasticity of demand: -0.165
The association between cigarette affordability and consumption: An update	He et al.	2018	30 HICs	13 UMICs	2011 – 2014	WDI database (prices); EIU (prices); EuroMonitor International Database (total retail volume of cigarettes and all cigarette consumpt	RIP	Cigarette affordability more elastic in HICs than in LMICs Affordability elasticity of demand in HICs: -1 Affordability elasticity of demand in LMICs: -0.2
			16 LICs	19 LMICs			

						ion including illicit trade)		
Price, income, and affordability as the determinants of tobacco consumption: A practitioner's guide to tobacco taxation	Nargis et al.	2020	45 HICs	124 LMICs	2007 – 2016	Euromonitor International Database (total retail volume of cigarettes); WDI Database (per capita GDP)	RIP	Affordability elasticity of demand: HICs: -0.171 LMICs: -0.207
Affordability of cigarettes among adult smokers in Kosovo	Prekazi & Berisha	2023	Kosovo		2019	STC-SEE survey (prices); HBS (quantity of cigarettes consumed)	RIP	Affordability elasticity of demand: -0.03
Decrease affordability to reduce consumption of cigarettes in Southeastern Europe	Đukić et al.	2021	SEE		2008 – 2018 2009 – 2019	EUROSTAT (prices) IMF's World Economic Outlook (WEO) (GDP pc)	TAI RIP	Affordability elasticity of demand: -0.65 – -1.2

Note: China Health and Retirement Longitudinal Study (CHARLS); Upper-middle-income countries (UMICs); Low-income countries (LICs); Survey on Tobacco Control – Southeastern Europe (STC-SEE); Tobacco Affordability Index (TAI).

In addition to the previously mentioned categories of studies, certain research explored the topic of cigarette affordability based on income groups (Zheng et al., 2016) and price tiers (Hu et al., 2019; Nargis et al., 2020). A study conducted by Zheng et al. (2016) estimated the association between cigarette affordability and cigarette consumption in China from 2001 to 2016. Their analysis was conducted by using two indicators, including RIP and IPC, and both methods demonstrated that economy-brand cigarettes were more affordable for low-income groups than other cigarette price categories for average-income groups. Nargis et al. (2020) highlighted that cigarette affordability in China increased across all price tiers of cigarette brands. Hu et al. (2019) categorized cigarettes into five groups based on price tiers: luxury, premium, medium-priced, discount brands, and deep-discount brands. They found deep-discount-brand cigarette smokers were less responsive to cigarette affordability change compared to smokers who consumed cigarettes of higher price tiers.

To date, there exists a notable scarcity of in-depth analyses on cigarette affordability in Southeast Europe (SEE), with a specific focus on the Western Balkans (WB) region. The estimates available regarding cigarette affordability trends in Montenegro are derived from the World Health Organization Global Health Observatory (WHO-GHO)[2] database, *Tobacconomics Cigarette Tax Scorecard* (Drope et al., 2024),[3] and other research (Đukić et al., 2021). The data from WHO's global database show that cigarettes became less affordable between 2010 and 2020 (trend average), but more affordable in 2022 compared to 2020. Also, referring to the results from the *Tobacconomics Tax Scorecard*, it is evident that cigarette affordability in Montenegro significantly increased in recent years. The affordability score decreased from 5 in 2018 (indicating the highest

[2] https://www.who.int/data/gho/data/indicators/indicator-details/GHO/affordability-of-the-most-sold-brand-of-cigarettes-(tobacco-control--raise-taxes)

[3] *The Tobacconomics Cigarette Tax Scorecard* assesses the cigarette tax systems of countries using a 5-point rating system across four key components: cigarette price, changes in cigarette affordability over time, the proportion of taxes in retail cigarette prices, and the structure of cigarette taxes.

reduction in affordability) to 4 in 2020, and then to 0 in 2022 (indicating no reduction or even an increase in affordability).). The analysis undertaken by Đukić et al. (2021) reviewed trends in cigarette affordability among ten SEE countries, encompassing Montenegro. This study concluded that cigarettes in Montenegro became less affordable in 2018 compared to 2008 and that affordability elasticity for a group of Southeastern European countries ranges from -0.65 to -1.1, depending on the model applied.

Methodology

Data

To examine affordability trends and their relationship with cigarette consumption, we will utilize an analytical framework comprising two key components:

- Estimation of cigarette affordability levels for each year spanning from 2010 to 2023 using various indicators recommended by the literature. These indicators will enable us to identify trends and ascertain the magnitude of change in affordability over the observed period.

- Specification of models to evaluate the impact of affordability on cigarette consumption per capita, employing different indicators derived from micro and macro data.

In the initial phase of the research, the study defines two primary metrics for affordability based on existing literature: the relative income price (RIP) and minutes of labour (MoL). These metrics are slightly modified to tackle some of their limitations. RIP is derived as the percentage of GDP per capita needed to purchase 100 packs of cigarettes in the period from 2010 to 2023 (Blecher & van Walbeek, 2004), with higher values indicating reduced cigarette affordability.

One limitation of the traditional method of measuring cigarette affordability is the reliance on a single-brand retail price, usually the most sold, which may not accurately reflect the actual price smokers pay (Kostova et al., 2014). To address this issue, we constructed consumption-weighted average prices for the whole market and for different market segments to consider the variability of cigarette prices and specific consumption patterns. Also, to overcome the problem of GDP per capita as a broad income measure that incorporates public and private income, we estimated the RIP indicator, taking average disposable income as a denominator. One limitation is the unavailability of disposable income data until 2013 and for the year 2023, preventing the calculation of this indicator for the entire observed period (2010–2023).

Additionally, using wage as a proxy for income, we calculated the MoL needed to purchase one pack of cigarettes, using the average price for the whole market and the average hourly wage in Montenegro (Guindon et al., 2002).

Previous research has shown that low-income groups in Montenegro have the highest prevalence of smoking (40.1 percent according to Mugoša et al. (2020)) and are the most sensitive to price changes compared to wealthier groups (with a price elasticity of -1.019 according to Cizmovic et al. (2022). Low-income households allocate the highest share of their budget to tobacco (5.6 percent),[4] which crowds out spending on necessities, potentially exacerbating poverty. Given the budget constrain of low-income groups, greater attention is given to them when assessing the affordability of cigarettes. To evaluate the affordability trend for this group, similar to Kan (2007), we computed the MoL indicator, focused on measuring the minutes of labor needed to buy a cigarette pack in the economy market segment. To calculate this indicator we used the average wages

[4] Calculated using Household Budget Survey data obtained from Monstat.

for the first 30th percentiles of employees as an estimate of income for the low-income group.[5]

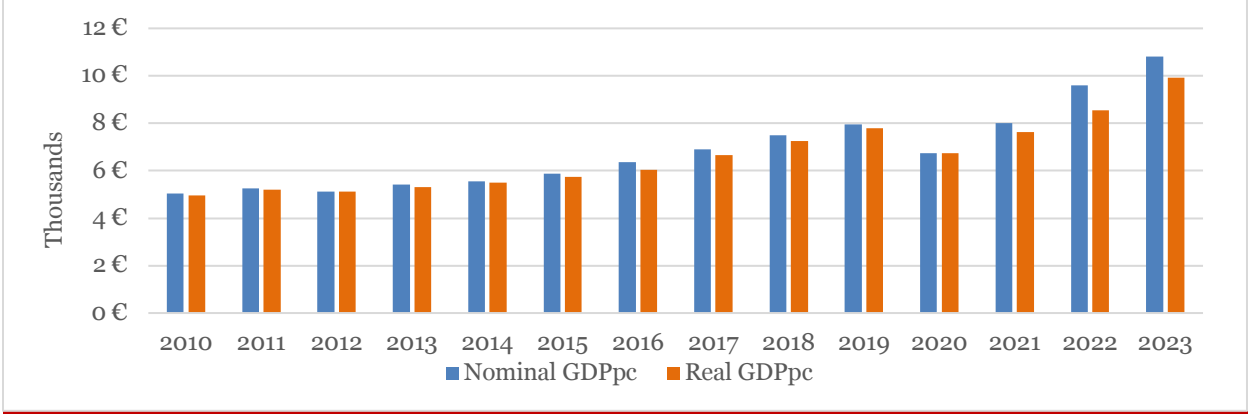
The following are descriptions of the data required for estimating the presented indicators and affordability elasticity.

Gross domestic product per capita

Over the past 14 years, Montenegro has undergone significant changes in economic conditions, reflected in the trends of nominal and real gross domestic product (GDP) per capita. These indicators demonstrate significant upward trends in two distinct phases (from 2012 to 2019 and from 2020 to 2023), with a particularly pronounced increase in the final two years of the latter observed period. The greatest disparity between real and nominal values is also noticeable in 2022 and 2023 due to a high level of inflation (Figure 1, Panel a).

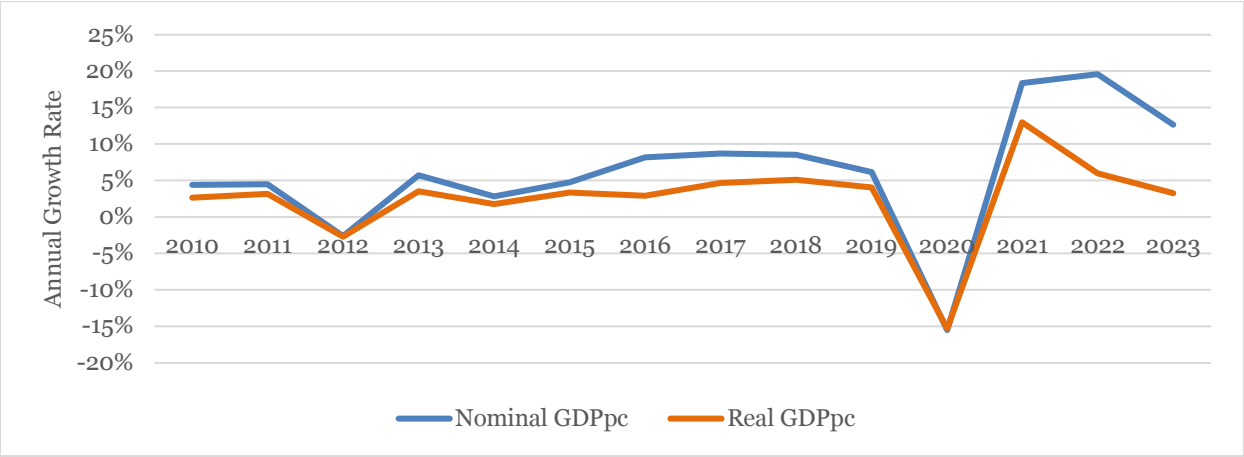
Figure 1. Nominal and real GDP per capita (GDPpc) (Panel a) and growth rates (Panel b) from 2010 to 2023

Panel a.



Panel b.

[5] The literature presents mixed criteria regarding which percentile should be used for each income group, for example, the 20th, 25th, or 30th percentile (Delgado et al., 2022; Iglesias et al., 2015). Given this variability, we explored how varying percentile thresholds impact our findings and obtained similar results.



Source: Monstat

Note: Real GDP per capita is calculated by the authors based on available data on GDP at constant prices (prices from the previous year as a base) and population. More details are given in Table A1 in the Appendix.

Figure 1 shows that the most notable period of economic volatility, characterized by mixed positive and negative growth rates, occurred between 2010 and 2012, potentially influenced by structural adjustments. Additionally, the global COVID-19 pandemic in 2020 led to a significant downturn in GDP per capita growth rate (-15.21 percent).[6] However, Montenegro exhibited economic resilience, experiencing a noteworthy rebound in 2021 and 2022, with growth rates of 13 percent and 6 percent, respectively.

When compared with the EU average, Montenegro's economic performance has shown a relative improvement over the observed period. According to the World Bank's data, the percentage share of Montenegro's GDP per capita in current international dollars (PPP) relative to the EU's average has exhibited a consistent upward trajectory, rising from 41.5 percent in 2010 to 49.5 percent in 2022

[6] A considerable decline in economic activity, coupled with reduced budgetary revenues and increased needs for providing assistance to the economy and citizens to mitigate the negative consequences of the pandemic, resulted in a budget deficit of more than 10 percent and a public debt exceeding 100 percent of GDP at the end of 2020. (https://wapi.gov.me/download-preview/02f8c410-f87b-4004-96fa-a8eb7eb20b32?version=1.0)

(Table A2 in the Appendix). Despite recent robust growth rates, there is still room for improvement to achieve economic convergence with higher-income countries, as Montenegro's GDP per capita levels notably lag behind those of EU members.

Disposable income

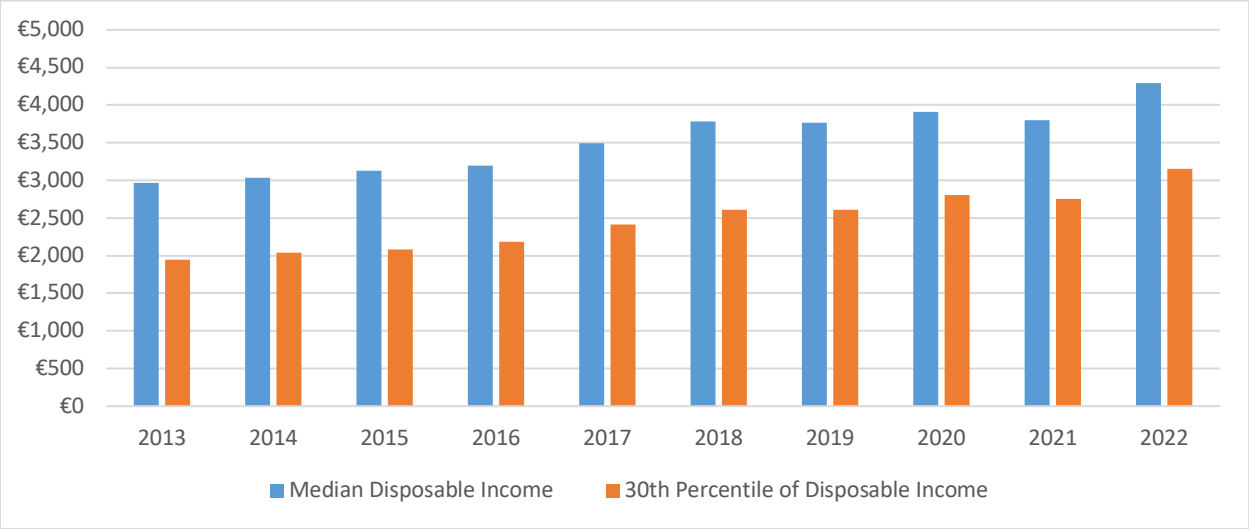
As GDP per capita may not accurately reflect the real-life financial situation of the majority of the population, we opt also for a more narrow and precise income measure—equalized disposable income.[7] Unlike GDP per capita, equalized disposable income accounts for income distribution and purchasing power after taxes and benefits, providing a more accurate representation of the typical individual's economic well-being across different income groups.

Figure 2 illustrates the distribution of median and 30th percentile disposable income from 2013 to 2022. An overall upward trend is evident, with some variations in certain years. Notably, contrary to GDP trends in 2020, both disposable income groups experienced a slight increase compared to the previous year. This upswing is potentially attributable to the higher level of social benefits provided by the Government of Montenegro as part of its comprehensive measures to alleviate the adverse impacts of the health and economic crisis brought about by the COVID-19 pandemic.[8]

[7] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Equivalised_disposable_income

[8] Growth of subsidies and social benefits—that is, sets of measures to contain the crisis—slightly increased budget spending in 2020 by 1.9 percent. https://cbcg.me/slike_i_fajlovi/eng/fajlovi/fajlovi_publikacije/radne_studije/analysis_covid_pandemic_impact_banking_system_mne-eng.pdf

Figure 2. Distribution of equalized disposable income



Source: Eurostat – Survey on Income and Living Conditions (SILC)

Note: Data are available only on an annual basis. Values are expressed in nominal terms, while real values are given in Table A3 in the Appendix.

During the period of observation, there was a noticeable disparity between the GDP per capita and median disposable income levels. Although both indicators had similar trends (except in 2020) the GDP per capita was roughly double the size of the median disposable income. This observation underscores a significant divergence between the economic situation of individuals and the overall economic growth of the country.

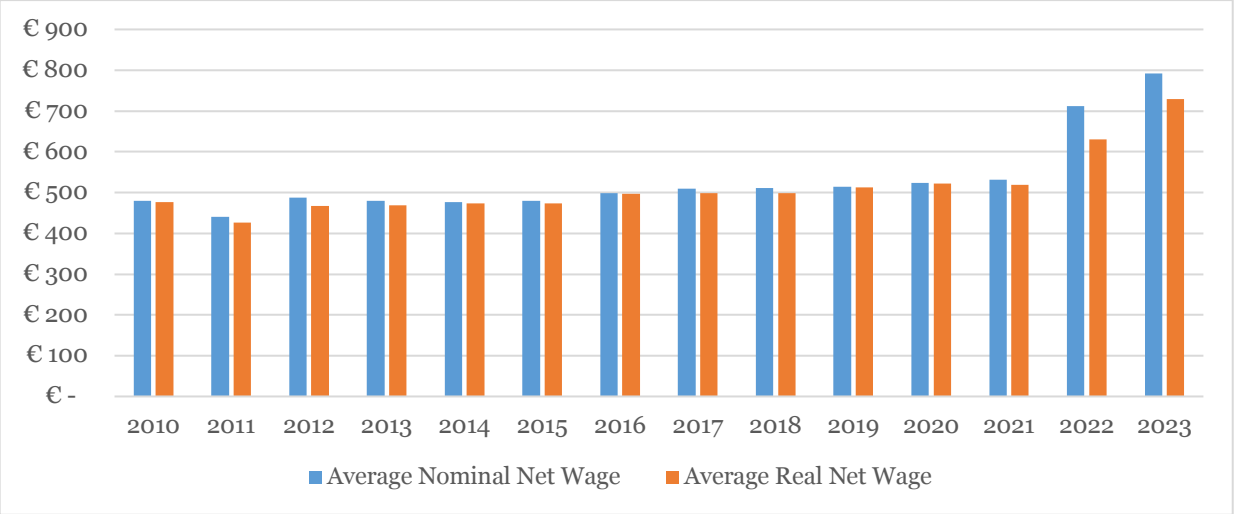
Wages

To calculate MoL, we utilized data on wages obtained from the Statistical Office of Montenegro-Monstat. The average monthly net wages[9] in nominal and real terms have demonstrated a steady increase from €479 in 2010 to €532 in 2021 (Figure 3). As previously noted, the fiscal reforms enacted by the Government of Montenegro in 2022 led to a minimum net monthly wage increase from €250 to €450, alongside an average wage increase to €712, further rising to €792 in

[9] Net wages reflect income after deductions such as taxes and social contributions.

2023. Despite the high inflation in the last two years, these reform measures also have had a positive impact on real wage growth (more details in Table A4 in the Appendix).

Figure 3. Average monthly nominal and real net wage



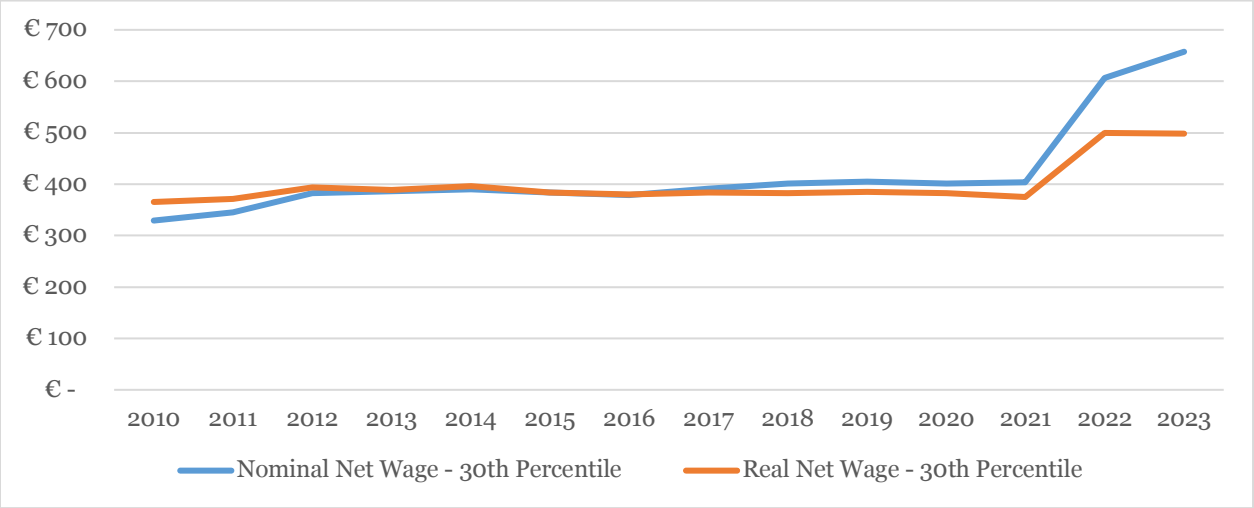
Source: Monstat

Note: More details are given in Table A4 in the Appendix.

Given the absence of data on wage decomposition by percentiles from Monstat, we opted to approximate the average monthly wage for employees with the lowest salaries. This involved utilizing statistics on the number of employees and average wages per occupation.[10] Figure 4 illustrates the average wage for the first 30th percentile cohort of employees, ranked from the lowest to the highest wage per occupation annually from 2010 to 2023. The graph reveals a pattern of stagnation or slow growth in wages until 2021, followed by a significant increase of 50 percent (nominal wage) in 2022 compared to the previous year.

[10] Occupations that fell within this group in 2023 are manufacturing, water supply, sewerage, waste management and remediation activities, wholesale and retail trade, repair of motor vehicles and motor recycles, administrative and support service activities.

Figure 4. Average monthly net wage in the 30th percentile of employees



Source: Authors' calculations based on data on average monthly net wages, number of employees by occupation, and CPI obtained from Monstat.

For the calculation of the wage per hour (or day) to define MoL, we used the official number of working days (or hours) in each month/year of the observed period. Data on wages are available on a monthly, quarterly, and annual basis.

Price

To analyze the trend in affordability and elasticity, we utilize pricing data obtained from the Directorate for Issuing Permits for the Production, Processing, and Trade of Tobacco Products (Tobacco Agency), specifically focusing on the retail price per pack of manufactured cigarette brands in Montenegro spanning from 2010 to 2023. All brands considered in the study were imported and sold in packs containing 20 cigarettes, which is the standard size in Montenegro. The provided data set comprises details on prices and cigarette sales by brand, reported monthly in kilograms and tons. The count of different brands (totaling 290 in our sample) in the Montenegrin cigarette market has exhibited a declining pattern ranging from 143 in 2010 to 102 in 2023.[11] The price of the most-sold

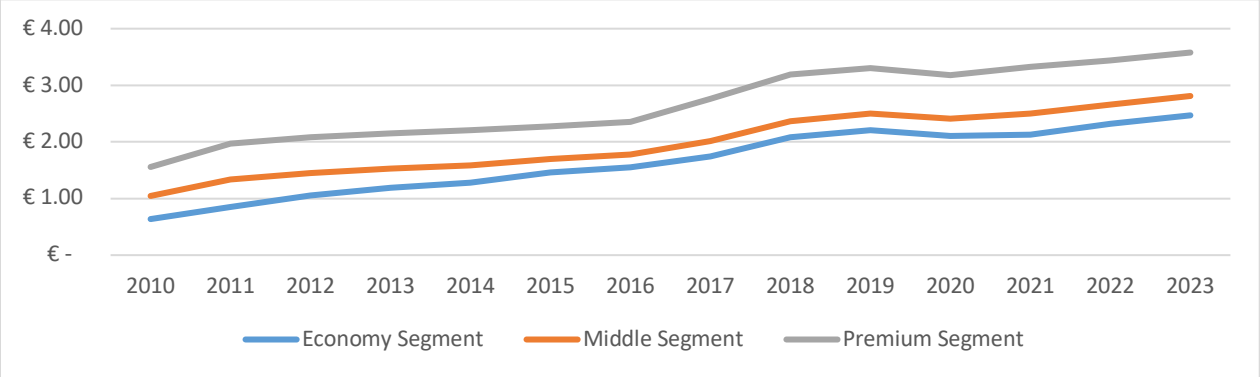
[11] Brands that have negligible market share (less than 1 percent) will be excluded from analysis.

brands during the observation period ranged €0.7–2.9, while in the case of the premium and the cheapest brands the ranges were €0.4–2.5 and €1.7–3.7,[12] respectively (Table A5 in the Appendix). Changes in prices by year/month mostly coincide with the changes in the excise calendar.

Market segmentation is conducted using a described database, following the methodology outlined in Mugoša et al. (2023).[13] From Figure 5, it is evident that the prices among market segments followed a similar trend throughout the observed period. There were two periods of significant price increases: from 2010 to 2013 and from 2017 to 2019, corresponding to substantial increases in specific taxes (more details related to the excise calendar from 2010 to 2023 are given in Table A6 in the Appendix).

Figure 5. Average price by segments (Panel a) and whole market (Panel b)

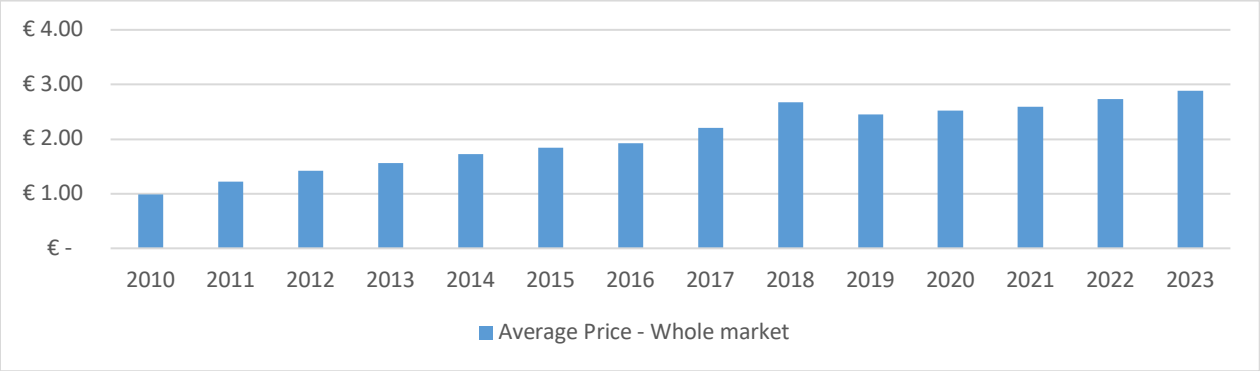
Panel a.



[12] For the price of a premium brand, Marlboro is used, according to WHO.

[13] In the absence of official tobacco market segmentation, segments (premium, middle-price, and economy) are established using industry reports and information from importers, along with publicly available data from retailer websites (Philip Morris International, 2023; Japan Tobacco International, 2023). This methodology aligns with previous studies, such as Tauras et al. (2006), where market segmentation data were unavailable. The middle-price segment is identified as brands priced within +/-25 cents of the most-sold brand, serving as a reference point for segment delineation. Brands not categorized using mention reports and other information are assigned to segments based on their average annual price relative to the defined middle-price segment (Tauras et al., 2006).

Panel b.



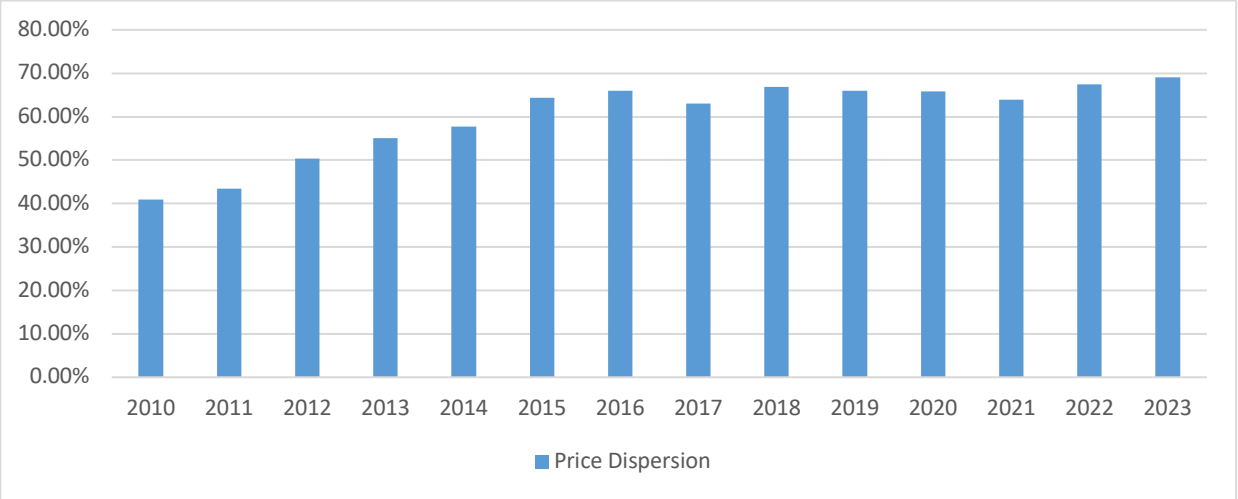
Source: Tobacco Agency

Note: Values are given in nominal terms.

In the measurement of affordability, another important metric to consider is price dispersion, which evaluates the proportion of the cheapest cigarette price in premium brands. In Figure 6, it is apparent that price dispersion14—calculated using the average price for the economy and premium market segments—increased until 2015, after which it remained relatively stable with minor fluctuations. As a higher percentage indicates that low-cost cigarettes are less affordable than premium ones, we can infer there has been little or almost no change in this aspect of cigarette affordability over the last eight years.

14 The price dispersion indicator is also available from the WHO-GHO database, with the difference that single prices for the cheapest and premium brands were utilized for indicator calculation.

Figure 6. Price dispersion



Source: Tobacco Agency

When it comes to the relationship between the economy and the middle segment, there is generally a slight difference in average cigarette prices between them. In 2023, for instance, the average prices for these two tiers were €2.5 and €2.8, respectively.

Data for affordability elasticity estimation

To estimate the affordability elasticity of cigarette demand using individual micro-level data, we will utilize the Household Budget Survey spanning from 2005 to 2015, 2017, and 2021. The survey is conducted annually by Monstat across 21 municipalities in three regions and encompasses a total sample of 16,323 households. The HBS offers insights into total cigarette consumption (legal and illegal) and expenditure per household alongside data on household income, size, structure, and sociodemographic characteristics. However, it does not include data on cigarette retail prices. This data set enables us to investigate whether the impact of cigarette affordability on individual consumption varies among population subgroups defined by demographics and income status.

When analyzing affordability elasticity with HBS data, the affordability indicator will be formulated by considering unit values as a proxy for prices (computed as the ratio of cigarette expenditure to purchased quantity) alongside household income. We will utilize annual household income as a proxy for income. This approach offers distinct advantages over using aggregate GDP per capita as an income measure. First, household income better reflects household purchasing power, capturing informal transactions and the influence of income distribution on individual affordability. Moreover, this income specifically encompasses private earnings while excluding foreign nationals and public revenues. However, a drawback of relying on household income to measure affordability is the potential for underreporting bias within the reported income data (Nargis et al., 2018).

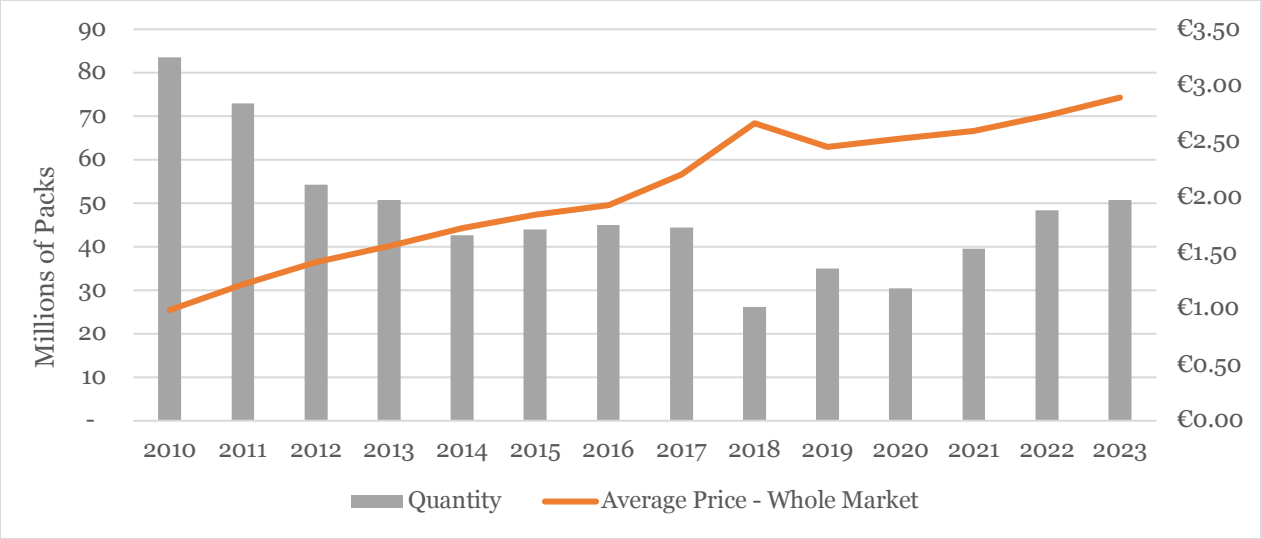
Table A7 in the Appendix presents an overview of the trends in unit values and household income by year. Throughout this period, there is a notable upward trajectory in the annual average unit values, rising from €0.83 in 2005 to €1.77 in 2021.

We will be using various sociodemographic variables as control variables, such as household size (number of members in the household), male ratio (percentage of males in the household), adult ratio (percentage of adults older than 15 in the household), maximum education (maximum years of education of a member in the household), average age of household members, age and gender of household head, and the household's activity classification (unemployed, pensioners, or employed).[15] Descriptive statistics of sociodemographic variables are provided in Table A8 in the Appendix.

[15] To account for the impact of the tobacco control environment during the observed period, we opted also to use variables related to regulatory changes, but they did not have a significant effect.

To check the robustness of the affordability elasticity results, we utilize aggregate data on cigarette consumption per brand sourced from the Tobacco Agency. Figure 7 presents cigarette consumption in Montenegro, indicating the quantity of cigarette packs sold annually from 2010 to 2023, alongside the average nominal price of cigarettes. A period of declining consumption from 2010 to 2018 corresponds with price increases and declining affordability, while consumption notably increased from 2020 despite price hikes. Besides the effect of reducing the illicit market share (Tobacconomics, 2023), high income growth during this period resulted in increased affordability and, subsequently higher tobacco use.

Figure 7. Quantity of cigarettes sold and average annual price



Source: Tobacco Agency

To estimate affordability elasticity, we used monthly data from January 2010 until December 2023 and adopted monthly net average wages as a proxy for income and monthly weighted average cigarette retail prices (using the quantity of packs sold as a weight). The affordability indicator is defined as a percentage of the average net wage needed to purchase 100 packs of cigarettes. We use cigarette consumption per person aged 15 years and older as a dependent variable. Moreover, our analysis incorporates certain macro variables as control variables, such as the unemployment rate and regulatory changes

(binary variable indicating the introduction of the new Law on Limiting the Use of Tobacco in 2019).

Methodology

In the first part of research, we conducted a comprehensive descriptive analysis of various affordability measures. In addition, we employed the fixed effects (FE) regression model for unbalanced panel data with clustered standard errors and time effects, to assess the statistical significance of changes in affordability trends. Using aggregate data provided by the Tobacco Agency, annual affordability fluctuations are assessed, both throughout the entire market and within each market segment. We utilized methodologies like those employed by Gordon et al. (2020) and Goodchild et al. (2020). This analysis enables us to identify any variations and trends within specific sequences of the observed period, which facilitate a better understanding of the market dynamics.

Due to data limitations, conducting this analysis presents two main challenges. First, we cannot perform a multivariate regression analysis to separate affordability trends from the impact of smokers' sociodemographic characteristics, which can potentially affect the distribution of affordability measures (Nargis et al., 2019).16 To deal with this limitation, we will estimate affordability trends and changes using OLS regression with clustering at the municipal level on Household Budget Survey (HBS) data, incorporating various sociodemographic variables. The affordability indicator will be defined as the percentage of household income required to purchase 100 packs of cigarettes. This will be calculated using unit values as a proxy for prices, defined as the ratio of tobacco expenditure to the number of cigarettes consumed by each household.

[16] This potentially could be done using HBS data, but this database does not cover the most recent period of wage and income changes.

Second, we cannot establish a precise affordability indicator per market segment due to the absence of income data in the Tobacco Agency's database. While premium cigarette smokers are expected to generally have higher income than those who use middle and economy segments, there is no empirical data to support this claim. Therefore, we have to use the same denominator (GDP per capita, average wage, or disposable income) across all three market segments, similar to Gordon et al. (2020) and Goodchild et al. (2020). As a result, we avoid making conclusive statements about the affordability ranking across various market segments. Additionally, using a similar approach to the *WHO Report on the Global Tobacco Epidemic* (2023), we estimated the overall annual growth rate of affordability for cigarettes with WAP by fitting a FE regression trend line to the logarithmic values of the affordability indicator for the period 2010–2023.

In this part of the research, we also assess how tobacco industry pricing strategies influence cigarette affordability. Specifically, we will present information on the difference between an affordability indicator calculated based on actual retail price and a potential indicator calculated under the assumption of full tax pass-through to cigarette prices. The expected cigarette price under the assumption of full tax pass-through is estimated following the methodology outlined in Mugoša et al. (2023).

In the second part, we will rely on data from the HBS database when estimating affordability elasticity. We employed a two-part model to estimate the overall affordability elasticity of cigarette consumption. This model is widely used in both theoretical and applied research in health economics, particularly for mixed discrete–continuous outcomes (Belotti et al., 2015). Also, the model is applied in estimation of tobacco price and income elasticity (Cizmovic et al., 2022; Gligorić et al., 2022). Analysis will be conducted at the cluster level defined as municipality multiplied by year to address potential concerns regarding endogeneity of unit values. In addition to the previously mentioned affordability measure, we will integrate sociodemographic characteristics and regulatory

variables into the model specification. Estimation of affordability elasticity will be done for the whole sample, as well as by income groups.

The two-part model facilitates separate examination of smoking participation and intensity, crucial for crafting effective tobacco taxation policies. In the initial stage, a logit model will be utilized to evaluate the likelihood of smoking participation. Following this, the subsequent stage often involves employing generalized linear models (GLM) to estimate smoking intensity.

In the first stage of the two-part model, a binary variable is generated to estimate the probability of smoking participation. This variable is assigned a value of 0 if there is no reported cigarette consumption in the household and 1 otherwise. The logit model is defined as follows:

$$P(consumption = 1) = \mu(\alpha_0 + \alpha_1 affordability + \alpha_2 Z_i) \quad (1)$$

Smoking participation is influenced by the affordability indicator and a vector of sociodemographic characteristics and regulatory variables (*Zi*). Elasticity will be calculated using marginal effects.

To estimate conditional elasticity, we will employ the GLM methodology with a family gamma and a log link function. This choice of link function transforms the probabilities of categorical response variable levels into a continuous numerical scale. The model will encompass the same independent variables as the logit model. During post-estimation analysis, we will conduct several diagnostic tests to validate the adequacy of our preferred specification for both parts of the model. Total elasticity will be defined as the sum of participation and conditional intensity affordability elasticity.

To ensure the robustness of our results and expand our analysis to include periods beyond the scope of HBS data, we will also estimate affordability

elasticity using aggregate data obtained from the Tobacco Agency. However, due to the absence of a precise affordability indicator per market segment or income category, we can only estimate the affordability elasticity specifications for the overall market.

The long-run and short-run affordability elasticity of cigarette demand using macro data is empirically examined using a conventional static demand model, applying error-correction and ARDL time series methodology. We assessed the time series properties of the data, existence of unit root (seasonal and at zero frequency using HEGY procedure described in the research conducted by Hylleberg et al. (1990), and cointegration using bound and Johansen tests. To check the validity of our models, we also employed post-estimation diagnostic tests to analyze the potential presence of heteroskedasticity (Breusch-Pagan/ Cook-Weisberg test), autocorrelation (Durbin's alternative and Breusch-Godfrey LM test), multicollinearity (mean variance inflation – mean VIF) and misspecification of functional form (Ramsey RESET test) and residual normality (Jarque-Bera and Skewness/Kurtosis tests). Stability of the model is checked using the CUSUM test. However, it is important to acknowledge the limitations of this approach, including the small number of observations and the potential issue of low variability of the affordability indicator, which could potentially affect the estimation process.

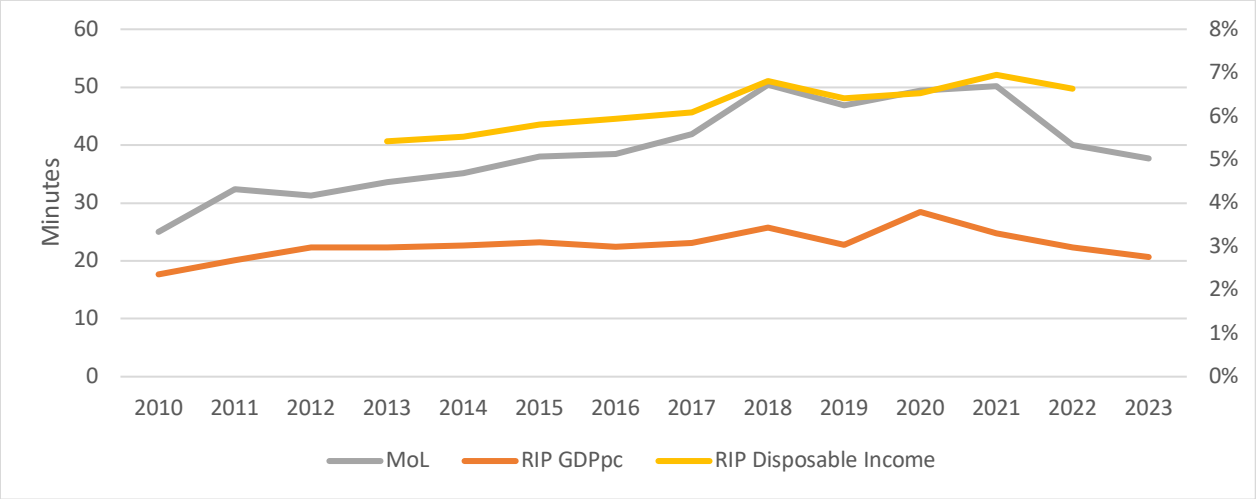
Results

Descriptive statistics

The assessment of cigarette affordability levels, trends, and the magnitude of change was conducted using two variants of indicator RIP (based on whether GDP per capita or disposable income was used as a proxy for income) and MoL. Despite gaps in data, all three indicators consistently show a similar trend, indicating that cigarette affordability has declined over the entire period from

2010 to 2023 (Figure 8 and Table A9 in the Appendix). This trend demonstrates that a greater proportion of income or labor is required to purchase cigarettes. For instance, in 2023, it took 37.41 minutes of the average net wage to purchase one pack of cigarettes at the weighted average price, compared to 25.01 minutes required in 2010. The difference in the level of RIP indicators is due to much lower disposable income per capita compared to GDP per capita.

Figure 8. Affordability indicators – RIP and MoL from 2010 to 2023



Source: Authors' calculations based on Ministry of Finance and Monstat data

Over the years, changes in cigarette affordability trends hinge on the relative changes in income and prices. To better understand changes in affordability over the years, Panel a of Figure 9 illustrates the annual growth rate of nominal WAPC in comparison to the annual growth rate of nominal GDP per capita. It is evident that there are three periods of significant decrease in cigarette affordability: 2010–2013, 2017–2018, and 2020. During the first two periods, the government substantially increased specific excise taxes (from €5 in 2010 to €17.5 per 1,000 cigarettes in 2013, and from €24 in 2017 to €40 per 1,000 cigarettes in 2018), leading to a considerable rate of price increases. This and relatively stable nominal GDP growth rates contributed to decreased affordability. In 2020, the main reason for decreased affordability was the significant economic downturn,

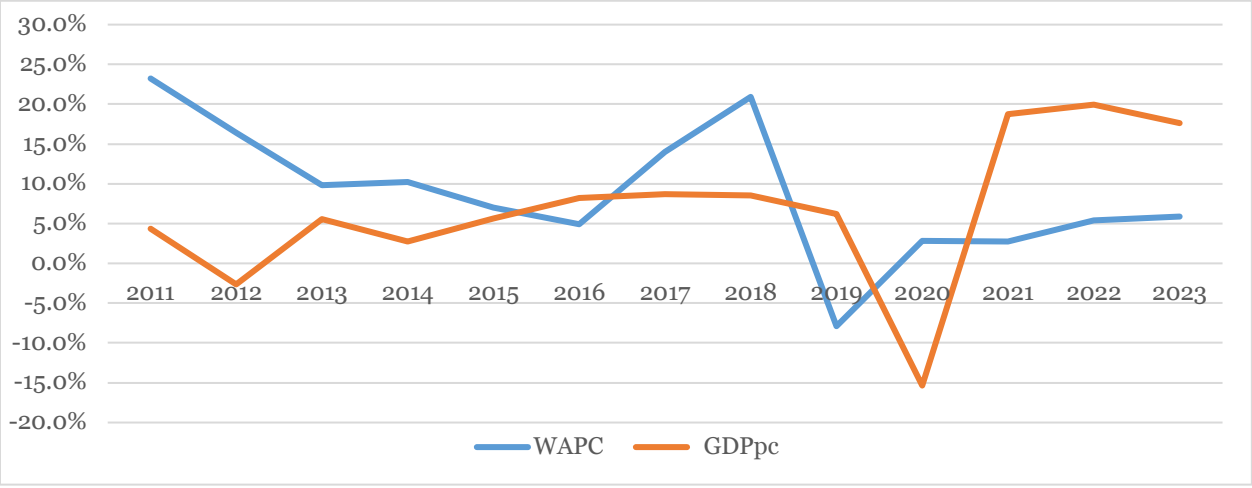
during which the annual growth rate of cigarette prices outpaced the GDP per capita growth.

There were two distinct periods during which affordability increased. The first occurred in 2019 when the government implemented a 25-percent reduction of specific excise tax due to market turbulence. The second period was observed during the final three years of the study period and was mostly attributable to the post-COVID economic rebound and an expansive fiscal policy aimed at significant wage increases.

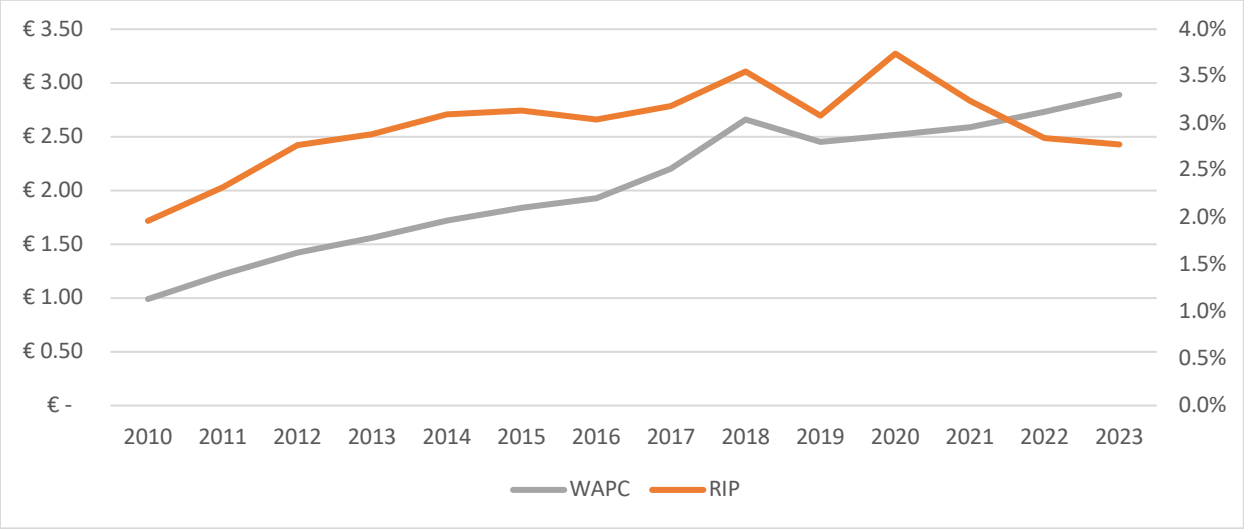
The trend of WAPC, along with the RIP indicator presented in Panel b of Figure 9, reveals that until 2019, the decrease in affordability coincided with a rise in prices due to relatively stable income growth. However, in 2020, changes in affordability were heavily influenced by income changes, leading to opposite movements in WAPC and RIP. Given the Government's intention to persist with an expansive fiscal policy in the coming years, there is growing concern regarding the potential for substantial increases in cigarette affordability.

Figure 9. Annual growth rate of nominal GDP per capita and cigarette prices (Panel a) and Level of WAPC and RIP 2010–2023 (Panel b)

Panel a.



Panel b.

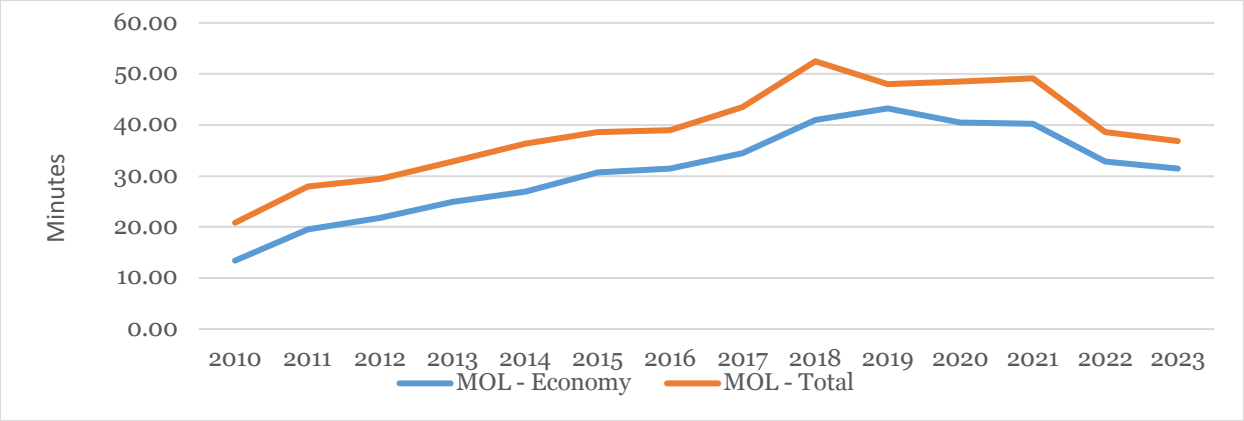


Source: Authors' calculations based on Monstat and Ministry of Finance data. More details in tables A10 and A11 in the Appendix.

To assess potential variations in affordability trends for low-income groups, we analyzed the MoL necessary to purchase cigarettes within the economy segment of the tobacco market. The data, shown in Figure 10, indicate a noteworthy decrease in the affordability of economy-segment cigarettes until 2019, followed by a subsequent increase. Even though prices remain low compared to the EU level (WHO, 2023), the period of decreased affordability can be primarily attributed to an increase in prices, as average net wages within this income group remained almost unchanged until the past three years.

As illustrated in Figure 10, the trends of MoL for the whole market and MoL for the economy segment are similar. Notably, small fluctuations arise due to disparities between the price gap (measured as a share of WAPC for the economy segment in WAPC for the total market) and the income gap (representing the share of the average net wage of the low-income group in the average net wage for the total population).

Figure 10. MoL for the economy segment of cigarettes



Source: Authors' calculations based on Monstat and Ministry of Finance data

To assess the statistical significance of the annual and fixed-base growth rates of the cigarette affordability indicator, we employed a FE regression model. While using a uniform income variable across all market segments (as in the *WHO Report on the Global Tobacco Epidemic* (2023) and Goodchild et al. (2020)) limits our ability to make definitive statements about affordability rankings among these segments, standardizing the numerator (retail prices) allows us to analyze pricing differences across them effectively.

Table 3 presents a contrast of marginal prediction of regression results to estimate the level and statistical significance of the RIP change in each year compared with the previous one. Additionally, the last row presents the affordability change in 2023 compared to 2010. It is evident that affordability indicators exhibit fluctuating and statistically significant annual changes in almost each year and across all market segments. The most noticeable periods of negative annual RIP rate changes are in 2019 and the last three years of the observed period, with annual increases in affordability for the whole sample of 13 percent, 14 percent, and 7 percent in 2021, 2022, and 2023, respectively. When taking 2010 as the base year, it can be concluded that cigarette affordability decreased in the whole market by 2023. Similar results for the MoL indicator are given in tables A12–A13 in the Appendix.

Table 3. Annual and fixed-base growth rate of affordability indicator

	Whole sample		Economy		Middle		Premium	
Year	Coef.	Se	Coef.	Se	Coef.	Se	Coef.	Se
Affordability annual growth								
(2011 vs. 2010)	0.15***	0.01	0.25***	0.024	0.17***	0.01	0.11***	0.02
(2012 vs. 2011)	0.11***	0.01	0.15***	0.02	0.09***	0.01	0.08***	0.01
(2013 vs. 2012)	0.00	0.00	0.08***	0.018	0.01	0.01	-0.02***	0.01
(2014 vs. 2013)	0.03***	0.01	0.05***	0.014	0.02***	0.01	0.01	0.01
(2015 vs. 2014)	0.01*	0.01	0.04***	0.017	-0.00	0.01	-0.00	0.0
(2016 vs. 2015)	-0.04***	0.00	0.01	0.012	-0.03***	0.00	-0.04***	0.00
(2017 vs. 2016)	0.02***	0.01	0.03*	0.017	0.04***	0.00	0.02***	0.00
(2018 vs. 2017)	0.11***	0.01	0.08***	0.024	0.14***	0.01	0.10***	0.01
(2019 vs. 2018)	-0.13***	0.01	-0.09***	0.016	-0.14***	0.01	-0.13***	0.00
(2020 vs. 2019)	0.18***	0.01	0.20***	0.005	0.20***	0.00	0.19***	0.00
(2021 vs. 2020)	-0.13***	0.01	-0.14***	0.008	-0.13***	0.01	-0.14***	0.00
(2022 vs. 2021)	-0.14***	0.00	-0.10***	0.013	-0.13***	0.00	-0.14***	0.00
(2023 vs. 2022)	-0.07***	0.00	-0.02	0.015	-0.06***	0.00	-0.09***	0.01
Affordability fixed base growth (2010=100)								
2023 vs. 2010	0.098***	0.02	0.54***	0.03	0.18***	0.02	0.03	0.05

Source: Authors' calculations

Note: Complete regression results are given in Table A14 in the Appendix.

The estimation of the overall affordability trend showed that the average annual growth of RIP in the period 2010–2023 is approximately one percent. This growth is higher for the economy segment (four percent) compared to the middle segment (two percent), while the estimates for the premium segment were not statistically significant. These percentages are lower compared to previous estimates (4.9 percent for Southeast European countries in the period 2008–2018 (Đukić et al., 2021) due to the broader observed period, which includes recent years when affordability significantly increased.

Another significant factor affecting cigarette affordability is the tobacco industry's pricing strategies. To evaluate whether these strategies have contributed to increased affordability, we additionally estimated annual changes in affordability based on the expected market price under full pass-through conditions (Mugoša et al., 2023). The Hausman test (chi2(13) = 347.45, Prob>chi2 = 0.0000) revealed that the difference between these expected changes and those observed with actual retail prices per brand is statistically significant, indicating that the tobacco industry has played a role in increasing the affordability of cigarettes in Montenegro (Table 4.)

Table 4. Hausman test – RIP using retail and expected (full pass-through) prices

Year	RIP retail price	RIP expected price	Difference	Se
2011	0.15	0.19	-0.04	0.01
2012	0.26	0.35	-0.09	0.01
2013	0.26	0.36	-0.10	0.01
2014	0.29	0.36	-0.08	0.01
2015	0.30	0.36	-0.06	0.01
2016	0.26	0.29	-0.04	0.01

2017	0.27	0.31	-0.03	0.01
2018	0.38	0.42	-0.04	0.01
2019	0.26	0.27	-0.01	0.01
2020	0.44	0.45	-0.01	0.01
2021	0.31	0.34	-0.03	0.01
2022	0.17	0.22	-0.05	0.01
2023	0.10	0.16	-0.06	0.01

Source: Authors' calculations based on Ministry of Finance data

To validate the results of RIP changes, we applied multivariate regression on HBS data, incorporating sociodemographic factors potentially affecting affordability indicators. Although the HBS data set does not cover the same period as the aggregate data and lacks information on retail prices, it provides valuable insights into changes in affordability across different income groups and the impact of various sociodemographic variables. This analysis defines RIP metrics using unit values as a proxy for prices.

Considering sociodemographic variables, the findings in Table 5 reveal that households without employed members or with pensioners experience lower affordability. Regionally, cigarettes are more affordable in the South than in the Center, while households in the North require a higher percentage of their income to buy 100 packs of cigarettes. Additionally, a higher mean age of household members slightly decreases affordability, whereas having a male household head increases it. Accounting for time effects, the estimation reveals patterns consistent with those observed in the aggregate data. Using 2010 as the base year for easier comparison, it is evident that cigarette affordability declined in 2010 compared to previous years (2005–2009) and continued this trend in the subsequent years.

When it comes to income groups, throughout the observed period, cigarette affordability was higher for wealthier compared to low-income households.

Specifically, middle-income and high-income households spent, respectively, 0.72 and 1.21 percentage points less of their income to buy 100 packs of cigarettes compared to those in the low-income group. This finding of lower cigarette affordability for the poorest households is consistent with various previous studies (Blecher & van Walbeek, 2009; He et al., 2018b; John et al., 2009; Rodríguez-Iglesias et al., 2015, U.S. NCI & WHO, 2016) and is expected in Montenegro due to the lower income and living standards of this population segment.

Table 5. Factors affecting RIP – HBS data

	Model 1		Model 2	
VARIABLES	Coef.	Se	Coef.	Se
Education: Primary				
Secondary	-0.43*	(0.24)	-0.43*	(0.24)
Faculty	-0.27	(0.28)	-0.26	(0.29)
Graduate	-0.01	(0.28)	0.00	(0.28)
Adult ratio			0.14	(0.25)
Region: Center				
South	-1.75***	(0.50)	-1.74***	(0.50)
North	1.33***	(0.45)	1.33***	(0.45)
HH activity: Unemployed				
Pensioners	-0.48*	(0.26)	-0.45*	(0.26)
Employed	-0.69***	(0.21)	-0.67***	(0.21)
Mean age of HH members	0.01**	(0.00)	0.01**	(0.01)
HH head gender	-0.15*	(0.08)	-0.16*	(0.08)
HH head age			-0.01	(0.00)
Year: 2010=100				
2005	0.27	(1.10)	0.27	(1.10)

2006	-1.05	(0.65)	-1.05	(0.65)
2007	-1.35***	(0.51)	-1.35***	(0.51)
2008	-2.30***	(0.70)	-2.30***	(0.70)
2009	-0.98*	(0.54)	-0.99*	(0.54)
2011	2.31***	(0.49)	2.31***	(0.49)
2012	4.23***	(0.87)	4.22***	(0.87)
2013	5.14***	(0.98)	5.14***	(0.97)
2014	4.96***	(0.59)	4.95***	(0.59)
2015	4.66***	(0.80)	4.66***	(0.80)
2017	3.20***	(0.56)	3.20***	(0.56)
2021	5.85***	(0.94)	5.86***	(0.94)
Income groups: Low				
Middle	-0.71***	(0.13)	-0.72***	(0.13)
High	-1.17***	(0.20)	-1.21***	(0.20)
Constant	12.21***	(0.56)	12.33***	(0.58)
Observations	6,710		6,710	

Source: Authors' calculations

Note: Model 2 is chosen due to slightly higher log-likelihood (-16,295 compared to -16,297) and pseudo R-squared (0.53 compared to 0.51).

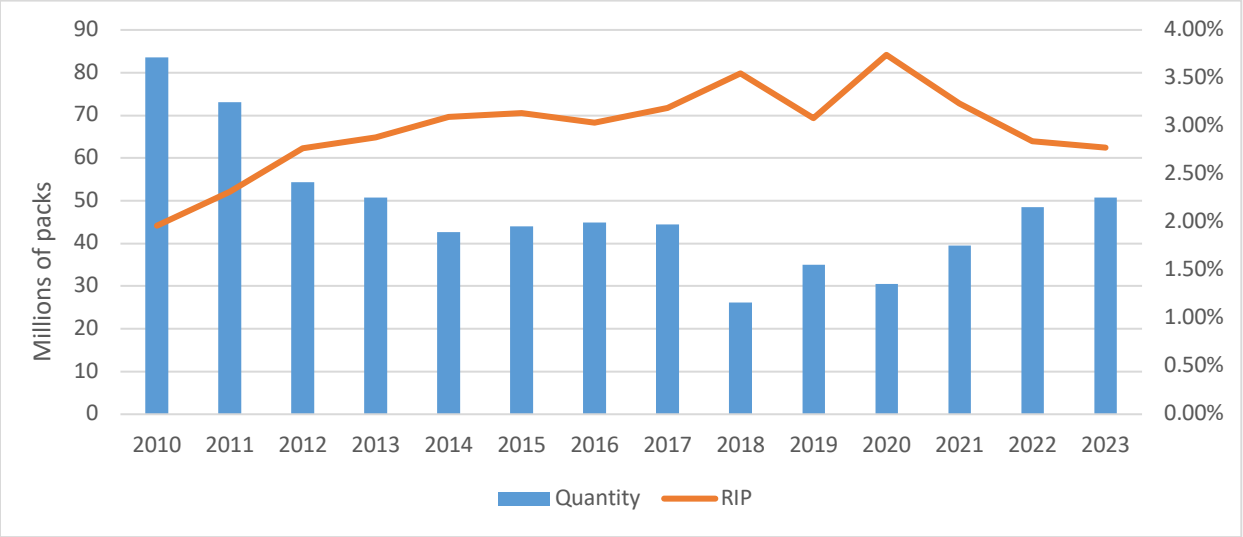
Impact of affordability on cigarette consumption per capita

In the context of robust income growth, as evidenced in recent years in Montenegro, the effectiveness of tobacco tax policy depends on the affordability of cigarettes and the potential impact of any affordability changes on consumption patterns. Figure 11 illustrates the strong correlation between legal sales—serving as a proxy for cigarette consumption—and the RIP indicator over the period 2010–2023. A period of declining consumption from 2010 to 2018 corresponds with price increases and declining affordability, while consumption notably increased from 2020 despite price hikes. Besides the effect of reducing

the illicit market share (Tobacconomics, 2023), high income growth during this period resulted in increased affordability and, subsequently, higher tobacco use.

This highlights the crucial role of estimating affordability elasticity as a fundamental input factor when formulating effective tobacco control policies.

Figure 11. Quantity of cigarettes sold and affordability



Source: Authors' calculations based on data from the Ministry of Finance

To assess affordability elasticity for the whole adult population and by income groups we applied a two-part model on micro HBS data from 2005–2015, 2017, and 2021. In the first part, to estimate the elasticity on the extensive margin, we test several models using logistic regression (given in Table A15 in the Appendix) and select the preferred one based on the Bayesian information criterion (BIC), pseudo-R-square, and log-likelihood criteria. All post-estimation diagnostic tests confirm the validity of the chosen model (tables A16–A21 in the Appendix). Results of the chosen model in Table 6 illustrate that prevalence affordability elasticity is approximately -0.3, with very small, statistically insignificant variations between income groups. More precisely, if affordability decreases by 10 percent, prevalence should reduce by three percent.

When considering sociodemographic characteristics across the whole sample, it is evident that the probability of cigarette consumption increases with larger household sizes, as well as with a higher number of men, adults, and employed members per household. Households where the most educated member has lower educational attainment are more likely to smoke compared to those with higher education levels. Additionally, there is a lower probability of cigarette consumption in the North and South regions compared to the Center region (Table 6). When income groups are considered, the magnitude and sign of coefficients are similar, with some differences in statistical significance for certain variables.

Table 6. Prevalence elasticity by income groups

	Whole sample		**Low-income group**		**Middle-income group**		**High-income group**	
VARIABLES	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**
Affordability	-3.42***	(1.02)	-2.20***	(0.29)	-4.02***	(0.92)	-3.78***	(1.31)
Household size	0.08***	(0.02)	0.02	(0.03)	0.01	(0.04)	0.03	(0.04)
Male ratio <0.25								
0.25–0.50	0.26***	(0.06)	0.04	(0.09)	0.15	(0.11)	0.43***	(0.10)
0.5–0.75	0.33***	(0.07)	0.20**	(0.01)	0.20	(0.13)	0.44***	(0.11)
>0.75	0.53***	(0.09)	0.22	(0.19)	0.82***	(0.17)	0.63***	(0.14)
Adult ratio	0.45***	(0.13)	0.46**	(0.20)	0.29	(0.23)	0.61*	(0.35)
Maximum education: Graduate								
Primary	0.30***	(0.09)	0.42***	(0.28)	0.14	(0.17)	0.62***	(0.16)
Secondary	0.35***	(0.07)	0.57***	(0.14)	0.30**	(0.26)	0.21**	(0.11)
Faculty	0.17***	(0.06)	0.38***	(0.13)	0.03	(0.77)	0.15*	(0.09)
Region: Center								
South	-0.38***	(0.15)	-0.01	(0.22)	-0.35**	(0.16)	-0.27*	(0.15)
North	-0.28***	(0.10)	-0.37***	(0.11)	-0.33***	(0.12)	-0.20*	(0.11)
HH activity: Unemployed								

Pensioners	0.05	(0.08)	0.12	(0.10)	-0.33*	(0.18)	-0.12	(0.16)
Employed	0.24***	(0.08)	0.00	(0.10)	-0.23	(0.18)	0.29**	(0.14)
Mean age of HH members:<25								
25–44	0.12*	(0.06)	-0.01	(0.08)	0.29**	(0.13)	0.11	(0.16)
44–65	0.10	(0.08)	-0.19	(0.13)	0.43***	(0.15)	0.05	(0.17)
>65	-0.44***	(0.10)	-0.64***	(0.18)	-0.13	(0.18)	-0.40**	(0.18)
HH head gender	0.12**	(0.06)	0.13*	(0.07)	0.10	(0.09)	0.04	(0.09)
Constant	-2.10***	(0.28)	-1.37***	(0.37)	-1.07**	(0.45)	-2.00***	(0.49)
Observations	16,169		5,316		5,231		5,358	
Prevalence elasticity	**-0.29*** **	**(0.08)**	**-0.31*** **	**(0.04)**	**-0.37*** **	**(0.09)**	**-0.29*** **	**(0.10)**

Source: Authors' calculations; ***p<0.01, **p<0.05, *p<0.1.

Note: Equality test – Tests showed the absence of statistically significant differences between affordability elasticity among all income groups: low-income and middle-income groups (x2(1)=0.71, prob>x2=0.399); low-income and high-income groups (cx2(1)=1.16, prob >x2=0.282); and middle-income and high-income groups (x2(1)=0.05, prob >x2=0.828).

To estimate conditional price elasticity, we use the GLM methodology with a gamma family and log link. The model selection, based on comparisons of BIC and log-likelihood criteria, provides strong support for the chosen model, and several diagnostic tests confirm the validity of specification (tables A22–A30 in the Appendix). The results of the GLM model presented in Table 7 indicate that the total conditional affordability elasticity is approximately 0.4, implying that a 10-percent decrease in affordability will lead to an approximately four-percent reduction in consumption. Even though there is no statistically significant difference between coefficients, the magnitude of elasticity estimates shows variation among income groups regarding the impact of affordability changes on cigarette consumption, with low- and middle-income groups more affected by changes in affordability compared to wealthier ones.

Considering the patterns observed in the sociodemographic variables, we can conclude that, among all income groups, larger households with more men and

adults exhibit higher cigarette consumption, while consumption decreases in households with more unemployed members. Additionally, cigarette consumption is lower in the South and North regions compared to the Center region (Table 7).

Table 7. Conditional elasticity by income groups

	Whole sample		Low-income group		Middle-income group		High-income group	
VARIABLES	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**
Affordability	-3.07***	(0.44)	-3.08***	(0.49)	-2.99***	(0.52)	-2.77***	(0.65)
Household size	0.05***	(0.01)	0.06***	(0.01)	0.06***	(0.02)	0.06***	(0.02)
Male ratio <0.25								
0.25–0.50	0.11***	(0.03)	0.09*	(0.05)	0.05	(0.05)	0.19***	(0.05)
0.5–0.75	0.15***	(0.03)	0.12**	(0.05)	0.11	(0.07)	0.26***	(0.06)
>0.75	0.21***	(0.04)	0.11	(0.07)	0.15**	(0.07)	0.33***	(0.06)
Adult ratio	0.20***	(0.07)	0.15	(0.11)	0.27**	(0.11)	0.10	(0.15)
Maximum education: Graduate								
Primary	-0.01	(0.03)	0.11	(0.07)	-0.43	(0.07)	-0.00	(0.06)
Secondary	0.00	(0.03)	0.14*	(0.07)	0.05	(0.06)	-0.08	(0.05)
Faculty	0.00	(0.03)	0.14**	(0.07)	0.00	(0.04)	0.04	(0.04)
Region: Center								
South	-0.26***	(0.07)	-0.21**	(0.10)	-0.35***	(0.07)	-0.24***	(0.07)
North	-0.04	(0.04)	-0.05	(0.04)	-0.03	(0.05)	-0.03	(0.05)
HH activity: Unemployed								
Pensioners	0.06*	(0.03)	0.12**	(0.05)	0.01	(0.07)	-0.05	(0.07)
Employed	0.11***	(0.03)	0.11**	(0.04)	0.10	(0.07)	0.01	(0.06)
Mean age of HH members:<25								
25–44	0.00	(0.03)	-0.04	(0.05)	0.01	(0.06)	0.13	(0.08)
44–65	0.13***	(0.03)	0.13**	(0.06)	0.09	(0.06)	0.26***	(0.09)
>65	0.06	(0.04)	-0.00	(0.07)	0.06	(0.08)	0.18*	(0.09)
HH head gender	0.04*	(0.02)	0.00	(0.04)	0.13***	(0.04)	-0.02	(0.04)

Constant	3.000***	(0.13)	3.28***	(0.17)	2.74***	(0.25)	2.90***	(0.23)
Observations	6,710		2,313		2,233		2,164	
Conditional elasticity	**-0.39*** **	**(0.06)**	**-0.41*** **	**(0.07)**	**-0.38*** **	**(0.06)**	**-0.33*** **	**(0.08)**

Source: Authors' calculations; ***p<0.01, **p<0.05, *p<0.1.

Note: Equality test – Tests showed the absence of statistically significant difference between affordability elasticity among all income groups: low-income and middle-income groups (x2(1)=0.23, prob >x2=0.631); low-income and high-income groups (cx2(1)=1.19, prob >x2=0.274); and middle-income and high-income groups (x2(1)=0.36, prob >x2=0.547).

Taking into account the estimated participation and conditional elasticity, we calculated a total affordability elasticity of demand for all households at -0.68 (Table 8). Magnitude in coefficients indicates that changes in affordability have a greater impact on cigarette use among lower- and middle-income households compared to wealthier ones. These estimated elasticities are consistent with findings from previous research conducted in low- and middle-income countries.

Table 8. Total affordability elasticity of demand

	All households		**Low-income group**		**Middle-income group**		**High-income group**	
	Coef.	**Se**	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**
Elasticity	-0.68***	(0.10)	-0.72***	(0.11)	-0.75***	(0.13)	-0.62***	(0.13)

Source: Authors' calculations; ***p<0.01, **p<0.05, *p<0.1.

Note: Equality test – Tests showed the absence of statistically significant difference between affordability elasticity among all income groups: low-income and middle-income groups (x2(1)=0.46, prob >x2=0.497); low-income and high-income groups (cx2(1)=0.59, prob >x2=0.442); and middle-income and high-income groups (x2(1)=0.04, prob >x2=0.842).

To ensure the robustness of our results, we also estimated affordability elasticity using official monthly data on retail prices and cigarette pack consumption by

brand from 2010 to 2023.[17] Since this analysis involves time series data, the first step was to examine the properties of each variable to select an appropriate econometric model for estimating the tobacco demand function. The variables in this study are typically non-stationary, and due to monthly frequency there may be seasonal unit roots, as can be seen in the figures of variables given in the Appendix (figures A1 and A2). Despite the relatively short length of the time series for stationarity analysis, we tested for the presence of unit roots due to the characteristics of the data. Nevertheless, it should be noted that in small samples like this (164 observations), all unit root tests could have lower power. The detailed autoregressive distributed lag error-correction model (ARDL-ECM) specification results, along with diagnostic test results and explanations, are presented in text and tables A35–A36 in the Appendix.

As observed in Table 9 the short-run price elasticity is estimated at -0.51, which is lower than the long-run elasticity due to cigarettes' addictive nature. In the long run, a 10-percent decrease in affordability results in nearly a nine-percent reduction in per capita consumption. This coefficient is slightly higher than estimates from the micro model, though small differences were anticipated due to variations in time periods covered, data structure, and applied methodology.

Table 9. Long and short-run affordability elasticity of demand

Affordability elasticity	Coef.	Se
Error correction coefficient	-0.57***	(0.07)
Long run	-0.89***	(0.10)
Short run	-0.51***	(0.09)

Source: Authors' calculations; ***p<0.01, **p<0.05, *p<0.1.

[17] We also examined the specification using quarterly data and GDP per capita as a proxy for income; however, due to the limited number of observations for time series analysis, we present the more robust estimates based on monthly data frequency.

The coefficient of lagged residuals from the long-run equation represents the error-correction coefficient that measures the speed of adjustment towards the equilibrium. The estimate of this coefficient is significant, negative, and less than 1 in absolute value, indicating that after a short-run response to a change, consumption monotonically converges back towards its long-run equilibrium. The adjustment parameter yields a half-life estimate of 1.23 periods, which means that the time needed in order to eliminate 50 percent of the deviation from the equilibrium is a little bit below a month and a half.

Discussion and Conclusion

Discussion

The recent period of high-income growth in Montenegro presents a unique context for evaluating tobacco tax policy. While the considerable wage increases can lead to a higher living standard and poverty reduction, they also pose a challenge to effective tobacco excise tax policy. As incomes rise, cigarette affordability increases, potentially counteracting the positive effects of higher taxes intended to reduce tobacco consumption. This dynamic underscores the crucial importance of considering both price and income effects when designing effective tobacco control measures.

In this research, we analyzed the trends of different affordability indicators and their impacts on cigarette consumption. Taking 2010 as a base year, the results indicated that cigarettes became almost 10-percent less affordable in 2023 compared to 2010. Additionally, the trend growth rate of the RIP indicator was around one percent, with the highest increase observed in the economy segment of the tobacco market. However, the observed period showed distinct episodes of rising and decreasing RIP, mostly influenced by income growth changes, which tobacco legislation did not adequately consider.

Throughout the observed period, cigarette prices have increased at varying rates due to implementing a mandatory excise policy to raise the cigarette tax burden. As an EU accession country, Montenegro has made significant progress in harmonizing its excise policy with EU directives, resulting in efficient tax increases and, consequently, higher cigarette retail prices. However, prices remain lower compared to EU countries (WHO, 2023) due to the low base value. The effectiveness of this excise policy in lowering cigarette use also varied with economic conditions. During periods of wage stagnation or recession, the policy was more effective. Conversely, in periods of economic growth, especially from 2021 onwards, when the government implemented an expansionary fiscal policy, affordability increased significantly, leading to higher cigarette consumption. Besides income growth, pricing strategies of the tobacco industry additionally contributed to the higher affordability of tobacco products.

In addition to variations over time, differences in affordability levels are also evident across different income groups and sociodemographic categories. Analysis of the effects of sociodemographic factors on the RIP indicator, using HBS data, revealed that cigarettes are less affordable for households without employed members or pensioners, those living in the North region, and those with a female household head. Additionally, the results showed that cigarette affordability is higher for wealthier households compared to the poor. Considering the long period of stable, low wages in the low-income group, these results were expected, suggesting that even small price changes significantly impact affordability for this group.

Overall, our study demonstrates that cigarette demand in Montenegro is highly responsive to changes in affordability. The findings using micro HBS data indicate that a 10-percent decrease in affordability leads to a 6.8-percent reduction in cigarette consumption, with the effect being more evident among lower- and middle-income groups. Using macro aggregate data, results showed that the short-run affordability elasticity is estimated at -0.51, while in the long

run, a 10-percent decrease in affordability would lead to nearly a nine-percent reduction in per capita consumption. Considering both micro and macro estimates, the elasticity coefficient ranges from -0.68 to -0.89, being somewhat higher than the typical estimates found for LMICs, which range from -0.2 to -0.6 depending on the methodology used. However, it remains within the range of previous research for Southeastern Europe, which estimates elasticity between -0.65 and -1.2.

Our study contributes to the literature demonstrating that in countries experiencing high-income growth (which also means higher consumer spending power of current and possible new tobacco users), affordability elasticity can effectively guide necessary tax adjustments to reduce both affordability and tobacco consumption (Blecher & van Walbeek, 2004; Nargis et al., 2020; Zheng et al., 2016). This research underscores the importance of considering affordability elasticity in policy making to curb tobacco use within these economic contexts.

We must also recognize several limitations in our study, primarily due to data constraints. First, as with many studies dealing with this issue, GDP per capita was used as a proxy for income when defining the RIP indicator (Blecher, 2020; Blecher et al., 2013; Blecher & van Walbeek, 2004). While GDP per capita serves as a broad measure that encompasses both public and private revenues and expenditures, it does not account for variations in income distribution and may not perfectly reflect individual-level income. To address this, we also included affordability indicators based on disposable income and net average wages for comparison of trends. Second, as noted in the Methodology section, the aggregate data lacked details on income and sociodemographic characteristics for each market segment.

Additionally, common issues with HBS data include potential biases from self-reporting and the risk of endogeneity when using unit values as a proxy for prices.

Conclusion

When crafting effective tobacco control policies, integrating the affordability indicator is essential. Variations in affordability can impact smoker behavior in multiple ways, such as prompting cessation, reducing consumption intensity, or leading to brand switching. Thus, while it is important to use affordability elasticity, considering both prevalence and intensity, it is equally crucial to monitor affordability trends across various market segments, particularly the cheapest one, to address potential brand switching. Furthermore, with the introduction of new tobacco products in Montenegro, tracking the affordability of these emerging products is important to ensure the policies' overall effectiveness.

Results indicated that, as a signatory of the WHO FCTC, Montenegro should strongly consider implementing Article 6 of the FCTC to ensure that tax increases are substantial enough to counteract positive inflation and income growth trends. The *WHO Technical Manual on Tobacco Tax Policy and Administration* (WHO, 2021) also highlights the need for tax increases to make tobacco products less affordable and reduce consumption effectively. Affordability considers both price and income growth, acknowledging that rising incomes can offset the impact of higher prices. To address this, tax increases must ensure that prices increase faster than income, discouraging demand and promoting better public health outcomes.

Tax policies that are responsive to underlying economic conditions make cigarettes less affordable, contributing to the reduction of tobacco use prevalence and its related adverse health effects. In addition to effective income-adjusted price measures, it is crucial to emphasize the importance of strengthening tax

administration and implementing a variety of non-price tobacco control measures. This comprehensive approach would be the most effective in combating tobacco use, illicit trade, and the vested interests of the tobacco industry.

Further harmonization of Montenegro's tobacco tax regulations with the soon-to-be revised EU Tobacco Tax Directive (TTD) in the coming years could also lead to more effective policy outcomes, particularly if proposed improvements to the TTD are implemented. These adjustments include raising the current minimum tax and incorporating affordability into policy making. Some proposals from the empirical research advocate for setting minimum tax rates based on consumer purchasing power across different countries and implementing automatic inflation adjustments (Branston & Ángel López-Nicolás, 2022; The Smoke Free Partnership Statement on the delay of the EU Tobacco Tax Proposal, 2022. In the context of high economic growth and inflation, such regulatory updates would significantly help reduce tobacco consumption and boost government revenues.

In conclusion, while high income growth poses challenges to tobacco control efforts by increasing cigarette affordability, carefully designed and adaptive policies can still achieve significant reductions in tobacco use. Continuous monitoring and responsive adjustments are essential to ensure the long-term success of these policies in reducing tobacco-related harm

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Appendix

Table A1. Nominal and real GDP per capita (in € and annual growth rate)

Year	Nominal GDP per capita (€)	Real GDP per capita (€)	Nominal GDP per capita growth rate	Real GDP per capita growth rate
2010	5,045	4,966	4.4%	2.7%
2011	5,265	5,202	4.5%	3.2%
2012	5,126	5,117	-2.6%	-2.7%
2013	5,413	5,303	5.7%	3.5%
2014	5,561	5,504	2.8%	1.8%
2015	5,874	5,746	4.8%	3.4%
2016	6,354	6,046	8.2%	2.9%
2017	6,907	6,653	8.7%	4.7%
2018	7,495	7,260	8.5%	5.1%
2019	7,959	7,802	6.2%	4.1%
2020	6,737	6,749	-15.5%	-15.3%
2021	8,002	7,641	18.4%	13.0%
2022	9,598	8,543	19.6%	6.0%
2023	10,814	9,916	12.66%	3.3%

Source: Monstat

Table A2. Percent share of GDP per capita of Montenegro in the EU (in current US$ and PPP current international $)

	GDP per capita (current US$)			GDP per capita, PPP (current international $)		
Year	Montenegro	EU	% share	Montenegro	EU	% share
2010	6,688	32,966	20.3%	13,636	32,867	41.5%
2011	7,329	35,767	20.5%	14,472	34,495	42.0%

2012	6,586	33,169	19.9%	13,864	34,965	39.7%
2013	7,189	34,565	20.8%	14,870	36,065	41.2%
2014	7,388	35,282	20.9%	15,371	37,065	41.5%
2015	6,517	30,487	21.4%	16,333	38,223	42.7%
2016	7,033	31,174	22.6%	18,199	40,551	44.9%
2017	7,803	33,091	23.6%	19,682	42,665	46.1%
2018	8,850	35,752	24.8%	21,514	44,653	48.2%
2019	8,910	35,080	25.4%	23,792	47,497	50.1%
2020	7,677	34,357	22.3%	20,483	45,935	44.6%
2021	9,466	38,722	24.4%	23,318	49,367	47.2%
2022	10,093	37,433	27.0%	27,027	54,626	49.5%
2023	12,016	40,824	29.4%	31,216	60,348	51.7%

Source: Monstat and World Bank, World Development Indicators

Table A3. Real median and 30th percentile of disposable income (in €)

Year	Real median disposable income	Real 30th percentile of disposable income
2013	2,904	1,907
2014	3,001	2,016
2015	3,063	2,035
2016	3,045	2,076
2017	3,367	2,328
2018	3,664	2,526
2019	3,693	2,555
2020	3,918	2,806
2021	3,625	2,626
2022	3,821	2,805

Source: Eurostat

Note: The real median disposable income and 30th percentile of disposable income are calculated by the authors by applying corresponding CPI obtained from Monstat.

Table A4. Average nominal and real net wage (in € and growth rate)

Year	Average nominal net wage (€)	Average real net wage (€)	Average real net wage growth rate (%)
2010	479	476	6.3
2011	441	426	-10.4
2012	487	468	9.7
2013	479	469	0.2
2014	477	474	1.1
2015	480	473	-0.2
2016	499	498	5.3
2017	510	498	0.1
2018	511	498	0.0
2019	515	513	3.0
2020	524	523	1.9%
2021	532	519	-0.6%
2022	712	630	21.2%
2023	792	729	15.8%

Source: Monstat, Labour Force Survey

Note: Average net wage in nominal terms is obtained from Monstat. Average real net wage is calculated by authors by applying the corresponding CPI obtained from Monstat. Annual growth rate of average real net wage is calculated by authors and is based on YoY comparison.

Table A5. Prices (in €) and No. of packs (in millions) of economy, middle, and premium cigarette brands (in nominal and real terms)

	Economy segment			Middle segment			Premium segment		
Year	Nom price	Real price	No. of packs sold	Nom price	Real price	No. of packs sold	Nom price	Real price	No. of packs sold
2010	0.64	0.63	37.9	1.05	1.03	24.1	1.56	1.53	21.4
2011	0.85	0.84	35	1.33	1.32	24.8	1.97	1.94	13.2
2012	1.05	1.05	22.6	1.45	1.45	20.6	2.09	2.08	11.1
2013	1.18	1.16	17.5	1.53	1.50	20.9	2.15	2.11	12.3
2014	1.27	1.26	10	1.59	1.57	18.7	2.21	2.19	13.9
2015	1.46	1.43	11.8	1.70	1.67	16.4	2.27	2.22	15.8
2016	1.56	1.48	8.3	1.77	1.69	20.9	2.36	2.24	15.7
2017	1.74	1.68	5.5	2.02	1.94	26.1	2.76	2.66	12.8
2018	2.16	2.09	5.3	2.44	2.36	11.7	3.23	3.13	9.2
2019	1.99	1.95	6.1	2.28	2.24	18.4	3.01	2.95	10.5
2020	2.08	2.09	5.8	2.39	2.40	17.3	3.16	3.17	7.4
2021	2.12	2.03	8.8	2.50	2.38	22.4	3.33	3.17	8.4
2022	2.32	2.07	13.3	2.66	2.37	26.8	3.44	3.06	10
2023	2.47	2.17	13.5	2.81	2.47	25.8	3.58	3.15	11.4

Source: Tobacco Agency

Note: Nominal prices of economy, middle, and premium brand of cigarettes are obtained from the Tobacco Agency.

Real prices of all three categories of cigarette brands are calculated by the authors by applying the corresponding CPI obtained from Monstat.

Table A6. Excise tax calendar from 2010 to 2023

Year	Specific excise tax (in €)	Ad valorem excise tax (%)	VAT (%)
2010	5	35	17
2011	10	37	17
2012	15	36	17
2013	17.5	35	19
2014	19	35	19
2015	20	34	19
2016	22	32	19
2017	24	33	19
2017	30	32	19
2018	40	32	21
2019	30	32	21
2020	33.5	30.5	21
2021	37	29	21
2022	40.5	27.5	21
2022	44	26	21
2023	47.5	24.5	21
2023	49	24.5	21
2024	50.5	24.5	21
2024	52	24.5	21

Source: Ministry of Finance

Table A7. Average unit values and income per household – HBS data

Year	Unit value (€)	Income per household (€)
2005	0.83	1,180
2006	0.74	1,078
2007	0.73	1,278
2008	0.78	1,266
2009	0.82	1,271
2010	0.88	1,177

2011	1.03	1,171
2012	1.22	1,126
2013	1.30	1,124
2014	1.35	1,207
2015	1.32	1,260
2017	1.36	1,316
2021	1.77	1,469

Source: Authors' calculations based on HBS data

Note: Data are given in constant prices with 2010 as a base year. Average unit values and income per household are given in nominal terms.

Table A8. Sociodemographic characteristics of household – HBS data

Variable	Observations	Mean	Std. dev.	Min	Max
Household size	16,323	3.13	1.66	1.00	8.00
Male ratio (%)	16,323	47	0.27	0.00	1.00
Adult ratio 15+ (%)	16,323	90	0.18	0.38	1.00
Maximum education*	16,323	5.56	2.14	1.00	9.00
HH members – average age	16,323	46.63	17.68	16.00	85.00
HH head – males (%)	16,323	74	0.44	0.00	1.00
HH head – age	16,323	58.56	13.41	28.00	87.00
Household type					
Unemployed (%)	16,323	9	0.28	0.00	1.00
Pensioners (%)	16,323	33	0.47	0.00	1.00
Employed (%)	16,323	58	0.49	0.00	1.00

Source: Authors' calculations based on the HBS data provided by Monstat

Note: *Data on education indicates that, on average, the maximum education of adult household members is tertiary level.

Table A9. Affordability indicators – RIP and MoL from 2010 to 2023

Year	RIP GDPpc	MoL	RIP disposable income
2010	2.36%	25.01	
2011	2.69%	32.32	
2012	2.97%	31.27	
2013	2.97%	33.54	5.42%
2014	3.01%	35.14	5.53%
2015	3.09%	38.01	5.80%
2016	2.99%	38.41	5.94%
2017	3.08%	41.87	6.08%
2018	3.44%	50.42	6.81%
2019	3.03%	46.89	6.41%
2020	3.79%	49.35	6.53%
2021	3.30%	50.19	6.95%
2022	2.97%	40.02	6.64%
2023	2.76%	37.71	

Source: Authors' calculations

Table A10. Annual growth rate of nominal GDP per capita and WAPC

Year	WAPC	GDPpc
2011	23.2%	4.4%
2012	16.4%	-2.6%
2013	9.9%	5.6%
2014	10.3%	2.8%
2015	7.0%	5.6%
2016	4.9%	8.2%
2017	14.0%	8.7%
2018	20.9%	8.5%
2019	-7.9%	6.2%

2020	2.9%	-15.4%
2021	2.8%	18.8%
2022	5.4%	19.9%
2023	5.9%	17.6%

Source: Authors' calculations

Table A11. Level of WAPC and RIP from 2010 to 2023

Year	RIP	WAPC
2010	2.36%	0.99
2011	2.69%	1.22
2012	2.97%	1.42
2013	2.97%	1.56
2014	3.01%	1.72
2015	3.09%	1.84
2016	2.99%	1.93
2017	3.08%	2.2
2018	3.44%	2.66
2019	3.03%	2.45
2020	3.79%	2.52
2021	3.30%	2.59
2022	2.97%	2.73
2023	2.76%	2.89

Source: Authors' calculations

Table A12. Annual and fixed-base growth rate of affordability indicator – MoL

	Whole sample		Economy segment		Middle segment		Premium segment	
Year	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**
Affordability annual growth								
(2011 vs. 2010)	0.273***	0.012	0.378***	0.024	0.292***	0.011	0.232***	0.023
(2012 vs. 2011)	-0.022***	0.007	0.013	0.02	-0.043***	0.008	-0.056***	0.01
(2013 vs. 2012)	0.071***	0.005	0.149***	0.018	0.077***	0.007	0.055***	0.007
(2014 vs. 2013)	0.059***	0.006	0.081***	0.014	0.052***	0.007	0.042***	0.01
(2015 vs. 2014)	0.063***	0.007	0.097***	0.017	0.050***	0.007	0.051***	0.004
(2016 vs. 2015)	0.002	0.004	0.052***	0.012	0.017***	0.005	0.002	0.004
(2017 vs. 2016)	0.077***	0.006	0.090***	0.017	0.101***	0.005	0.076***	0.005
(2018 vs. 2017)	0.185***	0.01	0.161***	0.024	0.212***	0.008	0.174***	0.006
(2019 vs. 2018)	-0.073***	0.008	-0.035**	0.016	-0.085***	0.007	-0.076***	0.005
(2020 vs. 2019)	0.008	0.006	0.023***	0.005	0.026***	0.005	0.015***	0.005
(2021 vs. 2020)	0.027***	0.007	0.012	0.008	0.026***	0.006	0.017***	0.004
(2022 vs. 2021)	-0.259***	0.005	-0.225***	0.013	-0.249***	0.005	-0.266***	0.003
(2023 vs. 2022)	-0.059***	0.004	-0.004	0.015	-0.047***	0.003	-0.078***	0.01
Affordability fixed base growth (2010=100)								
2023 vs. 2010	0.350***	0.021	0.791***	0.029	0.431***	0.018	0.190***	0.029

Source: Authors' calculations

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

Table A13. Affordability changes by year – MoL

	Whole sample		Economy		Middle		Premium	
VARIABLES	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**
Year (2010)								
2011	0.27***	(0.01)	0.38***	(0.02)	0.29***	(0.01)	0.23***	(0.02)
2012	0.25***	(0.01)	0.39***	(0.03)	0.25***	(0.01)	0.18***	(0.02)
2013	0.32***	(0.02)	0.54***	(0.03)	0.33***	(0.01)	0.23***	(0.03)
2014	0.38***	(0.02)	0.62***	(0.04)	0.38***	(0.02)	0.27***	(0.02)
2015	0.44***	(0.02)	0.72***	(0.03)	0.43***	(0.02)	0.32***	(0.02)
2016	0.45***	(0.02)	0.77***	(0.03)	0.45***	(0.02)	0.33***	(0.02)
2017	0.52***	(0.02)	0.86***	(0.03)	0.55***	(0.02)	0.40***	(0.02)
2018	0.71***	(0.02)	1.02***	(0.03)	0.76***	(0.02)	0.58***	(0.02)
2019	0.63***	(0.02)	0.99***	(0.03)	0.67***	(0.02)	0.50***	(0.02)
2020	0.64***	(0.02)	1.01***	(0.03)	0.70***	(0.02)	0.52***	(0.03)
2021	0.67***	(0.02)	1.02***	(0.03)	0.73***	(0.02)	0.53***	(0.02)
2022	0.41***	(0.02)	0.79***	(0.03)	0.48***	(0.02)	0.27***	(0.02)
2023	0.35***	(0.02)	0.79***	(0.03)	0.43***	(0.02)	0.19***	(0.03)
Constant	3.15***	(0.03)	2.64***	(0.03)	3.11***	(0.02)	3.53***	(0.03)
Fixed effects	YES		YES		YES		YES	
Observations	1,859		458		831		570	
Number of id	277		126		178		101	

Source: Authors' calculations

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

Table A14. Affordability changes by year – RIP

	Whole sample		Economy		Middle		Premium	
VARIABLES	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**
Year (2010)								
2011	0.15***	(0.01)	0.25***	(0.02)	0.17***	(0.01)	0.11***	(0.02)
2012	0.26***	(0.01)	0.40***	(0.03)	0.26***	(0.01)	0.19***	(0.02)
2013	0.26***	(0.02)	0.48***	(0.03)	0.26***	(0.01)	0.17***	(0.03)
2014	0.29***	(0.02)	0.53***	(0.04)	0.28***	(0.02)	0.18***	(0.02)
2015	0.30***	(0.02)	0.57***	(0.03)	0.28***	(0.02)	0.18***	(0.02)
2016	0.26***	(0.02)	0.58***	(0.03)	0.26***	(0.02)	0.14***	(0.02)
2017	0.27***	(0.02)	0.61***	(0.03)	0.30***	(0.02)	0.15***	(0.02)

2018	0.38***	(0.02)	0.70***	(0.03)	0.43***	(0.02)	0.25***	(0.02)
2019	0.26***	(0.02)	0.61***	(0.03)	0.30***	(0.02)	0.12***	(0.02)
2020	0.44***	(0.02)	0.81***	(0.03)	0.50***	(0.02)	0.31***	(0.03)
2021	0.31***	(0.02)	0.66***	(0.03)	0.37***	(0.02)	0.17***	(0.02)
2022	0.17***	(0.02)	0.56***	(0.03)	0.24***	(0.02)	0.03	(0.02)
2023	0.10***	(0.02)	0.54***	(0.03)	0.18***	(0.02)	0.027	-0.05
Constant	-3.82***	(0.03)	-4.33***	(0.03)	-3.86***	(0.02)	-3.44***	(0.03)
Fixed effects	YES		YES		YES		YES	
Observations	1,859		458		831		570	
Number of id	277		126		178		101	

Source: Authors' calculations

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

Prevalence elasticity specification

Table A15. Estimation of prevalence elasticity – different models

	Model 1		Model 2		Model 3		Model 4	
VARIABLES	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**	**Coef.**	**Se**
Affordability	-3.46***	(1.02)	-3.42***	(1.02)				
Log affordability					-0.35**	(0.16)	-0.34**	(0.16)
Household size	0.08***	(0.02)	0.08***	(0.02)	0.08***	(0.02)	0.08***	(0.02)
Male ratio <0.25								
0.25–0.50	0.25***	(0.06)	0.26***	(0.06)	0.25***	(0.06)	0.26***	(0.06)
0.5–0.75	0.33***	(0.07)	0.33***	(0.07)	0.32***	(0.07)	0.33***	(0.07)
>0.75	0.50***	(0.09)	0.53***	(0.09)	0.49***	(0.09)	0.52***	(0.09)
Adult ratio	0.44***	(0.13)	0.45***	(0.13)	0.44***	(0.13)	0.45***	(0.13)
Education: Graduate								
Primary	0.31***	(0.09)	0.30***	(0.09)	0.31***	(0.09)	0.30***	(0.09)
Secondary	0.36***	(0.07)	0.35***	(0.07)	0.36***	(0.07)	0.35***	(0.07)
Faculty	0.17***	(0.06)	0.17***	(0.06)	0.18***	(0.06)	0.17***	(0.06)

Region: Center								
South	-0.39***	(0.15)	-0.38***	(0.15)	-0.41***	(0.15)	-0.40***	(0.15)
North	-0.27***	(0.10)	-0.28***	(0.10)	-0.30***	(0.10)	-0.31***	(0.10)
HH activity: Unemployed								
Pensioners	0.06	(0.08)	0.05	(0.08)	0.07	(0.08)	0.06	(0.08)
Employed	0.25***	(0.08)	0.24***	(0.08)	0.25***	(0.08)	0.25***	(0.08)
Mean age of HH members:<25								
25–44	0.12*	(0.06)	0.12*	(0.06)	0.12*	(0.06)	0.12*	(0.06)
44–65	0.11	(0.08)	0.10	(0.08)	0.11	(0.08)	0.10	(0.08)
>65	-0.43***	(0.10)	-0.44***	(0.10)	-0.43***	(0.10)	-0.44***	(0.10)
HH head gender	0.12**	(0.05)	0.12**	(0.06)	0.12**	(0.05)	0.12**	(0.05)
Constant	-1.73***	(0.28)	-2.10***	(0.28)	-2.90***	(0.40)	-3.26***	(0.39)
Observations	16,169		16,169		16,169		16,169	
AIC	20939.4		20904.3		20979.7		20943.2	
BIC	21116.3		21088.9		21156.5		21127.8	
r2_p	0.0479		0.0496		0.0461		0.0479	
ll	-10446.7		-10428.1		-10466.8		-10447.6	

Source: Authors' calculations

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

Table A16. Linktest

	Model 1				**Model 2**			
	Coef.	**Se**	**z**	**P>z**	**Coef.**	**Se**	**z**	**P>z**
_hat	-1.20	2.93	-0.41	0.68	-0.67	2.92	-0.23	0.82
_hatsq	0.48	0.43	1.12	0.26	0.40	0.43	0.93	0.35
_cons	4.54	4.96	0.92	0.36	3.71	4.95	0.75	0.45
	Model 3				**Model 4**			

	Coef.	Se	z	P>z	Coef.	Se	z	P>z
_hat	3.18	3.35	0.94	0.35	3.37	3.17	1.06	0.29
_hatsq	-0.16	0.49	-0.34	0.74	-0.20	0.46	-0.44	0.66
_cons	-2.73	5.70	-0.48	0.63	-3.05	5.38	-0.57	0.57

Source: Authors' calculations

Table A17. VIF test

	Model 2
Mean VIF	2.13

Source: Authors' calculations

Table A18. Hosmer and Lemeshow Goodness of Fit Test

	Model 2			
Observations	16,169	16,169	16,169	16,169
Groups	5	10	15	20
Chi2	3.84	9.91	13.74	27.67
p	0.28	0.27	0.39	0.07

Source: Authors' calculations

Table A19. Linktest of prevalence by income groups

	Low-income group				Middle-income group				High-income group			
	Coef.	Se	z	P>z	Coef.	Se	z	P>z	Coef.	Se	z	P>z
_hat	0.96	0.08	11.26	0	1.05	0.08	13.17	0	1.03	0.11	9.63	0
_hatsq	-0.04	0.07	-0.62	0.54	0.05	0.05	0.87	0.39	0.03	0.08	0.38	0.70
_cons	0.00	0.03	0.13	0.90	-0.00	0.03	-0.17	0.87	0.00	0.03	0.01	0.99

Source: Authors' calculations

Table A20. Hosmer and Lemeshow Goodness of Fit Test

	Low-income group				Middle-income group				High-income group			
Observations	5,316	5,316	,5316	5,316	5,231	5,231	5,231	5,231	5,358	5,358	5,358	5,358
Groups	5	10	15	20	5	10	15	20	5	10	15	20
Chi2	0.50	11.91	6.48	20.01	0.75	6.44	7.97	12.85	4.61	12.74	18.73	24.04
p	0.92	0.15	0.93	0.33	0.86	0.60	0.84	0.80	0.20	0.12	0.13	0.15

Source: Authors' calculations

Table A21. VIF test

	Low-income group	Middle-income group	High-income group
Mean VIF	2.05	2..42	2.49

Conditional intensity elasticity – GLM

Table A22. Estimation of conditional elasticity – different models

VARIABLES	Model 1	Se	Model 2	Se	Model 3	Se	Model 4	Se
Affordability	-3.10***	(0.44)	-3.07***	(0.44)				
Affordability (ln)					-0.38***	(0.06)	-0.37***	(0.06)
Household size	0.05***	(0.01)	0.05***	(0.01)	0.05***	(0.01)	0.05***	(0.01)
Male ratio: 0.25-0.50	0.10***	(0.03)	0.11***	(0.03)	0.10***	(0.03)	0.11***	(0.03)
0.5-0.75	0.15***	(0.03)	0.15***	(0.03)	0.15***	(0.03)	0.15***	(0.03)
>0.75	0.20***	(0.04)	0.21***	(0.04)	0.20***	(0.04)	0.21***	(0.04)
Adult ratio	0.20***	(0.07)	0.20***	(0.07)	0.19**	(0.07)	0.19***	(0.07)
Education: Secondary	-0.01	(0.10)	-0.03	(0.10)	-0.02	(0.10)	-0.04	(0.10)
Higher secondary	0.06	(0.09)	0.04	(0.09)	0.07	(0.09)	0.04	(0.09)
Faculty	0.05	(0.11)	0.04	(0.11)	0.05	(0.11)	0.04	(0.11)
Master	0.07	(0.10)	0.06	(0.10)	0.08	(0.10)	0.06	(0.10)
PhD	0.04	(0.11)	0.03	(0.11)	0.05	(0.11)	0.04	(0.11)
Region: South	-0.27***	(0.07)	-0.26***	(0.07)	-0.28***	(0.07)	-0.28***	(0.07)
North	-0.04	(0.04)	-0.04	(0.04)	-0.05	(0.04)	-0.05	(0.04)
HH activity: Pensioners	0.06*	(0.03)	0.06*	(0.03)	0.06*	(0.03)	0.06*	(0.03)
Employed	0.12***	(0.03)	0.11***	(0.03)	0.12***	(0.03)	0.12***	(0.03)
Mean age of HH members: 25-44	0.00	(0.03)	0.00	(0.03)	0.01	(0.03)	0.01	(0.03)
44-65	0.13***	(0.03)	0.13***	(0.03)	0.14***	(0.03)	0.13***	(0.03)

>65	0.06	(0.04)	0.06	(0.04)	0.06	(0.04)	0.06	(0.04)
HH head gender	0.05**	(0.02)	0.04*	(0.02)	0.05**	(0.02)	0.05**	(0.02)
Constant	3.17***	(0.13)	3.000***	(0.13)	1.98***	(0.18)	1.83***	(0.17)
Elasticity (%)								
Conditional elasticity	-0.39***	(0.06)	-0.39***	(0.06)	-0.38***	(0.06)	-0.37***	(0.06)
Observations	6,710		6,710		6,71		6,710	
AIC	59363.1		59351.8		59375.4		59363.8	
BIC	59519.8		59515.3		59532.1		59527.3	
ll	-29658.6		-29651.9		-29664.7		-29657.9	

Source: Authors' calculations

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

Table A23. Pregibon's Link Test total prevalence

	Model 1				**Model 2**			
	Coef.	**Se**	**z**	**P>z**	**Coef.**	**Se**	**z**	**P>z**
lyhat	-1.20	2.93	-0.41	0.68	-0.67	2.93	-0.23	0.82
lyhat2	0.48	0.43	1.12	0.26	0.40	0.43	0.93	0.35
_cons	4.54	4.96	0.92	0.36	3.71	4.95	0.75	0.45
	Model 3				**Model 4**			
	Coef.	**Se**	**z**	**P>z**	**Coef.**	**Se**	**z**	**P>z**
lyhat	3.15	3.35	0.94	0.35	3.37	3.17	1.06	0.29
lyhat2	-0.16	0.49	-0.34	0.74	-0.20	0.46	-0.44	0.66
_cons	-2.73	5.70	-0.48	0.63	-3.05	5.38	-0.57	0.57

Source: Authors' calculations

Table A24. Box-Cox test of functional form

	Model 2			
	Coef.	**Se**	**z**	**P>z**
theta	0.43	0.01	35.33	0

Source: Authors' calculations

Table A25. VIF test

	Model 2
Mean VIF	2.13

Source: Authors' calculations

Table A26. Modified Park Test (GLM Family Test)

	Model 2			
	Coef.	**Se**	**z**	**P>z**
lyhat	1.98	0.15	13.39	0
_cons	-0.70	0.5	-1.34	0.18
	Chi2		P > Chi2	
λ=2 (lyhat2=0)	0.01		0.9089	

Source: Authors' calculations

Table A27. Pregibon's Link Test by income groups

	Low-income group				**Middle-income group**				**High-income group**			
	Coef.	**Se**	**z**	**P>z**	**Coef.**	**Se**	**z**	**P>z**	**Coef.**	**Se**	**z**	**P>z**
lyhat	-2.04	4.25	-0.48	0.63	-1.20	2.15	-0.56	0.57	-0.33	3.66	-0.09	0.93
lyhat2	0.59	0.63	0.93	0.35	0.50	0.32	1.55	0.12	0.33	0.55	0.61	0.54
_cons	6.18	7.14	0.87	0.39	4.38	3.60	1.22	0.22	3.20	6.08	0.53	0.60

Source: Authors' calculations

Table A28. VIF test

	Low-income group	**Middle-income group**	**High-income group**
Mean VIF	1.98	2.19	2.49

Source: Authors' calculations

Table A29. Modified Park Test total prevalence and by income groups

	Whole sample				**Low-income group**			
	Coef.	**Se**	**z**	**P>z**	**Coef.**	**Se**	**Z**	**P>z**
lyhat	1.98	0.15	13.39	0	1.87	0.22	8.39	0
_cons	-0.70	0.52	-1.34	0.179	-0.31	0.77	-0.41	0.68
	Middle-income group				**High-income group**			
	Coef.	**Se**	**z**	**P>z**	**Coef.**	**Se**	**z**	**P>z**
	2.15	0.16	13.85	0	1.93	0.17	11.16	0

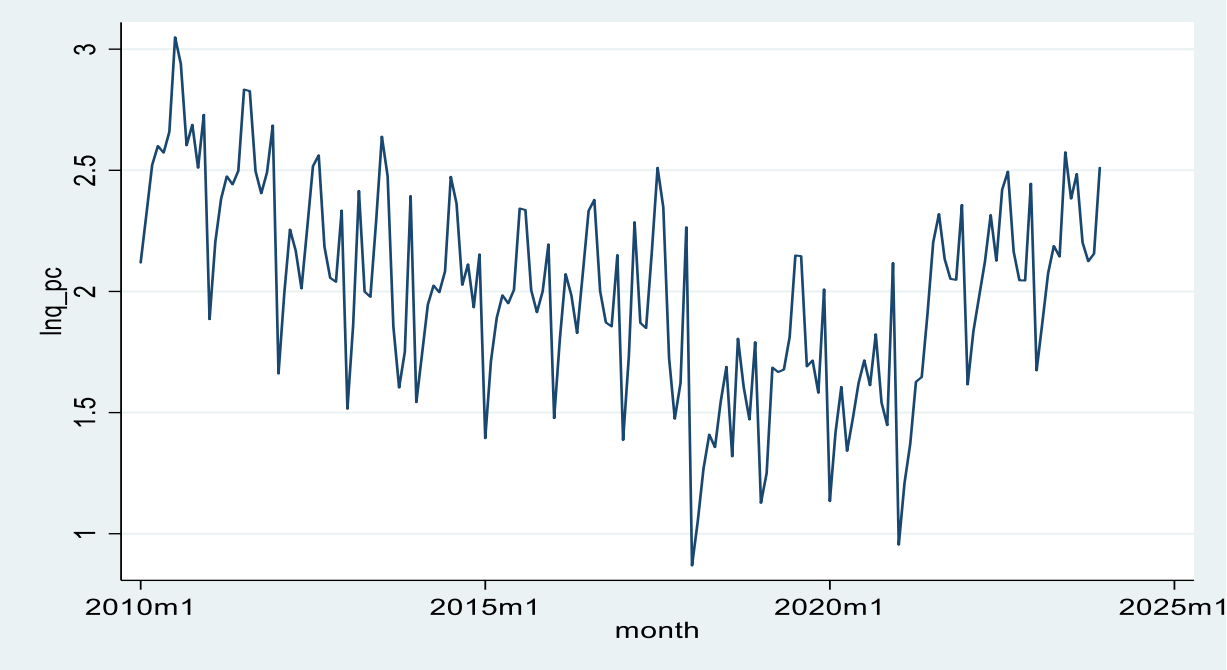
Source: Authors' calculations

Table A30. Hosmer and Lemeshow Goodness of Fit Test

	Low-income group		**Middle-income group**		**High-income group**	
Groups	5	10	5	10	5	10
Chi2	0.80	1.17	0.45	0.69	0.88	1.84
p	0.55	0.30	0.81	0.73	0.49	0.05

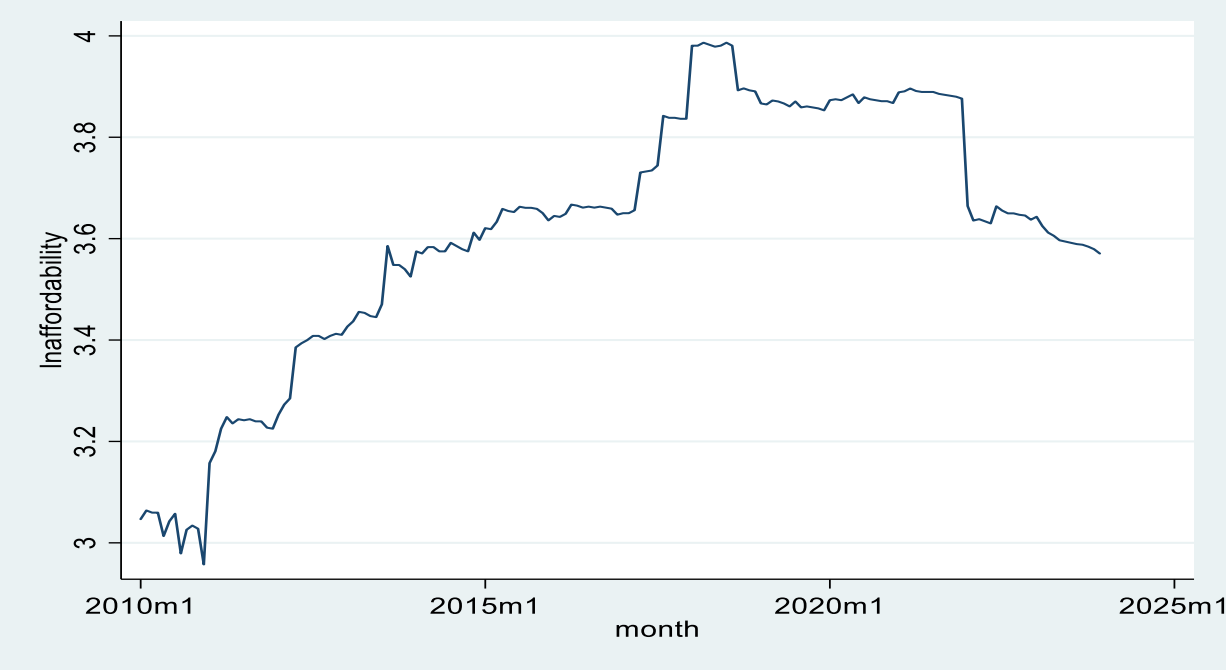
Source: Authors' calculations

Figure A1. Log of quantity of cigarette packs consumed per capita



Source: Stata

Figure A2. Log of affordability indicator



Source: Stata

Error correction – ARDL model tests and results

Traditional unit root and cointegration tests were originally designed for non-seasonal or zero frequency data. These tests can be applied to monthly data, provided it is demonstrated that unit roots at other frequencies do not exist. To check for the presence of seasonal unit root (stochastic seasonality) we have applied HEGY procedure introduced by Hylleberg et al. (1990). We bootstrap the critical values of our HEGY tests to allow for the structural break and particular sample size. Results in given in tables A31–A32 indicate that log of cigarette consumption per capita and log of affordability are integrated of order 1, at the 0 frequency, and there is no stochastic seasonal unit root.

Table A31. Seasonal Unit Root Test | HEGY – Log of cigarette consumption per capita

Null	Simulated P-value*	Statistical
Non-seasonal unit root (Zero frequency)	0.78	-1.51
Seasonal unit root (2 months per cycle)	0.00	-5.33
Seasonal unit root (4 months per cycle)	0.00	16.55
Seasonal unit root (2.4 months per cycle)	0.00	17.25
Seasonal unit root (12 months per cycle)	0.00	14.66
Seasonal unit root (3 months per cycle)	0.00	9.27
Seasonal unit root (6 months per cycle)	0.00	16.22

Source: Authors' calculations

Note: Monte Carlo Simulations: 1,000; Selected lag using AIC criteria: 0

Table A32. Seasonal unit root test| HEGY – Log of affordability

Null	Simulated P-value*	Statistical
Non-seasonal unit root (Zero frequency)	0.99385	-0.263926
Seasonal unit root (2 months per cycle)	0.00564	-5.111858

Seasonal unit root (4 months per cycle)	0.00000	22.14813
Seasonal unit root (2.4 months per cycle)	0.00000	15.05543
Seasonal unit root (12 months per cycle)	0.00000	13.42745
Seasonal unit root (3 months per cycle)	0.00000	16.18930
Seasonal unit root (6 months per cycle)	0.00018	13.83740

Source: Authors' calculations

Note: Monte Carlo Simulations: 1,000; Selected lag using AIC criteria: 0

Given the data's potential structural changes, we implemented the Zivot-Andrews Unit Root test, which allows for a single break in intercept and/or trend to check the stationarity of variables at first differences. The test showed that the variables are stationary at first differences (Table A33), allowing us to proceed with testing for cointegration. The Johansen cointegration test revealed that a linear combination of cigarette consumption per capita and the affordability indicator is stationary, indicating the existence of one cointegration vector (Table A34).

Table A33. Unit root first difference test

	Zivot-Andrews	
Variables	Minimum t-statistic H0: variable has a unit root with a structural break in the intercept/trend	
	First dif. Z(t)	
Log cigarette sale	-12.07***	Log cigarette sale
Log affordability	-14.07***	Log affordability

Source: Authors' calculations

Table A34. Johansen co-integration tests

Null hypotheses	Eigen value	Trace statistic	0.05 Critical value	Prob.**	Max-Eigen	0.05 Critical value	Prob.**
H0: (R=0)*	0.25	55.07	25.87	0.00	46.54	19.39	0.00
H0: (R≤1)	0.05	8.53	12.52	0.21	8.53	12.52	0.211

Source: Authors' calculations

Note: **MacKinnon-Haug-Michelis (1999) p-values; R is the number of the cointegrating equation.

*indicates the rejection of the null hypothesis at the 5-percent level. Optimal lag length is chosen by using Akaike's information criterion.

These tests demonstrate that a long-run equilibrium relationship exists among the variables, enabling us to estimate the cigarette demand function using an ARDL error-correction model (ARDL-ECM), which accounts for both the long-run relationships and short-run dynamics of the variables. The final specification of the ARDL-ECM model included cigarette consumption per capita and the affordability indicator, along with seasonal monthly dummies and regulatory variable.[18] The detailed ARDL-ECM specification results, along with diagnostic tests, are presented in tables A35–A36.

Table A35. Affordability elasticity estimation – ARDL-ECM

ADJ		
l.consumption	-0.57***	(0.07)
LR		
l.lnaffordability	**-0.89*** **	(0.10)
SR		
d.lnaffordability	-**0.51*** **	(0.09)
dum2	0.64***	(0.08)
dum3	0.81***	(0.07)

[18] We checked also specifications with unemployment, but it was dropped due to issues of collinearity.

dum4	0.67***	(0.06)
dum5	0.67***	(0.06)
dum6	0.84***	(0.06)
dum7	1.03***	(0.05)
dum8	0.88***	(0.05)
dum9	0.62***	(0.05)
dum10	0.63***	(0.06)
dum11	0.66***	(0.06)
dum12	1.03***	(0.06)
r	-0.13***	(0.04)
Constant	2.30***	(0.45)
Observations	164	

Post estimation tests	
Breusch-Pagan/ Cook-Weisberg test for heteroskedasticity	chi2(1) = 0.44
Ho: Constant variance	Prob > chi2 = 0.50
Durbin's alternative test for autocorrelation	chi2(1) = 0.485
H0: no serial correlation	Prob > chi2 = 0.49
	Lags 1
Breusch-Godfrey LM test for autocorrelation	Prob > chi2 = 0.46
H0: no serial correlation	chi2(1) = 0.54
	Lags 1
Ramsey RESET test	F(3, 146) = 2.01
Ho: model has no omitted variables	Prob > F =0.14
Jarque-Bera normality test	Chi(2)= 1.56
Ho: normality	Prob>chi2= 0.46
Mean VIF	2.83

Source: Authors' calculations

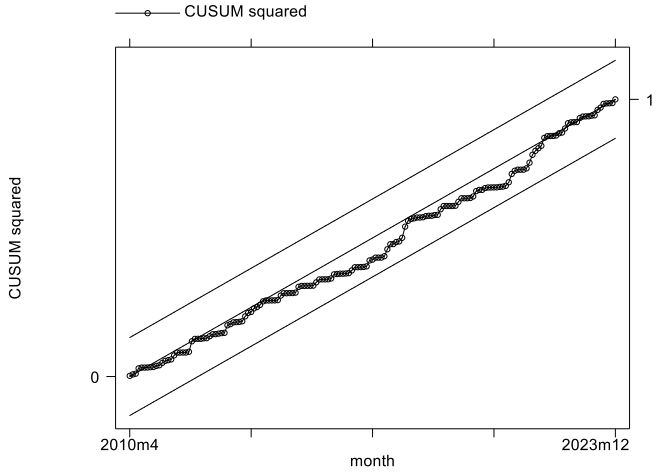
The presence of cointegration is verified by the Bound test (Table A36), as the calculated F-statistic exceeds both the lower and upper critical values. Additionally, the CUSUM test (Figure A3) indicates no significant signs of coefficient instability, and the model has successfully passed all post-estimation diagnostic checks.

Table A36. ARDL Bounds test

	F-statistic	**Critical values F statistic**	
		Bottom	
ARDL 1	31.86	6.97	ARDL 1

Source: Authors' calculations

Figure A3. Plots of the CUSUM



Source: Stata