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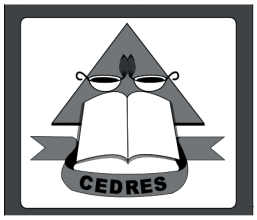

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SOMMAIRE

Tobacco control policies and cigarette demand among adolescents attending school in the Economic Community of West African States (ECOWAS) region

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ABSTRACT

This paper deals with the effects of the existence of tobacco control measures on cigarette demand (smoking participation and smoking intensity). We specify a logit model and generalized linear model with the gamma distribution and pooled cross-sectional data from the Center for Diseases Control and Prevention (CDC) Global Youth Tobacco Survey (GYTS). The empirical results show that 1% increase in the price of a pack of cigarettes results in 0.114% decrease in smoking participation and a 0.448% decrease in smoking intensity among adolescents aged 13 to 15 years. Anti-smoking media messages have a negative and significant effect on smoking intensity among adolescents aged 12 and under. Pro-smoking messages in magazines and newspapers encourage participation in smoking. Health policies should, in addition to heavy taxation, establish a monitoring strategy of cigarette sellers towards teenagers near schools and correct their behaviors. The total share of taxes has to increase permanently with the higher ad valorem taxes and the specific tax which encourages higher prices. Print media that expose adolescents to cigarette advertising messages should be heavily taxed.

Keywords : smoking intensity, smoking participation, ECOWAS, tobacco control.

JEL Codes: **I11, P36**

1. INTRODUCTION

The economic analysis of individual behavior, which starting point is the classical theory, has undergone a revolution since the microeconomic work of Becker (1962), who developed the concept of human capital. The author, a winner of the 1992 Nobel Prize in Economics, introduced social behavior by supporting the thesis that human capital, is defined as the accumulation of general or specific knowledge and the maintenance in good condition of physical capital, including health, nutrition, and hygiene, through investments, contributes to providing income. At the macroeconomic level, Lucas (1988) introduced in his model of endogenous growth, the existence of human capital which is one of the productive factors contributing to economic growth. Moreover, Grossman (1972), inspired on human capital approach, emphasizes that the individual and society have an initial healthy stock level in which they invest to maintain their health status over the lifetime. Thus, on the one hand, the author considers health as a consumer good and, on the other hand, as an investment good. In the latter case, health as health capital is an investment that contributes to human capital by determining the amount of time available for work. Health is therefore component of human capital that improves economic well-being through the monetary gains that time has made possible. However, in reality, some individuals invest in their health through a lifestyle such as smoking, which deteriorate of their health, and thus human capital (Allo, Sukartini, & Saptutyningsih, 2018).

Tobacco use is one of the scourges that represent a heavy economic and social burden for the global economy. On the one hand, it is the cause of nearly 8 million deaths each year (WHO, 2019). On the other hand, smoking-attributable diseases constitute health expenditures that amount to US$467 billion in 2012, or nearly 6% of global health expenditures (Goodchild, & al, 2017). The economic costs amount to nearly US$1.9 trillion or 1.8% of total global economic output (Drope, & al, 2018). According to Goodchild and colleagues, nearly 40% of these costs are located in developing countries. This scourge affects not only adults but also adolescents in both developed and developing countries.

More and more adolescents in developing countries, including those in West Africa, whom are smoking cigarettes, although these countries have tobacco control measures in place.

According to World Health Organization (WHO) statistics, in most ECOWAS countries, the price of the most popular brand of cigarettes has increased slightly but remains very low compared to developed countries. On average, the price increased from US$1.77 in 2008 to US$3.87 in 2018. It is worth noting that cigarette prices have decreased in Benin and Cape Verde. The price of the most popular cigarette has not exceeded US$5 in most countries over the past decade. In Ghana and Gambia, the price crossed that mark in 2016. Furthermore, from 2008 to 2018, the share of taxes in the price of a pack of cigarettes has not increased significantly in ECOWAS countries. This tax share is lower (less than 50%) than the WHO recommended share of 70% of the retail price of cigarettes to reduce cigarette demand. Because prices are too low teenagers have access to tobacco. Approximately 22.1% (Togo) to 49.5% (Mali) of adolescents buy their cigarettes in stores (WHO, Global Youth Tobacco Survey data sheets: 2003-2011). In addition, more than 50% of school-aged adolescents are exposed to cigarette advertising through billboards. Most of these adolescents are unaware that the presence of nicotine in cigarettes leads to addictive behavior in the consumer (Drope, & al. 2018) and these adolescents with greater exposure to nicotine are more likely to become addicted (Caraballo, Novak, & Asman, 2009). The literature review reveals that, although tobacco control policy studies are conducted in both developed and developing countries, the lack of limits the studies in these countries.

The findings of Chaloupka et al. (2010) on 21 European countries suggest that a strong dependence of tobacco control tax policies on the specific tax leading to a significant decrease in smoking but under the influence of the market power of manufacturers, this decrease would become more less. In addition, Nikaj & Chaloupka (2013) found that tobacco control tax policy in 38 low- and middle-income countries shows a deterrent effect on adolescent smoking participation and intensity but that adolescents in low- and middle-income countries are relatively more sensitive (-2.2) to price

increases than in high-income countries (-1.5). Nesson (2017) have shown that in the United States, tobacco control policies, particularly policies targeting minors, have a positive effect on cigarette demand. The findings of Odermatt & Stutzer (2018) show that cigarette price increases tend to be negatively associated with smoking among men and people under 30 in 21 European countries while smoking bans have no effect on smoking levels, after controlling for unobservable country and time effects.

Some studies have been carried out on the effects of tobacco control measures in a few ECOWAS countries, specifically Ghana, Nigeria, and others African countries. Indeed, the findings of Asare, Stoklosa, Drope, & Larsen (2019) reveal that in Ghana and Nigeria, increasing the price of cigarettes contributes to reducing the number of days of cigarette consumption and would prevent adolescents from taking up smoking. In the same vein, Immurana, Boachie, & Iddrisu (2021) found that increase in cigarette taxes and prices, controlling with the level of gross domestic product (GDP) per capita, urbanization, mortality rate and net foreign direct investment; reduces the smoking prevalence in Africa. Boachie & Ross (2020) also showed that, controlling for income, population growth and education, the short-run price elasticity of cigarette demand in Ghana is 0.1. MSocSci & van Walbeek (2022) show that increasing cigarette prices significantly reduces smoking participation and decreases the intensity of cigarette consumption among adolescents in 16 African countries.

Studies in European and American regions have shown that tobacco control policies are only effective if they are targeted and take into account the structure of excise duties (ad valorem and specific). However, in African regions, few take into account the structure of the tobacco market and the relevance of excise duties to cigarette demand. As a result, analyses in these regions would be mixed. Although, West African countries have ratified the WHO Framework Convention on Tobacco Control, including tax and non-tax policies to reduce demand, supply of tobacco products and illicit trade, most of ECOWAS countries have focused on reducing the demand for tobacco products.

However, these policies depend on the regional (ECOWAS and WAEMU[1]) and national legislation of each country, which would lead to inconsistency and divergence in tax and non-tax practices, thus hindering the effectiveness and neutrality of the effects of these policies on cigarette demand. In addition, both tax and non-tax measures are aimed to the all public (seniors, adults, youth and adolescents). Therefore, some measures may not have the same effect on all of these people, especially teenagers, who are a large population and very sensitive to the marketing of multinational tobacco companies. Limiting access to cigarettes for young people of a certain age is a measure that does not exist in some countries, and in those where it does, it is not yet effective. Moreover, most ECOWAS countries are among the poorest in the world, where access to clean water, good health care and education remains difficult, and if smoking behavior starts early among adolescents, it will constitute additional social and economic costs in the medium and long term, because of the smoking-related diseases they will suffer later on. This behavior will deteriorate their health, and constitute a loss of human resources, which is one of the factors of economic growth. In addition, countries invest heavily in the education of adolescents and they expect a pay-off for the investment. It is therefore necessary to undertake an analysis of the effect of anti-smoking measures on the demand for cigarettes by adolescents in school. Although the specificities of each country must be taken into account, the question is which measures have a greater deterrent effect on cigarette demand among adolescents and which do not, depending on the age of the adolescent. This article examines the effect of tobacco control measures on cigarette demand among school-going adolescents in the ECOWAS region.

In the remainder of this section, the analysis methodology used, results and interpretations, implications, and finally the conclusion is presented.

[1] West African Economic and Monetary Union

2. Literature review

Theoretical review

Economic issues relating to health are not excluded from the question of human capital, especially since Becker (1962), in extending the analysis of this notion, emphasized that health is a component of human capital. The first theoretical approaches to the demand for health (Andersen & Benham, 1970) developed a framework inspired by the neoclassical model but based on an accounting framework, in which individuals (patients) are demanders of care and as such they maximize their utilities, the arguments for which are medical and non-medical goods and services. This analytical framework was designed for health policy purposes. However, this model soon showed its limitations when considering the economic behavior of agents, they expect a given satisfaction after having consumed medical goods and services, hospital stays, analyses etc.; information that this model does not offer. In other words, this model makes it possible to compare the utility acquired by consuming two medical goods or services, but cannot formalize arbitrage between the time spent on maintaining an individual's good health and the expenditure he makes in terms of investments for which he expects future returns (Menahem, 2000).

New bases for human capital analysis have emerged with authors such as Becker (1964) and Lancaster (1966) for whom consumption is now a productive act. In this framework of analysis, satisfaction is no longer exclusively the result of the consumption of goods and services but also the combination with the consumer's personal time to relieve the ailment, to cure the ailment and to be able to return to work. This satisfaction will allow the consumer to have remunerations which will then have an impact on his consumption. Thus, the consumer is now the producer of his satisfaction. According to Mushkin (1962) and Fuchs (1966), health increases the wage rate since individuals with good health are productive and therefore expect remuneration. Grossman did not fully agree and shows that health capital is a different form of human capital than that

developed by his predecessors. He argues that the stock of knowledge available to the individual affects his or her market and non-market production, while the stock of health determines the amount of time he or she devotes to producing monetary and non-market gains. Therefore, individuals produce goods from the goods and services they buy in the market and the time they spend on them. For this author, the model must now take into account the productive efficiency of the different consumptions to maintain health capital, on the one hand, and on the other hand, to optimize the profitability of the different parts of human capital.
Based on the theoretical approach to human capital, Grossman (1972) emphasizes, in his approach to health demand, that the individual does not only consume health care but also produces his state of health, thus investing in a health capital. The individual who has an initial stock of health must maintain it throughout his life. As this stock depreciates with age, it can be increased by investments. These investments are not simply the purchase of medical care, but the individual's personal time, diet, exercise, leisure and housing. If the stock of health is considered an investment, it enters into the determination of the time needed for market and non-market activities whose goal is monetary gain. Thus, increasing the stock of health helps to reduce the time lost to these activities. Grossman sees this reduction as a monetary value that is the index of return on an investment in health. Ultimately, health, as a component of human capital, is a source of socio-economic well-being.

The author uses the household production function from the development of consumer behavior (Becker, 1965 ; Lancaster, 1966 ; Michael & Becker, 1973) to materialize the difference between health as a product and medical care as an input in the production process of this health. In this context, he links home production theory to human capital investment theory. He explains that the consumer, as an investor in his human capital, produces his own investments from his time, books, educational services and computers. In doing so, some outcomes of home production maximize the utility function, while other outcomes determine income or wealth. He argues that health is involved in both the determination of satisfaction (utility function) and the determination of income.

Grossman's model assumes that since health capital is a component of human capital, at birth the individual has a stock of health that depreciates with age at a more or less increasing rate and would increase through investments. Thus, when this stock falls below a certain threshold, death occurs and this individual chooses his life span. In addition, household production functions link a health output to health inputs such as health care utilization, diet, exercise, smoking and alcohol consumption. These production functions are affected by consumer productivity, which is defined as the amount of health obtained from a given amount of health inputs.

In the same vein, some authors have highlighted the individual's exposure to a lifestyle that is more or less risky for health. Dowie (1975) suggests that individuals are investors who can choose a portfolio of different lifestyles (which may include harmful activities such as drinking or smoking) that optimizes the expected return and the risk-health ratio. This issue was then taken up by Becker and Murphy (1988) in the rational addiction models. According to these authors, it is those who place little value on the future who are likely to adopt addictive behaviors such as smoking. Further, Becker, Grossman, & Murphy, (1991) show that it is people with a high level of education who are more reactive to the harmful future consequences of consuming addictive goods because they have a preference for the future. Since this behavior has a detrimental effect on health, the adoption of this behavior may increase present utility but reduce future utility (Becker & Mulligan, 1997). These authors therefore suggest that lower future utility reduces the benefits of lower discounted future utility and higher consumption of harmful substances would lead to higher rates of time preference, thus discouraging investment to reduce these rates. This result is contrary to Becker and Murphy's (1988) finding that people with a low preference for the future are more likely to become addicted. Thus, health-damaging addictions lead rational people to discount the future more strongly, which may lead them to be more addicted. In this model, it is understood that an investment such as smoking is risky for the health of the individual, especially as this behavior highlights the relevance of the benefits and costs it generates, not only for

the individual but also for society as a whole. Assessing the costs and benefits of consuming a good is often beyond the reach of the individual, as he or she does not have perfect information about the market.

Although the theory of rational addiction has been very successful in contributing to rational choice theory, it has not caught on because in real life it is much more complicated to relate addictive behavior to this model. Therefore, the traditional framework of consumer utility maximization is retained in our analysis.

Empirical review

Studies have increasingly focused on analyzing tobacco control policies on cigarette demand as either participation or prevalence (smoking or not) or conditional demand (smoking intensity), among youth or adults. The debate on the tobacco control policies and cigarette demand has focused i.e. on price and tax measures and non-price measures such as anti-smoking messages in the media, restrictions in public and private places, and cigarette advertising bans in both developed and developing countries. Odermatt & Stutzer (2018) analyzed the effect of tobacco control policies in 21 European countries and their results reveal that smoking bans are not associated with low conditional cigarette demand. However, there is negative relationship between high cigarette prices and cigarette demand, in the subgroup of men and people under 30 years of age, when considering smoking participation, a decrease of 3.7 percentage points and 4.9 percentage points, respectively. Their results also suggest that when cigarette prices are instrumented with ad valorem taxes (with the price resulting in a 50% increase), conditional demand (number of cigarettes per day) falls by 0.52, which is less than the effect on those under 30 at 1.19. To overcome the problems of simultaneity between cigarette demand and price and endogeneity, the authors used instrumental variables. Similarly, they included country-specific effect vectors in their estimates to account for regional heterogeneity in tobacco control policies over time.

The findings from the US (Nesson, 2017) show that increasing cigarette taxes leads to a decrease in smoking prevalence (participation in smoking) as measured by smokers self-reports and blood cotinine levels among adolescents. Moreover, among self-reported smokers, the tax does not have a significant effect on cigarette consumption but rather on blood cotinine levels. According to socio-economic groups in 9 European countries, Hu, et al. (2016) found that the most popular cigarette prices and non-tax policies were negatively associated with smoking prevalence among men and that the cheapest cigarette prices were negatively associated among women. These effects are stronger in the lowest socio-economic groups. According to findings on adolescents in 43 states in America reveal that Between 1999 and 2013; Hawkins, Bach, & Baum, (2016) show that teen smoking dropped from 35.3% to 13.9% with a 257% increase in taxes in 41 states. In addition, the authors show that among 14-to 15-year-olds, a US$1 increase in cigarette taxes results in a reduction in daily smoking by 2.2 and 1.6 percentage points, respectively. Passage of smoke-free restaurant legislation is associated with an overall reduction in smoking of 1.1 percentage points among adolescents regardless of age. Cigarette taxes and smoking bans are also associated with a decrease in the frequency of daily cigarette consumption.

Immurana, Boachie, & Iddrisu (2021) show about 16 African countries that high price is associated with low smoking participation, considering both local and international cigarette pack prices. Adolescents' exposure to tobacco advertisements is also associated with high levels of smoking participation for local brands but not for foreign brands. Anti-smoking messages deter smoking participation by considering foreign brands and not local brands. In places where smoking is prohibited, it is not easy for adolescents to smoke. The authors also showed that increasing the price of cigarettes had a significant negative effect on cigarette consumption but that there was no association between anti-smoking opinion, cigarette advertising or access to youth on the number of cigarettes. Exposure to anti-smoking messages leads to a decrease in the number of cigarettes smoked.

Cotti, Nesson, & Tefft (2016) found that analysis of US household panel data shows that increases in cigarette taxes decrease cigarette purchases and increase purchases of smoking cessation products, but smoking bans are not significant. Taxes on smokeless tobacco products lead to a decrease in the use of these products but cause compensatory behavior with substitute products, which the reduction in the number of cigarettes purchased cancel out.

More recent work on young smokers in low- and middle-income countries has shown that they are highly sensitive to cigarette prices. Results from Kostova & al. (2010) on 20 low- and middle-income countries reveal that the total price elasticity of demand is higher in these countries compared (-0.63) for smoking participation and -1.2 for cigarette conditional demand. The authors also found that neither anti-smoking opinion, cigarette advertising, nor access restrictions are associated with conditional cigarette demand among current smokers, however, exposure to anti-smoking media does reduce the number of cigarettes smoked. Comparing the results for low and high income countries, Nikaj & Chaloupka (2014) found that the price effect is significant and does not differ substantially between the two groups of countries. This suggests that adolescents in poor countries will behave in the same way as adolescents in high-income countries when faced with price increases.

Considering these studies, the results differ between geographic and economic areas. These results indicate that in many cases, tobacco control policies or measures only affect subgroups based on age or socioeconomic group membership. Although these policies exist in the ECOWAS region, they are intended to address the entire population and very few target different categories based on age or economic status. Moreover, the studies that focus on this area are mostly concerned with Ghana, Nigeria, Sierra Leone and the Gambia (Asare, & al. 2019; Nketiah-Amponsah, Afful-Mensah, & Ampaw, 2018; Boachie & al. 2022 ; Cham, Scholes, Groce, & Mindell, 2019).

This paper fill this gap by analyzing the effect of tobacco control policies on adolescent demand for cigarettes according to age in the ECOWAS region in order to determine which policies are appropriate.

Methodology

3.1 Specification of the estimation model

We used a two-part model to analyze smoking participation (smoking or not) and cigarette demand intensity (number of cigarettes smoked). The logit model analyzes adolescent smoking participation which is a dichotomous variable on the one hand, and the model is a generalized linear model that analyzes smoking intensity on the other hand. In this category of models, some take into account the dependence between the decision to participate and the quantity consumed, while other authors consider that the two decisions are independent (Manning et Mullahy, 2001). Estimation by the two-independent-parts model in the presence of heteroskedasticity yields unbiased and convergent parameter estimates, compared to estimation by ordinary least squares and the Heckman selection model. The ordinary least squares estimation method ignores selection bias, whereas the two-step independent models minimize selection bias. These estimates were done by age groups and for all ages.

The probability that the adolescent is a smoker is :

$$P(Y_{it} > 0) = f(\beta_0 + \beta_1 Prix_{jt} + \beta_2 X_{1jt} + \beta_3 X_{2ijt} + \varepsilon_i) \qquad (1)$$

With i denoting the adolescent, j denoting the country, and t denoting the year, X_{1jt} are anti-smoking and pro-smoking variables (anti-smoking opinion, cigarette advertising in print media, anti-smoking media message, access restrictions for youth) X_{2ijt} are socioeconomic and individual variables (pocket money, at least one parent smokes, gender, age).

The second part models the number of cigarettes smokers consume per month. It is the generalized linear model in which the relationship between the explained variable and the explanatory variable is the logarithm with a gamma distribution of the explained variable (Nikaj et Chaloupka, 2014). According to the general notation, the generalized linear model is expressed as follows :

$$g[E(Y)] = X\beta$$

With the link function $g(.) = \ln(.)$ and $Y \sim Gamma$. Gamma distribution has obtained by the Park test. This test consists of first regressing the variable of interest Y on the explanatory variables X by the ordinal least squares method; calculating the prediction of the variable of interest Y and the estimated residuals û and finally regressing ln ($\hat{u}^2$) on ln (Y) and a constant (Huber, 2006). The decision of the choice of the law depends on the parameters obtained in this last regression, if b, estimated equal 1, it means that the variance is exactly proportional to the expectation, it is the Poisson law. If b is estimated equal to 2, this means that the variance is proportional to the square of the expectation, in this case, it is the Gamma distribution. Specifying a gamma distribution with a log GLM link produces convergent and unbiased elasticity estimates in the presence of heteroskedasticity (Manning & Mullahy, 2001).

$$g\left(E\left[Y_{ijt}|Y_{ijt} > 0\right]\right) = \alpha_0 + \alpha_1 Prix_{jt} + \alpha_2 X_{1jt} + \alpha_3 X_{2ijt} + \varepsilon_i \qquad (2)$$

The independent variables are the same as the independent variables in the first equation.

3.2 Data

We use the Global Youth Tobacco Survey (GYTS), which is a set of micro-data on adolescent smoking provided by the Center for Disease Control and Prevention (CDC). These surveys cover adolescents aged 11-19 in 10 of the 15 ECOWAS countries (Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Ghana, Mali, Niger, Nigeria, Senegal, Togo), as information on cigarette prices is not available for The Gambia, Guinea, Guinea-Bissau, Liberia and Sierra Leone. We used the pooled data from these 10 countries (Appendix).

3. Results and discussions

Descriptive summary of data

We analyze cigarette demand using smoking participation (decision to smoke) and smoking intensity (conditional cigarette demand). Smoking participation is a binary variable equal to 1 if the adolescent smoked at least one cigarette in the month preceding the survey and 0 otherwise. Smoking intensity is the average number of cigarettes smoked in the month by the smoker. We calculated this quantity by multiplying the average number of days smoked and the average number of cigarettes smoked per day in the past month (Kostova et al., 2011). We obtained these two quantities from the questions, "In the *past 30 days, on the days you smoke, how many cigarettes do you usually smoke*? " and "In the *last month, how many days did you smoke*? ". **Table 1** shows that current smokers represent approximately 51.47% of our sample and the average number of cigarettes ranges from 1.5 to 600 cigarettes. The average consumption of cigarettes per month is approximately 41 cigarettes, or two (02) packs and one (01) cigarette per smoker.

In the GYTS database that we use in this article, the cigarette pack price is in local currency and available in a price range. Because of the price endogeneity, we averaged the price in the database of each country (Kostova and al., 2010; Ross & Chaloupka, 2004). Due to the endogeneity of prices (Kostova et al., 2010), we averaged the prices in each country's database. Endogeneity is present because, firstly, some teenage smokers look for low cigarette prices, which may influence the price of cigarettes. Secondly, smokers are better informed about real cigarette prices than non-smokers. Therefore, smoking status affects adolescents' cigarette price perception. The endogeneity problem will revise by calculating the average of cigarette price packs. According to Ross & Chaloupka (2004), assigning the average price to all students improves the precision of the estimates. The pack of cigarettes costs on average 5.10 US $. The independent variables are binary variables except for the price of cigarettes and pocket money (this variable was considered as a binary variable in the smoking participation equation) which is a continuous quantitative variable.

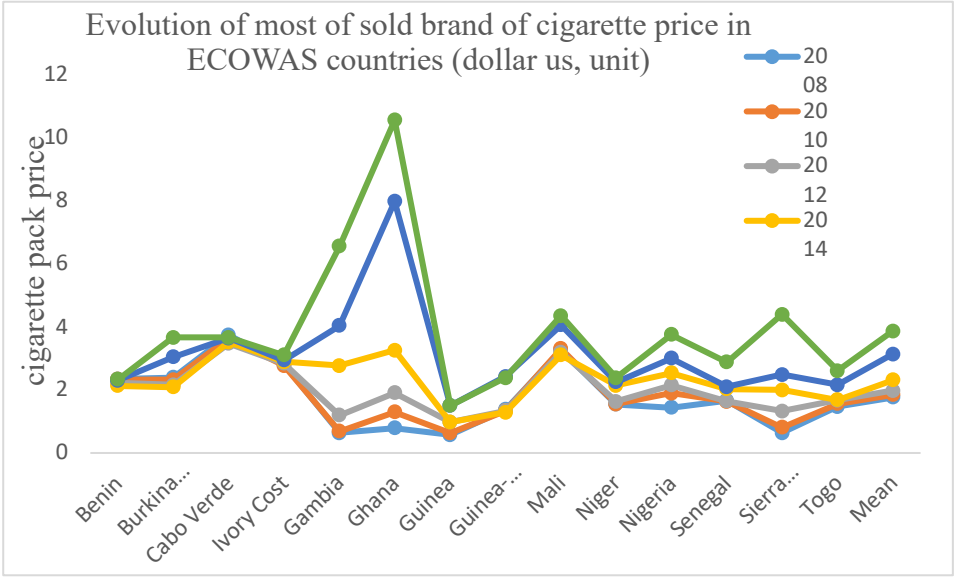
Table I. Descriptive analysis and description of dependent and independent variables

Variable	Description	Observations	mean	Standard deviation	Min	Max
Cigarettes smoked	Number of cigarettes smoked in the past month	1995	41.51667	104.583	1.5	600
Current Smokers	1 if smoked at least one cigarette past month, 0 otherwise	5799	0.5147439	0.4998257	0	1
Cigarette price	Real price (us dollar)	5799	5.107255	6.915046	.4310018	25.44654
At least one of the parents smoke	1 at least one parent smoke, 0 otherwise	5799	0.3347129	0.4681067	0	1
Pocket money	1 if received pocket money, 0 otherwise	5799	0.7599201	0.4719307	0	1
Income per month (pocket money received)	The amount received by adolescents per month	5799	9.864443	21.01213	0	186.3743
Age	Age in year	5799	14.31367	1.876326	11	19
Gender	1 if male, 0 otherwise	5799	0.6614934	0.4732426	0	1
Exposed to anti-tobacco media messages	1 if often exposed to anti-smoking media message, 0 otherwise	5799	0.7891016	0.4079816	0	1
Anti-smoking opinion	1, if nonsmokers support the public smoking ban, 0 otherwise	5799	0.6858079	0.4642333	0	1
Exposed to cigarette printed advertising message	1 if often exposed to cigarette advertising by printed media, 0 otherwise	5799	0.6689084	0.4706465	0	1
Youth access restrictions	1 if being unable to buy cigarettes due to age, 0 otherwise	5799	0.294706	0.4559498	0	1

There are recent databases from The Gambia, Ghana, and Sierra Leone (2017) and databases from Togo and Senegal (2013). However, these different databases do not contain all the variables of interest for our analysis, so our data are limited to 2009. For example, for The Gambia and Sierra Leone, we did not find variables on **Price** "How much do you usually pay for a pack of 20 cigarettes?" and **Pro-tobacco messages** "In the last 30 days (one month), how many advertisements or promotions for cigarettes have you seen in newspapers or magazines?" In the case of Ghana, we do not have the question variables: **Parent** "Do your parents smoke?" and "**Pro-tobacco messages** "In the past 30 days (one month), how many advertisements or promotions for cigarettes have you seen in newspapers or magazines?

Over the last ten years, the price of a pack of cigarettes in the various ECOWAS countries has not increased significantly (**figure 1**). However, it is noted that on average, the price has doubled in 2018 compared to the price in 2008. Thus, ECOWAS countries lack strong measures to keep prices continuously on the rise. Togo is one of the countries that recently increased its excise duty on tobacco products from 50% in 2019 to 150% in 2020 (*Loi des finances, article.* 243, 2020). Moreover, if all countries could increase excise duties to such a level, cigarette consumption would drop remarkably.

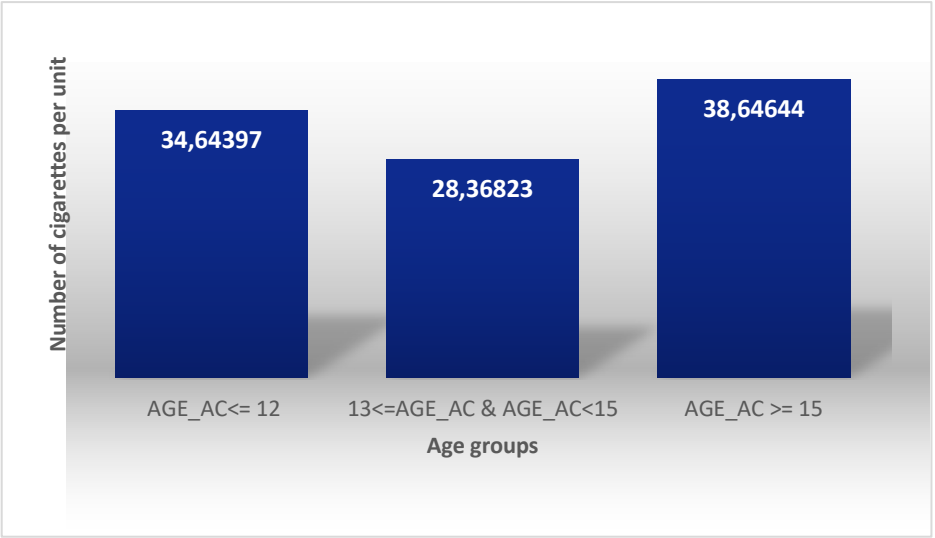
Figure 1. Evolution of most sold brand of cigarette price in ECOWAS countries from 2008 to 2018.



Source: Author, data from WHO, 2020

In our work sample, adolescents aged 13-15 years consume fewer cigarettes than the other two age groups in the ECOWAS region. It is also noticeable that the older ones consume more cigarettes (39 cigarettes) in a month than others (**figure 2**).

Figure 2. Average monthly cigarette consumption by age group.



Source: Author, data from database GYTS

Smoking participation (smoking prevalence, smoked or not)

Table II shows the effect of tobacco control policies on participation in smoking (decision to smoke). The price of a pack of cigarettes has a negative and statistically significant effect on the smoking participation of school-going adolescents. Smoking participation decreases by 0.114 when the price of cigarettes increases by 1%. This means that the increase in cigarette prices can have a deterrent effect on whether or not to smoke, thus preventing adolescents from taking up smoking, as they do not have enough income to buy cigarettes. This result is similar to the results of Kostova, et al. (2010) who found that the price elasticity of adolescent smoking participation is -0.63 in developing countries in different World Health Organization (WHO) regions. In the same vein, Nikaj & Chaloupka (2014) found that the price elasticity of adolescent smoking participation is -0.59 for 29 low- and middle-income countries. In addition, MSocSci & van Walbeek (2022) also showed in 16 Africa countries, that the price elasticity of participation is -0.70. Although the effects are in the same

direction as in previous studies, in ECOWAS countries this effect is lower than those found in developing countries and in other regions. One of the reasons for this is that ECOWAS countries practice ad valorem taxes that encourage low prices ((Shang, Chaloupka, Zahra, & Fong, 2014). In addition, the total tax share in the price of a cigarette pack is still very low compared to the WHO recommendation (75%). Across age groups, price does not have a significant effect on smoking participation for adolescents aged 12 years or younger. In contrast, the price has a negative and significant effect among adolescents between 13 and 15 years of age and those over 15 years of age. Adolescents over 15 years of age are more sensitive (-0.246) to high prices than adolescents between 13 and under 15 years of age (-0.138). Similarly, Hawkins, Bach, & Baum (2016) results reveal that from 1999 to 2013, tax increases had a significant effect on teenage smoking rates, i.e., a $1 increase in cigarette taxes was associated with a 2.2 and 1.6 percentage point decrease in current smoking among 14- to 15-year-olds in 43 US states. Thus, increasing the price of cigarettes through higher taxes will prevent in-school adolescents from becoming smokers.

Age-based restrictions on access to cigarettes have a positive and significant effect on smoking participation across all ages and age groups. It means that the likelihood of being a smoker increases if cigarette sellers do not show resistance when adolescents come to buy cigarettes. We explained it by the fact that vendors are not supervised in selling cigarettes to adolescents. Rimpela et Rainio, (2004) analyze the impact of the 1977 law limiting the minimum age of access to cigarettes to 16 and 18 in 1995 in Finland. Their results show that there is no immediate effect for 18-year-olds, but that after the revision of this law, including the requirement that vendors comply with laws prohibiting sales to minors, youth smoking prevalence and daily cigarette consumption declined later among 14 and 16 year old. Etter (2006) also found that most studies of laws banning the sale of tobacco to minors under 18 in 50 US states have shown that these measures are not effective, due to a lack of scientific data.

Anti-smoking opinion has a significant effect on smoking participation across ages but not across age groups. Having nonsmoking adolescents who support a ban on smoking in public places negatively influences participation, a 0.954 percentage point decrease. Kostova, et al. (2011) showed that a higher level of anti-smoking opinion decreases the likelihood of participation in smoking in developing countries and low- and middle-income countries, respectively. Anti-smoking messages through the media have positive and significant effect on smoking participation. These result does not mean that we should stop anti-smoking messages in the media. It is a matter of reviewing how these messages are delivered and the content of the messages. Are they not likely to encourage adolescents to smoke? The ECOWAS countries must review the content and the process of popularizing these messages.

Our result also shows that if the adolescent receive pocket money (it means that adolescents have received personal income), smoking participation increases. Knowing that teenagers are receiving pocket money may lead health officials to adopt a steady increase in prices to the point where they exceed the price threshold at which teenagers cannot afford to buy cigarettes. Consistent with the findings of Perelman et al. (2015). The authors show that, in the case of 6 europans countries, pocket money determines the act of buying cigarettes and the level of addiction and intensity of smoking.

Pro-tobacco messages in print media has a significant effect on smoking participation. When adolescents are more exposed to pro-tobacco messages in magazines and newspapers, the probability of being a smoker increases by 0.45 percentage points, if 100% of adolescents are exposed to these messages. This probability is higher among adolescents aged 13 to 15 years compared to other age groups. These results are similar to those found in studies by Kostova et al. (2011), who showed that high prevalence is associated with exposure to cigarette promotion messages in print magazines and newspapers in low- and middle-income countries. Nikaj & Chaloupka (2013) also found that a 10% increase in exposure to cigarette advertising is associated with a 0.3 percentage point increase in smoking participation.

Table II. Logit model of smoking participation [a]

Variables	All ages	Aged≤12	Aged between13-15	Aged ≥ 15
LPrice	-0.114*** (-3.21)	-.058 (-1.06)	-.138* (-1.91)	-.246*** (-4.04)
Youth access restrictions	0.132*** (8.47)	0.181*** (5.70)	0.155*** (5.60)	0.0765*** (3.47)
Exposed to media anti-tobacco messages	-0.00410 (-0.23)	-0.0481 (-1.25)	-0.0475 (-1.49)	0.0482* (1.89)
Anti-smoking opinion	-0.0322** (-2.05)	-0.0515 (-1.55)	-0.0143 (-0.51)	-0.0323 (-1.49)
Exposed to printed media pro-tobacco messages	0.137*** (8.90)	0.0973*** (3.04)	0.157*** (6.02)	0.124*** (5.49)
Pocket money	0.170*** (11.64)	0.205*** (6.89)	0.126*** (4.84)	0.182*** (8.64)
At least one of the parents smokes	0.233*** (16.34)	0.240*** (7.52)	0.241*** (9.04)	0.221*** (11.59)
Age in year	0.0302*** (7.60)			
Gender	0.236*** (16.31)	0.111*** (3.61)	0.211*** (8.48)	0.306*** (14.57)
Price-elasticity	-0.114	-.058	-.138	-.246
Observations	5874	1199	1770	2981
LR chi2[b]	*1086.79*	176.56	285.45	571.32
Prob > chi2	*0.0000*	*0.0000*	*0.0000*	*0.0000*
Goodness-of-fit test[c]				
Hosmer-Lemeshow chi2	*8.65*	10.36	9.94	10.58
Prob > chi2	*0.3728*	0.2407	0.2690	0.2269

t Student in parenthesis, Significance* *p< 0.10, **p< *0.*05, ***p< 0.*01

a: Coefficients: marginal effects. b: likelihood ratio test; c: Goodness-of-fit test

Conditional cigarette demand (smoking intensity)

Table III shows the effect of tobacco control policies on smoking intensity (conditional demand). Cigarette price has no significant effect on smoking intensity, regardless of age or age group, except among adolescents aged 13-15 years. According to our descriptive analyses, these adolescents use cigarettes less than other age groups. A targeted tobacco control policy can reduce consumption by 0.45% if the price is increased by 1% among this group. Given that cigarette pack prices in the ECOWAS region are very low, the pocket money that adolescents receive each month may counterbalance the effect of price on cigarette demand intensity. Indeed, according to our descriptive analysis, the average price of cigarettes is $5 per pack, while adolescents receive an average of $15 per month in pocket money. Nevertheless, this effect was larger than the effect of pocket money.

Furthermore, the results show that the income elasticity of demand (pocket money) is 0.268% when the price increases by 1%. In other words, when the pocket money of adolescents increases by 1%, the quantities demanded of cigarettes increase by 0.268%. Consistence with some previous studies, our findings have shown that disposable income is an important determinant of adolescent smoking (Chen et al. 2013; Wen et al. 2009). For adolescents, this income is their pocket money, which they use to purchase cigarettes. In an analysis of Chinese adolescents, Maa et al. (2013) showed that as pocket money increases, cigarette consumption increases. Similar results were also found by Cui et al. (2019) in the case of Canadian adolescents. The authors show that income elasticity is on average 0.6% among colleague adolescents.

Youth restrictions on access to cigarettes because of their age have a negative and significant effect on the intensity of cigarette demand among all adolescents of all ages but are not significant among adolescents under age 12. This result means that the number of cigarettes purchased will decrease by 22.848% points on average if all adolescents do not have access to cigarettes due to age restrictions. This result is similar to some results in the literature (Ross & Chaloupka, 2004). Our results may be explained by the fact that the sources from which adolescents purchase

cigarettes are such that these sources comply with the regulation not to sell to adolescents because of their age. However, our result is in contrast to some findings in the literature. Some authors (Chaloupka, Tauras, et Grossman, 2001; Kostova et al. 2010) show that there is no evidence that youth access restrictions can influence smoking intensity.

Anti-smoking media messages have a negative and significant effect on smoking intensity among adolescents aged 12 and under. This result shows that the youngest are influenced by anti-smoking messages. More anti-smoking campaigns are intensified, and the number of smoking 12-year-olds decreases. In a similar analysis, Nikaj & Chaloupka (2014) and Kostova & al. (2010) showed that anti-smoking messages have a deterrent effect on the intensity of cigarette consumption if all adolescents are exposed to these messages, in developing countries.

Pro-smoking messages have a significant effect (0.619%) on the demand for cigarettes among children aged 12 and over, but have no significant effect on other age groups. We find that this result, although not an elasticity, suggests that the number of cigarettes consumed would increase more than the deterrent effect of prices on that number. This means that the more adolescents are exposed to cigarette advertisements, the more they use cigarettes. The findings from Nikaj & Chaloupka (2013) also found that a 10% increase in exposure to cigarette advertising is associated with a 4.4% increase in cigarette conditional demand (cigarette intensity). In a review of studies, Lovato, Watts, & Stead (2011) show that cigarette advertisements can lead adolescents to take up smoking.

Table III: General linear model of conditional cigarette demand [d]

Variables	All ages	Aged ≤12	Aged between 13-15	Aged ≥ 15
LPrice (price elasticity)	-0.0384 (-0.31)	0.0867 (0.41)	-0.448* (-1.75)	-0.101 (-0.67)
Youth access restrictions	-0.356** (-2.14)	-1.514*** (-5.02)	0.288 (0.81)	-0.366** (-2.06)
Exposed to media anti-tobacco messages	-0.0166 (-0.09)	-0.550* (-1.65)	-0.430 (-1.09)	0.232 (1.25)
Anti-smoking sentiment	-0.236* (-1.74)	-0.564* (-1.68)	-0.0318 (-0.10)	-0.269* (-1.87)
Exposed to printed media pro-tobacco messages	-0.112 (-0.67)	0.619** (2.25)	-0.534 (-1.62)	-0.217 (-1.16)
Income per month (pocket money received)	0.268*** (4.97)	0.444*** (3.22)	0.325** (2.37)	0.270*** (4.87)
At least one of the parents smokes	0.458*** (3.25)	1.170*** (3.91)	0.353 (1.08)	0.529*** (3.73)
Age in year	0.156*** (3.83)	-	-	-
Gender	0.274 (1.36)	0.223 (0.57)	-0.175 (-0.44)	0.532*** (2.60)
Observations	1546	184	366	1018

d: ***Coefficients: marginal effects***

4. CONCLUSION

This paper analyzed the effect of tobacco control policies on cigarette demand among school-going adolescents. Our results show that both tax and non-tax measures are channels for reducing adolescent cigarette demand. Of all these tobacco control policies, if any should be strengthened, it should be to increase prices; the total tax share of the cigarette price should be permanently increased by raising ad valorem rates and a preference for specific tax that encourages high prices. A large increase in taxes would lead to a consequent decrease in the demand for cigarettes among adolescents. This should be a permanent objective to avoid that the income level of teenagers (pocket money) counterbalances the price effect. Limiting the age of access to cigarettes would be an economic policy that would delay the age of initiation if there is a strategy to monitor cigarette sellers, implemented through consumer associations in ECOWAS states. It is also a question of reviewing the form of anti-smoking messages to adolescents in schools and banning cigarette advertising in all its forms. Our results also suggest that banning cigarette advertising prevents adolescents under the age of 12 from becoming smokers. Local tobacco control programs at the decentralized level instituted in ECOWAS countries can help reinforce anti-smoking views preventing adolescents from becoming smokers and help reduce the number of cigarettes consumed by adolescents over the age of 15. This paper does not highlight the long-term effects, the results of which would be more relevant for health economic policy. In addition, gender and country-specific work would help to refine tobacco control policies.

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Appendix

Park test

lrdv2	Coef.	Std. Err.	T	P>t	[95% Conf.	Interval]
Lny	1.893622	.0508854	37.21	0.000	1.793825	1.993419
_cons	.0355337	.1853891	0.19	0.848	-.3280523	.3991198

$$b\ estimed\ = 1.79714 \cong 2 \Longrightarrow \ \text{Gamma}$$

Table IV. List of ECOWAS countries and observations

	Year								
Countries	2000	2001	2002	2003	2006	2007	2008	2009	Observations
Benin	-	-	-	1225	-	-	-	-	1225
Burkina Faso	-	895	-	-	1541	-	-	1402	3838
Cape Verde	-	-	-	-	-	648	-	-	648
Ivory Coast	-	-	-	1457	-	-	-	1413	2870
Gambie	-	-	-	-	-	-	412	-	412
Ghana	421	-	-	-	1667	-	-	2137	4225
Guinee	-	-	-	-	-	-	862	-	862

	Year								
Countries	2000	2001	2002	2003	2006	2007	2008	2009	Observations
Guinee Bissau	-	-	-	-	-	-	714	-	714
Liberia	-	-	-	-	-	-	521	-	521
Mali	-	812	-	-	-	-	1683	-	2495
Niger	-	578	-	-	430	-	-	469	1477
Nigeria	120	-	-	-	-	-	454	-	574
Senegal	-	-	722	-	-	-	-	-	722
Sierra Leone	-	-	-	-	-	-	1076	-	1076
Togo	-	-	662	-	-	-	-	-	662
Observations	541	2285	1384	2682	3638	648	5722	5421	22321

Generalized linear model (tests)

Model 1 (All ages)

Parameters test

Chi2 (9) = 50.69

Prob > chi2 = 0.0000

Test model specification

Cigarettes smoked	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
_hat	.2341744	1.469949	0.16	0.873	-2.646872	3.115221
_hatsq	.1037905	.1984537	0.52	0.601	-.2851717	.4927527
_cons	1.38207	2.68735	0.51	0.607	-3.885039	6.649179

Model 2 (Aged ≤12)

Parameters test

Chi2 (8) = 88.52

Prob > chi2 = 0.0000

Test model specification

Cigarettes smoked	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
_hat	1.1292	.5076804	2.2	0.026	.1341643	2.124235
_hatsq	-.025068	.0957245	-0.26	0.793	-.2126846	.1625485
_cons	-.1260417	.6063883	-0.21	0.835	-1.314541	1.062458

Model 3 (Aged between 13-15)

Parameters test

Chi2 (8) = 54.38

Prob > chi2 = 0.0000

Test model specification

Cigarettes smoked	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_hat	.0380262	1.896426	0.02	0.984	-3.6789	3.754952
_hatsq	.1232313	.2419134	0.51	0.610	-.3509103	.5973729
_cons	1.85054	3.691276	0.50	0.616	-5.384227	9.085308

Model 4 (Aged ≥ 15)

Parameters test

Chi2 (8) = 14.51

Prob > chi2 = 0.0695

Test model specification

Cigarettes smoked	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_hat	6.026738	3.57794	1.68	0.092	-.9858955	13.03937
_hatsq	-.7425972	.525096	-1.41	0.157	-1.771766	.2865721
_cons	-8.29905	5.97049	-1.39	0.165	-20.001	3.402896

Table V. Evolution of most sold cigarette pack price (dollar)

ECOWAS Countries	Evolution of most sold cigarette pack price (dollar)					
	2008	2010	2012	2014	2016	2018
Benin	2,34713739	2,33172121	2,22178542	2,13671382	2,30478808	2,33884933
Burkina Faso	2,39470947	2,32345586	2,16145248	2,09223708	3,04595542	3,66418316
Cape Verde	3,74366189	3,64637139	3,47224061	3,5196954	3,6429056	3,66985871

ECOWAS Countries	Evolution of most sold cigarette pack price (dollar)					
	2008	2010	2012	2014	2016	2018
Ivory Coast	2,81733549	2,77325663	2,83953389	2,895968	2,94157646	3,11246833
Gambia	0,63651176	0,69048306	1,19943584	2,76978556	4,03994068	6,56378547
Ghana	0,78979112	1,29513827	1,91061898	3,2634474	7,98650183	10,5661587
Guinea	0,57723888	0,6330433	0,98041304	0,98041304	1,50324353	1,50324353
Guinea-Bissau	1,38447308	1,33685643	1,34346251	1,29202797	2,42409493	2,38837238
Liberia	113,116713	96,4882789	124,553882	107,066522	119,435035	242,795987
Mali	3,27198669	3,31193705	3,20098468	3,10588346	4,06820727	4,35821997
Niger	1,54386289	1,55630547	1,63934631	2,14199937	2,25239518	2,38397754
Nigeria	1,4412279	1,89800291	2,15558987	2,53380179	3,00306294	3,75971459
Senegal	1,66720648	1,6349372	1,64191256	2,03583221	2,10173986	2,888639
Sierra Leone	0,64316281	0,8099855	1,32687971	1,99950012	2,48309261	4,39494372
Togo	1,47488557	1,5602348	1,67901829	1,68138406	2,16530878	2,60583864
Mean	9,18999363	8,1526672	10,1551037	9,30101406	10,8931899	19,799616