Cigarette Affordability in North Macedonia

Economics for Health Working Paper Series

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Paper No. 26/2/1

February 2026

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Suggested citation: Mijovic Spasova, T., Mijovic Hristovska, B., & Angjelkovska, T. (2026). *Cigarette affordability in North Macedonia* (Economics for Health Working Paper No. 26/2/1). Analytica. www.economicsforhealth.org/research/cigarette-affordability-in-north-macedonia-working-paper-series/

Acknowledgments: Analytica is funded by the Economics for Health team at John Hopkins University (JHU) to conduct economic research on tobacco taxation in Macedonia. JHU is a partner of the Bloomberg Philanthropies' Initiative to Reduce Tobacco Use. The views expressed in this document cannot be attributed to, nor can they be considered to represent, the views of JHU or Bloomberg Philanthropies.

Abstract

Background

Cigarette affordability remains a key driver of smoking behavior in North Macedonia—one of the countries with the highest smoking prevalence in Europe. Despite gradual alignment with European Union (EU) tobacco taxation standards, cigarette prices remain relatively low in comparison to income levels and regional averages. As an upper-middle-income country with rising household incomes and persistent income inequality, North Macedonia faces the challenge of reducing tobacco use in a context where cigarettes remain affordable to a large share of the population. Given this, reducing cigarette affordability is essential to lowering consumption, particularly through policies that consider both income growth and price trends.

Methodology

This study examines cigarette affordability trends in North Macedonia using a combination of retail price data from Customs and income data from the Household Budget Survey (HBS). Affordability is measured as the percentage of household income required to purchase 100 packs of cigarettes. A two-part model is employed to estimate affordability elasticity, capturing both the likelihood of cigarette consumption and the intensity of consumption, across the entire sample and by income groups. Additionally, for robustness purposes, cointegration is estimated based on macro data.

Results

The analysis finds that cigarette affordability has remained high in recent years, driven by increases in real income that outpace tax-related price adjustments. The estimated affordability elasticity is **0.58**, indicating that a 10-percent increase in income leads to a 5.8-percent increase in cigarette consumption. This suggests that current tax measures may not be sufficient to offset income growth and reduce tobacco use.

Conclusions

In light of strong income growth and relatively modest increases in tobacco taxes,

affordability of cigarettes in North Macedonia has not declined significantly. To effectively reduce cigarette consumption, future tobacco control efforts must incorporate substantial excise tax increases that exceed both inflation and real income growth. A comprehensive strategy addressing both price and income dynamics is essential to lowering smoking rates and aligning with EU public health standards.

JEL Codes: I18, H25, D12, C25
Keywords: tobacco taxation, cigarette affordability, smoking behavior, tobacco control, North Macedonia

1. Introduction

Analysis of cigarette affordability is a useful tool to help guide tobacco control policies, especially tobacco taxation. It is generally assumed that the higher the price of cigarettes, the less affordable they will become, and in response many people will either reduce tobacco consumption, quit, or not initiate use. Tobacco control economists have demonstrated consistently that significantly increasing tobacco excise taxes is the most efficient and effective tobacco control strategy (Blecher & Van Walbeek, 2004). Tobacco excise tax increases will raise the price of retail cigarette packs, and most studies find that the demand for cigarettes is affected by this change in the price. However, there is strong global evidence that income increases can partially or fully offset the effect of excise tax increases, and cigarettes will remain relatively affordable unless excise tax increases exceed the sum of inflation plus real income growth (Nargis et al., 2021; Nazar et al., 2021). Therefore, an understanding of affordability is an important complement to a focus on price alone.

Tobacco affordability in North Macedonia has exhibited significant fluctuations and trends since 2010, influenced by economic conditions, regulatory frameworks, and cultural factors surrounding tobacco consumption. As a leading producer of raw tobacco in Europe, North Macedonia faces the challenge of strengthening tobacco control while starting to reorient from tobacco dependence toward sustainable alternative livelihoods (Gjorgjievski et al., 2023). North Macedonia has one of the highest prevalence of cigarette use in Europe, reaching 48.4 percent in 2019 (Hristovska et al., 2020). Additionally, a survey from 2014 and 2016 noted that the prevalence of tobacco use was high, with particular concern regarding smoking rates among various demographic groups including health care workers (29% and 33% respectively)—people who ideally should be involved in the process of reducing and discouraging tobacco use (Gjorgjievski et al., 2023).

In 2019, North Macedonia had some of the lowest cigarette prices in Southeastern Europe, influenced by a relatively low excise tax of €54 per 1,000 cigarettes. While specific retail prices for 2019 were not directly mentioned, the country faced pressure to increase

its tobacco excise tax to align with European Union (EU) standards, which require a minimum of €90 per 1,000 cigarettes (Hristovska et al., 2020). A number of tobacco control policies have been introduced, and there have been steady increases in prices of cigarettes, yet prices are still relatively low and affordable compared to the rest of the Western Balkans and the EU.[1]

Research indicates that smoking is deeply ingrained in North Macedonian culture (World Health Organization (2023), (Hristovska et al., 2020). This cultural acceptance is coupled with an existing market where a plethora of brands—including low-cost options—exist, contributing to the high likelihood that some tobacco products remain affordable regardless of price hikes. The price of a pack of standard cigarettes can vary based on the brand, but on average a pack of cigarettes in 2025 typically costs between 135 and 180 Macedonian denars (MKD). This is roughly equivalent to around €2.2 to €3, depending on the exchange rate and specific brand. As theory suggests, it is not enough to increase the price of the cigarettes, because if income growth outpaces cigarette price increases, then the effect of the tobacco taxes will be offset.

In North Macedonia, there were relatively steady nominal and real increases in wages over the period of our research, 2014–2023. This is partly due to the increase in the minimum wage, which was first introduced in 2012 with the adoption of the Law on the Minimum Wage, defined as the lowest monthly amount an employer is required to pay to employees for full-time work performed. There are steady and strong increases in the minimum wage in this time period. With this law, the minimum wage had two historical increases of about 19 percent each in 2016 and 2020, respectively. Comparing the 2023 net minimum wage of €328 to the 2016 minimum wage level of €175 shows that the minimum wage has increased by 87 percent.

[1] https://www.who.int/data/gho/data/indicators/indicator-details/GHO/gho-tobacco-control-raise-taxes-r-price-mp-estimate

In order to ensure that this law would be justifiable, it foresaw a linear increase in all other public wages for the same nominal amount that the minimum wage would increase. These two wage increases combined put upper pressure on the average nominal and real wages in the country and increased the income of households. With that, along with the modest pace of cigarette price increases, there is a risk that cigarettes are becoming more affordable, and consequently that smoking prevalence will remain high.

Decades of research demonstrates that price elasticity of demand for cigarettes in general is negative, however, in the case of North Macedonia this relationship might be less substantial due to the fact that smoking is embedded and widespread. Previous research (Jovanovic, B., 2018) suggests that smoking persists even when the prices of cigarettes and income both increase. This, however, can be attributed to the socioeconomic factors that dictate tobacco affordability—where lower-income families still prioritize tobacco expenditure despite rising prices due to the addictive nature of smoking and possibly the social norms.

However, the latest data from the World Health Organization (WHO, 2025) suggest that there are some positive developments in the affordability segment. According to the most recent cigarette affordability index, there is an increase in the number, suggesting that cigarettes are becoming less affordable. This is similar to what was seen during the COVID-19 period (2020–2022), which had at least two possible explanations: 1) peoples' incomes were threatened to some extent due to the partial closure of the economy, and 2) growing inflation. Because of these higher prices, people had to make different choices with the available funds.

Evidence shows that affordability is a central factor influencing consumption patterns (Blecher & Van Walbeek, 2009, WHO, 2021). When income grows faster than cigarette prices, tobacco products become more affordable, making it easier for consumers to maintain or even increase their consumption. This phenomenon has been observed in North Macedonia in recent years.

Tobacco control policy in North Macedonia is governed by several legal frameworks, including:

- the Law on Excise Duties, which mandates both specific excise taxes (per cigarette or per kilogram for fine-cut tobacco) and ad valorem taxes (as a percentage of retail price);
- the Law on Restriction of Tobacco Use, which outlines public smoking bans, health warnings, age restrictions, and advertising regulations in line with the WHO Framework Convention on Tobacco Control (FCTC); and
- ongoing efforts to harmonize tobacco taxation with EU Directive 2011/64/EU, including scheduled increases in excise duties through 2030.

As of 2024, the excise regime for cigarettes includes a specific duty of 0.23 MKD per cigarette (or 4.6 MKD per pack of 20), alongside a nine percent ad valorem tax. These rates are set to increase annually. Nonetheless, cigarettes remain affordable. For example, a pack of Marlboro in Skopje in 2025 costs about 170 MKD (approximately €2.8), significantly lower than the EU average of €5.98 (Tax Foundation Europe, 2024).

Economic indicators further illuminate the affordability issue. Between 2021 and 2023, the average gross monthly salary rose from approximately €696 to €892 (State Statistical Office, 2023) an increase of more than 28 percent, while cigarette prices rose only modestly. Over the same period, cumulative inflation reached 22–25 percent, but the excise tax increases were relatively minor—typically around 0.23 MKD per cigarette per year. This mismatch has allowed cigarettes to become more affordable in real terms, undermining the intended public health impact of excise taxation.

In summary, since 2010, North Macedonia has witnessed a complex interplay of economic, social, and regulatory influences that shape tobacco affordability. While cigarette prices have risen through taxation, household income growth has outpaced these increases, keeping tobacco products relatively affordable—especially among low-income groups. However, the persistence of high smoking rates despite modest changes

in affordability suggests that social acceptance of smoking may dampen the behavioral response to price and tax increases. In North Macedonia, smoking remains socially tolerated, even among health professionals, which helps explain the limited impact of affordability changes on consumption patterns. Effective tobacco control will therefore require comprehensive policy strategies that consider both economic realities and cultural contexts of smoking in North Macedonia, combining fiscal measures with efforts to shift social norms around smoking.

2. Literature review

The affordability of tobacco products in low- and middle-income countries (LMICs) has become a critical focus of research due to its implications for public health and tobacco consumption patterns. An emerging body of literature underscores that the interplay between prices, taxes, and the general economic conditions of populations significantly influences tobacco affordability and its subsequent consumption.

The concept of tobacco affordability is multilayered and cannot be fully understood by simply examining pricing structures. Movsisyan and Connolly emphasize that a comprehensive assessment of affordability must consider the real income levels and living standards of a population to effectively gauge how price changes impact consumption behaviors (Movsisyan & Connolly, 2014). In that context is a systematic review by Nazar et al. (2021), which highlights the necessity of contextualizing tobacco pricing within the socioeconomic realities of Southeast Asian countries. Furthermore, Nargis et al. (2018) point out that changing economic statuses, such as Bangladesh's transition from a low-income to a lower-middle-income country, critically affect perceptions and realities of tobacco affordability. Nargis et al. (2018) go on to assert that higher prices do not necessarily equate to reduced consumption if incomes simultaneously rise.

Furthermore, studies conducted in different regions demonstrate significant variances in affordability metrics. Nargis et al. (2019) provide insights into trends in Bangladesh, where tobacco products have increasingly become more affordable despite tax increases,

suggesting that the interplay between income growth and price changes complicates efforts to curb smoking rates. Additionally, an affordability analysis performed in ten Southeastern European countries revealed nuanced responses to price changes, indicating that even with gradual income improvements, tobacco remains accessible to many consumers due to stagnant or declining prices relative to rising incomes (Zubović et al., 2023).

In their 2002 study, Guindon et al. calculated the affordability of cigarettes for more than 80 countries. A key finding of their research was that cigarettes were significantly more affordable in high-income countries than in low- and middle-income countries, but the rate of increase in affordability was much faster in developing nations due to rapid income growth combined with lagging tax increases. In 2003, Guindon et al. conducted a study on tobacco affordability in Southeast Asia (India, Indonesia, Nepal, Sri Lanka, and Thailand) that analyzed the relative prices of tobacco products in relation to each country's gross domestic product (GDP) per capita. The study found that tobacco products became approximately 50-percent cheaper over the past twenty years. Prices varied significantly in Bangladesh, where tobacco items were less expensive in the late 1990s compared to the early 1980s.

There are several established ways of measuring cigarette affordability. First, there is the minutes of labor (MoL) method, which is derived from daily income data to calculate the number of working minutes needed to buy a pack of locally produced or Marlboro (or equivalent) cigarettes (Guindon et al., 2002). The most-used measurement for cigarette affordability, relative income price (RIP), was introduced in 2004. RIP calculates the percentage of annual GDP per capita required to buy 100 packs of 20 cigarettes (Blecher & Van Walbeek, 2004).

Blecher and van Walbeek (2004) conducted a cross-country study of 70 countries and found that during 1990–2001, cigarettes became more affordable in 11 out of 28 developed countries and in 24 out of 42 developing countries. Moreover, they found an

increase of one percent in the relative income price (RIP) was associated with a 0.49-percent to 0.57-percent decline in consumption.

While the RIP measure offers broad comparability using per capita GDP, other studies utilizing the minutes of labor (MoL) approach can provide more relative insight into how labor earnings translate into affordability. Each measure also has its own drawbacks: RIP may mask inequalities in income, while MoL depends heavily on choice of wage proxy and occupation.

The first study to calculate cigarette affordability using individual-level data from the Global Adult Tobacco Survey (GATS) across 15 low- and middle-income countries (LMICs) was conducted by Kostova et al. (2014). In that study, the authors estimated the relative income price (RIP) by calculating consumption-weighted average prices based on what smokers reported paying. They then combined this with GDP per capita to determine the proportion of a person's income required to purchase 2,000 cigarette sticks at the median price per stick. Kostova et al. (2014) found that income increases in 15 selected LMICs made tobacco products more affordable.

Blecher and Van Walbeek (2009) studied both high-income countries (HICs) and lower-middle-income countries (LMICs) and found cigarettes were significantly more affordable in HICs than in LMICs, although since 1990 affordability decreased in HICs but increased in LMICs. Moreover, in the most recent study Blecher (2020) found that cigarettes, based on RIP from 2010–2018, were less affordable in 2018 in 32 of 40 HICs and in 26 of 45 LMICs. Iglesias et al. (2015) conducted a study in Argentina, suggesting that cigarettes were more affordable in 2014 than in 2004. This is due to substantial increases in incomes across all income groups, despite a strong nominal increase in cigarette prices. Hu et al. (2019) conducted a study on China using self-reported data, and found negative affordability elasticity of demand for tobacco for the observed period. Similarly, Nargis et al. (2020) detected negative affordability elasticity of demand for tobacco among both HICs and LMICs; however, the magnitude differs among the different income group of countries. Specifically, they found that demand is more

responsive to affordability changes in LMICs than in HICs. This relates directly to our study on North Macedonia, as it suggests that policies aimed at reducing affordability (via taxes that outpace income) would be particularly effective in lowering consumption given the country's socio-economic status.

There is a new wave of studies covering the Western Balkan countries, though the findings are still limited. Djukic et al. (2021) analyzed cigarette affordability in Southeastern Europe for the period 2009–2019, finding that there is a positive trend of reduction in tobacco consumption, but the findings are not the same for all countries. The results from both the Tobacco Affordability Index (TAI) and RIP indicate that the affordability of cigarettes decreased in all observed countries except in North Macedonia. Prekazi and Berisha (2023) conducted a study for Kosovo using 2019 data, and they detected lower affordability is associated with lower cigarette consumption. Furthermore, the results show that age, gender, level of education, employment, affect cigarette consumption among adults and that consumption intensity varies across regions.

It is evident from most of these studies that mere increases in taxes and prices do not automatically translate to reduced consumption if underlying socioeconomic factors and affordability are not also addressed. According to the *WHO Technical Manual on Tobacco Tax Policy and Administration* (2021), raising tobacco taxes is one of the most effective tools for reducing tobacco use, particularly when it leads to a reduction in affordability. The WHO recommends that excise taxes should be increased regularly, at a pace that at least matches or exceeds income growth and inflation, so that cigarettes become less affordable over time.

For policies to effectively reduce tobacco consumption, it is clear that policy makers must incorporate a thorough understanding of affordability alongside robust taxation measures to effectively mitigate tobacco use and its associated health risks. This is where we find the value of this research, both as an addition to the existing literature but also for strengthening tobacco control in North Macedonia.

3. Data and Methodology

This section describes the data sources, key variables, and empirical methodology employed to assess the affordability trends and their relationship with cigarette consumption.

3.1. Data

The analysis utilizes micro and macro data. The micro data are obtained from the Household Budget Survey (HBS), a nationally representative survey that collects data annually as a repeated cross section (that is, without a panel structure), conducted by the State Statistical Office (SSO) between 2018–2022. The dataset includes nationally representative information on household tobacco consumption,[2] expenditures, and demographics, covering 2,646 households in 2018, 2,564 households in 2019, 2,871 households in 2020, 3,061 households in 2021, and 2,783 households in 2022. For the macro data, we use databases and reports from the State Statistical Office, Customs, Ministry of Finance, International Monetary Fund, World Bank, and World Health Organization (2014–2023) using various indicators recommended by the literature. These indicators enable us to identify trends and ascertain the magnitude of change in affordability over the observed period.

Gross domestic product per capita

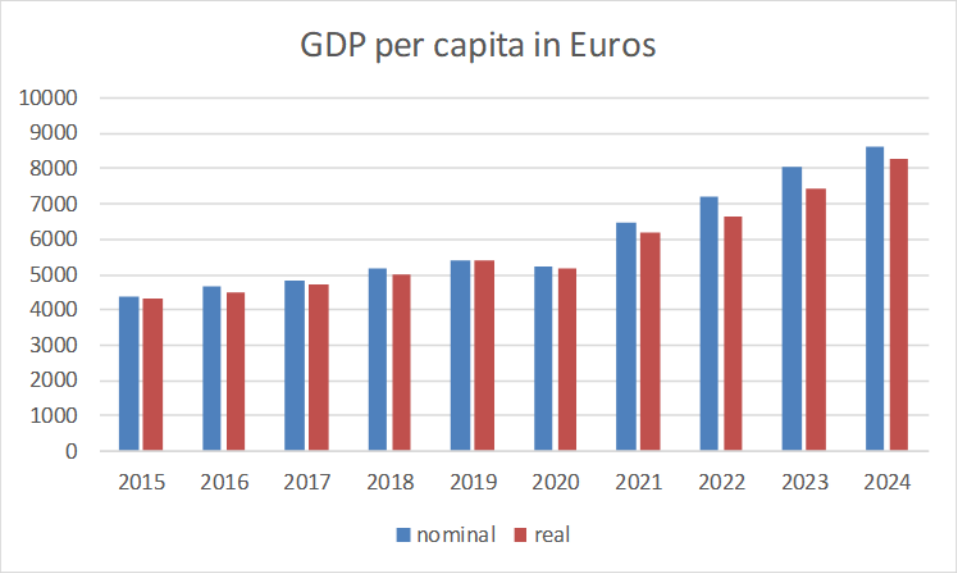
During the 2014–2019 period North Macedonia's economy experienced growth, driven by increased investments, EU integration efforts, and key infrastructure projects. The global COVID-19 pandemic led to a dip in GDP per capita due to disruptions in trade, tourism, and local businesses. The GDP per capita decreased somewhat, but the

[2] In a household survey, "tobacco expenditures" refer to the money spent by households on cigarettes and other tobacco products, so we use this amount and divide it by the average price per pack of cigarettes to obtain tobacco consumption.

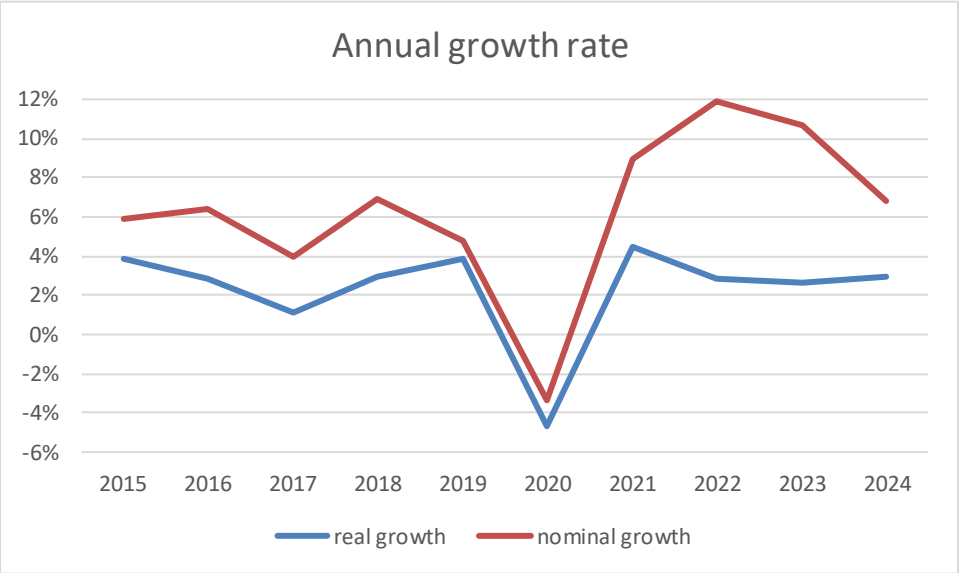
government implemented measures to help the economy recover. From 2020 to 2023 the country's economy rebounded as it adapted to the post-pandemic conditions. GDP per capita continued to rise, supported by the recovery in exports, remittances, and investments, with a particularly pronounced increase in the final two years of the observed period. The biggest disparity between real and nominal values is noticeable in 2021 and 2022 due to a high level of inflation (Figure 2, Panel a).

Figure 1. Nominal vs. real – GDP per capita (Panel a) and GDP growth (Panel b)

Panel a.



Panel b.



Source: Stat.gov.mk

Disposable income

Equalized disposable income[3] is a measure that accounts for income distribution and purchasing power after taxes and benefits, providing a more accurate representation of the typical individual's economic well-being by different income quintiles. We include this variable to capture the real-life financial situation of the majority of the population. Figure 3 illustrates the distribution of disposable income by quartile over the period from 2013 to 2020,[4] providing the top income level for the 25th, median, and 75th percentiles of the

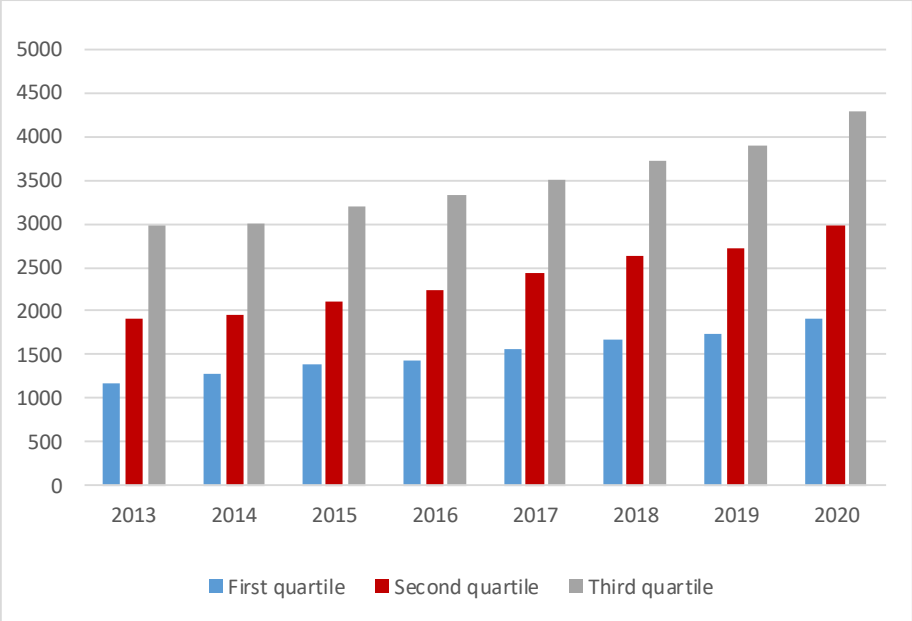
[3] Equalized disposable income refers to the total income of a household, after tax and other deductions, available for spending or saving. It is divided by the number of household members converted into equalized adults, with household members weighted according to their age using the modified OECD equivalence scale. This income includes cash income from work (for employees and self-employed individuals), income from capital, pensions, social transfers, and other transfers received by households from individuals who are not household members. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Equivalised_disposable_income

[4] In 2020, North Macedonia faced an economic decline due to lockdowns and supply chain issues. However, equalized disposable income for all income groups increased. This was largely due to the government's response measures, including job-retention schemes that provided financial support to businesses, relaxed social assistance criteria to help those in poverty, and one-off cash allowances to vulnerable citizens. These measures acted as stabilizers, protecting household income despite the economic downturn. Since the full income breakdown by quartiles in euros is not

distribution. It is evident that all income quartiles display an overall upward trend, with some variations in certain years.

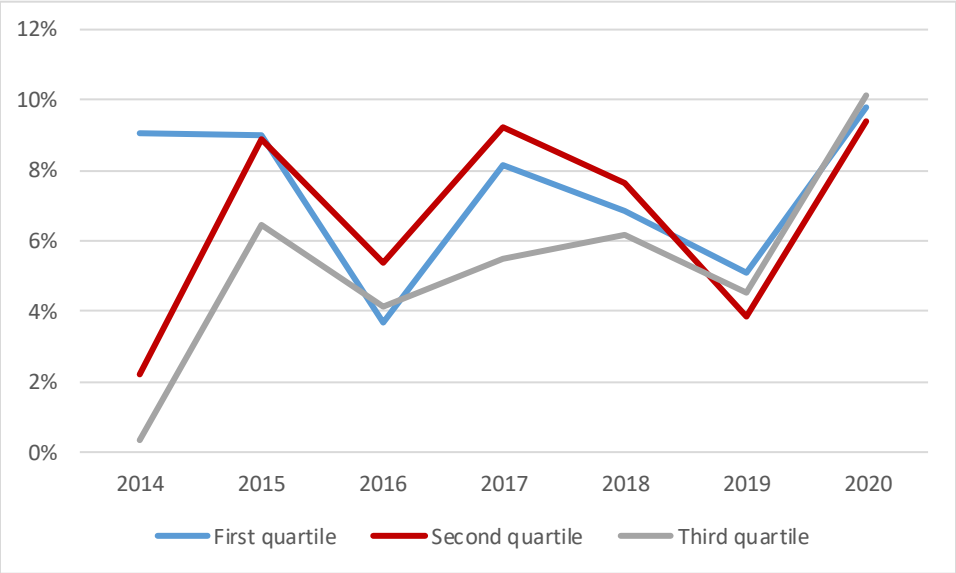
Figure 2. Distribution of equalized disposable income by quartiles (EUR)

Panel a.



published by EUROSTAT for years after 2020, key inequality indicators derived from the EU-SILC survey (like the Gini coefficient, which fell to 29.8 percent in 2022) were used to confirm that income distribution became more equal despite global inflation.

Panel b. Percentage change in equalized disposable income



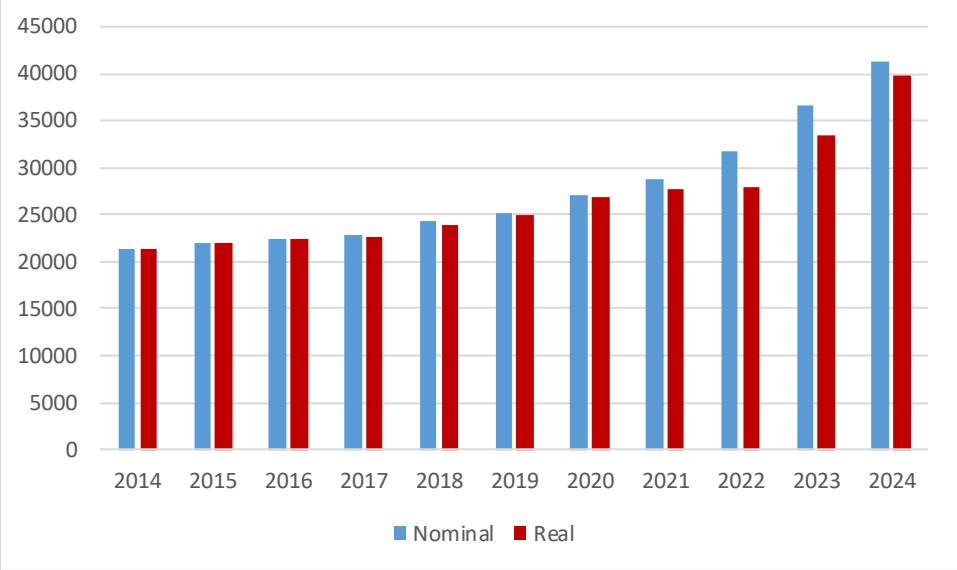
Source: Eurostat – Survey on Income and Living Conditions (SILC)

Wages

To calculate MoL, we utilize data on wages obtained from the State Statistical Office of North Macedonia. The average monthly net wages[5] in nominal and real terms have demonstrated steady growth over the observed period. Since the introduction of the law on minimum wage in 2012, the overall wage levels have increased steadily over the period of 15 years. With this law, there is a yearly increase in the minimum wage. The increase margin is calculated as 50 percent of the growth of the national average net wage plus 100 percent of the growth of the consumer price index (inflation) from the previous year. Additionally, the specific increment should be added to all other wages in the public sector, along with recommendations for the private sector. With this, the overall wage level increases.

[5] Net wage reflecting income after deductions such as taxes and social contributions.

Figure 3. Average net wage, in local currency (MKD)



Source: Stat.gov.mk.

Despite the global disruptions of the past several years—pandemics, political uncertainty in Europe and the Middle East, and high inflation—wages in North Macedonia are exhibiting strong and steady growth, both in nominal and real terms.

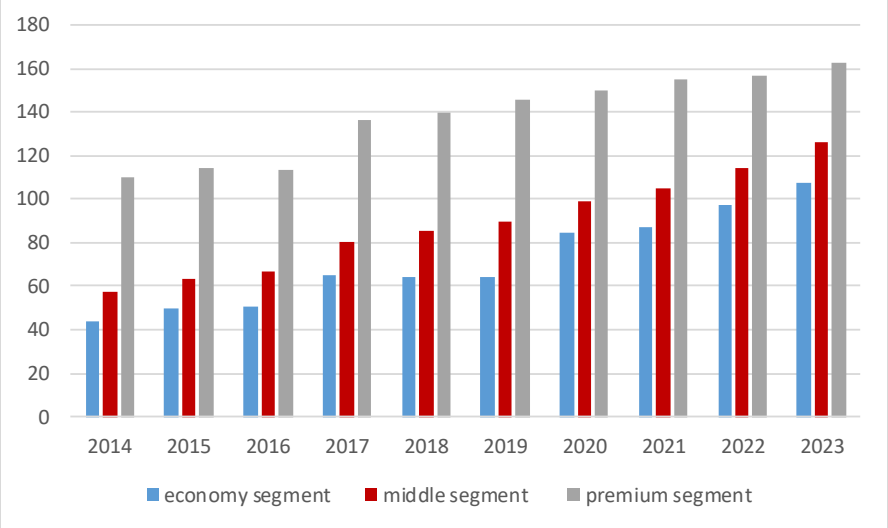
Price

To analyze the trend in affordability and elasticity, we utilize pricing data obtained from the Macedonian Customs authority, specifically, the number of issued stamps per month for different priced products. Domestically produced brands from 2014–2020 were in packs of 19 cigarettes, and imported cigarettes were 20 in a pack. Since 2021, all packs are back to a standard pack of 20 sticks. The provided dataset comprises details on retail prices and quantities according to the stamps obtained by Customs. There is fluctuation in the quantities, but it exhibits a declining trend. During the observation period, prices ranged from 0.7 EUR to 3 EUR, with economy brands increasing from 0.7 EUR in 2014 to 1.8 EUR in 2024, and premium brands rising from 1.3 EUR in 2014 to 3 EUR in 2024. Changes in prices by year/month mostly coincide with the changes in the excise calendar.

In the absence of detailed data on the tobacco market segments, we follow existing literature, such as Tauras et al. (2006) and Cizmovic et al. (2024). We define the market segments according to the most-sold brand—or price level, in our case, as we do not have data on the stamps issued by brand but rather by product price. The middle price segment is defined as +/-25 cents of the most-sold brand.

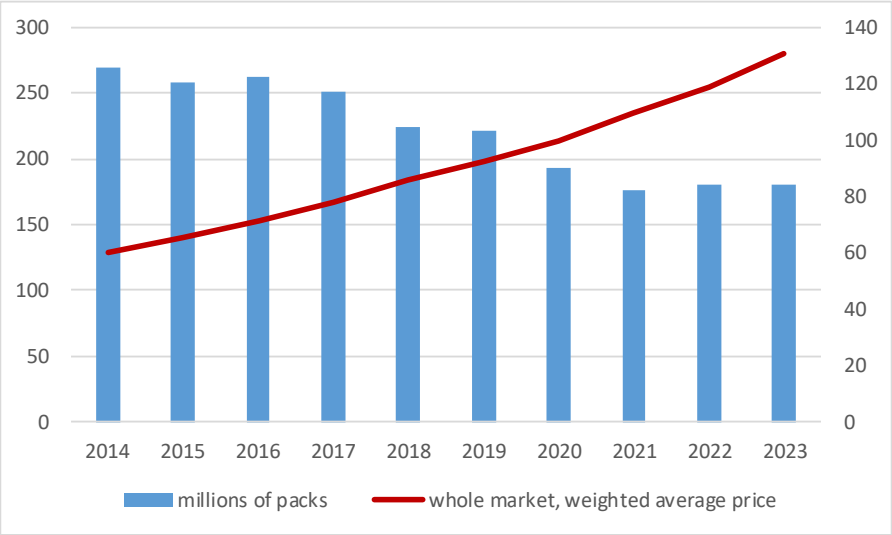
Figure 4. Average price by segment, in local currency (MKD, Panel a) and whole market (Panel b)

Panel a.



Source: Customs and authors' calculations

Panel b.



Source: Customs and authors' calculations

Data for affordability elasticity estimation

To estimate the affordability elasticity of cigarette demand using individual micro-level data, we utilize the Household Budget Survey spanning from 2018–2022. The survey is conducted annually by the State Statistical Office, following specific statistical protocols and principles to ensure quality and accuracy of the data. HBS is a nationally representative survey that collects data annually as a repeated cross section (that is, without a panel structure) from 2,646 households in 2018, 2,564 households in 2019, 2,871 households in 2020, 3,061 households in 2021, and 2,783 households in 2022. It takes into account eight statistical regions.

The HBS offers insights into household-level expenditures alongside data on household income, size, structure, and sociodemographic characteristics. However, it does not make data on the number of cigarettes purchased available to us. For that purpose, we use a proxy by dividing expenditures on tobacco by randomly assigned prices obtained from

Customs for the specific year.[6] This dataset 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 is formulated by considering unit values as a proxy for prices together with household expenditures, since the HBS does not report data on household income. We opt for the use of household expenditure over GDP, as it represents actual spending and is a better proxy of income, but still with the potential problem of underreporting.

We use 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). Education and regional characteristics are included in the model as sets of dummy variables to capture categorical effects. For education, primary education is used as the reference category, as it represents the most common level of completed education in the sample and provides a meaningful baseline for comparison with secondary and tertiary education groups. Regional dummies are created for all eight statistical regions, with the Vardar region serving as the reference category, due to its central geographic position and average socioeconomic profile. This specification allows the estimated coefficients to be interpreted as deviations from the reference categories, facilitating comparison across education and regional groups.

[6] We use STATA to randomly assign prices per pack of cigarettes by applying two assumptions. First we assume that the lower-income households would consume economy-segment cigarettes, middle income would consume middle-segment cigarettes, and higher-income households would consume premium. Then, for each of the income groups, we assign the actual prices per pack for different cigarettes for each available year.

3.2. Methodology

We begin by conducting a comprehensive descriptive analysis of various affordability measures. As an indicator of affordability, we use the individualized relative income price (RIP). To calculate the RIP, real GDP per capita and the sum of average net wages are applied (ANW). We also calculate affordability measures based on the minutes of labor (MoL), which measures the minutes of labor required to purchase the cheapest pack of cigarettes (Guindon et al., 2002). We utilize methodology following Goodchild et al. (2020).

We continue to estimate affordability elasticity based on HBS data. We define the affordability indicator as the percentage of household income needed to buy 100 packs of cigarettes. We consider using a two-part model for the overall affordability of cigarettes using microdata form the HBS.[7] This model is widely used in both theoretical and applied research in health economics, particularly for mixed discrete–continuous outcomes (Belotti et al., 2015). Estimation of affordability elasticity will be done for the whole sample, as well as by income groups.

The two-part model enables examination of smoking participation and intensity separately, important for creating effective tobacco controls. The logit model is defined as follows:

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

where:

[7]We use clustered standard errors at the region × year level to account for unobserved heterogeneity and potential correlation within those clusters. Since the HBS microdata include household-level observations nested within regions and across years, this level of clustering allows us to control for both spatial and temporal dependencies.

- *consumption* is defined as 1 if the household reported smoking expenses, and 0 otherwise;
- *affordability* is the percentage of household income needed to buy 100 packs of cigarettes;
- Z_i is a vector of individual demographics, socioeconomic characteristics, and geographic indicators; and
- elasticity is calculated using marginal effects.

In the second part, we use generalized linear model (GLM) methodology, which encompasses the same independent variables as in logit. Additionally, we conduct several diagnostic tests to validate the chosen model specification and estimate total elasticity. The analysis in this part estimates affordability elasticities for the whole sample and by income groups.

As a robustness exercise, we also estimate the affordability elasticity using macro data from Customs and the State Statistical Office, following the example of Cizmovic et al. (2024). This part only analyzes cigarette affordability for the overall market. For the purpose of estimating short-run and long-run affordability elasticities on the macro data, we employ error correction and autoregressive distributed lag (ARDL) methods.

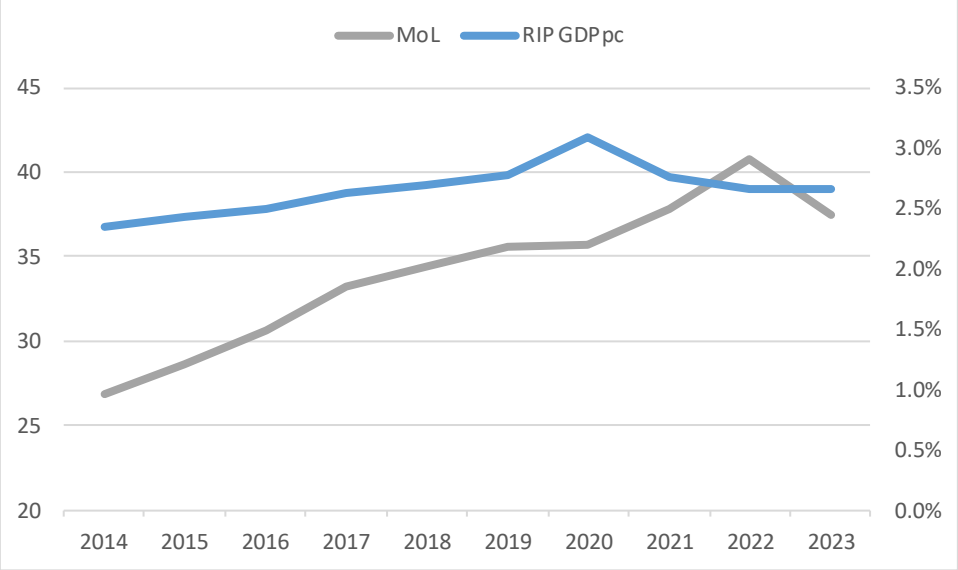
4. Results

4.1. Descriptive statistics

We begin by assessing cigarette affordability levels, trends, and the magnitude of change using two complementary indicators: the relative income price (RIP) and minutes of labor (MoL). RIP reflects the percentage of annual GDP per capita required to purchase a standard pack of cigarettes, while the MoL measures the number of working minutes needed to buy one pack at the average wage rate. Both indicators exhibit similar long-term patterns, showing that cigarette affordability declined over the past decade—that is,

more income or labor was required to purchase the same quantity of cigarettes (Figure 5). For instance, in 2014 it took only 26.8 minutes of labor to buy a pack of cigarettes, whereas in 2023 it required 37.5 minutes. However, between 2022 and 2023, the MoL indicator showed a slight decline while the RIP remained broadly stable, reflecting strong nominal wage growth that outpaced price increases during this period.

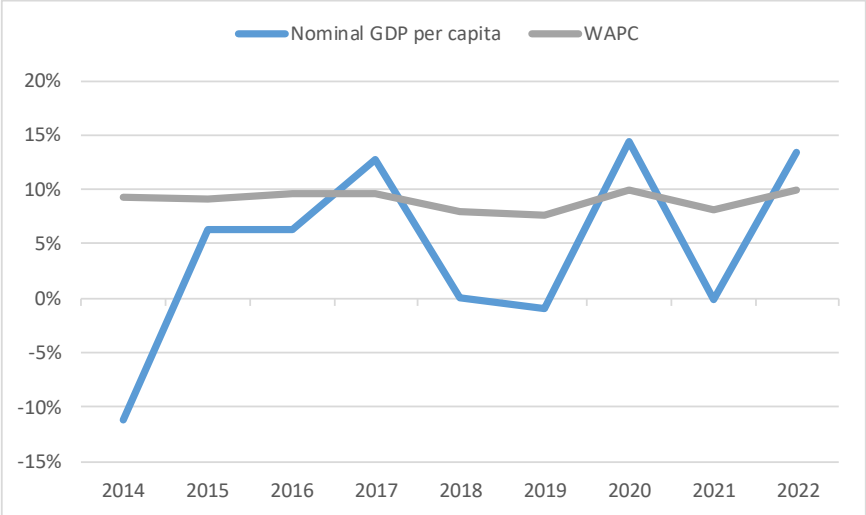
Figure 5. Affordability indicators: RIP and MoL from 2014–2023



Source: stat.mk, Customs, and authors' calculations

To further understand cigarette affordability, we observe the movements in the weighted average price per cigarette (WAPC) in relation to the changes in per capita GDP (Figure 6).

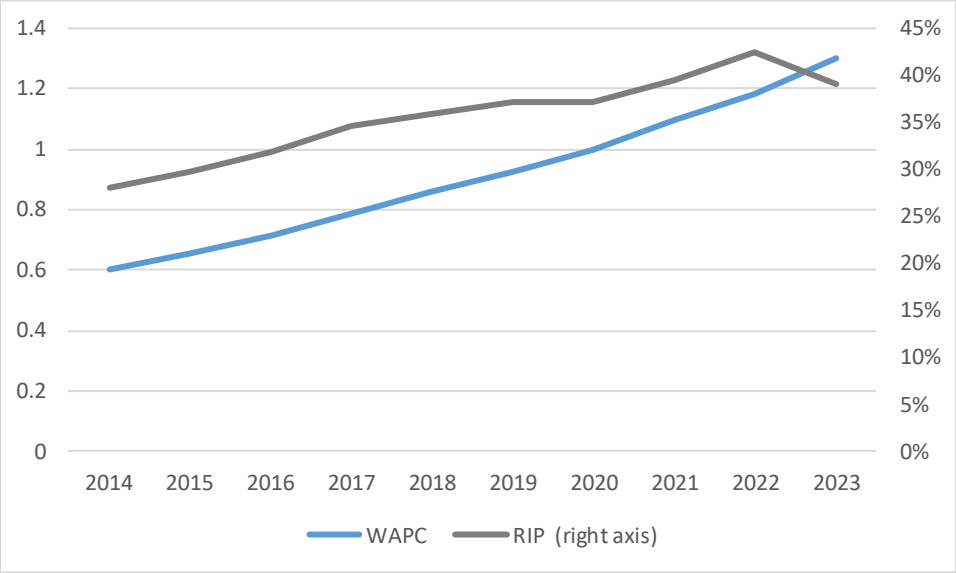
Figure 6. Annual growth rate of nominal GDP per capita and cigarette price (WAPC)



Source: stat.mk, Customs, and authors' calculations

Between 2015 and 2019, cigarette affordability remained broadly stable, as the growth in nominal GDP per capita closely followed the annual increase in the weighted average cigarette price (WAPC). In 2020, affordability declined sharply because GDP per capita contracted due to the COVID-19 crisis, while cigarette prices continued to rise at a steady pace. In 2021, affordability increased markedly as income growth rebounded far faster than price increases, reflecting the post-pandemic recovery. The following year, in 2022, the slowdown in economic growth amid the Russia–Ukraine war and inflationary pressures again reduced affordability, although nominal wage increases partly offset the effect. In 2023, both income and cigarette prices grew at a similar pace, indicating a period of relative stabilization in affordability levels.

Figure 7. Level of WAPC and RIP from 2014 to 2023

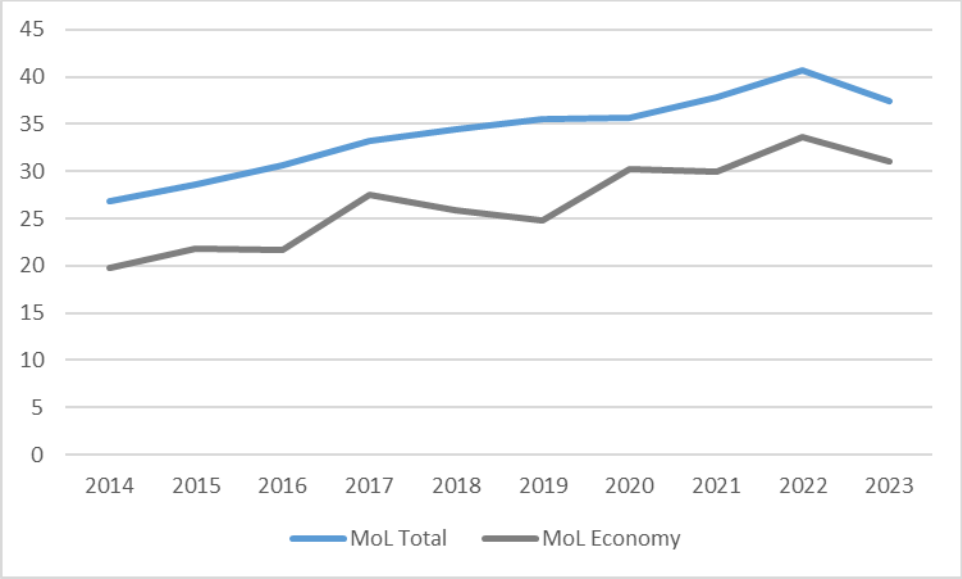


Source: stat.mk, Customs, and authors' calculations

Figure 7 illustrates the trends in WAPC and RIP (based on average wage). Until 2021, the decrease in affordability coincides with an increase in the WAPC. However, since 2022 there were big wage adjustments in the public sector that heavily impacted the increase in overall income levels. Taking into consideration the increase in the minimum wage, along with ongoing negotiations for wage increases in the public sector, we can expect negative impacts on affordability, meaning cigarettes will remain more affordable, keeping in mind the slow increase in excise taxes and final cigarette prices in the past three years.

To better understand the affordability trends, we use MoL to see if there is a difference in affordability for different market segments of cigarettes.

Figure 8. MoL for total market and economy-segment cigarettes



Source: stat.mk, Customs, and authors' calculations

From Figure 8 we can see that there is no significant difference between the total market MoL and the economy segment, as the gap is only due to the price gap and income gap. The main difference is that in the early period, 2014, it was easier to buy economy-segment cigarettes, as MoL was approximately 27 minutes for the average market price, whereas for the economy segment it was approximately 20 minutes. In 2023, the average market price MoL was approximately 37 minutes, whereas for the economy segment it was approximately 31 minutes. This means affordability for cigarettes is decreasing, and the gap between economy and total market prices has decreased by one minute of labor over the 10-year span.

To better understand the RIP changes, we apply multivariate regression on the HBS data, taking into account sociodemographic characteristics that can affect cigarette affordability. RIP reflects the percentage of total household expenditure required to purchase a standard pack of cigarettes. Lower RIP values imply greater affordability, while higher values suggest a heavier financial burden. With all the drawbacks of the HBS

data availability and quality, it is still a great source for understanding changes in affordability across different income groups, along with other important sociodemographic characteristics. We begin our analysis by looking into a few important characteristics, following the literature on cigarette affordability.

Table 1. Factors affecting RIP – HBS data

VARIABLES	Model 1 (coef/se)	Model 2 (coef/se)
Education Level		
Secondary Education	-0.01** (0)	-0.01** (0)
Tertiary education	-0.02*** (0)	-0.02*** (0)
Primary education (base)	-	-
Household Characteristics		
Adult ratio	-	0.09*** (-0.01)
Mean age of household members	0.00*** (0)	0.00*** (0)
Gender of household head	0.04*** (0)	0.04*** (0)
Regional Dummies		
East	0.02** (-0.01)	0.02** (-0.01)
Southwest	-0.02*** (-0.01)	-0.02*** (-0.01)
Southeast	-0.01 (-0.01)	-0.01 (-0.01)
Pelagonija	0.03*** (-0.01)	0.03*** (-0.01)
Polog	-0.04*** (-0.01)	-0.04*** (-0.01)
Northwest	-0.02** (-0.01)	-0.01** (-0.01)
Skopje	-0.02*** (-0.01)	-0.02*** (-0.01)

VARIABLES	Model 1 (coef/se)	Model 2 (coef/se)
Vardar (base)	-	-
Employment Status		
Pensioner	0.03*** (0)	0.02*** (0)
Employed	0 (0)	0 (0)
Unemployed (base)	-	-
Income Groups		
Middle-income	-0.06*** (0)	-0.06*** (0)
High-income	-0.08*** (0)	-0.08*** (0)
Low-income (base)	-	-
Time Dummies		
y2018	-0.03*** (0)	-0.02*** (0)
y2019	-0.02*** (0)	-0.02*** (0)
y2021	0.01*** (0)	0.01*** (0)
y2022	0.03*** (0)	0.03*** (0)
Constant	0.07*** (-0.01)	0.02* (-0.01)
Observations	5,449	5,449
R-squared	0.25	0.27
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1		

Source: HBS and authors' calculations

Table 1 reports estimates from two linear regression specifications examining determinants of cigarette affordability, measured by the relative income price (RIP). Model 1 estimates cigarette affordability controlling for key socioeconomic and demographic characteristics, while Model 2 augments the specification by incorporating the household adult dependency ratio to account for household structure.

The results indicate that household educational attainment is significantly linked to cigarette affordability. Across both models, educational attainment is a strong and statistically significant determinant of cigarette affordability, measured by the relative income price (RIP). Relative to individuals with primary or no formal education, those with secondary education exhibit a 0.01-percentage-point-lower RIP, while tertiary education is associated with a larger reduction of 0.02 percentage points, indicating that more educated households devote a smaller share of income to cigarette purchases.

Household income shows a similarly robust gradient: compared to low-income households, middle-income and high-income households experience significantly lower RIP by 0.06 and 0.08 percentage points, respectively. This reflects greater cigarette affordability among higher-income groups, suggesting that high- and middle-income households spend less of their income to buy 100 packs of cigarettes, relative to households with low income. This finding is consistent with previous findings regarding the lowest-income households (Blecher & van Walbeek, 2009; Cizmovic et al., 2024) and is expected for North Macedonia due to the lower standard and limited funds for that population.

Pensioners face consistently higher RIP—by 0.03 percentage points in Model 1 and 0.02 percentage points in Model 2—suggesting lower affordability linked to fixed and relatively lower income levels. Substantial regional heterogeneity is observed relative to the Vardar region, with households in Pelagonia and the East exhibiting significantly higher RIP, while those in the Southwest, Polog, Northwest, and Skopje regions display significantly lower RIP, likely reflecting persistent regional income differences and socioeconomic patterns rather than price or tax variation, which is uniform nationwide.

Time-fixed effects indicate that affordability was significantly higher prior to 2020, with lower RIP in 2018 and 2019, while RIP increased modestly but significantly in 2021 and rose further in 2022, potentially reflecting post-pandemic inflationary pressures and income dynamics. Demographic characteristics also matter: higher mean household age and male-headed households are associated with higher RIP, indicating greater financial burden from cigarette expenditures.

In Model 2, the adult dependency ratio is positive and highly significant, implying that households with a larger number of adults relative to dependents face higher cigarette affordability burdens. Overall, the results demonstrate that cigarette affordability in North Macedonia is systematically shaped by education, income, household composition, and region, with the burden falling disproportionately on lower-income and pensioner households.

We proceed with the two-part model, with the aim of estimating affordability elasticities for the whole adult population and by different income groups. In the first part we estimate logistic regression and choose the preferred model based on Bayesian information criterion (BIC), pseudo-R-squared, and log-likelihood criterion. The results of the chosen model are presented in Table 2.

Table 2. Prevalence elasticity by income groups

Variables	Whole sample	Low-income	Middle-income	High-income
Main Indicator				
Affordability	-0.712***	-0.881***	-0.295	-0.289***
	(0.259)	(0.204)	(0.559)	(0.099)
Household Structure				
Household size	-0.045	0.035	0.111	0.028

Variables	Whole sample	Low-income	Middle-income	High-income
Se	(0.042)	(0.055)	(0.14)	(0.060)
Male ratio	0.109***	-0.061	0.143***	0.266***
Se	(0.038)	(0.057)	(0.026)	(0.068)
Adult ratio	0.313***	0.368*	0.269	0.148
Se	(0.065)	(0.174)	(0.186)	(0.189)
Education Level				
Secondary education	0.034	-0.080	-0.047	0.210**
Se	(0.093)	(0.095)	(0.092)	(0.089)
Tertiary education	-0.259***	-0.159	-0.411***	-0.097
Se	(0.059)	(0.226)	(0.067)	(0.115)
Primary education (base)	-	-	-	-
Regional & Location				
East	0.717***	0.636*	0.957***	0.366***
Se	(0.016)	(0.350)	(0.024)	(0.120)
Skopje	0.653***	0.936***	0.742***	0.17
Se	(0.032)	(0.326)	(0.046)	(0.098)
Rural	0.009	-0.026	-0.063	0.155
Se	(0.063)	(0.121)	(0.084)	(0.096)
Employment				

Variables	Whole sample	Low-income	Middle-income	High-income
Pensioner	-0.332***	-0.346***	-0.351***	-0.364***
Se	(0.073)	(0.129)	(0.095)	(0.073)
Employed	0.249***	0.247**	0.302***	0.256***
Se	(0.092)	(0.113)	(0.098)	(0.094)
Summary				
Observations	13,214	3,467	5,568	4,179
PREVALENCE ELASTICITY	-0.155*	-0.281*	-0.278	-0.277*
Se	(0.053)	(0.064)	(0.519)	(0.146)

Source: HBS data and authors' calculations

Note: Equality test – Wald tests indicate no statistically significant differences in prevalence elasticity across income groups: low-income versus middle-income groups ($\chi^2(1)=0.00$, $p>0.10$), low-income versus high-income groups ($\chi^2(1)=0.00$, $p>0.10$), and middle-income versus high-income groups ($\chi^2(1)=0.00$, $p>0.10$).

All post-estimation diagnostics tests confirm the validity of the chosen model. Overall, the results of the chosen model suggest that the prevalence affordability elasticity is approximately −0.2. The elasticity is −0.28 for both the low- and high-income groups, where the results are statistically significant, indicating a similar responsiveness to affordability changes across these two strata. This tells us that if there is 10-percent decrease in cigarette affordability, the prevalence should reduce by 2 percent. Alternately, by income groups that decrease would be 2.8 percent for low- and high-income households. However, for the middle-income group, the result did not reach statistical significance, suggesting that their tobacco consumption patterns may be less sensitive to affordability or influenced by other non-price factors.

The estimated prevalence elasticity of tobacco use is relatively high, particularly among low-income households. This indicates that changes in cigarette affordability have a substantial impact on smoking participation rather than merely on consumption intensity. A plausible explanation is that lower-income households are more sensitive to price and affordability changes due to tighter budget constraints. As tobacco products become less affordable, individuals in these households are more likely to quit smoking or refrain from initiating smoking altogether.

The high prevalence elasticity also suggests that tobacco taxation and price policies are effective not only in reducing cigarette consumption, but also in lowering smoking prevalence, thereby generating significant public health benefits. This finding is consistent with the notion that affordability-based measures capture both price changes and income growth, making them particularly powerful in middle-income countries where incomes are rising. In contrast, the prevalence elasticity for the middle-income group is statistically insignificant, which may reflect more heterogeneous smoking behavior or lower responsiveness to affordability changes in this group. Overall, the results highlight the progressive nature of tobacco taxation, as reductions in smoking prevalence are strongest among lower-income households.

When examining sociodemographic characteristics across the whole sample, the results suggest that cigarette consumption is more likely among households with a higher proportion of male and adult members, and where the household head is employed. Specifically, the male ratio and adult ratio both significantly increase the likelihood of smoking. Employment status of the household head is also positively associated with consumption. In contrast, higher educational attainment appears to reduce smoking prevalence. Households where the most-educated member has a tertiary education are significantly less likely to consume cigarettes, while secondary education shows no significant effect.

Regionally, cigarette consumption is significantly higher in nearly all regions compared to the reference (Vardar), particularly in Pelagonija, Southeast, and Northwest. Only, the

Polog region shows a negative association, indicating a lower likelihood of smoking. The analysis of the two regression models reveals a consistent relationship for the Vardar region (which serves as the reference group) between the relative price of cigarettes and the probability of smoking. Based on the coefficients from Table 1, we can conclude that the Vardar region has relatively lower cigarette affordability compared to most other regions.

The coefficients for most regions (Skopje, Polog, Southwest, Northwest) are negative and significant. This means those regions have a lower RIP than Vardar, which relates to greater affordability there. If cigarettes are more affordable in those regions, it indirectly means they are relatively less affordable in Vardar. Based on the coefficients from Table 2, the Vardar region has the lowest probability of smoking (prevalence) in the country. The coefficients for all other regions (except Polog, which has a negative but low coefficient) are positive and highly significant. A positive coefficient means the probability of smoking is higher in all those regions relative to Vardar.

The relationship between the two findings is economically consistent. Lower affordability leads to lower consumption or, in this case, a lower probability of smoking. This result suggests that price mechanisms (such as RIP) are acting effectively in the Vardar region, or alternately, that sociodemographic characteristics of the region contribute to reduced prevalence, irrespective of price elasticity.

Other variables like household size and urban/rural residence show no statistically significant impact. Additionally, being a pensioner is associated with a lower probability of cigarette consumption, possibly reflecting lower affordability or health-related behavior changes in older age.

The second part of the analysis is estimation of conditional price elasticity, by applying GLM method with a gamma family and log link.

Table 3. Conditional elasticity by income groups

Variables	Whole sample	Low-income	Middle-income	High-income
Main Indicator				
Affordability	-0.328***	-0.591**	-0.174***	-0.086**
Se	(0.084)	(0.242)	(0.048)	(0.038)
Household Structure				
Household size	-0.005	-0.046	0.037*	0.103***
Se	(0.025)	(0.054)	(0.021)	(0.024)
Male ratio	0.047***	-0.017	0.088***	0.011
Se	(0.016)	(0.027)	(0.025)	(0.031)
Adult ratio	0.206***	0.037	0.221**	0.227**
Se	(0.039)	(0.127)	(0.088)	(0.092)
Education Level				
Secondary education	-0.045**	-0.118**	-0.079***	0.002
Se	(0.018)	(0.056)	(0.028)	(0.037)
Tertiary education	-0.003	-0.058	-0.049	0.036
Se	(0.039)	(0.060)	(0.054)	(0.051)
Primary education (base)	-	-	-	-
Regional Dummies				

Variables	Whole sample	Low-income	Middle-income	High-income
East	-0.043*** (0.009)	-0.030 (0.032)	-0.063 (0.080)	-0.097 (0.086)
Skopje	0.008 (0.008)	-0.059*** (0.018)	-0.065 (0.074)	0.069 (0.072)
Rural	0.005 (0.037)	-0.027 (0.034)	-0.020 (0.026)	0.008 (0.033)
Employment				
Pensioner	-0.031* (0.018)	-0.010 (0.093)	-0.079** (0.033)	-0.029 (0.037)
Employed	0.030** (0.014)	-0.087** (0.039)	0.012 (0.030)	0.029 (0.029)
Summary				
Observations	5,207	1,136	2,181	1,890
CONDITIONAL ELASTICITY	-0.413*	-0.512*	-0.313*	-0.361*
Se	(0.016)	(0.031)	(0.197)	(0.023)

Source: HBS data and authors' calculations

Note: Equality tests were conducted to examine whether conditional affordability elasticities differ across income groups. The null hypothesis of equal elasticities could not be rejected for low-income and middle-income groups ($\chi^2(1)=1.00$, $p>0.10$) or for middle-income and high-income groups ($\chi^2(1)=0.06$, $p>0.10$). However, the difference between low-income and high-income groups is statistically significant ($\chi^2(1)=15.3$, $p<0.01$).

Table 3 presents the results of affordability elasticity and its relationship with cigarette consumption across the whole sample and by income group. Across all models, affordability is found to be negatively and significantly associated with cigarette consumption, consistent with economic theory. The whole sample shows a conditional

elasticity of −0.413, indicating that a 10-percent decline in affordability is associated with a 4.13-percent decline in consumption.

The effect varies significantly across income groups. The low-income group displays the highest responsiveness to affordability changes, with an elasticity of −0.591, while the middle-income group shows an elasticity of −0.174. The high-income group has the smallest, but still significant, elasticity at −0.086. These findings suggest that lower-income households are more price-sensitive than the high-income group, which has important policy implications for tobacco taxation and affordability-based interventions.

The adult ratio is positively and significantly associated with consumption in the whole sample, and this relationship holds in both the middle- and high-income groups, with similar effect sizes. The male ratio is significant in the whole sample and in the middle-income group, reinforcing the expectation that households with more men are more likely to consume cigarettes.

Educational attainment within the household has a clear association with cigarette consumption. Households where the most educated member has completed secondary education consume less than those with only primary education, with significant coefficients in the whole sample and in the low-income and middle-income groups. However, tertiary education does not show a statistically significant effect in any income group.

We estimated total affordability elasticity of demand for all households at -0.568 (Table 4). The overall elasticity reflects the average responsiveness across all households and therefore lies within the range of the subgroup estimates. This indicates that for every 10% decrease in cigarette affordability, total cigarette consumption in North Macedonia decreases by approximately 5.68%. When looking at the income strata, the results show that the low-income group has the highest responsiveness with an elasticity of -0.793,

while the high-income group has a slightly lower elasticity of -0.638. Although these point estimates differ, the overlapping confidence intervals suggest that the difference between the low- and high-income groups is not statistically significant. Both groups, however, remain significantly more responsive than the middle-income group (-0.591), whose results did not reach statistical significance ($p > 0.05$). Consequently, while the middle-income results are included for completeness, the analysis confirms that the primary impact of affordability changes is driven by the low- and high-income segments of the population.

Table 4. Total affordability elasticity of demand

	Whole sample		Low-income group		Middle-income group		High-income group	
	Coef.	Se	Coef.	Se	Coef.	Se	Coef.	Se
Elasticity	-0.568	0.069	-0.793	0.095	*-0.591*	*0.716*	-0.638	0.169

Source: Authors' calculations

Note: Equality test – Wald tests were conducted to examine whether affordability elasticities differ across income groups. The null hypothesis of equal elasticities could not be rejected for any pairwise comparison: low-income versus middle-income groups ($\chi^2(1)=0.08$, $p>0.10$), low-income versus high-income groups ($\chi^2(1)=0.64$, $p>0.10$), and middle-income versus high-income groups ($\chi^2(1)=0.004$, $p>0.10$). These results indicate no statistically significant differences in affordability elasticity across income groups.

For a robustness check of the results, we estimate the affordability of cigarettes on macro data from Customs and State Statistical Office data, using official monthly data on retail prices and quantities from 2014–2023. The series are too short, and the results we obtain should be treated with caution due to the possible caveats of the short time series, seasonality, and other limitations. The detailed analysis is presented in the Appendix, and here in Table 5, we present short-run and long-run coefficients as well as the error correction model added.

Table 5. Robustness check - Time-series analysis results

Parameter	Affordability Elasticity
Short-run Elasticity	-0.48***
Long-run Elasticity	-0.62***
Error Correction Coefficient (ECT)	-0.34***
Significance levels:	*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations

The short-run price elasticity is estimated at −0.48, which is lower than the long-run elasticity. In the long run, a 10-percent decrease in affordability would result in a 6.2-percent reduction in consumption. This is similar to the micro data output.

The error correction term of −0.34 is negative, statistically significant, and less than one in absolute value. This confirms the existence of a stable long-run relationship between cigarette consumption and affordability. It indicates that approximately 34 percent of the deviation from long-run equilibrium is corrected each month, suggesting a moderate pace of adjustment toward equilibrium after short-run shocks.

To calculate the half-life (how long it takes for 50 percent of a shock to dissipate), we use:

$$Half\ life = \frac{\ln(0.5)}{\ln\left(1 - |ECT|\right)} = \frac{\ln(0.5)}{\ln\left(1 - |0.34|\right)} = 1.78$$

This means that after a deviation from equilibrium, half of the adjustment occurs within about 1.8 months.

Discussion and Conclusion

Despite the measures and tobacco controls in place, prices for tobacco in North Macedonia are still low enough that tobacco products are affordable to the vast majority of the population. North Macedonia—being one of the countries in Europe with the highest smoking prevalence among the adult population, and tobacco consumption widespread across different discrete and semi-discrete social groups and accepted as a social norm—should do more to make tobacco less affordable to drive down consumption. To our knowledge, this paper is the first to investigate and elaborate the relationship between cigarette affordability and cigarette consumption in North Macedonia. As well as contributing to the existing literature, this paper, importantly, adds value to the ongoing policy making and discussion on tobacco consumption in the country. This study calculates the RIP and MoL indicators from macro data to inspect trends in the market and habits of tobacco consumers. Additionally, these data are further imputed into price segments of HBS data, in order to enable further analysis. The main analysis uses a two-step approach, a logit model accompanied by GLM. In both analyses, while inspecting the relationship between cigarette consumption and affordability we control for a number of sociodemographic characteristics already pointed to in the literature elucidated in the literature review.

This study finds that lower affordability is associated with lower smoking rates and consumption elasticity, with men more likely to smoke. The data indicate an affordability elasticity of –0.568, meaning that a 10-percent decrease in affordability is linked to a 5.7-percent decrease in overall consumption. This decrease in affordability is also associated with declines of 7.9 percent, 5.9 percent, and 6.4 percent among low-, middle-, and high-income groups, respectively. Education, age, gender, and having a pensioner in the household reduce the prevalence for smoking, whereas being employed increases the affordability and increases consumption. The results from the whole sample are similar to the results by income groups, with some differences in the magnitude and significance

of the coefficients. These results can be used to support better evidence-based policy making.

It is important to keep in mind the number of assumptions we had to make in the beginning of the analysis. The major limitation of this study is a lack of data, in terms of availability of meaningful measures and time periods. The HBS data we had access to are only for a very short period from 2018 to 2022, and without all of the needed variables, so we had to work with proxies and assumptions that make the measurements less precise. For example, price per pack paid by households, despite being in the questionnaire, was not available to us. The macro data are available, but the series are short, so we have to work with quarterly data, which adds the issue of possible seasonality in our data. Also, the data from Customs has quantities and prices by month, yet brands are not included, so we had to follow existing theory and assume the different market segments. Despite these limitations, we expect that the findings are robust and meaningful and represent the situation in this time period in the country.

Policy Recommendations

In line with WHO guidelines, North Macedonia should adopt a tobacco tax policy that aims to systematically reduce cigarette affordability. This involves not only continuing the planned excise increases through 2030 but accelerating them so they outpace both inflation and per capita income growth. Based on the findings of this study, a number of targeted policy actions are recommended to reduce tobacco consumption by addressing the persistently high affordability of cigarettes in North Macedonia.

- **Simplify the Tax Structure**: Currently, a mixed tax system (ad valorem and specific components) is in place, which can allow producers to exploit loopholes by adjusting retail prices. Shifting toward a larger specific component (or fully specific structure) would improve tax predictability, limit manipulation, and ensure more stable revenue collection while having a stronger public health effect. It would also

likely serve to drive up the prices of the lowest-priced brands more effectively than the existing hybrid structure.

- **Improve Data Availability and Transparency**: To support evidence-based policy making, it is essential to improve access to high quality data, particularly at the individual (micro) level. This includes ensuring full access to all HBS variables (such as price paid per pack, quantities consumed, or number of smokers per household), disaggregated wage and income data, and brand-level import and sales data from Customs and the Ministry of Finance. Strengthening surveillance systems and transparency would enable better monitoring of affordability trends and policy effectiveness.
- **Monitor Affordability Metrics Annually**: Annual monitoring of affordability metrics can ensure that tax increases are having the desired effect and facilitate course corrections and adjustments as needed.
- **Automate Excise Tax Adjustment for Inflation and Wage Growth**: The structure of excise taxation should shift toward specific taxes that are automatically adjusted for inflation and wage growth, as recommended by the WHO, to simplify administration and minimize tax avoidance.

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Appendix A: Micro-econometric Analysis (HBS Data)

Table A1: Robustness of prevalence elasticity: Comparison of alternative model specifications

	Model 1	Model 2	Model 3	Model 4
Affordability	-0.072**	-0.070**		
	-3.16	-3.12		
Log Affordability			-0.749**	-0.717**
			-2.87	-2.77
Household Size	0.0409	0.00788	-0.0203	-0.0453
	-0.89	-0.19	(-0.45)	(-1.10)
Male Ratio	0.122**	0.114**	0.116**	0.109**
	-3.08	-2.83	-3.1	-2.86
Adult Ratio	0.147	0.341***	0.129	0.311***
	-1.7	-4.77	-1.55	-4.83
Primary edu	-0.0962	-0.158*	-0.134	-0.191**
	(-1.50)	(-2.38)	(-1.90)	(-2.62)
Secondary edu	0.0602	-0.0622	-0.0173	-0.129
	-0.64	(-0.61)	(-0.16)	(-1.10)
Tertiary edu	-0.240**	-0.323***	-0.351***	-0.423***
	(-2.98)	(-3.83)	(-4.47)	(-4.51)
Vardar	0	0	0	0
	(.)	(.)	(.)	(.)
East	0.689***	0.748***	0.665***	0.722***
	-57.08	-36.43	-72.07	-42.7
Southwest	0.766***	0.821***	0.698***	0.755***
	-18.23	-22.86	-10.33	-11.97

Southeast	0.905***	0.905***	0.822***	0.827***
	-22.38	-22.13	-11.82	-11.73
Pelagonija	0.993***	1.006***	0.960***	0.975***
	-74.35	-72.55	-53.31	-52.33
Polog	-0.206**	-0.140*	-0.260**	-0.196*
	(-2.96)	(-2.39)	(-2.86)	(-2.37)
Northwest	0.819***	0.872***	0.783***	0.835***
	-22.56	-28.85	-16.53	-19.22
Skopje	0.631***	0.685***	0.605***	0.656***
	-19.15	-26.21	-17.01	-21.14
Urban				
Rural	0.0228	0.00382	0.0231	0.00525
	-0.36	-0.06	-0.35	-0.08
Household head gender	-0.354*	-0.258	-0.297	-0.209
	(-2.05)	(-1.43)	(-1.71)	(-1.17)
Pensioner		-0.359***		-0.333***
		(-5.90)		(-4.56)
Employed		0.268**		0.254**
		-2.79		-2.77
Constant	-1.608***	-1.720***	-2.171***	-2.251***
	(-4.21)	(-3.99)	(-3.92)	(-3.80)
aic	16775.5	16614.8	16647	16508.1
bic	16827.9	16667.3	16699.4	16560.5
r2_p	0.0541	0.0632	0.0614	0.0692
ll	-8380.7	-8300.4	-8316.5	-8247.1
t statistics in parentheses				

* p<0.05, **p<0.01, *** p<0.001

Source: Authors' calculations

Table A2. Model specification test (Linktest) for prevalence models 1-4

	Linktest							
	Model 1				Model 2			
	Coef.	Se	z	P>z	Coef.	Se	z	P>z
_hat	0.907	0.030	25.340	0.000	0.887	0.034	25.830	0.000
_hatsq	-0.174	0.024	-6.980	0.000	-0.178	0.024	-7.380	0.000
_cons	0.041	0.024	1.740	0.082	0.043	0.023	1.890	0.059
	Model 3				Model 4			
	Coef.	Se	15	P>z	Coef.	Se	z	P>z
_hat	-0.702	0.046	15.000	0.000	-0.691	0.045	15.250	0.000
_hatsq	-0.352	0.042	-8.350	0.000	-0.353	0.040	-8.770	0.000
_cons	0.050	0.023	2.160	0.030	0.060	0.023	2.630	0.009

Source: Authors' calculations

Table A3. Multicollinearity diagnostics: Variance Inflation Factor (VIF) for Model 4

VIF test	
	Model 4
Mean VIF	2.68

Source: Authors' calculations

Table A4. Hosmer-Lemeshow Goodness-of-Fit test for Model 4

	Model 4			
Observations	13,214	13,214	13,214	13,214
Groups	5	10	15	20
Chi2	8.77	53.22	54.47	61.03
P	0.03	0	0	0

Source: Authors' calculations

Table A5. Model specification test (Linktest) by income groups

	Linktest											
	Low-income				Middle-income				High-income			
	Coef.	Se	z	P>z	Coef.	Se	z	P>z	Coef.	Se	z	P>z
_hat	-0.609	0.114	5.32	0.000	-0.76	0.059	12.75	0.000	-0.888	0.061	14.67	0.000
_hatsq	-0.271	0.071	-3.82	0.000	-0.288	0.052	-5.5	0.000	-0.318	0.074	-4.33	0.000
_cons	-0.026	0.053	-0.5	0.619	0.076	0.036	2.12	0.034	0.097	0.041	2.39	0.017

Source: Authors' calculations

Table A6. Multicollinearity diagnostics (VIF) by income groups

VIF test			
	Low-income	Middle-income	High-income
Mean VIF	1.8	2.52	1.9

Source: Authors' calculations

Table A7. Hosmer-Lemeshow Goodness-of-Fit test by income groups

	Low-income				Middle-income				High-income			
Observations	3,467	3,467	3,467	3,467	5,568	5,568	5,568	5,568	4,179	4,179	4,179	4,179
Groups	5	10	15	20	5	10	15	20	5	10	15	20
Chi2	7.22	20.54	24.03	25.17	14.22	39.65	56.27	52.79	13.8	20.24	29.7	36.6
p	0.065	0.008	0.031	0.12	0.003	0	0	0	0.003	0.009	0.005	0.006

Source: Authors' calculations

Appendix B: Time-Series Analysis (Monthly Data Analysis)

Error correction –ARDL model test and results

To monthly data from Customs and the State Statistical Office, we apply unit root and co-integration tests. We first use the Hylleberg-Engle-Granger-Yoo (HEGY) procedure to check for the presence of a seasonal unit root. The outcome suggests that the log of tobacco consumption per capita and log of affordability are integrated of order 1 at 0 frequency, and no stochastic unit root.

Table B1. Seasonal Unit Root Test (HEGY) for Cigarette Consumption per Capita

Seasonal Unit Root HEGY-Log of cigarette consumption per capita		
Null	Simulator P-Value	Statistical
Non-seasonal unit root (zero frequency)	0.91	-2.14
Seasonal Unit Root (2 months per cycle)	0.02	5.54
Seasonal Unit Root (4 months per cycle)	0.00	7.42
Seasonal Unit Root (12 months per cycle)	0.01	7.31
Seasonal Unit Root (3 months per cycle)	0.02	6.41
Seasonal Unit Root (6 months per cycle)	0.00	11.69

Source: Authors' calculations

Table B2. Seasonal Unit Root Test (HEGY) for Log of Affordability

Seasonal Unit Root HEGY-Log of affordability		
Null	Simulater P-Value	Statistical
Non-seasonal unit root (zero frequncy)	0.14	-0.92
Seasonal Unit Root (2 months per cycle)	0.03	1.73
Seasonal Unit Root (4 months per cycle)	0.01	2.61
Seasonal Unit Root (12 months per cycle)	0.00	11.09
Seasonal Unit Root (3 months per cycle)	0.01	6.33
Seasonal Unit Root (6 months per cycle)	0.00	14.05

Source: Authors' calculations

We also implement the Zivot-Andrews unit root test, to check for the stationarity of variables in first difference.

Table B3. Zivot-Andrews Unit Root Test with Structural Break (First Differences)

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 Log affordability	-9.145*** -8.407***	Log cigarette sale Log affordability

Source: Authors' calculations

Table B4. Johansen Co-integration Test: Trace and Maximum Eigenvalue Results

Johansen co-integration tests							
Null hypotheses	Eigen value	Trace statistics	0.05 Critical value	Prob.**	Max-Eigen	0.05 Critical value	Prob.**
H0: (R=0)*	0.18	28.61	15.49	0.00	23.01	14.26	0.00
H0: (R≤1)	0.05	5.60	3.84	0.02	5.60	3.84	0.02
Max-eigenvalue test indicates 2 cointegrating equation(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values							

Source: Authors' calculations

Since the long-run relationship is detected by the initial tests, we proceed with ARDL ECM, from which we account for long-run relationships and short-run dynamics.

Table B5. ARDL Error Correction Model (ECM) Results and Diagnostic Tests

Affordability elasticity estimation – ARDL-ECM		
ADJ		
l.consumption	-0.34***	0.010
LR		
l.lnaffordability	-0.62***	0.027
SR		
d.lnaffordability	-0.48***	0.001
dum2	0.008	0.934
dum3	-0.076	0.553
dum4	0.054	0.670
dum5	0.123	0.321
dum6	0.197	0.107
dum7	0.280**	0.019
dum8	0.160	0.177
dum9	0.275**	0.022
dum10	0.136	0.271
dum11	0.273**	0.024
dum12	0.211*	0.081
Observations		119
Breusch-Pagan/ Cook-Weisberg test for heteroskedasticity		chi2(1)=0.38
Ho: Constant variance		Prob > chi2 = 0.35

Durbin's alternative test for autocorrelation H0: no serial correlation Breusch-Godfrey LM test for autocorrelation H0: no serial correlation Ramsey RESET H0: model has no omitted variables Jarque-Bera normality test Ho: normality Mean VIF	chi2(1) = 0.255 Prob > chi2 = 0.38 Prob > chi2 = 0.46 chi2(1)>0.24 test F(3, 119) = 1.86 Prob > F =0.09 Chi(2)= 1.56 Prob>chi2=0.42 2.65

Source: Authors' calculations

Finally, we confirm the presence of co-integration by a bound test, where the F-stat exceeds the lower and upper critical values.

Table B6. ARDL Bounds Test for Co-integration

ARDL bound test			
	F-statistic	Critical values F statistic	
ARDL 1	49.05	5.58	ARDL 1

Source: Authors' calculations