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TOBACCO PRICE INCREASES AND JOINT TAX REFORMS:

THE CASE OF MEXICO AND NONCOMMUNICABLE DISEASES

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Key Messages

- ***An increase in the prices of tobacco, alcohol, and soft drinks due to higher taxes would decrease their consumption, resulting in lower health costs and higher revenue in Mexico.***
- ***Among smokers, a ten-percent increase in cigarette prices would reduce tobacco consumption by 6.8 percent, alcohol consumption by 1.38 percent, and soft drink consumption by 0.54 percent.***
- ***Among smokers, a ten-percent increase in cigarette prices would reduce tobacco consumption by 6.8 percent, a ten-percent increase in alcohol prices would decrease alcohol consumption by 7.7 percent, and a ten-percent increase in soft drink prices would reduce soft drink consumption by 5.02 percent.***
- ***A simultaneous increase in excise taxes would produce an even larger aggregate reduction in cigarette, alcohol, and soft drink consumption in the general population than if the taxes were implemented separately over time.***
- ***A fiscal reform that increases cigarette prices by 43.7 percent, alcohol prices by 8.3 percent, and soft drinks prices by 8.7 percent, would reduce cigarette consumption the most—by 40.46 percent—while also decreasing alcoholic beverage consumption by 6.88 percent and soft drink consumption by 7.22 percent.***
- ***The expected smoking cessation associated with a 43-percent increase in the price of cigarettes would lead to a 7.9-percent decrease in smoking by people with high blood pressure, a decrease of 9.1 percent in people with diabetes, and a decrease of 4.3 percent among people with obesity.***

Executive Summary

The consumption of tobacco, alcohol, and sugary drinks (including soft drinks) is a public health problem that has become even more pronounced in the context of the COVID-19 pandemic. All three products are directly associated with noncommunicable diseases (NCDs) like diabetes, obesity, and high blood pressure (hypertension), which are in turn directly linked to a greater risk of severe COVID-19 outcomes.

It is in this context that this policy report presents two analyses. First, the authors look at the effect of an increase in tobacco taxation on the consumption of tobacco, alcohol, and soft drinks in Mexico. The estimates shows that a tax increase that effectively raises the retail price of cigarettes would decrease consumption not only of tobacco but also alcohol and soft drinks. Second, the authors analyze the effect of an increase in tobacco tax and tobacco retail prices on smokers with specific NCDs, or comorbidities. Overwhelming evidence demonstrates that increasing tobacco taxes is a tool that serves to decrease tobacco consumption; but in Mexico it brings about an even greater decrease among smokers with NCDs, in particular among individuals with diabetes, obesity, and high blood pressure.

Tobacco, alcohol, and soft drinks are complementary goods in Mexico. This means that they exhibit associated demand: as tobacco prices increase, the demand for cigarettes falls, but so does the demand for alcohol and soft drinks. This effect occurs across the entire smoking population but is even more marked among smokers with NCDs.

A ten-percent increase in the retail price of cigarettes, alcohol, and soft drinks in Mexico would achieve a decrease in tobacco consumption of 8.16 percent for smokers with obesity, 8.47 percent for smokers with diabetes, and 8.67 percent among smokers with high blood pressure. Meanwhile, all three groups would also decrease their consumption of alcohol, with elasticity values of -5.01, -5.28, and -3.61 percent, respectively, while the product that will see the sharpest fall in consumption is soft drinks, which exhibit an average elasticity of -9.97 percent across the three NCD groups.

The tobacco reform proposed in 2020 would increase the retail price of cigarettes by 43 percent by raising the specific component of the IEPS excise tax from 0.49 pesos to 1.50 pesos per cigarette, bringing the total tax burden, including VAT, to 77 percent of the final retail price. This would bring about the greatest reduction in consumption among smokers with diabetes and hypertension, who exhibit the highest elasticity. In addition, the smoking cessation expected in such a context is highest among smokers with high blood pressure, with a 20.9 percent decrease, followed by an 18.14 percent decrease in smokers with diabetes and a 9.84 percent decrease among smokers with obesity.

The analysis shows how an increase in the price of tobacco, effected through fiscal reform, can bring about a decrease in consumption that primarily benefits groups with comorbidities or who consume high-risk products, such as alcoholic beverages and soft drinks. Therefore, this study provides new findings on the viability of reducing smoking, particularly among people with NCDs.

The results obtained in this study are useful for designing health and fiscal policy against the backdrop of the challenges posed by the COVID-19 pandemic amid the economic crisis faced by Mexico in 2021. The state needs resources, and tobacco taxation is one fiscal reform measure that would make it possible to raise these resources progressively. Indeed, it would yield a number of dividends by reducing tobacco use across the population as a whole but even more so among groups with health conditions that make them more vulnerable to severe outcomes from COVID-19: smokers with diabetes, obesity, and high blood pressure.

The savings generated for the country's health system would be substantial, as it is these groups that would be most responsive in decreasing their consumption of all three goods—and to a high extent. A consistent and significant increase in the prices of tobacco, alcohol, and soft drinks is crucial in order to update tax rates and thus enable the Mexican state to cover the current costs of providing health care to those whose health has been harmed as a result of consuming these three goods.

Introduction

The consumption of tobacco, alcohol, and soft drinks is a global public health concern. These products are associated with diabetes, obesity, and high blood pressure, which—when combined with smoking—cause heart disease and other adverse effects on health. In Mexico, noncommunicable diseases (NCDs) and road traffic accidents associated with alcohol abuse are the leading causes of death (Colchero et al., 2016).

Obesity now affects more than 40 percent of Mexicans and has been declared an epidemic in the country (Colchero et al., 2015) as the prevalence of obesity and overweight has remained at 72 percent since 2011 (Colchero et al., 2016). Recent studies have found that Mexico's rates of diabetes, overweight, and obesity are among the highest in the world, and they are the highest in Latin America (OECD, 2015; Popkin et al., 2017).

It is well known that fiscal policy is highly effective in reducing smoking (Warner, 2000). However, it is also known that such policies can bring about joint effects on alcoholic or sugary drinks (Colchero et al., 2015, 2016; Guerrero-López et al., 2017), which at times can counteract the policy goal.

It is possible that when the price of one good increases it has the effect of increasing consumption of another good, instead of decreasing the consumption of both. This happens in the case of substitute goods, the opposite of which are complementary goods (Decker & Schwartz, 2000).

Whatever the impact of fiscal policy, it will be felt in poorer households more quickly (Singhal & Joshi, 2017; Huesca et al., 2019) as they have less disposable income, but such policy offers a tool with which additional revenue can be generated that can be used to counter any potentially negative effects.

Smoking and the comorbidities associated with the consumption of tobacco, alcohol, and a poor diet are factors that increase the likelihood of more severe outcomes from COVID-19, including hospitalization and/or needing to use a ventilator (Patanavanich & Glantz, 2020; Gülsen et al., 2020; Li et al., 2020; Apicella et al., 2020), thereby posing a greater risk of death. In fact, the cumulative effects of smoking on the body confer a greater risk of requiring supplemental oxygen and death if individuals contract COVID-19 (Li et al., 2020). The combination of smoking and having an NCD leads to an increase in mortality generally (WHO, 2017; Sung et al., 2016; Yeh et al., 2010; Oba et al., 2012; Campagne et al., 2019) and an increase in the likelihood of severe outcomes from COVID-19 infection, especially for individuals with any type of diabetes mellitus, high blood pressure, or chronic lung disease (Apicella et al., 2020).

This situation is compounded by the obesity pandemic in Mexico (TLDE, 2021; Apicella et al., 2020) posing a dual challenge for Mexico and its health system, which has had to deal with both these comorbidities and with the COVID-19 pandemic itself.

In 2020, COVID-19 claimed the lives of 125,000 Mexicans (INEGI, 2021), and, according to recent figures, as of February 2021 as many as 294,287 deaths in Mexico may be associated with COVID-19 (BBC, 2021). The risk posed by COVID-19 is much higher for individuals with an NCD, and the likelihood of severe outcomes from COVID-19 among smokers and people with diabetes mellitus and cardiovascular disease has been confirmed in a number of studies (WHO, 2017; Sung et al., 2016; Yeh et al., 2010; Oba et al., 2012; Kawakami et al., 1997). Furthermore, the combined harmful effects of smoking and high blood sugar can speed up vascular damage in smokers with diabetes (Campagne et al., 2019). The alarm bell sounded by the pandemic should therefore be responded to with a focus on promoting tax reforms that provide the government with funds it can allocate to the health system.

Therefore, public policies that discourage tobacco and alcohol consumption and encourage healthy eating not only help reduce the risk of developing NCDs but also lower the risk and mortality associated with communicable diseases like COVID-19. Of all public policies that states may choose to implement, fiscal policy is one of the most cost-effective strategies to reduce consumption of harmful products while generating additional revenue that can be used to cover health care costs incurred as a result of NCDs or the COVID-19 pandemic. Such ideas have been widely discussed in

global and Latin American health care institutions (Pan American Health Organization [PAHO], 2015; Guerrero-López et al., 2017).

The objective of this study is to estimate the effect of an increase in prices due to higher taxes on tobacco, alcoholic beverages, and soft drinks and determine its impact on consumption in Mexico. In particular, the analysis also seeks to explore the effect of an increase in taxes and retail prices on at-risk groups, such as people with obesity, diabetes, and high blood pressure.

Because tobacco, alcohol, and soft drinks are related goods, an increase in the price of one of these items—through taxes—will result in changes in the consumption of the other two. Some authors argue that tobacco and alcohol are substitute goods, maintaining that an increase in tobacco prices will reduce consumption of tobacco but result in an increase in alcohol consumption (insofar as the price of alcohol remains constant or increases to a lesser extent than that of tobacco). On the other hand, other studies (see, for example, Tauchmann et al., 2013, for Germany and Chávez, 2016, for Ecuador) assert that the two goods are complementary and suggest that an increase in tobacco prices will reduce the consumption of tobacco but will also achieve a moderate decrease in alcohol consumption.

Until now, there were no estimates to answer theses empirical questions about substitutability and complementarity among unhealthy products. Accordingly, this research estimates first the own- and cross-price elasticities of demand for tobacco, alcohol, and soft drinks in the general population and in subpopulations of consumers, and second the elasticities for smokers by type of comorbidity and the impact in terms of smoking cessation.

This paper is structured as follows. The first section presents the methodology; and the second part discusses the response to price increases among groups of consumers of tobacco, alcohol, and soft drinks and groups with an NCD, specifically obesity, diabetes, and high blood pressure. The third section discusses the results obtained in the context of the challenges posed by the COVID-19 pandemic and the impacts of a comprehensive tax reform increasing the prices of tobacco, alcohol, and soft drinks simultaneously, considering the general population and groups with specific comorbidities. The fourth section presents the conclusion of the research and highlights the most relevant aspects to inform appropriate fiscal and health policy, with policy recommendations that can be implemented this year, in 2021, in the context of the COVID-19 pandemic.

Methodology

Data

This analysis utilizes the National Survey of Household Income and Expenditure (ENIGH) of Mexico, which provides information on the amounts of tobacco, sugary drinks (in this case, only soft drinks)[1], and alcohol consumed and unit values. Because the ENIGH does not include information on consumer health, which is necessary to conduct an analysis of subgroups by health condition, the database is merged with the National Health and Nutrition Survey (ENSANUT) for the same year, 2018.

Survey of Household Income and Expenditure

The National Survey of Household Income and Expenditure (ENIGH) is a cross-sectional survey conducted every two years by the National Institute of Statistics and Geography in Mexico. It employs two-stage cluster probability sampling based on primary sampling units (PSUs) in which the dwelling is the selection unit and the household the observation unit. The stratification of the surveys also takes into account the size of localities (urban or rural). In this

[1] Henceforth, the terms soft drinks and sodas are used indistinctively.

sense, the ENIGH is nationally representative, and the results can be extended to the whole population—even at a subnational level—with 269,206 observations that represent 125,091,790 people in 2018. The target population considered in the analysis is individuals aged 12 and older, with a total of 212,394 observations. The appendix A presents basic statistics pertaining to the sample employed.

To estimate the demand for cigarettes, alcoholic beverages, and soft drinks, the authors use microdata from the 2018 survey; the ENIGH includes the quantities needed to convert consumption of tobacco, alcohol, and sugary drinks (in this case, soft drinks) to measurable unit values for each good. In the case of cigarettes, the survey reports weekly household expenditure in kilograms. This unit of measurement is adapted based on a standard criterion for conversion in the literature, which considers each cigarette to weigh 1.25 grams. Alcohol is reported based on type of beverage and categorized into three levels: light alcohol (beer, pulque, and cider), table alcohol (wine, anisette, and sherry), and high-alcohol drinks (tequila, vodka, rum, and mezcal). This classification provides the volume of alcohol content, making it possible to apply the corresponding tax rate to each type of alcoholic beverage. Thus, the authors determine the amount consumed, and then expenditure can be used to obtain the respective unit values. In this empirical exercise, the authors choose beer because it is the most frequently consumed beverage in the country. Lastly, in this study, the authors select only soft drinks, as they constitute one of the most commonly consumed products in the country and enable the direct application of the excise tax rate in the proposed tax reforms.

In this definition, the authors adopt the concepts of a smoking household, an alcohol-drinking household, and a soda-drinking household whenever a household has positive expenditure on the corresponding good. Lastly, taxes are calculated by reconstructing the taxable base for expenditure on these goods and then applying the new tax and adding the corresponding value-added tax (VAT).

National Health and Nutrition Survey

The National Health and Nutrition Survey (ENSANUT) is a nationally representative survey that employs a sampling procedure involving over 46,000 households (158,044 individuals) for a total national population of 126,468,224. The survey includes demographic, socioeconomic, nutritional, and health-related information collected through questionnaires administered to individuals aged 20 years and older from a random sample of households, selected by stratified cluster sampling. The data collected also report dietary intake and anthropometric values. The survey asks whether respondents have an NCD, and diabetes, high blood pressure, and obesity are evaluated directly by the survey. The sample for the 2018 survey comprises 125,516 individuals.

Lastly, this survey, like the ENIGH, also provides information on household expenditure on tobacco, alcoholic beverages, and soft drinks. See Table A2 in Appendix A for a further breakdown of basic statistics for the sample.

Matching of ENIGH and ENSANUT databases

Although the ENIGH and ENSANUT differ in their objectives, they are conducted within the same methodological framework. The ENIGH aims to capture the different sources of income available to households and their members and expenditure patterns, while the ENSANUT is designed to describe the health of the national population and understand firsthand the comorbidities and NCDs among the population. Both surveys share common characteristics and are conducted using the same statistical method, within the same sampling and methodological framework. Both were conducted in 2018.

In order to combine information from the two surveys, they must capture the same characteristics, such as area of residence, gender, and education levels of household members. It is therefore necessary to “match” the surveys. The use of matching models provides robust estimators to analyze the surveys. In this case, by combining the surveys, it becomes possible to estimate the demand for cigarettes, alcohol, and soft drinks in Mexico, as well as to obtain results

detailing the change in consumption that comes with changes in prices among individuals with specific medical conditions, for example obesity, diabetes, or high blood pressure.

The two databases are fused together using the probability matching technique, for which there is a wide array of literature providing insight into its numerous applications (Ridder & Moffitt, 2007; Wozny et al., 2010; Rios-Avila, 2018). While the authors cannot be certain that the same primary sampling units are selected in the different surveys, this issue is overcome using a matching approach under predefined groupings (Rios-Avila, 2018). The authors use the *psmatch* procedure, in which population groups in the databases are selected based on the degree to which they match. For example, the two groupings could be based on gender (male/female) or income stratum (by quintile, or tertile in this case). If the proportion of males and females is similar in the different samples, the authors can keep these two groupings. Within each group, the authors execute a *psmatch* model. The population groups are selected based on the degree of matching following the nearest neighbor approach.[2]

One key variable in achieving better propensity score matching between the two surveys is the income group. Similar groups are formed based on tobacco expenditure, alcohol expenditure, and residents' income. Each group is subdivided by tertile. These three variables are available in ENIGH and ENSANUT data, ensuring a better combination of these three categories and producing 3 x 3 x 3 = 27 groups. Each group is constructed considering the tertile of tobacco consumers, the tertile of alcohol consumers, and the tertile of soft drink consumers.[3]

Tertiles by income and by type of consumer are calculated in the ENIGH, maintaining consistent groups in each database. The matching exercise is completed by applying a probit regression to the variables contained in both surveys (see Tables B1 and B2 in Appendix B): stratum; gender; age; urban/rural locality; state of residence; marital status; if they speak a native language; if they attend school; if they have a refuse collection service; homeownership status; if they have a water tank (rooftop or ground-level), an electricity meter, air conditioning, a car, a van, a truck, or a motorcycle; and if they have pay television, a computer, use of a cell phone, an Internet or telephone connection, an iron, a blender, a refrigerator, a stove, a washing machine, a microwave, and access to medical services. This regression provides the highest likelihood of matches between individuals in both databases, which ultimately constitutes the condition for overlaying data from both databases (ENSANUT + ENIGH).

Estimation of demand for the Mexican population

In order to report on tax reforms and their impacts on the prices of goods considered in the analysis, below we present the general demand model is presented below for the three goods and their own-price elasticity and elasticity with respect to the price of the other goods in Equation (1):

$$q_i = \alpha_i + \sum_{i=1}^{n} \beta_{1i} p_i + \gamma \left[\theta(q,u) e^{\gamma^i p} \right], i = 1,2,3 \quad (1)$$

where q_{i1} is the amount of good 1 consumed, p_1 its price and β_1 the elasticity for that good; q_2, p_2 and β_{i1} the amount of good 2, its price and its cross-elasticity with the related good, respectively; and q_3, p_3 and β_{i1} are the amount, price, and cross-elasticity for good 3. Equation (1) considers i = 3 in reference to the goods included in the fiscal reform in this paper (tobacco, alcohol, and soft drinks), where θ is the quasi-indirect utility function.

[2] In this case, the authors employ the nearest neighbor method and STATA's psmatch2 code, ensuring the most similar clusters in both databases. For more details on this technique, see Becker & Ichino (2002).
[3] Few combinations occur that could be observations with zero consumption. Ultimately, after observations from groups with zeros were excluded, they were replaced based on the primary sampling units (PSUs) in order of increasing household income.

Deaton's Unit Value Model (DUVM) was used to estimate demand. In the Deaton model, demand is defined as

$$w_{h,c} = \alpha_0 + \beta_0 lnx_{ic} + \gamma_0 z_{hc} + \phi_0 \ln(V_{h,c}) + u_{0,c} \quad (2)$$

where $w_{h,c}$ is the log for expenditure on the basket of three goods (cigarettes, alcohol, and soft drinks), lnx is the log of income, and z_{hc} is a vector of other individual characteristics of the head of the household (age; sex; marital status [if married or not]; stratum identifying urban and rural areas of residence; social stratum, divided into four subgroups: high, medium, medium-low, and low; and education, based on last level completed by the head of the household). $\phi_0 \ln (V_{h,c})$ is the unit value of the price of each good consumed (tobacco, alcohol, and soft drinks) in logarithms. The subscript *c* represents the number of households in the cluster, and subscript *h* indicates the number of households that report purchasing each good.

The regression equations for the calculations are expressed for expenditure and unit value in Equations (3) and (4) respectively, considering the variables with superscripts α^1, y^1, u^1 as the number of households reporting purchasing *i* goods, namely tobacco, alcohol and soft drinks, in Equation (3):

$$w_{hc} = \alpha^0 + \beta^0 lnx_{ic} + \gamma^0 Z_{hc} + \sum_{N=1}^{3} \theta ln\pi_c + (f_c + u_{hc}^0) \quad (3)$$

$$lnv_{hc} = \alpha^1 + \beta^1 lnx_{ic} + \gamma^1 Z_{hc} + \sum_{N=1}^{3} \psi ln\pi_c + u_{hc}^1 \quad (4)$$

For cross demand, the authors consider subscript *j* to represent each subset of consumers and subscript *c* to indicate geographical location:

$$y_{cj}^1 = \propto^1 + \sum_{N=1}^{3} \gamma ln\pi_{cj} + u_{cj}^1 \quad (5)$$

$$y_{cj}^0 = \propto^0 + \sum_{N=1}^{3} \theta ln\pi_{cj} + f_{cj} + u_{cj}^0 \quad (6)$$

Both expressions show the mean unit value and mean demand for cigarettes, alcohol, and soft drinks in the group after eliminating the effects of household expenditure and household characteristics considered. Own-price and cross elasticities are calculated following the usual procedure, as described in Deaton (1997).

Estimation of demand for populations with an NCD

To estimate demand for the population with an NCD, the authors include *k* subgroups of consumers, where *k* indicates the type of comorbidity—be it obesity, high blood pressure, or diabetes. Equations (7) and (8) show the impact on consumption of each good, by type of comorbidity.

$$y_{cij,k}^1 = \propto^1 + \sum_{k=1}^{3} \gamma ln\pi_{cij,k} + u_{cij,k}^1 \quad (7)$$

$$y_{cij,k}^0 = \propto^0 + \sum_{k=1}^{3} \theta ln\pi_{cij,k} + f_{cij,k} + u_{cij,k}^0 \quad (8)$$

$$Prob(use = 1) = \Phi(\beta_0 + \beta_{price} \ln(price) + \beta_{ij} X_{ij} + u) \quad (9)$$

In order to then calculate elasticity, with the change in the proportion of consumers (cessation) that would occur in the event of the increase in the retail price of tobacco, essentially the authors follow the literature on two-part models that calculate participation elasticity (Cragg, 1971; Heckman, 1976; Dow & Norton, 2003; Nargis et al., 2013; Saha et al., 1997), where $ln(price)$ is the unit price of the good in question, X_{ij} is a vector of explanatory variables like the total number of household members (tot_integ), the individual's age (edad), the log of current income (ling_cor), whether the person is female (sexo_2) or lives in an urban area (urbano_2), his or her social stratum (estrato), completed schooling on a discrete scale from 0 to 9 (nivelaprob), and marital status on a discrete scale from 1 to 6 (edo_conyug).

In this study, the authors observe the necessary information on expenditure in the event of price changes. Conversely, to estimate the impact on the margin, the decision to consume is being modeled subject to positive amounts of the good consumed (that is, alcohol, tobacco, and soft drinks). The literature on two-part models focuses on estimating statistics at the population level and how to infer change in the mean amount consumed.[4]

Results

Own-price and cross elasticities by population subgroup

Table 1 shows the results of the estimation of own-price and cross elasticities for cigarettes, alcoholic beverages, and soft drinks for the Mexican population based on the ENIGH. The evidence demonstrates that an increase in prices would result in a decrease in consumption of all three goods. Moreover, cigarettes, alcoholic beverages, and soft drinks are complementary within the Mexican population—meaning that a price increase in one good would reduce the consumption not only of that good but also the other two.

A ten-percent increase in the price of cigarettes would reduce consumption of cigarettes by 7.57 percent, consumption of alcohol by 0.22 percent, and consumption of soft drinks by 0.81 percent. A ten-percent increase in the price of alcohol would reduce consumption of alcohol by 6.0 percent, consumption of tobacco by 0.36 percent, and consumption of soft drinks by 0.17 percent (Table 1, second column). The third column of Table 1 shows that a ten-percent increase in the price of soft drinks would reduce consumption of soft drinks by 4.04 percent, consumption of tobacco by 8.1 percent, and consumption of alcohol by 1.09 percent.

Table 1. Effect of a ten-percent increase in the prices of cigarettes, alcohol, and soft drinks (general population, based on ENIGH 2018)

Effect on consumption of:	Increase of 10% in the price of		
	Tobacco	Alcohol	Soft drinks
Tobacco	-7.57***	-0.36***	-8.09***
Alcohol	-0.22**	-5.99***	-1.09***
Soft drinks	-0.81**	-0.17**	-4.04***

*** STE at 0.001 significance level; ** STE at 0.05 significance level; * STE at 0.10 significance level
Source: Authors' calculations

[4] See Appendix B for a mathematical explanation of this approach.

Results for smokers

Table 2 presents the results of own-price and cross elasticities among smokers. The differences found in Tables 1 and 2 are due to the selection of consumers. For example, a ten-percent increase in the price of cigarettes would result in a decrease in total consumption of cigarettes of 7.57 percent (Table 1) due to the fact that some smokers would quit smoking while others continue to smoke despite the price increase. However, among smokers, the decrease in consumption would only be 6.8 percent, as the calculation only takes into account those who continue to smoke.

Table 2. Effect of a ten-percent increase in the prices of cigarettes, alcohol, and soft drinks in Mexico (smokers, based on ENIGH 2018)

Effect on consumption of:	Increase of 10% in the price of		
	Tobacco	Alcohol	Soft drinks
Tobacco	-6.81**	-0.18**	-0.26***
Alcohol	-1.38***	-7.71**	-1.92**
Soft drinks	-0.54**	-0.48***	-5.02***

*** STE at 0.001 significance level; ** STE at 0.05 significance level; * STE at 0.10 significance level
Source: Authors' calculations

Among smokers, a ten-percent increase in the price of cigarettes would reduce alcohol consumption by 1.38 percent and soft drink consumption by 0.54 percent. This means that among smokers a greater reduction would be achieved in alcohol consumption, indicating that among smokers there exists greater complementarity between cigarettes and alcohol and less complementarity between cigarettes and soft drinks.

A ten-percent increase in the price of alcoholic beverages would lead smokers to reduce their consumption of alcohol by 7.7 percent, their consumption of cigarettes by 0.2 percent, and their consumption of soft drinks by 0.5 percent. In the event of a ten-percent increase in the price of soft drinks, smokers' consumption of soft drinks would decrease by 5.02 percent, while their cigarette consumption would fall by 0.26 percent and their alcohol consumption would fall by 1.92 percent.

Smokers would be more responsive than the general population in terms of reducing their consumption of alcoholic and soft drinks but less responsive in terms of purchasing cigarettes. The results obtained here for tobacco are in line with previous estimations using a similar methodology in Mexico (Huesca et al., 2020; CIEP, 2020) and constitute evidence that cigarettes, soft drinks, and alcoholic beverages are complementary for smokers. The results are also consistent with findings reported in recent years in Germany (Tauchmann et al., 2013) and Ecuador (Chávez, 2016).

Results for alcohol consumers

Table 3 presents the results of own-price and cross elasticities among consumers of alcohol. In the event of a ten-percent increase in the price of cigarettes, alcohol drinkers would reduce their consumption of cigarettes to a lesser extent, by 1.14 percent, their consumption of alcohol by 0.56 percent, and their consumption of soft drinks by 0.38 percent. A ten-percent increase in alcohol prices, on the other hand, would lead alcohol drinkers to reduce their consumption of cigarettes by 4.85 percent and their consumption of alcohol by 3.08 percent, yet their consumption of soft drinks would increase by 4.3 percent. In the case of a ten-percent increase in the price of soft drinks, alcohol drinkers would reduce their consumption of cigarettes by 1.19 percent, increase their consumption of alcohol by just 1.56 percent, and reduce their consumption of soft drinks by 8.96 percent.

Table 3. Effect of a ten-percent increase in the prices of cigarettes, alcohol, and soft drinks in Mexico (alcohol drinkers, based on ENIGH 2018)

Effect on consumption of:	Increase of 10% in the price of		
	Tobacco	Alcohol	Soft drinks
Tobacco	-1.14**	-4.85**	-1.19**
Alcohol	-0.56***	-3.08*	1.56*
Soft drinks	-0.38**	4.30***	-8.96**

*** STE at 0.001 significance level; ** STE at 0.05 significance level; * STE at 0.10 significance level
Source: Authors' calculations

This group of consumers tends to be less responsive to increases in the price of alcohol than other groups, and it is the only group to exhibit substitution between alcohol and soft drinks. However, the elasticities are in line with recent literature on soft drinks that report values close to unity (Colchero et al., 2015, 2016).

It is worth keeping in mind the limitations in the way products are grouped under the categories of alcohol and soft drinks. No distinction is made between different levels of alcohol content, and the only types of sugary drinks considered in this analysis are soft drinks (sodas). The estimations presented later demonstrate how the elasticities for soft drinks are most responsive to a comprehensive tax reform affecting all three goods.

Results for soft drink consumers

Table 4 presents the results of own-price and cross elasticities among consumers of soft drinks. In the face of a ten-percent increase in the price of cigarettes, consumers of soft drinks would reduce their consumption of tobacco by 5.96 percent, their consumption of alcohol by 2.80 percent, and their consumption of soft drinks by 1.16 percent. Meanwhile, a ten-percent increase in the price of alcohol would lead this group of consumers to reduce their consumption of cigarettes by 4.40 percent, their alcohol consumption by 3.81 percent, and their soft drink consumption by 4.48 percent. Complementarity is maintained.

If soft drink prices rise by ten percent, the impact achieved is a 1.02-percent decrease in consumption of cigarettes, a 2.54-percent decrease in alcohol consumption, and a decrease as high as 6.96 percent in the consumption of soft drinks. This result is as expected, as the greatest impact is on soft drinks themselves.

A ten-percent increase in the price of their preferred good would primarily lead soft drink consumers to drink fewer soft drinks but would also result in a reduction of their consumption of tobacco and alcohol, given that the elasticities between them are complementary. This suggests that a tax increase applied to the three products can feasibly yield positive results. This group of consumers exhibits trends consistent with recently estimated elasticities in the literature for Mexico (Colchero et al., 2015).

Table 4. Effect of a ten-percent increase in the prices of cigarettes, alcohol, and soft drinks in Mexico (soft drink consumers, based on ENIGH 2018)

Effect on consumption of:	Increase of 10% in the price of		
	Tobacco	Alcohol	Soft drinks
Tobacco	-5.96**	-4.40**	-1.02**
Alcohol	-2.80***	-3.81**	-2.54**
Soft drinks	-1.16**	-4.48***	-6.96**

*** STE at 0.001 significance level; ** STE at 0.05 significance level; * STE at 0.10 significance level
Source: Authors' calculations

Results for smokers by type of comorbidity

This section reports the changes that price increases would cause in consumption of the three goods among smokers with an NCD. Table 5 presents the results of the own-price and cross elasticities for the total population and for smokers with obesity, diabetes, and high blood pressure.

Table 5. Effect of a ten-percent increase in the prices of cigarettes, alcohol, and soft drinks in Mexico on smokers, by comorbidity group (based on ENSANUT-ENIGH 2018)

	Increase of 10% in the price of		
	Tobacco	Alcohol	Soft drinks
Total population	-5.93***	-4.52***	-9.98***
Hypertension	-8.16**	-5.01**	-9.97**
Diabetes	-8.47***	-5.28***	-9.97**
Obesity	-8.67***	-3.61**	-9.96**

*** STE at 0.001 significance level; ** STE at 0.05 significance level; * STE at 0.10 significance level
Source: Authors' calculations

The own-price elasticities for the Mexican population shown in Table 5 differ from the results presented in Table 1. These differences are due to new information obtained by combining the ENIGH and ENSANUT databases. For cigarettes and alcohol, the difference is around one percentage point: a ten-percent increase in the price of cigarettes would lead to a decrease in consumption of cigarettes of between 7.57 and 5.93 percent, and the difference is highly statistically significant (>0.001). A ten-percent increase in the price of alcohol would see a decrease in alcohol consumption of between 5.99 and 4.52 percent (significant at the 0.001 significance level). For soft drinks, however, the difference is considerable (-4.04 and -9.98 percent), although the sign is the same. In this case, the new information provided by the ENSANUT survey may lead to a slight overestimation of the coefficient for soft drinks with respect to the previous estimation based solely on the ENIGH data, but this is closer to values reported by the literature on soft drink elasticity in Mexico (Colchero et al., 2015, 2016).

Among smokers with obesity, a ten-percent increase in the price of cigarettes would reduce consumption of tobacco by 8.16 percent. This figure stands at 8.47 percent for smokers with diabetes and 8.60 percent for smokers with high blood pressure (hypertension). Meanwhile, a ten-percent increase in the price of alcohol would result in a similar reduction in consumption among individuals with obesity and diabetes, with changes of -5.01 and -5.28 percent, respectively, while for smokers with hypertension the decrease would be lower, with a change of -3.61 percent (second column, Table 5). Lastly, an increase of ten percent in soft drink prices may result in a decrease in consumption close to unity among groups with a comorbidity, as reported by the literature, with changes of -9.96 percent for smokers with hypertension and -9.97 percent for smokers with diabetes or obesity.

Generally speaking, among groups with a comorbidity, tax reforms that have an impact on the price of soft drinks would produce the greatest reduction in the consumption of that same good (own-price elasticity), followed by increases in the prices of tobacco and lastly alcohol.

Implementation of a joint tax reform

This section discusses the potential impact of implementing a tax increase that simultaneously raises the prices of cigarettes, alcoholic beverages, and soft drinks in Mexico. This section considers the bill put forward in the Mexican Congress on April 7, 2020, by deputies Laura Imelda Pérez Segura and Carmen Medel Palma (Cámara de Diputados [Chamber of Deputies], 2020).

The proposed initiative would increase the specific component of excise tax (IEPS) on tobacco from 0.4944 pesos to 1.4944 pesos per cigarette. For alcohol, the increase would depend on alcohol content. For drinks with alcohol content up to 14°GL (Gay Lussac) this tax would increase from 26.5 percent to 35 percent, for drinks with alcohol content over 14°GL and up to and including 20°GL it would increase from 30 percent to 60 percent, and for drinks over 20°GL the applicable tax rate would rise from 53 percent to 80 percent. Specific IEPS on sugary drinks (and energy drinks with added sugar) would go from 1.2616 pesos to 2.2616 pesos per liter (Cámara de Diputados, 2020).

Assuming that this tax increase is passed on in full to the consumer, the price of a pack of cigarettes would increase from the current price of 64 pesos to 92 pesos, which equates to a 43.7-percent increase. For alcohol, the authors take the base value of a six-pack of the most commonly consumed beer, the price of which would go from 78.5 to 85 pesos, or an increase of 8.3 percent. Lastly, for soft drinks, the authors take the most frequently consumed Coca-Cola product, the three-liter bottle, which would increase in price from 40 to 43.5 pesos: a percentage change of just 8.7 percent.

Table 6. Reductions in consumption as a result of the 2020 reform initiative for cigarettes, alcohol, and soft drinks in Mexico (in %)

Effect on consumption of:	Increase in product price due to reform			
	Only tobacco	Only alcohol	Only soft drinks	All three products
% change in price	43.7	8.3	8.7	
Tobacco	-33.08	-0.30	-7.08	-40.46
Alcohol	-0.96	-4.96	-0.95	-6.88
Soft drinks	-3.54	-0.14	-3.54	-7.22

Source: Authors' calculations

Based on the information in Table 6 and using the cross-elasticity of demand equation together with the parameters obtained in the section on NCDs, it is estimated that the change in price of each product (top row) would have the greatest impact on tobacco, with a 43.7-percent increase due to the reform, followed by an 8.7-percent increase in the price of soft drinks and an 8.3-percent increase in the price of alcohol. This produces the following results:

- If the increase in IEPS is only applied to tobacco, consumption of cigarettes would decrease by 33.08 percent, while alcohol consumption would drop by 0.96 percent and soft drink consumption would drop by 3.54 percent (first column).
- If the increase in IEPS is only applied to alcoholic drinks, consumption of cigarettes would decrease by 0.30 percent, while alcohol consumption would be more heavily impacted with a reduction of 4.96 percent, and soft drink consumption would decrease by 0.14 percent.
- If the increase in IEPS is only applied to soft drinks, consumption of cigarettes would fall by 7.08 percent, while soft drink consumption would decrease by 3.54 percent and alcohol consumption by 0.95 percent.

- Implementing all three components included in the 2020 bill would reduce consumption of cigarettes by 40.46 percent, consumption of alcoholic beverages by 6.88 percent, and consumption of soft drinks by 7.22 percent.

Increasing IEPS on all three products would yield a greater reduction in the consumption of cigarettes, alcohol, and soft drinks than the effects of an increase in the price of each good individually. Therefore, the authors recommend implementing a reform that impacts all three goods, given that they are currently complementary in Mexico.

Implementation of a tobacco tax reform by type of comorbidity

The data from ENIGH 2018 is combined with the data from the ENSANUT 2018 survey to analyze the effect of an increase in the price of cigarettes by population group as well as how this influences prevalence in groups of individuals with an NCD and aged ten years or older. This exercise is based on the increase in IEPS on tobacco proposed in 2020—a tax reform that brings IEPS on tobacco up from 0.4944 pesos to 1.4944 pesos per cigarette, adding the taxes included in the initiative and described in the previous section. As discussed earlier, this proposed tax reform would entail a price increase of 43.7 percent and would raise the retail price of a pack of cigarettes from 64 to 92 pesos, bringing the total tax burden, including VAT, to 77 percent of the final retail price (CIEP, 2021). The results are summarized in Table 7.

Among a population of 18.6 million smokers (17.6 percent), a one-time increase of 43.7 percent in the price of cigarettes as a result of the reform proposed in 2020 would result in a 9.2-percent drop in the likelihood of consuming cigarettes, equivalent to just over 1.7 million people. Similarly, an increase of 8.3 percent in alcohol prices reduces consumption of alcohol by 4 percent, meaning that out of a total of 37.9 million consumers of alcohol, more than 1.4 million would give it up. As for soft drinks, an 8.7-percent increase in prices would lead to a 0.6-percent decrease in consumption, meaning close to 327,000 people would stop drinking soft drinks out of a total of 54 million consumers. This analysis shows that it is tobacco that would see the greatest impact in terms of the number of consumers that would stop consuming the product altogether, followed by alcohol. Less of an impact would be achieved with soft drinks.

Table 7. Cessation of consumption due to the 2020 tax reform in Mexico

Item and change in price	Participation elasticity (eq. 5)	Change in proportion of consumers (as a %) due to reform			
	With 10% increase	*Consumers (%) before / after*		*Cessation (individuals)*	*Change due to reform (variation)*
Tobacco (p=43.7)	-4.813%	17.6	14.5	1,767,103	-9.2
Alcohol (p=8.3)	-4.790%	35.9	34.5	1,458,825	-4.0
Soft drinks (p=8.7)	-0.736%	51.6	51.2	326,904	-0.6

Note: The prevalence values recorded in ENCODAT (2017) are adjusted with those reported in ENSANUT for alcohol and tobacco. For soft drinks, the survey only reports expenditure by household, and the values are expanded as potential consumers. The total population aged ten or older is 105,653,068.
Source: Authors' calculations

Greater changes would be needed in alcohol and soft drink prices in the 2020 reform, because a tax increase applied solely to tobacco, despite the complementary nature of the relationship between tobacco and the other two goods, does not achieve as high an impact on cessation among consumers of alcohol and soft drinks as with tobacco.

Table 8 below presents the results by consumer according to the type of NCD they have; 37.7 percent of smokers have at least one NCD. The exercise is based on a ten-percent price increase, and the greatest level of cessation is achieved among smokers with diabetes, 2.1 percent of whom stop smoking, followed by 1.91 percent among smokers with hypertension and 0.98 percent among smokers with obesity. This means that the proposed tobacco reform, which would result in a price increase of 43.7 percent, would lead to a 6.9-percent reduction in smoking among the general population, with an even sharper decrease in groups with NCDs (except those with obesity). Cessation among smokers with diabetes is 9.1 percent, among those with hypertension 7.9 percent, and among those with obesity 4.3 percent.

Table 8. Impact on tobacco consumption and cessation due to the 2020 tax reform in Mexico (by type of comorbidity)

	Participation elasticity (eq. 6)	**Change in proportion of consumers (as a %) due to reform**			
	With 10% increase	*Consumers (%) before / after*		*Cessation (individuals)*	*Change due to reform (variation)*
General population	-1.575%	37.70	35.26	2,813,328	-6.9
Hypertension	-1.814%	12.02	11.13	61,133	-7.9
Diabetes	-2.092%	6.71	6.15	38,892	-9.1
Obesity	-0.984%	28.11	26.95	80,514	-4.3

Note: Of all smokers with an NCD (2,619,582 individuals), 79.4 percent have just one comorbidity, 17 percent have two, and 3.6 percent have three.
Source: Authors' calculations

The total number of smokers with at least one comorbidity in the country in 2018 was 2,619,582, of whom 169,084 (6.9 percent) would stop smoking as a result of the tobacco reform increasing the price of tobacco by 43.7 percent. By type of NCD, 61,133 smokers with high blood pressure (hypertension) would quit (equivalent to 7.9 percent), while 38,892 smokers with diabetes would quit (9.1 percent), with the highest number of people to quit smoking found among those with obesity, with 80,514 individuals (4.3 percent). This confirms that the proposed tobacco reform would be highly beneficial as a cost-effective measure to reduce tobacco consumption. In addition to increasing public revenue, the measure would also result in almost 170,000 sick smokers quitting.

Discussion

This study derives the maximum benefit from the information available and, for the first time in Mexico, analyzes the relationship between price and consumption of addictive substances by individuals with health problems. This opens the door to discussing the possibility of promoting tax reforms that yield a double dividend for the population and the Mexican state, reducing the health problems and easing the budgets of consumers, all while bringing down high health care costs and increasing revenue for the benefit of the Mexican health system.

Although globally these products have often been found to exhibit a degree of substitutability in the event of price increases, comparable evidence has emerged recently from a high-income country (Germany) and a middle-income country (Ecuador) showing cigarettes, soft drinks, and alcoholic beverages to be complementary, which is in line with the results in this study for Mexico (Tauchmann et al., 2013; Chávez, 2016). There is also recent evidence from high-income countries that points to a degree of complementarity between tobacco and alcohol when taxes increase, notably in the United States and Sweden (Decker & Schwartz, 2000; Bask & Melkersson, 2004), but also in Italy, with own-price elasticities less than unity and cross-price elasticities that are also negative and confirm the complementarity between the two goods (Pierani & Tiezzi, 2009).

This research is not without limitations. First, the data only consider soft drinks, rather than the full range of sugary drinks available. Second, the data for alcohol employ only aggregate estimates of alcoholic beverages, and the authors only run this example with beer. Therefore, the authors believe that, although this analysis of the 2020 tax reform is a good illustration of the trend of positive effects expected from the tax reform for the remaining goods that are not included, it should nonetheless be read with caution, as only soft drinks (sodas) are included under sugary drinks, which could lead to much higher elasticities than those reported in the recent literature for Mexico. Moreover, the effects of alcohol only take into account the most commonly purchased alcoholic drink in Mexico: beer. Despite these limitations, the results show that the responsiveness to joint tax reforms on tobacco, alcohol, and soft drinks in the country would help to reduce consumption and encourage smokers, especially those with NCDs, to quit.

The elasticities estimated here for tobacco are consistent with recent literature (CIEP, 2020; Huesca et al., 2020), but there is no available point of comparison combining recent cross-elasticities with soft drinks and alcohol and consumption by groups with NCDs. This is the first time these values have been calculated for Mexico, and the results confirm the recent complementarity between the three goods in the event of a price increase due to a comprehensive fiscal reform.

The results obtained are of use in designing health and fiscal policy in the context of the challenges posed by the COVID-19 pandemic amid the economic crisis faced by Mexico in 2021, as well as in a context in which the executive has not envisaged any tax increase in the planned budget for the remainder of the current administration. The Mexican state needs resources, and taxing tobacco, alcohol, and soft drinks is one measure that would progressively provide revenue. It is worth keeping in mind that Mexico has among the highest rates of diabetes, overweight, and obesity in the world and has earned the unenviable distinction of top place in Latin America (OECD, 2015; Popkin et al., 2017).

The proposed tax reform would yield multiple dividends by reducing rates of consumption among the general population but in particular among people with health conditions that make them more vulnerable to severe outcomes from COVID-19: individuals with diabetes, obesity, and high blood pressure. These measures do not affect business activity; quite the contrary. They are healthy both in terms of government finance and literally, as a gradual, automatic improvement to the health of Mexicans. The proposed tax reforms would increase revenue for the state while leading almost 170,000 people with medical conditions to quit smoking.

This joint fiscal policy would result in savings for the health system, as smokers with NCDs would be the most responsive in reducing—and, to a fair extent, giving up—consumption of all three goods. The case of smokers with diabetes who consume soft drinks is interesting, as the reduction in consumption of soft drinks is consistent with the literature, with inelastic rates close to unity, higher than for tobacco and alcohol (as shown in Table 5).

Although the findings reported are not fully comparable with the evidence in specialized literature, they do exhibit a trend in the same direction. The elasticities reported for each ten-percent increase in the price of soft drinks are in the range of -1.25 to -1.0 (Colchero et al., 2015); it is worth stressing that the database used in this study introduces health groups with an NCD who are smokers and who consume alcohol or soft drinks, opening up a gap for future fiscal analysis.

Conclusions and Recommendations

The results of this study indicate that, in the event of tax increases on cigarettes, alcohol, and soft drinks, demand would be most heavily impacted among smokers, who would reduce their consumption of tobacco, alcohol, and soft drinks to the greatest extent. The key takeaway is that this study draws attention to the need to apply this measure simultaneously to all three components included in the 2020 bill. This would lead to a far greater decrease in consumption of cigarettes—up to 40.46 percent—but would also reduce consumption of alcohol by 6.88 percent and consumption of soft drinks by 7.22 percent.

This research calculates, for the first time, tobacco cessation levels among smokers with comorbidities like obesity, diabetes, and high blood pressure. These noncommunicable diseases have been strongly linked to severe outcomes from COVID-19; and by smoking, individuals with these conditions face even greater risk and have experienced high levels of mortality, as reported in recent literature and reviewed in this paper. Implementation of the 2020 bill, however, would result in around 170,000 individuals with an NCD giving up smoking.

Second, this evidence points to higher taxes contributing directly to smoking cessation and lower tobacco consumption, with higher reductions among smokers with health problems. One recommendation that can be drawn from this study is to push for a simultaneous increase in taxes on tobacco, alcoholic beverages, and soft drinks, as this would produce the greatest impact on the Mexican population, particularly for individuals with NCDs and preventable health problems. The results indicate that consumption of soft drinks is most heavily reduced among smokers with obesity, while the highest decreases in tobacco consumption are observed in the group with diabetes, followed by those with hypertension.

Increasing the specific IEPS to 1.50 pesos per cigarette thus delivers a triple benefit: 1) decreased consumption across the whole population, 2) a greater reduction among smokers with NCDs, and 3) an increase in public revenue to tackle the COVID-19 pandemic.

In sum, higher taxes on tobacco would make it possible to reduce not only tobacco consumption but also, at the same time, the consumption of alcohol and soft drinks among the general population, but especially among consumers with NCDs. A simultaneous increase in taxes on alcohol and soft drinks magnifies this positive effect, further reducing consumption and aiding cessation for the general population as well as for particular groups with preventable diseases brought on by consuming these same products. Moreover, simultaneous taxes on tobacco, alcohol, and soft drinks can also address the obesity pandemic in Mexico, further contributing to better health and lowering the country's public health costs.

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Appendix A.

Basic Statistics

Table A1. Basic statistics in ENIGH 2018 (population aged 12 or older)

Variable	Obs.	Mean	Std. Dev.	Min	Max
Consumes tobacco	212,394	0.049	0.216	0	1
Consumes alcohol	212,394	0.044	0.206	0	1
Consumes soft drinks	212,394	0.639	0.480	0	1
Age	212,394	38.42	18.75	12	110
Sex	212,394	1.483	0.500	1	2
Urban	212,394	0.615	0.487	0	1
est_socio (socioeconomic stratum)					
2 (low)	212,394	0.530	0.499	0	1
3 (middle)	212,394	0.165	0.371	0	1
4 (high)	212,394	0.061	0.239	0	1
edo_conyug (marital status)	212,394	3.404	2.030	1	6
nivelaprob (completed schooling)	212,394	3.419	1.822	0	9
Additional variables					
hablaind (speaks native language)	256,825	0.066	0.249	0	1
asis_esc (attends school)	256,825	0.304	0.460	0	1
eli_basura (refuse collection)	269,206	1.663	1.239	1	8
tenencia (dwelling tenancy)	269,206	3.346	1.111	1	6
tinaco_azo (rooftop water tank)	269,206	0.540	0.498	0	1
cisterna (ground-level water tank)	269,206	0.170	0.375	0	1
medidor_luz (electricity meter)	269,206	0.922	0.268	0	1
aire_acond (air conditioning)	269,206	0.178	0.383	0	1
automovil (car)	269,206	0.289	0.453	0	1
camioneta (van or truck)	269,206	0.139	0.346	0	1
motocicleta (motorcycle)	269,206	0.119	0.324	0	1
tv_paga (pay TV)	269,206	0.456	0.498	0	1
computadora (computer)	269,206	0.236	0.425	0	1
licuadora (blender)	269,206	0.876	0.330	0	1
refrigerador (refrigerator)	269,206	0.871	0.336	0	1
estufa (stove)	269,206	0.884	0.321	0	1
lavadora (washing machine)	269,206	0.698	0.459	0	1

Source: ENIGH, 2018

Table A2. Basic statistics in ENSANUT 2018 (population aged 12 or older)

Variable	Obs.	Mean	Std. Dev.	Min	Max
c_tabaco (consumes tobacco)	57,043	0.150	0.357	0	1
c_alcohol (consumes alcohol)	48,112	0.667	0.471	0	1
c_refrescos (consumes soft drinks)	125,516	0.530	0.499	0	1
edad (age)	125,516	38.879	18.830	12	115
sexo (sex)	125,516	0.478	0.500	0	1
est_socio (socioeconomic stratum)					
2 (low)	125,516	0.530	0.499	0	1
3 (middle)	125,516	0.191	0.393	0	1
4 (high)	125,516	0.071	0.257	0	1
urbano (urban)	125,516	0.729	0.445	0	1
edo_conyug (marital status)	125,516	3.414	2.026	1	6
nivelaprob (completed schooling)	125,516	3.529	1.895	0	9
Additional variables					
hablaind (speaks native language)	150,960	0.063	0.244	0	1
asis_esc (attends school)	150,960	0.298	0.457	0	1
eli_basura (refuse collection)	158,038	1.606	1.195	1	8
tenencia (dwelling tenancy)	158,044	3.312	1.121	1	6
tinaco_azo (rooftop water tank)	158,044	0.599	0.490	0	1
cisterna (ground-level water tank)	158,044	0.197	0.397	0	1
medidor_luz (electricity meter)	158,044	0.926	0.263	0	1
aire_acond (air conditioning)	158,044	0.180	0.385	0	1
automovil (car)	158,044	0.318	0.466	0	1
camioneta (van or truck)	158,044	0.236	0.425	0	1
motocicleta (motorcycle)	158,044	0.126	0.332	0	1
tv_paga (pay TV)	158,044	0.504	0.500	0	1
computadora (computer)	158,044	0.354	0.478	0	1
licuadora (blender)	158,044	0.903	0.295	0	1
refrigerador (refrigerator)	158,044	0.886	0.318	0	1
estufa (stove)	158,044	0.917	0.276	0	1
lavadora (washing machine)	158,044	0.709	0.454	0	1

Source: ENSANUT, 2018

Appendix B.

Results of probit models

Table B1. Probit coefficients on cessation results by type of good in Mexico, 2018

Variables	Tobacco		Alcohol		Soft drinks	
luvtab	-0.257	***				
tot_integ	0.049	***	0.009	*	0.054	***
edad	-0.002	***	-0.003	**	-0.008	***
ling_cor	0.221	***	0.420	***	0.164	***
sexo_2	-0.034	*	0.161	***	0.070	***
estrato_2	0.248	**			0.243	***
estrato_3	0.366	***	0.249	***	0.414	***
estrato_4	0.460	***	0.344	***	0.423	***
nivelaprob_2	-0.562		-0.667	*		
nivelaprob_3	-0.093	*			0.051	***
nivelaprob_4	-0.150	***	-0.080	**	0.082	***
nivelaprob_5	-0.247	***	-0.136	***		
nivelaprob_6	-0.437	***	-0.667	***	-0.132	*
nivelaprob_7	-0.200	***	-0.148	*		***
nivelaprob_8	-0.408	***	-0.153	***	-0.156	***
nivelaprob_9	-0.533	***	-0.470	***	-0.385	***
edo_conyug_2	-0.247	***	-0.108	***	0.023	*
edo_conyug_3	-0.103	***				
edo_conyug_4			-0.146	***	-0.072	*
edo_conyug_5	-0.325	***	-0.294	***		
edo_conyug_6	-0.074	***	-0.115	***	-0.143	***
luvalc			-0.337	***		
urbano_2			0.185	***		
luvsdb					-0.121	***
constante	-3.950	***	-4.222	***	-1.172	***
N	183,942		65,913		189,705	
pseudo R-sq	0.051		0.09		0.029	

*** STE at 0.001 significance level; ** STE at 0.05 significance level; * STE at 0.10 significance level
Source: Authors' calculations based on ENIGH 2018

Translation: tot_integ = total household members; edad = age; sexo = sex; estrato = stratum; nivelaprob = completed schooling; edo_conyug = marital status; urbano = urban; constante = constant

Table B2. Probit coefficients on cessation results by type of comorbidity and good in Mexico, 2018

	Population	Hypertension	Diabetes	Obesity
smok				
luvtab	-0.0996***	-0.138**	-0.145*	-0.0759*
ehsize	-0.0941***			
edad	-0.0153***	-0.0256***	-0.0207**	-0.0256***
lingresos	0.0482**			
sexo_2	0.398***	0.533***	0.471**	0.500***
edo_conyug_4	0.192*	0.513*		
edo_conyug_6	-0.145**	0.416**		-0.192
nivelaprob_8	-0.118**			
edo_conyug_2	-0.169***			-0.334***
nivelaprob_2	0.898			
edo_conyug_3	0.251***	0.528**		
nivelaprob_9			0.743	
nivelaprob_6				1.669
urbano_2				0.264*
estrato_3				0.195*
estrato_4				0.208
constante	-0.659***	0.119	0.112	-0.0249
N	22,585	1,430	774	3,432
pseudo R-sq	0.062	0.116	0.074	0.085

*** STE at 0.001 significance level; ** STE at 0.05 significance level; * STE at 0.10 significance level
Source: Authors' calculations based on ENSANUT/ENIGH 2018

Translation: edad = age; sexo = sex; edo_conyug = marital status; nivelaprob = completed schooling; urbano = urban; estrato = stratum; constante = constant

Appendix C

Tobacco Cessation Approach.

The approach adopted to estimate tobacco cessation is linked to the consumption of alcohol and soft drinks, but it considers only the impact of simulated tax reforms that affect tobacco prices. This approach draws on the literature on two-stage models (see, for example, Dow & Norton, 2003; Nargis et al., 2013; Cragg, 1971; and Heckman, 1976). After analyzing the change in the amount consumed in the first stage, the second stage focuses on the change in the proportion of effective consumers. Thus, assuming a normal distribution of the error term in the probit models of consumption of the good of interest (in this case, tobacco, alcohol, and soda), the probability of use/consumption can be written as

$$Prob(d_i) = f(\log(I_i), \log(p_i), Z_i) \tag{1}$$

For the probit model, and if the set of explanatory variables is denoted as *X* for the sake of simplicity, the authors can write

$$Prob(d = 1|X) = \Phi(X\beta) \tag{2}$$

alternatively as Equation (3):

$$Prob(use = 1) = \Phi\left(\beta_0 + \beta_{price} \ln(price) + \cdots + u\right) \tag{3}$$

where Φ (.) denotes the normal cumulative distribution function (CDF). The authors then proceed to discuss the probabilistic price elasticity, which is given by

$$\varepsilon_P = \frac{\partial Prob\,(.)}{\partial Price} * \frac{\overline{Price}}{\overline{Prob}} \tag{4}$$

where $\overline{Price}$ and $\overline{Prob}$ refer to the average price and average probability of positive consumption at the population level (reference individual), respectively. By taking derivatives and using the chain rule in the specification of the probit model, Equation (4) can be rewritten as

$$\begin{aligned} \varepsilon_P &= \frac{\partial \Phi(XB)}{\partial (XB)} \frac{\partial (XB)}{\partial \ln(Price)} \frac{\partial \ln(Price)}{\partial (Price)} \frac{\overline{Price}}{\overline{Prob}} \\ &= \phi(.)\beta_P \left(\frac{1}{\overline{Price}}\right) \frac{\overline{Price}}{\overline{Prob}} \\ &= \frac{\phi(.)\beta_P}{\overline{Prob}} \end{aligned} \tag{5}$$

where ϕ (.) denotes the probability density function (PDF) of normal distribution.

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