Tobacco Price Increases

After Tax Reform and Smoking Cessation Among Smokers with Noncommunicable Diseases (NCDs)

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Key messages

1. Smoking prevalence varies between regions in Mexico; and rates above the national average are found in the State of Mexico, the Border region, Mexico City, and the Pacific-Center region.

2. The Center and State of Mexico regions saw the largest increases in smoking prevalence between 2018 and 2021 (15.4 and 36.6 percent, respectively).

3. A 10-percent increase would achieve a significant, sharp decrease in consumption in all geographic areas—ranging from 6.7 to 7.4 percent—achieving widespread effectiveness.

4. A 10-percent increase in the price of cigarettes would decrease consumption by 7.2, 7.3, and 7.0 percent among smokers with hypertension, diabetes, and obesity, respectively. These rates are all higher than the national average decrease of 6.9 percent.

5. A fiscal reform increasing the specific component of tobacco tax by one peso per stick would reduce overall smoking prevalence from 19.07 to 18.3 percent in Mexico.

6. An increase in the specific tobacco tax of one peso per stick would lead 602,500 smokers to quit, 55 percent of whom have a noncommunicable disease (NCD) such as hypertension, diabetes, overweight, or obesity.

Executive summary

Tobacco use is a major public health concern worldwide. Smoking is closely linked to hypertension (high blood pressure) and coronary heart disease, among other noncommunicable diseases (Colchero et al., 2016). These consequences represent a heavy cost both for individuals and for broader health systems.

During the COVID-19 pandemic, smoking prevalence in Mexico increased among the population aged 20 or over, rising from 17.9 percent in 2018 to 19.1 percent in 2021. Smoking is more prevalent in men (29.5 percent) than women (9.4 percent) in Mexico (ENSANUT, 2021).

This work seeks to calculate the extent of smoking cessation (reduction in smoking prevalence) caused by a hypothetical one-peso increase in specific excise tax on tobacco in Mexico—nationally and by region—and determine the national and subnational regional response in terms of consumption (elasticities). Concurrently, these effects are also estimated among individuals with noncommunicable diseases (NCDs), with a particular focus on diabetes, obesity, and hypertension.

First, smoking prevalence is estimated using the National Health and Nutrition Survey (ENSANUT) for 2018 and 2021. The same regional divisions as the survey are employed and data for individuals older than 20 years of age are broken down by type of NCD. From 2018 to 2021, smoking prevalence decreased among those with hypertension, high cholesterol, heart problems, and diabetes, whereas an increase was observed among smokers with obesity.

Second, the propensity score-matching method (Heckman et al., 1997) is employed to group the most similar smokers with an NCD in the ENSANUT with the National Survey of Household Income and Expenditure (ENIGH) based on four variables: locality size (urban/rural), sex (male/female), education (four levels), and living in households with or without other smokers. Elasticities are estimated with Deaton's unit value model for a single product. These estimates show that a 10-percent increase in the price of cigarettes would reduce smoking by 6.9 percent, and the fall in consumption would be higher among those with an NCD—7.2 percent for smokers with hypertension, 7.3 percent for those with diabetes, and 7.1 percent for those who are overweight and obese. The price increase would also result in a greater decrease in consumption among the low-income groups—7.33 percent, compared to 7.05 percent for middle-income groups and 6.74 percent in high-income groups—which would make this a highly progressive measure in the current socioeconomic context.

The tax increase introduced under this reform would result in a 34.2-percent increase in the price of a pack of cigarettes, which is simulated as a unit value to estimate the change in the likelihood of smoking. This reduction is then used to calculate cessation.

The tax reform would bring smoking prevalence in Mexico down from 19.1 to 18.3 percent, which translates to 602,500 smokers quitting, a cessation rate of 3.74 percent. Greater rates of cessation would be observed among smokers with certain health conditions: 5.4 percent among those with hypertension and 4.7 percent among those with diabetes. However, a somewhat lower rate of cessation is observed among smokers with obesity, at 3.4 percent.

A regional analysis finds the highest cessation rates would be in the Peninsula, Pacific-North, Pacific-South, and Center-North regions, while the State of Mexico, Mexico City, and the Border region would see the lowest levels of cessation. A regional analysis by health condition reveals that smokers with NCDs would mostly experience higher cessation rates. For example, in the Center region, a cessation rate of 6.16 percent would be observed among smokers with hypertension, 5.34 percent in those with diabetes, and 3.68 percent in those with obesity; while cessation in the Peninsula would stand at rates of 6.13, 5.18, and 3.18 percent for hypertension, diabetes, and obesity, respectively. The regions where cessation would be lowest include the State of Mexico, which would see levels of cessation of 2.48, 2.10, and 1.41 percent, and Mexico City, where the rate is 2.51, 2.13, and 1.43 percent, for hypertension, diabetes, and obesity, respectively.

The results of this study show that increasing tobacco prices by raising the specific component of the excise tax would lower tobacco consumption overall for all of groups, regions, and NCDs. This price increase would escalate quitting among smokers that would be even more pronounced among those with an NCD and for specific regions, such as in the center of the country.

1. Introduction

Smoking has been linked to an increased risk of comorbidities and poor health outcomes. Currently, more than one billion people smoke worldwide and close to eight million people die annually as a result of active or passive smoking. Smoking causes 71 percent of lung cancers, 42 percent of chronic respiratory diseases, and 10 percent of cardiovascular diseases. Both the World Health Organization (WHO) (2017) and Campagna et al. (2019) report that the combination of smoking and having a noncommunicable disease (NCD) leads to an increased risk of mortality. Meanwhile, tobacco use not only causes serious harm to individual health, but it also results in lost labor productivity, premature mortality, and high health care costs across society as a whole. Another adverse effect is the displacement of consumption by households that consume tobacco in a phenomenon known as the crowding-out effect, whereby families reduce or eliminate their consumption of better quality food (Chaloupka et al., 2012), potentially causing health concerns associated with poor nutrition.

To deal with this global epidemic, the WHO adopted the Framework Convention on Tobacco Control in 2005, which Mexico signed that same year. The treaty constitutes a commitment to important tobacco control measures including monitoring tobacco use; protecting the population from tobacco smoke; offering help to quit smoking; warning of the dangers of tobacco; enforcing prohibitions on advertising, promotion, and sponsorship; and raising tobacco taxes. Several studies show that tax increases are the most effective measure to reduce the negative effects associated with tobacco use, and although some progress has been made in tobacco taxation in Mexico, better tax policies are still needed to drive down sales. A tax-based strategy would increase cessation and remains one of the most popular, effective, and cost-effective forms of tobacco control (Powell & Chaloupka, 2022; Sáenz-de-Miera, Wu, et al., 2022).

A recent report by the US Department of Health and Human Services (2020) summarizes the latest evidence on the health benefits of cessation. First, the report recognizes that smoking cessation is beneficial at any age, improving individuals' general state of health and quality of life, reducing the risk of premature death, and adding as much as a decade to life expectancy while cutting the costs of tobacco-related health care expenditures. Importantly, smoking cessation reduces the risk of many adverse health outcomes, including poor reproductive health outcomes, cardiovascular disease, chronic obstructive pulmonary disease (COPD), and cancer. Cessation is also beneficial for those already diagnosed with heart disease or COPD.

Smoking cessation reduces the risk of 12 kinds of cancers—including cancers of the lung; oral cavity, pharynx, and larynx; esophagus; pancreas; bladder; stomach; colon and rectum; liver; cervix; and kidney—and acute myelogenous leukemia (AML). Quitting smoking also reduces cardiovascular morbidity and mortality and lessens the burden of cardiovascular disease. Similarly, smoking cessation reduces morbidity and mortality from stroke and reduces the risk of cigarette smokers developing COPD. Pregnant women who have stopped smoking enjoy improved health that benefits both themselves and their unborn and newborn children.

The existing literature on cessation in Mexico faces some limitations. First, the research uses old elasticities from almost 10 years ago, with no updated estimates of elasticities at the provincial or regional level, resulting in a gap in knowledge of patterns of tobacco consumption behavior across the country. Second, the most recent cessation rates cited in the literature are drawn from research conducted in 2018 with figures from earlier years.

The need for new research in this field becomes even more relevant today, since a tobacco excise tax reform came into effect in Mexico in 2020, adjusting the specific component for inflation (which had remained unchanged from 2011 to 2019 at 0.35 pesos per stick). The main objective of this research is to determine how increases in tobacco prices as a result of a tax reform would lead to an increase in smoking cessation across different Mexican regions and by subgroup, with and without NCDs and other age-related health problems.

This research is structured as follows. The first section offers a description of the literature on cessation worldwide, with a focus on Mexico in recent years. The second section presents the methodology, data, and techniques employed to estimate elasticities and cessation itself for the overall smoking population by type of NCD and by region of Mexico. The third section shows the empirical application for each objective, based on the response to an increase in tobacco prices by region and the respective levels of cessation. Finally, the fourth part discusses policy recommendations, and the fifth section concludes the report.

2. Literature Review

Considerable disparities are observed in research on the success of cessation. According to the US Department of Health and Human Services (2020), the prevalence of key indicators of cessation of smoking—attempts to quit smoking in the United States, receiving advice to quit smoking from a health professional, and using cessation therapy—also varies by population, with lower prevalence found in some subgroups. Marked disparities in cessation behaviors, such as having made a quit attempt in recent years and recently successful cessation, persist in certain population subgroups defined by education level, poverty status, age, whether smokers have health insurance, race and ethnicity, and geographic location. Finally, the US report highlights that smoking cessation can be escalated by increasing cigarette prices, adopting comprehensive policies that guarantee smoke-free environments, implementing mass media campaigns, requiring illustrated health warnings, and maintaining comprehensive statewide tobacco control programs.

As mentioned above, cessation can be achieved by increasing tobacco tax and hence, cigarette prices. However, evidence available for Mexico is scant. One notable study, however, is that of Sáenz-de-Miera, Reynales-Shigematsu, et al. (2022), who found that although the 2020 tax adjustment for inflation was associated with a real price increase of around 9 percent, there was no drop in prevalence and consumption of tobacco declined less than expected. In addition, tobacco tax as a percentage of price per pack increased from 53.4 percent in 2019 to 54.8 percent in 2020, not including VAT, but it still fell short of 2011 levels (56.1 percent) and is still far from global best-practice recommendations (70 percent for tobacco excise tax, 75 percent for total tax). This evidence shows the need to apply stronger fiscal measures to achieve greater impacts on both cessation and smoking intensity.

In Mexico, there is little evidence on the health impact of cessation at a national level, and there remains a need for research on smoking cessation in relation to NCDs. In Latin America, the IECS Tobacco Control Policy Evaluation Model showed that a 50-percent increase in the price of cigarettes would avert 300,000 premature deaths and save about $27 billion USD in medical costs over the next 10 years in 12 countries (Pichon-Riviere et al., 2020). For Mexico, the IECS model has provided evidence of gains related to tobacco control polices (Sáenz-de-Miera, Reynales-Shigematsu, et al., 2022), including taxation (Pichon-Riviere et al., 2016, 2020). Recent data published in Mexico based on the IECS fiscal policy simulation model show that a 50-percent increase in the price of cigarettes would yield significant benefits over the next ten years (Sáenz-de-Miera, Reynales-Shigematsu, et al., 2022), averting 49,357

premature deaths and 295,091 new cases of disease, including 121,932 heart attacks, 12,298 new cases of cancer, 55,418 strokes, and 105,443 cases of COPD (Sáenz-de-Miera, Reynales-Shigematsu, et al., 2022; Palacios et al., 2020).

There is compelling evidence that shows how significant differences in prevalence rates by geographic region and income quintile bring about an increased effect of an additional one-peso specific excise tax in terms of smoking cessation, savings in medical treatment, improved tax progressivity, and life years gained, with the greatest impact in the south of Mexico, the country's most impoverished region (Sáenz-de-Miera, Reynales-Shigematsu, et al., 2022). Reports have noted, for example, a lack of regulation on the use of tobacco and few smoke-free spaces in the northern states of the country (Torres-Domínguez et al., 2022). However, following the implementation of the Regulations of the General Law on Tobacco Control in 2023, all public places throughout the country are now required to be smoke-free.

Huesca et al. (2021) show the expected smoking cessation among individuals with NCDs that would be achieved by a 43-percent increase in cigarette prices. They find a cessation rate of 7.9 percent among smokers with hypertension, 9.1 percent for those with diabetes, and 4.3 percent for those with obesity. These percentages are all higher than the average for smokers without NCDs. These findings appear to support the relevance of examining the effects of a tobacco tax reform on cessation at a subnational or regional level in Mexico, while also taking into account other relevant variables such as age.

2.1 Literature gap

Worldwide, there is little research available on subnational variations in the levels of smoking cessation achieved following price increases due to fiscal policies. In Mexico, there is a need to capture the heterogeneity of changes in consumption and tobacco cessation across the country after a feasible tax reform is approved. Similarly, a separate analysis that takes into account subnational differences in fiscal law is also called for. Policy makers might then require additional evidence on the impact of higher tobacco taxes at subnational levels, according to the different responses found in terms of changes in smoker behavior and, more importantly, cessation. Smoking cessation has not been fully assessed, and recent evidence shows a pattern of increasing smoking prevalence as the Mexican population ages (ENSANUT, 2020, 2021).

It is well known that fiscal policy on tobacco products could account for as much as half of any reduction in consumption (Chaloupka & Powell, 2018; Powell & Chaloupka, 2022). Therefore, fiscal policy is highly beneficial to public health and has considerable potential to improve the welfare of addicted smokers, with an even greater impact on those with NCDs (Huesca et al., 2021; Powell & Chaloupka, 2022).

Franco Churruarin and González-Rozada (2021) discuss the effect of an increase of tobacco taxes on smoking probability and observe different magnitudes depending on the measure adopted. Their research also finds that in Mexico an increase in prices is associated with a fall in smoking probability of 8.6 percent in the 45–64–year age range and that this decline is higher in men, at 12.7 percent, than women, among whom only 5.02 percent would quit smoking. They argue that tobacco taxes have a greater effect in terms of decreasing smoking intensity rather than leading smokers to quit altogether. These findings point to a broad gap in the literature for econometric studies that explore both smoking intensity and cessation as a result of a tax hike, particularly for smokers afflicted with NCDs.

Although the 2020 inflation adjustment was associated with a price increase of around nine percent in real terms, there was no drop in smoking prevalence and consumption of tobacco, bar a few specific exceptions observed in the context of the COVID-19 pandemic. This suggests a need for a greater increase in taxes in order to raise prices even higher and achieve a substantial decline in tobacco use, such as an additional one-peso increase in specific tax. This increase level would produce a cessation rate of 9.3 percent among the general population and even higher cessation in the lowest and second-lowest income quintiles, at 17 and 14 percent, respectively (Sáenz-de-Miera, Wu, et al., 2022).

3. Objectives and Hypothesis

This study has three specific objectives: 1) to estimate the prevalence of tobacco use before and after the tax reform across Mexican regions and by NCD and nutritional status; 2) to estimate price elasticities by regions; and 3) to describe cessation patterns after a tax increase in Mexico. The general hypothesis is that after a hypothetical increase in tobacco prices, smokers with NCDs (obesity, diabetes, or hypertension) will exhibit higher or lower cessation rates depending on the region where they live. The authors hypothesize that the poorer the state or region, the greater the levels of cessation.

3.1 Database procedures

Data from the National Health and Nutrition Survey (ENSANUT) for 2018 and 2021, conducted by the National Institute of Public Health (INSP), are used to estimate the prevalence of smoking. The 2018 ENSANUT is a cross-sectional survey, while the 2021 survey is longitudinal and repeated annually. In 2020, ENSANUT transitioned to continuous yearly surveys with data collection to be completed in 2024. Both surveys (2018 and 2021 ENSANUT) are based on stratified cluster probability sampling that enables reliable estimates that are representative both nationwide and in nine regions across the country. However, only the 2018 ENSANUT is representative at the state level.

To calculate elasticities by region and cessation levels, the authors also use microdata from the National Survey of Household Income and Expenditure (ENIGH) for 2018 and 2020. This survey is conducted every two years by the National Institute of Statistics and Geography (INEGI) and also employs cluster probability sampling, based on primary sampling units. The estimates are representative at a national level, by type of locality (urban/rural), and by state (Table 1).

Table 1. Sample size and representativity of ENIGH and ENSANUT

	Individuals	
Survey	**Sample**	**Expanded population**
2018 ENIGH	269,206	125,189,618
2020 ENIGH	315,743	126,838,467
2018 ENSANUT	158,044	126,468,224
2021 ENSANUT	43,724	128,093,153

Source: Authors' calculations based on ENIGH (2018, 2020) and ENSANUT (2018, 2021)

Although ENIGH does report household tobacco expenditure, it does not provide information on consumers' health status, so the ENIGH databases are matched with ENSANUT. Both surveys report the quantity of cigarettes consumed. ENSANUT reports consumption directly, using the questions listed in Table 3, while ENIGH reports the quantity of tobacco consumed per week in kilograms, so a standard criterion for conversion (accepted in the literature) is employed, whereby each cigarette is considered to weigh 1.25 grams (Jiménez-Ruiz et al., 2008). As a result, the authors employ the quantities reported in ENSANUT to avoid potentially underestimating the quantities consumed by households (Table 2). These figures (tobacco expenditure in ENIGH and quantities consumed in ENSANUT) could then be used to obtain the unit values to perform the econometric analysis. To remove any outliers that may influence

the calculation and produce higher-than-expected unit values, the authors trim the top and bottom five percent of the expenditure distribution, as suggested by John et al. (2019).

Table 2. Daily consumption of cigarettes reported by ENIGH and ENSANUT among smoking households and individual smokers

Survey	Unit of analysis	Expanded population	Mean	SD
2018 ENIGH	Household	1,805,283	6.8	9.7
2020 ENIGH	Household	1,662,366	6.2	10.0
2018 ENSANUT	Individual	14,820,107	3.9	6.1
2021 ENSANUT	Individual	16,096,791	3.9	6.1

Source: Authors' calculations based on ENIGH (2018, 2020) and ENSANUT (2018, 2021)

The target population is defined based on the availability of information relating to the comorbidities of interest in ENSANUT (obesity, hypertension, diabetes, hypercholesterolemia, and cardiovascular disease), and therefore, the study only takes into account the population aged 20 years or older. Due to the fact that ENSANUT inquires about tobacco use and individual health directly, it is possible to define variables based on the definitions in Table 3.

Table 3. Definitions adopted to construct variables in the 2018 and 2021 ENSANUT

Variable	Survey question	Participant response
Smoker	Do you consume tobacco at present?	Yes
	On average, how many cigarettes do you smoke per day at present?	Positive values
	On average, how many cigarettes do you smoke per week?	Positive values
Obesity	Has a physician/dietitian/nutritionist ever told you that you have or have had obesity?	Yes
	In your opinion, you currently weigh…	More than is healthy
	What diagnosis were you given… detection of overweight or obesity?	Positive
Diabetes	Has a physician told you that you have diabetes (or high blood sugar)?	Yes
	What diagnosis were you given… detection of diabetes?	Positive
Hypertension	Has a physician told you that you have high blood pressure?	Yes
	What diagnosis were you given… detection of hypertension?	Positive
Hypercholesterolemia	Has a physician told you that you have high cholesterol?	Yes
	What diagnosis were you given… detection of high cholesterol or triglycerides (blood test)?	Positive
Cardiovascular disease	Has a physician told you that you have had a stroke or heart attack?	Yes
	Has a physician told you that you have or have had heart failure (weak pumping of the heart, causing swelling in the feet, ankles and legs, fatigue and shortness of breath)?	Yes

Source: Authors' work based on ENSANUT (2018, 2021)

For the subnational analysis of elasticities and cessation, the authors follow the same division of regions as in the 2021 ENSANUT (Table 4), in light of the fact that this survey will continue to represent the states of Mexico in its present form until 2024. The survey divides the country into nine regions based on health and epidemiological patterns.

Table 4. Regions of Mexico as defined in the 2021 ENSANUT

Region	States
Pacific-North	Baja California, Baja California Sur, Nayarit, Sinaloa, Sonora
Border	Chihuahua, Coahuila, Nuevo León, Tamaulipas
Pacific-Center	Colima, Jalisco, Michoacán
Center-North	Aguascalientes, Durango, Guanajuato, Querétaro, San Luis Potosí, Zacatecas
Center	Hidalgo, Tlaxcala, Veracruz
Mexico City	Mexico City
State of Mexico	State of Mexico
Pacific-South	Guerrero, Morelos, Oaxaca, Puebla
Peninsula	Campeche, Chiapas, Quintana Roo, Tabasco, Yucatán

Source: Authors' work based on ENSANUT (2021)

3.1.1 ENIGH-ENSANUT database matching and data pool construction

The ENIGH and ENSANUT surveys provide demographic and socioeconomic information using the same data collection methodology and also share common features in a number of variables, making it possible to match data with identical attributes.

These identical attributes make it possible to combine information with matching models, using robust estimators from the survey analysis. In this case, the matched (combined) survey allows the authors to estimate demand for cigarettes and determine changes in consumption resulting from price changes among individuals with a health condition and by region. There is a wide array of literature supporting matching models and providing insight into their various applications (Ridder & Moffitt, 2007; Wozny et al., 2010; Rios-Avila, 2018).

This research uses the probability-matching technique to merge databases. To overcome the uncertainty arising from the possibility that the primary sampling units (PSU) may be different in the surveys, a *psmatch* approach is employed, whereby population groups in the databases are selected based on the degree to which they match. This approach to matching, based on predefined groupings, is discussed in Rios-Avila (2018). If the proportions for the variables are similar in the different samples, a *psmatch*

model is executed within each group. The population groups are selected based on the degree to which they match, following a nearest-neighbor approach.[1]

The variables employed to achieve the best propensity score matches in both surveys are area of residence (urban/rural), sex (female/male), level of education (incomplete or no basic education, completed basic education, completed high school, undergraduate or graduate studies), and smoking (which takes a value of zero if no member of the household smokes, or one if at least one member of the household smokes) (Table 5). Furthermore, these four variables are available both in ENIGH and ENSANUT data, ensuring a better combination of these four categories and generating 2 x 2 x 4 x 2 = 32 groups.

The matching exercise is finalized by applying logit models where the treatment group is assigned a value of one (ENSANUT) and the control group zero (ENIGH) for the independent variables contained in both surveys to characterize individual attributes. These include stratum, sex, age, urban area, state of residence, family relationship, whether they speak an indigenous language, whether they attend school, whether they have a refuse collection service, homeownership status, whether they have a water tank (rooftop or ground-level) or an electricity meter, air conditioning, a car, a van or truck, or a motorcycle, and whether 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 probability of matches between individuals in both databases, which ultimately constitutes the condition for joining the data in both databases (ENSANUT + ENIGH).

Consequently, probability matching is employed to merge the databases as follows: a) 2018 ENIGH with 2018 ENSANUT and b) 2020 ENIGH with 2021 ENSANUT. This yields two combined databases following the same matching criterion with identical variable definitions for logit. Given that the structure of the combined databases is the same, a data pool is then constructed, controlled by a time variable (year). Table 6 presents the sample sizes resulting from the probability matching process.

[1] In this case, the authors employ the nearest-neighbor approach and STATA's psmatch 2 command, ensuring the most similar clusters are retained in both databases. For more details on this technique, see Becker and Ichino (2002).

Table 5. Variables employed for database matching

Variables	2018 ENIGH		2018 ENSANUT		2020 ENIGH		2021 ENSANUT	
	Individuals	%	Individuals	%	Individuals	%	Individuals	%
Area of residence								
Rural	30,662,791	24.5	29,192,705	23.1	29,250,442	23.1	27,363,340	21.4
Urban	94,526,827	75.5	97,275,519	76.9	97,588,025	76.9	100,729,813	78.6
Sex								
Female	64,426,273	51.5	65,499,876	51.8	65,548,782	51.7	65,605,401	51.2
Male	60,763,345	48.5	60,968,348	48.2	61,289,685	48.3	62,487,752	48.8
Level of education								
< Basic	48,957,176	40.9	49,763,633	41.1	46,882,720	38.4	46,664,184	38.1
Basic	30,560,714	25.5	32,960,059	27.3	30,878,068	25.3	32,508,579	26.5
Upper secondary	23,735,397	19.8	21,184,068	17.5	25,833,599	21.2	24,156,520	19.7
Higher	16,451,279	13.7	17,058,122	14.1	18,420,115	15.1	19,177,461	15.7
Smokers in household (hh)[1/]								
Non-smoking hh	119,049,721	95.1	95,118,483	84.5	121,178,899	95.5	89,209,281	83.9
Smoking hh	6,139,897	4.9	17,495,688	15.5	5,659,568	4.5	17,092,898	16.1

[1/] Note: Individuals aged 20 years or older who live in a smoking household

Source: Authors' calculations based on ENIGH (2018, 2020) and ENSANUT (2018, 2021)

Table 6. Result of propensity score matching with the nearest-neighbor approach

Matched surveys	Sample size
2018 ENSANUT – 2018 ENIGH	142,851
2021 ENSANUT – 2020 ENIGH	40,068
Total data pool	182,919

Source: Authors' calculations based on ENIGH (2018, 2020) and ENSANUT (2018, 2021)

The Appendix (tables A1, A2, and A3) present the statistical tests employed in the probability matching process: estimation of the average treatment effect (ATE) and estimation of the means and variance ratios for the group of covariates employed (covariate balance). The results show an ATE of 0.081 and 0.150 for the matched surveys for 2018 and 2020, respectively. This is the estimated difference between the means for the treatment group (ENSANUT) and the control group (ENIGH) for the dependent variable "smoking." A positive value indicates a greater impact (in ENSANUT than in ENIGH), statistically significant at the 95% confidence level (Table A1).

The covariate balance test for each of the matched databases confirms differences in means close to zero (Table A2) and standard deviation ratios close to one (Table A3). This indicates that the full set of variables used has been matched consistently.

3.2 Econometric methods

3.2.1 Smoking prevalence by region

Smoking prevalence is shown by subgroup at national and state or regional levels—namely, the smoking population with NCDs and other health problems, such as those with knowledge of a diagnosis of a specific illness over time. The association between quitting smoking and the presence of NCDs (obesity, diabetes, hypertension) over time is tested using multiple probit regression analysis adjusted for potential covariates and data generated from 2018 and 2021 ENSANUT-ENIGH.

3.2.2 Regional price elasticities considering the presence of NCDs

Econometric estimations are performed using a single item Deaton system (SIDS) model proposed by Deaton (1997). An econometric model is specified to estimate elasticities by income tertile and for each region, with the data pool from the matched 2018 and 2021 ENIGH and ENSANUT databases, and controlled by setting 2020 as the base year. Regions are configured in accordance with ENSANUT, and the corresponding primary sampling units (PSUs) are used. To capture heterogeneity, the model calculates a SIDS for tobacco. The dependent variable is the log of cigarettes smoked, regressed with the explanatory variables as the unit value for cigarettes interacted with income tertiles, year of survey and age, sex, comorbidities as described above, marital status (=1 for married), the log of household size, education attained as a dummy variable with four levels, and the log of income as a continuous variable to capture income elasticity.

The model is standard with the unit value calculated as a proxy for the price of tobacco. The total variation in unit values is divided into "within-cluster" and "between-cluster" variations. The specification includes logarithmic variables of the unit price lnv_{hc} for tobacco and w_{hc} as the log of tobacco expenditure, while *Lnx* is the log of income. The covariates included in both equations in the

vector Z_{hc} are *Age* as the log of the age of the head of household; education measured as the maximum number of years of education attained in the household; gender=1 if the head of household is female; a dummy variable for whether the smoker had a heart attack or stroke and survived; alcohol if any member of the household purchased alcoholic beverages, reported as the share of income spent on alcohol; and comorbidities (including obesity, diabetes, and hypertension). Equations (1) and (2) denote expenditure and unit price specification and both include a dummy controlling for year effects with 2018 as a base year; π_c and f_c are, respectively, the unobserved prices and a cluster fixed effect treated as an error in addition to the error term u_{hc}^0 in equation (1), while u_{hc}^1 is the standard regression error term in equation (2), as follows:

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

$$lnv_{hc} = \alpha^1 + \beta^1 lnx_{ic} + \gamma^1 Z_{hc} + \psi ln\pi_c + u_{hc}^1 \quad (2)$$

Quality effects are present if ψ = 1 when $UV = p$; otherwise, there is a shading effect if ⇒ ψ < 1. Elasticities are obtained in the usual manner, using the mean share of total household expenditure ($\hat{\theta}$, $\hat{\psi}$) as well as $\widehat{\beta^0}$ and $\widehat{\beta^1}$ coefficients:

$$\widehat{\varepsilon_p} = \left(\frac{\hat{\theta}}{\bar{\omega}}\right) - \hat{\psi} \quad (3)$$

$$\widehat{\varepsilon_1} = 1 + \left(\frac{\widehat{\beta^0}}{\bar{\omega}}\right) - \widehat{\beta^1} \quad (4)$$

3.2.3 Cessation patterns after a tax increase in Mexico

The estimation of demand is analyzed to obtain tobacco cessation in the distribution of consumers and simulate the effect of a tobacco excise tax reform increasing the specific component from 0.59 pesos per stick (in effect in 2023) to 1.59 pesos per stick, which translates to a 34.2-percent increase in cigarette prices. Henceforth, tobacco cessation is defined as the change in smoking probability once a hypothetical price increase occurs. As tobacco prices increase, smoking probability is expected to decrease. The greater the difference between the pre- and post-reform probabilities, the greater the level of cessation.

First, the change in the proportion of consumers is estimated with the elasticity of participation by running separate models for each comorbidity, using the following equation with a probit model and a set of explanatory variables included in X as:

$$Prob(d = 1|X) = \Phi(X\beta) \tag{5}$$

where $\Phi(.)$ denotes the normal cumulative distribution function (CDF) and the set of explanatory variables included in X—namely age, dummy variables for whether the smoker had a heart attack and survived, marital status with 1=married and 0 otherwise, and area of residence with urban=1. Last but not least, regional control variables are included as nine dummies for controlling the econometric models, as well as the log of income, modeling tobacco use as follows:

$$Prob(use = 1) = \Phi\left(\beta_0 + \beta_{price} \ln(price) + \cdots + u\right) \tag{6}$$

The elasticity of participation with respect to price is needed to compute cessation with the following expression:

$$\varepsilon_P = \frac{\partial Prob\,(.)}{\partial Price} * \frac{\overline{Price}}{\overline{Prob}} \tag{7}$$

where $\overline{Price}$ and $\overline{Prob}$ refer to the average price and average probability of positive consumption at the population level (individual of reference), respectively. The first part is implemented with the change in the proportion of consumers (cessation) that would occur after the increase in the retail price of tobacco; essentially following the literature on two-part models that calculate participation elasticity (Cragg, 1971; Heckman, 1976; Dow & Norton, 2003; Nargis et al., 2014; Saha et al., 1997) by directly using the predicted probabilities with and without price changes. The absolute change in smoking probability is:

$$A_{P,i} = Prob_h(use = 1|X'_h) - Prob_h(use = 1|X_h) \tag{8}$$

The difference between X'_h and X_h will compute the change in tobacco consumers as the price of tobacco changes (the cessation levels obtained). Smoking cessation is then computed by obtaining the change in the proportion of consumers as the probability of use/consumption $Prob(d=1|\ X) = \Phi(X\beta)$ with and without certain NCDs and for each region of Mexico.

4. Results

This section presents the estimated smoking prevalence values in Mexico based on 2018 and 2021 ENSANUT data. Due to the nature of the ENSANUT survey, prevalence is estimated both nationally and regionally. Prevalence rates are also estimated by type of comorbidity, sex, and nutritional status.

Subsequently, the authors show the results of the elasticity models, broken down to the extent necessary to understand the behaviors of the various groups of consumers studied. Finally, this part presents the cessation results nationally, regionally, and by NCD group.

4.1 Smoking prevalence

Smoking prevalence in the full sample is found to be 17.9 percent and higher among men than women based on data from the 2018 ENSANUT survey. By 2021, prevalence had risen to 19.07 percent of the adult population; prevalence in men increased from 28.4 to 29.4 percent, while among women, this figure rose from 9.2 to 9.4 percent in the same time frame (Table 7). Notably, the 2021 ENSANUT survey reported tobacco use after the IEPS excise tax reform, and the results appear to show only a slight increase in the full sample and among women. This increase is more noticeable in men.

Table 7. Smoking prevalence in adults, Mexico

	2018			2021			
	Individuals (n)	Prevalence (%)	95% CI	Individuals (n)	Prevalence (%)	95% CI	Change (%)
Population aged 20 years or older	**82,627,566**	**100**		**84,422,327**	100		
Smokers	**14,820,107**	**17.94**	17.93-17.94	**16,096,791**	**19.07**	19.06-19.08	6.30
Distribution by sex							
Female	4,167,375	9.23	9.22-9.24	4,149,158	9.43	9.42-9.44	2.17
Male	10,652,732	28.41	28.40-28.43	11,947,633	29.56	29.55-29.58	4.05
Distribution by smoking frequency							
Occasional	8,460,625	57.09	57.06-57.11	8,888,477	55.22	55.19-55.24	-3.3
Daily	6,359,482	42.91	42.89-42.94	7,208,314	44.78	44.76-44.81	4.4
Former smokers	**16,812,951**	**20.31**	20.30-20.32	**14,659,127**	**17.36**	17.27-17.29	**-14.5**
Have never smoked	**50,994,508**	**61.61**	61.60-61.62	**53,666,409**	**63.26**	63.25-63.27	**2.7**

Source: Authors' calculations based on ENSANUT (2018) and Continuous ENSANUT (2021)

As far as smoking frequency is concerned, Table 7 clearly shows that a high proportion of smokers, 57.1 percent, use tobacco occasionally, while almost 43.0 percent smoke on a daily basis. These percentages remained steady in 2021. Meanwhile, in 2018, 20.3 percent of the adult population reported having quit smoking, whereas the proportion of former smokers reported in 2021 was smaller, at 17.36 percent.

The authors explore tobacco use among men and women, disaggregated by noncommunicable diseases and metabolic disorders like hypercholesterolemia and heart disease. It should be noted that from 2018 to 2021, smoking prevalence declined among smokers with high blood pressure (hypertension), high cholesterol, heart problems, and diabetes; whereas smoking became more prevalent among smokers with obesity (Table 8). The authors find that, regardless of disease and metabolic disorders, smoking prevalence is consistently higher in men than in women in both years of the ENSANUT survey.

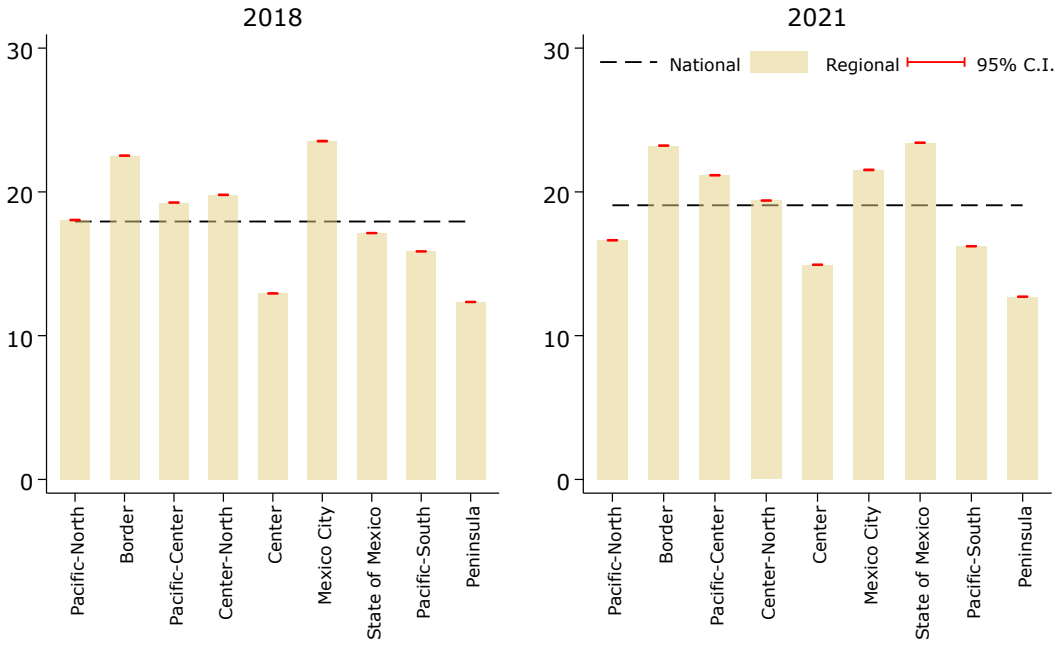
Table 8. Adult smoking population with a noncommunicable disease, Mexico, 2018 and 2021

	2018			2021			
Smokers	14,820,107			16,096,791			Change (%)
By type of disease	Individuals	%	95% CI	Individuals	%	95% CI	
With obesity[1]	**4,694,290**	**31.4**	**31.65-31.70**	**5,479,304**	**34.0**	**34.02-34.06**	**8.3**
Female	1,785,045	38.0	37.98-38.07	1,802,516	32.9	32.86-32.94	-13.5
Male	2,909,245	62.0	61.93-62.02	3,676,788	67.1	67.06-67.14	8.3
With hypertension[2]	**1,951,371**	**12.6**	**13.15-13.18**	**1,622,678**	**10.1**	**10.07-10.10**	**-20.3**
Female	731,276	37.5	37.41-37.54	620,381	38.2	38.16-38.31	2.0
Male	1,220,095	62.5	62.46-62.59	1,002,297	61.8	61.69-61.84	-1.2
With diabetes[3]	**1,058,326**	**12.0**	**7.13-7.15**	**1,260,456**	**7.8**	**7.82-7.84**	**-34.9**
Female	367,903	34.8	34.67-34.85	410,376	32.6	32.48-32.64	-6.3
Male	690,423	65.2	65.15-65.33	850,080	67.4	67.36-67.52	3.4
With cholesterol[4]	**2,162,732**	**14.7**	**14.58-14.61**	**1,898,485**	**11.8**	**11.78-11.81**	**-19.7**
Female	755,277	34.9	34.86-34.99	626,776	33.0	32.95-33.08	-5.5
Male	1,407,455	65.1	65.01-65.14	1,271,709	67.0	66.92-67.05	2.9
With a history of heart conditions[5]	**256,867**	**1.8**	**1.73-1.74**	**179,195**	**1.1**	**1.11-1.12**	**-39.3**
Female	78,636	30.6	30.44-30.79	51,066	28.5	28.29-28.71	-6.9
Male	178,231	69.4	69.21-69.56	128,129	71.5	71.29-71.71	3.0

Source: Authors' calculations based on ENSANUT (2018) and Continuous ENSANUT (2021)
1/ Believe they are currently above a healthy weight and/or have been diagnosed with overweight and obesity
2/ Have hypertension and/or a physician has told them they have hypertension
3/ Have diabetes and/or a physician has told them they have diabetes
4/ A physician has told them they have high cholesterol and/or have been diagnosed with high cholesterol
5/ Have (or have had) heart failure and/or have had a stroke or heart attack

Table 8 also shows an effect of sex on tobacco use in 2021 compared to 2018. For example, obesity prevalence increased in the full sample and a higher percentage of men with obesity smoked in 2021, whereas women smoked less. A similar situation arose with diabetes, cholesterol, and a history of heart conditions. As for health conditions and diseases that saw a decrease in smoking prevalence in 2021, this reduction was found to occur in both sexes, except for hypertension, which saw women smoke more and men smoke less.

Figure 1. Smoking prevalence by region of Mexico



Source: Authors' calculations based on ENSANUT (2018) and Continuous ENSANUT (2021).

Table 9 shows smoking prevalence among adults in Mexico, nationally and by region. Importantly, prevalence varies by region, and is estimated to range from 12.3 percent in the Peninsula region to a high of 23.5 percent in the Mexico City region in 2018. More recent data from the 2021 ENSANUT survey, on the other hand, show the State of Mexico region has become the region with the highest prevalence, at 23.4 percent, while the Peninsula maintains the lowest prevalence, at 12.7 percent. It is also worth observing that the regions with a prevalence level higher than the national average are the Border, Pacific-Center, Center-North, Mexico City, and the State of Mexico regions (Figure 1, Panel B). A comparison of the two years (before and after the IEPS tobacco tax reform) shows that three regions

achieved a slight decrease in smoking prevalence (Pacific-North, Center-North, and Mexico City), while the remainder saw an increase in 2021 (Table 9). Table 10 offers an overview of smoking behavior in individuals who are overweight and obese, by region. In 2018, prevalence is found to vary between regions, from 12.2 percent in the Center region, to 24.4 percent in Mexico City. In 2021, the lowest prevalence observed is 13.0 percent in the Peninsula region, while the Border region exhibits the highest prevalence, at 21.9 percent. Between 2018 and 2021, smoking prevalence fell in the Pacific-North, Mexico City, and the Peninsula, but rose in the remaining areas of the country.

Table 11 shows smoking behavior in individuals with arterial hypertension, by region. The lowest prevalence rate is found in the Peninsula region, followed by the Center region, while the highest smoking prevalence is observed in the Border region, according to data from the 2018 ENSANUT survey. In 2021, the lowest smoking prevalence is recorded in the Pacific-South region, at 7.3 percent, followed by the Center and Peninsula regions; whereas the highest prevalence is observed in the Mexico City region (16.9 percent). The Pacific regions (Pacific-North, Pacific-Center, Pacific-South), Border region, Center-North, and State of Mexico all exhibited lower prevalence rates in 2021 compared to 2018, while the remaining regions (Center, Mexico City, and Peninsula) displayed a slight increase in 2021.

Lastly, prevalence also varies by region among smokers with diabetes. In 2018, the lowest prevalence rate, 8.3 percent, is observed in the Peninsula, while the Pacific-Center region exhibits the highest prevalence, at 17.1 percent. In 2021, the region with the lowest prevalence is Pacific-North (7.0 percent), followed by the Peninsula region, at 8.4 percent. Table 12 also shows that prevalence increased in most regions, only showing a decline in the Pacific-North, Border, and Center-North regions. In short, while at a national level an increase is observed in smoking prevalence in adults, regional differences are found in both years studied (before and after the IEPS tobacco tax reform). The only regions where smoking prevalence fell are Pacific-North, Center-North, and Mexico City.

Additionally, by smoker comorbidity subgroup, at a national level, a reduction in prevalence is only found among those with hypertension (decrease of 6.9 percent). Prevalence increased in smokers who are overweight and obese and those with diabetes (by 7.6 and 18.1 percent, respectively). Meanwhile, this analysis also reveals regional differences in the three subgroups of smokers. Pacific-North is the only region to exhibit a negative change in smoking prevalence across all NCDs (overweight and obesity, -13.2 percent; arterial hypertension, -6.5 percent; diabetes, -36.3 percent).

Table 9. Smoking prevalence in adults in Mexico: Nationally and by region

Region	2018				2021				Change (%)
	Non-smokers	Smokers	%	95% C.I.	Non-smokers	Smokers	%	95% C.I.	
Pacific-North	6,498,081	1,430,662	18.04	18.02-18.07	6,650,285	1,327,118	16.64	16.61-16.66	-7.76
Border	8,348,328	2,427,038	22.52	22.50-22.55	8,443,701	2,553,582	23.22	23.20-23.25	3.11
Pacific-Center	7,122,357	1,698,776	19.26	19.23-19.28	7,257,830	1,947,746	21.16	21.13-21.18	9.87
Center-North	8,031,810	1,982,316	19.80	19.77-19.82	8,562,018	2,060,944	19.40	19.38-19.42	-2.02
Center	7,177,394	1,066,608	12.94	12.92-12.96	7,188,028	1,262,012	14.93	14.91-14.96	15.38
Mexico City	5,037,323	1,550,087	23.53	23.50-23.56	5,500,603	1,509,140	21.53	21.50-21.56	-8.50
State of Mexico	9,888,669	2,045,152	17.14	17.12-17.16	8,847,074	2,705,966	23.42	23.40-23.45	36.64
Pacific-South	8,563,863	1,614,148	15.86	15.84-15.88	8,721,737	1,688,371	16.22	16.20-16.24	2.27
Peninsula	7,139,634	1,005,320	12.34	12.32-12.37	7,154,260	1,041,912	12.71	12.69-12.74	3.00
National	67,807,459	14,820,107	17.94		68,325,536	16,096,791	19.07		6.30

Source: Authors' calculations based on ENSANUT (2018) and Continuous ENSANUT (2021)

Table 10. Smoking prevalence in adults with overweight and obesity in Mexico: Nationally and by region

Region	2018				2021				Change (%)
	Non-smokers	Smokers	%	95% C.I.	Non-smokers	Smokers	%	95% C.I.	
Pacific-North	2,507,258	457,695	15.44	15.40-15.48	1,868,300	289,150	13.4	13.36-13.45	-13.2
Border	2,912,088	787,523	21.29	21.24-21.33	3,273,153	918,642	21.92	21.88-21.95	3.0
Pacific-Center	1,878,223	398,603	17.51	17.46-17.56	2,104,952	546,736	20.62	20.57-20.67	17.8
Center-North	2,770,589	552,724	16.63	16.59-16.67	3,190,298	661,551	17.17	17.14-17.21	3.2

Center	2,852,485	397,719	12.24	12.20-12.27	2,930,719	615,002	17.34	17.31-17.38	41.7
Mexico City	1,778,681	581,955	24.65	24.60-24.71	2,588,906	646,023	19.97	19.93-20.01	-19.0
State of Mexico	3,070,600	655,250	17.59	17.55-17.63	3,232,125	889,210	21.58	21.54-21.62	22.7
Pacific-South	2,846,999	484,114	14.53	14.50-14.57	2,827,014	515,071	15.41	15.37-15.45	6.1
Peninsula	2,461,217	378,707	13.34	13.30-13.37	2,647,911	397,919	13.06	13.03-13.10	-2.1
National	23,078,140	4,694,290	16.90		24,663,378	5,479,304	18.18		7.6

Source: Authors' calculations based on ENSANUT (2018) and Continuous ENSANUT (2021)

Note: Includes smokers who are currently above a healthy weight and/or have been diagnosed with overweight or obesity

Table 11. Smoking prevalence in adults with arterial hypertension in Mexico: Nationally and by region

Region	2018				2021				
	Non-smokers	Smokers	%	95% C.I.	Non-smokers	Smokers	%	95% C. I.	Change (%)
Pacific-North	1,406,674	222,613	13.66	13.61-13.72	1,195,972	175,064	12.77	12.71-12.82	-6.5
Border	1,886,388	338,900	15.23	15.18-15.28	1,547,413	225,456	12.72	12.67-12.77	-16.5
Pacific-Center	1,235,238	184,932	13.02	12.97-13.08	1,171,250	170,557	12.71	12.65-12.77	-2.4
Center-North	1,639,186	235,335	12.55	12.51-12.60	1,708,065	231,200	11.92	11.88-11.97	-5.0
Center	1,612,877	152,795	8.65	8.61-8.70	1,147,896	112,377	8.92	8.87-8.97	3.1
Mexico City	1,147,022	203,595	15.07	15.01-15.13	1,196,487	244,122	16.95	16.88-17.01	12.5
State of Mexico	1,624,872	280,637	14.73	14.68-14.78	1,549,881	228,265	12.84	12.79-12.89	-12.8
Pacific-South	1,528,713	200,500	11.59	11.55-11.64	1,535,299	121,706	7.34	7.31-7.38	-36.7
Peninsula	1,405,332	132,064	8.59	8.55-8.63	1,110,068	113,931	9.31	9.26-9.36	8.4
Total	13,486,302	1,951,371	12.64		12,162,331	1,622,678	11.77		-6.9

Source: Authors' calculations based on ENSANUT (2018) and Continuous ENSANUT (2021)

Note: Includes smokers who have hypertension and/or have been told by a physician that they have hypertension

Table 12. Smoking prevalence in adults with diabetes in Mexico: Nationally and by region

Region	2018				2021				
	Non-smokers	Smokers	%	95% C.I.	Non-smokers	Smokers	%	95% C.I.	Change (%)
Pacific-North	754,610	93,945	11.07	11.00-11.14	726,728	55,082	7.05	6.99-7.10	-36.31
Border	1,140,565	164,098	12.58	12.52-12.63	1,053,930	126,142	10.69	10.63-10.75	-15.02
Pacific-Center	633,603	131,493	17.19	17.10-17.27	663,948	161,048	19.52	19.44-19.61	13.55
Center-North	867,654	137,032	13.64	13.57-13.71	962,922	127,601	11.7	11.64-11.76	-14.22
Center	904,759	102,964	10.22	10.16-10.28	871,592	197,186	18.45	18.38-18.52	80.53
Mexico City	777,317	101,845	11.58	11.52-11.65	632,045	150,074	19.19	19.10-19.28	65.72
State of Mexico	953,296	160,699	14.43	14.36-14.49	959,987	222,363	18.81	18.74-18.88	30.35
Pacific-South	959,136	97,961	9.27	9.21-9.32	1,065,580	159,306	13.01	12.95-13.07	40.35
Peninsula	745,741	68,289	8.39	8.33-8.45	670,283	61,654	8.42	8.36-8.49	0.36
Total	7,736,681	1,058,326	12.03		7,607,015	1,260,456	14.21		18.12

Source: Authors' calculations based on ENSANUT (2018) and Continuous ENSANUT (2021)

Note: Includes smokers who have diabetes and/or have been told by a physician that they have diabetes

4.2 Calculation of elasticities

Presented below is a summary of the database employed, along with the results of the various regression models with the SIDS specification and prevalence results for smoking cessation. Table 13 gives descriptive statistics for the database, showing the average unit value of cigarettes and the quantity of cigarettes consumed per month and corresponding monthly expenditure in Mexican pesos. Using a pooled database provides greater variability and likely changes in cigarette price levels between the two years, due to price changes arising from the yearly inflation adjustment added to the specific tax.

Table 13. Basic statistics for the matched data pool of characteristics and tobacco consumption. Mexico, 2018–2021 (expenditures and unit values are expressed in constant Mexican pesos, 2020=100)

Full sample -Smokers only- (n= 10 149)	(n 2018 = 8044)				(n 2021 = 2105)			
Variable description	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max
Panel year = 2018	2018	0	2018	2018	2021	0	2021	2021
Quantity of cigarettes (per household, per month)	112.3	169.4	4.3	2,970.0	110	168	4	2,400
Unit value of cigarettes	3.8	5.6	0.0	30.7	3.1	5.0	0.0	30.7
Tobacco expenditure (per month, pesos)	396.2	422.6	6.9	3,957.1	422	459	9	6,197.1
Per capita income (per month, pesos)	7,024.7	11,931.6	136.1	81,0264.7	5,800	4,915	359	42,402.9
Obesity = 1	0.312	0.463	0	1	0.33	0.47	0	1
Diabetes = 1	0.074	0.262	0	1	0.08	0.28	0	1
Hypertension = 1	0.134	0.340	0	1	0.12	0.32	0	1
Gender = Female	0.303	0.460	0	1	0.31	0.46	0	1
Heart attack	0.021	0.144	0	1	0.01	0.10	0	1
Civil status of individual = Married	0.357	0.479	0	1	0.28	0.45	0	1
3 quantiles of per capita income	2	1	1	3	2	1	1	3
Age of individual	41	15	20	111	41	15	20	90
Heavy smokers = 1; occasional = 0	0.423	0.494	0	1	0.458	0.498	0	1
Share of alcohol exp.	0.031	0.148	0.000	3.429	0.032	0.144	0	4.7
Max. level of education in household	12	3.922	0	22	12	4	0	21

Source: Authors' calculations using ENIGH (2018, 2020) and ENSANUT (2018, 2021) surveys

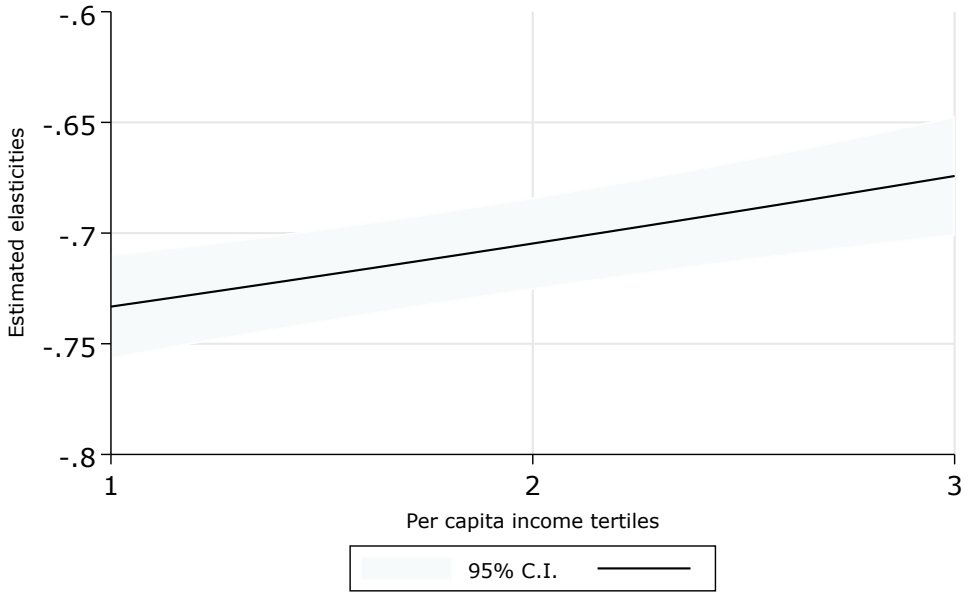
This analysis shows that smokers have an average age of 41, and the number of smokers per household ranges from one to five, with an average of 1.2 smokers per household. The quantity of cigarettes smoked is between 110 and 112 per month on average, in both years, but is highly variable, with a maximum of as many as four or five packs of 20 cigarettes a day for the heaviest smokers. This variable illustrates

how heavy smokers account for 42.3 and 45.8 percent of the total in 2018 and 2021, respectively, with the remaining 57.7 and 54.2 percent considered occasional smokers for each year.

Average prices, represented with the unit value, remain stable in both years of the data pool, at 3.8 and 3.1 pesos per cigarette, and the average number of cigarettes smoked is 112 and 110 per month in 2018 and 2021, respectively, around three to four cigarettes a day, with daily and occasional smokers all taken together. The comorbidity figures in the database are a clear reflection of the enduring nature of this problem in Mexico, with obesity affecting 33 percent of the population, diabetes eight percent, and hypertension 12 percent in 2021. Meanwhile, 30 percent of the sample of smokers are female and 35 percent are married. The average level of schooling is 12 years of education, equivalent to a high school diploma.

Equation (1), presented in the methodology, is employed to implement the tobacco demand models, and Table 14 shows elasticities with models including household controls and at least one of the health conditions most commonly associated with smoking, such as having had a heart condition. Figure 2 presents the estimated elasticity by per capita income tertile, which yields a positive gradient, indicating how low-income groups would be more responsive to any tobacco tax reform that brings about a price increase.

Figure 2. Price elasticity of tobacco by income group in Mexico, 2018–2021 (income divided into tertiles)



Source: Authors' calculations, CIAD.

Table 14 presents the results of the general demand model for tobacco, which yields a general elasticity of -0.697, meaning that for every 10-percent increase in the price of cigarettes resulting from fiscal reform, consumption would decrease by 6.9 percent. This inelastic behavior falls within the range of -0.4 to -0.9 reported in existing literature (John et al., 2019; Fuchs & Meneses, 2017; Fuchs et al., 2019). The table also presents results from the income tertile and regional models. Elasticities for the low, middle, and high-income tertiles were as expected, at -0.728, -0.719, and -0.680, respectively. These elasticities change as income levels change, but their variations are similar to each other and highly significant as well.

Table 14. Price elasticities of demand for tobacco in Mexico by income tertile and region, 2018–2020 pool

	mod1: General		*mod2: Tertiles*		*mod3: Regions*	
	Coeff.	*se*	Coeff.	*se*	Coeff.	*se*
Elasticity (log of price)	-0.6972***	*0.008*				
Income elasticity (log of income)	0.2956***	*0.019*	0.2975***	*0.02*	0.294***	*0.019*
Female	-0.042	*0.029*	-0.042	*0.029*	-0.041	*0.029*
Heart condition	-0.1803	*0.123*	-0.180	*0.122*	-0.172	*0.121*
Married	-0.035	*0.03*	-0.035	*0.03*	-0.034	*0.03*
Age	0.0115***	*0.001*	0.012***	*0.001*	0.011***	*0.001*
Drinks alcohol	3.120***	*0.671*	3.114***	*0.673*	3.114***	*0.66*

Highest level of education	-0.008*	*0.004*	-0.0075*	*0.004*	-0.008**	*0.004*
Tertile 1 elasticity	No		-0.7287***	*0.012*	No	
Tertile 2 elasticity	No		-0.7193***	*0.011*	No	
Tertile 3 elasticity	No		-0.6804***	*0.014*	No	
Pacific-North elasticity	No		No		-0.695***	*0.021*
Border elasticity	No		No		-0.681***	*0.019*
Pacific-Center elasticity	No		No		-0.674***	*0.027*
Center-North elasticity	No		No		-0.694***	*0.011*
Center elasticity	No		No		-0.739***	*0.023*
Mexico City elasticity	No		No		-0.735***	*0.018*
State of Mexico elasticity	No		No		-0.698***	*0.021*
Pacific-South elasticity	No		No		-0.696***	*0.02*
Peninsula elasticity	No		No		-0.680***	*0.021*
_cons	1.208***	*0.205*	1.193***	*0.312*	1.221***	*0.204*
Number of observations	10,148		10,148		10,148	
R-squared	0.715		0.402		0.715	

Significance level: < .01 ***; < .05 **; < .1 *

Source: Authors' calculations, CIAD

A regional analysis also shows the same pattern as with income levels above. In the Center and Mexico City regions, elasticities are slightly above the national average of -0.6972. The effect in the other regions is in line with or slightly below the national average, with values for the Pacific-North, Center-North, State of Mexico, Pacific-South, and Peninsula regions ranging from -0.674 to -0.698.

The income effect exhibits elasticity with the expected sign, meaning that with an increase in income comes an increase in purchasing power and demand for tobacco, as when the regional effect is factored in, the impact on consumption is 0.295 in the general model and 0.294 in the regional model.

4.2.1 Elasticities by type of NCD

Presented below are the elasticity results by type of NCD. The expectation is that smokers with an NCD will reduce their consumption more than smokers without an NCD. In general, elasticities are close to each other and, specifically, when the estimates are compared with the overall elasticity of -0.697; however, all of the estimates are highly significant at 99 percent of confidence, which means that cigarette consumption would decrease upon price increases regardless their group of reference, health condition, and regional location. There is one interesting finding when a comparison is made with the

overall elasticity, such as the one estimated within those smokers with diabetes, as overall elasticity is -0.732 (0.035 points higher) as can be seen in Table 14.

Obesity and smoking

The estimated coefficients show that in the event of a 10-percent increase in the price of tobacco, smokers with obesity would reduce their consumption by 7.1 percent, compared to 6.9 percent among smokers without this comorbidity. An additional analysis by income tertile shows that smokers with obesity in lower-income groups would respond similarly, with reductions in consumption on the order of 7.15 percent in low-income groups, 7.12 percent in middle-income groups, and 7.05 percent in high-income groups.

This behavior makes sense and is replicated among smokers with diabetes and hypertension, with some variation in the findings from the corresponding income tertile and regional analyses. These effects are reported in tables 15 to 18, demonstrating that a tax policy that raises tobacco prices will achieve an ever greater reduction in tobacco consumption in groups with NCDs and in regions with lower smoker densities (see Table 9)—specifically, as shown in Figure 1, the Peninsula, Center, Pacific-South, and Pacific-North regions, which have the lowest smoking prevalence rates and are more sensitive to changes in tobacco prices, as confirmed in the results shown in Table 18 further on.

Table 15. Price elasticities of demand for tobacco in Mexico in smokers with obesity, by income tertile, 2018–2020 data pool

	mod1: General		*mod2: Tertiles*	
	Coeff.	*se*	Coeff.	*se*
Elasticity (log of price)	-0.709***	*0.013*		
Income elasticity (log of income)	0.291***	*0.034*	0.289***	*0.036*
Female	-0.042	*0.050*	-0.042	*0.050*
Heart condition	-0.420*	*0.220*	-0.421*	*0.220*
Married	0.018	*0.052*	0.018	*0.051*
Age	0.013***	*0.002*	0.013***	*0.002*
Drinks alcohol	3.258**	*1.444*	3.267**	*1.441*
Highest level of education	-0.001	*0.007*	-0.001	*0.007*
Tertile 1 elasticity			-0.715***	*0.029*
Tertile 2 elasticity			-0.712***	*0.024*

Tertile 3 elasticity			-0.705***	*0.018*
Constant	1.299***	*0.365*	1.314***	*0.371*
Number of observations	3,199		3,199	
R-squared	0.726		0.727	

Significance level: < .01 ***; < .05 **; < .1 *
Source: Authors' calculations, CIAD

Diabetes and smoking

Table 16 shows that the response by smokers with diabetes to an increase in tobacco prices would be similar to that of smokers with obesity, suggesting that this is another health condition for which there is a margin for a price increase. Furthermore, in the face of a 10-percent increase in prices, the decline in consumption would be greatest in lower-income groups, at 7.3 percent. An additional analysis by income tertile shows that smokers with diabetes from low-income groups would be more responsive than those from high-income groups. The decline in consumption would be on the order of 7.8 percent for low-income groups, 7.5 percent for middle-income groups, and 6.7 percent for high-income groups.

Table 16. Price elasticities of demand for tobacco in Mexico in individuals with diabetes, by income tertile, 2018–2020 data pool

	mod1: General		*mod2: Tertiles*	
	Coeff.	*se*	Coeff.	*se*
Elasticity (log of price)	-0.732***	*0.024*		
Income elasticity (log of income)	0.351***	*0.058*	0.337***	*0.059*
Female	0.072	*0.094*	0.064	*0.094*
Heart condition	-0.127	*0.140*	-0.088	*0.148*
Married	-0.012	*0.098*	-0.031	*0.099*
Age	0.012***	*0.003*	0.012***	*0.003*
Drinks alcohol	6.428***	*1.519*	6.409***	*1.511*
Highest level of education	-0.021*	*0.012*	-0.020	*0.012*
Tertile 1 elasticity			-0.788***	*0.037*
Tertile 2 elasticity			-0.753***	*0.046*
Tertile 3 elasticity			-0.678***	*0.034*
Constant	0.814*	*0.484*	0.897*	*0.501*
Number of observations	772		772	
R-squared	0.756		0.759	

Significance level: < .01 ***; < .05 **; < .1 *
Source: Authors' calculations, CIAD

Hypertension and smoking

A greater reduction is observed among smokers with hypertension than among smokers with the other two NCDs, with a 10-percent increase in tobacco prices resulting in a 7.22 percent fall in consumption. The analysis by socioeconomic group yields an inverted-U-like curve, a sign that the effect is greater in low- and high-income households, with reductions of -7.57 percent in low-income groups, -7.06 percent in middle-income groups, and -7.13 percent in high-income groups. The rest of the control variables exhibit the expected sign, but the only variables with a statistically significant effect are age, whether the smoker drinks alcohol, and the highest level of education reported in the household.

Table 17. Price elasticities of demand for tobacco in Mexico in individuals with hypertension, by income tertile, 2018–2020 data pool

	mod1: General		*mod2: Tertiles*	
	Coeff.	*se*	Coeff.	*se*
Elasticity (log of price)	-0.722***	*0.021*		
Income elasticity (log of income)	0.348***	*0.063*	0.349***	*0.064*
Female	0.045	*0.082*	0.050	*0.082*
Heart condition	0.051	*0.127*	0.049	*0.128*
Married	-0.010	*0.090*	0.011	*0.090*
Age	0.011***	*0.003*	0.011***	*0.003*
Drinks alcohol	4.875***	*1.699*	5.066***	*1.672*
Highest level of education	-0.025**	*0.010*	-0.024**	*0.010*
Tertile 1 elasticity			-0.757***	*0.043*
Tertile 2 elasticity			-0.706***	*0.029*
Tertile 3 elasticity			-0.713***	*0.030*
Constant	0.816	*0.573*	0.802	*0.575*
Number of observations	1,324		1,324	
R-squared	0.705		0.706	

Significance level: < .01 ***; < .05 **; < .1 *
Source: Authors' calculations, CIAD

NCDs and regional impact

As described above, the comorbidities studied differ in their response, both from one another and from the behavior of the overall population; smokers with an NCD are more responsive to an increase in tobacco taxes. In this section, the authors present the elasticity findings by region and by smoker comorbidity. A full overview of the models applied can be found in Table 18.

As observed, smokers with diabetes and hypertension exhibit a similar response, reducing their consumption by 7.3 and 7.2 percent, respectively, for every 10-percent increase in tobacco prices (models 2 and 3), while smokers with obesity are relatively less responsive, at 7 percent (model 1). This analysis by NCD reveals heterogeneity in the response between regions, and this evidence takes on relevance in improving fiscal policy design in tobacco control to strengthen public health impacts nationwide.

Table 18. Integrated model of response to price increases in the consumption of cigarettes, Mexico 2018–2021

	Model 1: Obesity	Model 1: Obesity-region	Model 2: Diabetes	Model 2: Diabetes-region	Model 3: Hypertension	Model 3: Hypertension-region
Elasticity (log of price)	-0.709***		-0.732***		-0.722***	
Income elasticity	0.291***	0.284***	0.351***	0.365***	0.348***	0.359***
Female	-0.042	-0.040	-0.072	0.062	0.045	0.046
Heart condition	-0.420*	-0.395*	-0.127	-0.088	0.051	0.049
Married	0.018	0.018	-0.012	-0.025	0.011***	-0.018
Age	0.013***	0.013***	0.012***	0.010***	4.875***	0.011***
Drinks alcohol	3.258**	3.195**	6.428***	6.495***	-0.025**	4.599***
Highest level of education	-0.001	-0.001	-0.021*	-0.022*	-0.722***	-0.028***
Pacific-North elasticity		-0.6874***		-0.7469***		-0.7602***
Border elasticity		-0.7056***		-0.7128***		-0.7341***
Pacific-Center elasticity		-0.6746***		-0.7080***		-0.6668***
Center-North elasticity		-0.6924***		-0.7066***		-0.7177***
Center elasticity		-0.7718***		-0.8479***		-0.8127***
Mexico City elasticity		-0.7219***		-0.7340***		-0.7901***
State of Mexico elasticity		-0.7388***		-0.7327***		-0.6857***
Pacific-South elasticity		-0.6931***		-0.6556***		-0.6895***
Peninsula elasticity		-0.6565***		-0.7245***		-0.6703***
Constant	1.299***	1.3377***	0.814*	0.7893	0.816	0.7943
Observations	3,199	3199	772	772	1324	1324
R-squared	0.726	0.728	0.756	0.76	0.705	0.708

* p<0.05, ** p<0.01, *** p<0.001
Source: Authors' calculations, CIAD

Models 2 and 3 both show the Center region as most responsive to the price increase, at 8.5 and 8.1 percent for smokers with diabetes and hypertension, respectively, with obesity trailing at 7.7 percent.

The greatest decline in consumption among smokers with hypertension is found in the Center region, at 8.1 percent, followed by Mexico City, at 7.9 percent. As for smokers with diabetes, the greatest response is found in the Center and Pacific-North regions, at 8.4 and 7.5 percent, respectively. For obesity, the greatest falls in consumption are observed in the Center and State of Mexico regions, at 7.7 and 7.4 percent, respectively.

The regions that experience medium levels of reduction in tobacco use among smokers with obesity are Center-North and Pacific-South, at 6.9 percent, followed by Pacific-North and Pacific-Center, at 6.8 and

6.7 percent, respectively. As for smokers with diabetes, medium-level declines in consumption can be found in the Border, Center-North, and Pacific-South regions, with elasticities ranging from 6.6 to 7.1 percent; and for hypertension, the Center-North and Pacific-South regions see declines of 7.2 and 6.9 percent, respectively.

The least responsive smokers with obesity can be found in the Peninsula, Pacific-Center, and Pacific-North regions, at 6.5, 6.7, and 6.8 percent, respectively. For diabetes, the lowest levels of response are observed in Pacific-South, Pacific-Center, and Center-North, at 6.6, 7.1, and 7.1 percent, respectively; and among smokers with hypertension, it is the Pacific-Center, Peninsula, and State of Mexico regions that are least responsive, with response levels of 6.6, 6.7, and 6.8 percent, respectively.

The Mexico City region is noteworthy as a special case. In 2021, the capital was home to the largest number of smokers with hypertension, accounting for 17 percent of the national total, above even the State of Mexico, with 12.9 percent, or the Center-North region, with 12 percent (see Table 11).

4.3 Cessation

This section presents the results that enable the authors to determine the expected impacts in terms of smoking cessation, both for the population as a whole and for each group of smokers with NCDs included in this study. This will provide a greater level of detail to enable more effective fiscal policy design recommendations in tobacco control, resulting in greater benefits throughout the country by capturing differences in behavior between the different groups.

Cessation is estimated as the difference in the likelihood of smoking participation before and after the price for cigarettes increased: first, for all the smokers and second, for the smokers suffering at least one of the NCDs considered. A 34.2-percent increase in the price of a pack of cigarettes is simulated through a unit value in the *Probit* model specification and controlling for regions. The difference that results in participation reduction is then used to calculate cessation.

Table 19 shows the regression coefficients from the probit estimation, considering Equations (5) and (6). With regional controls, there is a rise in estimated prevalence after the tax-related price increase. This leads to the conclusion that there are statistically significant regional differences that result in a

greater smoking cessation impact from a tobacco tax reform. A complete description of the Stata codes is included in the Appendix.

The best-fit model includes regional controls, gender, urban-rural area of residence, and the price effect given by the unit value. The price coefficient is positive and somewhat higher when regional controls are included, which is an indication that including these controls better captures the effects. A lesser effect on prevalence is observed in urban areas, where it is more difficult to quit smoking. The sex variable produces a slight increase in the effect on prevalence, and age remains highly significant and unchanged in both econometric specifications.

Table 19. Probit model coefficients for cessation in Mexico by comorbidity, 2018–2021

Population and comorbidity	Unit value (log)	Urban	Sex	Age	Regional controls	Constant	N	Pseudo R-sq
Population	0.0970***	0.255***	-0.765***	-0.0114***	No	-0.330***	9048	0.090
Population	0.104***	0.201***	-0.775***	-0.0116***	Yes	-0.245***	9048	0.100
Hypertension	0.119*	0.385***	-0.753***	-0.0151***	No	-0.314	1706	0.110
Hypertension	0.130**	0.377***	-0.760***	-0.0155***	Yes	-0.28	1706	0.116
Diabetes	0.111	0.289*	-0.865***	-0.0179***	No	0.0243	954	0.119
Diabetes	0.115*	0.252	-0.876***	-0.0180***	Yes	0.0274	954	0.125
Obesity	0.0594	0.311***	-0.668***	-0.0123***	No	-0.349**	3213	0.075
Obesity	0.0869**	0.257***	-0.674***	-0.0129***	Yes	-0.360***	3213	0.085

* p<0.05, ** p<0.01, *** p<0.001
Source: Authors' calculations based on ENSANUT (2018, 2021) and ENIGH (2018, 2020)

Table 20 shows the effects of a hypothetical fiscal reform that levies an additional one peso in tax per stick, in terms of reducing smoking prevalence (column A) based on the cessation model applied, both nationally and by subgroup of smokers with an NCD, as calculated by Equation (8) in the methodology.

The 3.74-percent figure for cessation in column B is the result of 602,500 smokers quitting; and by NCD, the greatest share of cessation is observed among smokers with obesity, at 30.5 percent, followed by those with hypertension, at 14.6 percent, and smokers with diabetes, at 9.9 percent, making a total of 331,764 individuals with NCDs who would stop smoking. The distribution shows that the remaining 44.9 percent of smokers who would quit do not have a NCD (column D).

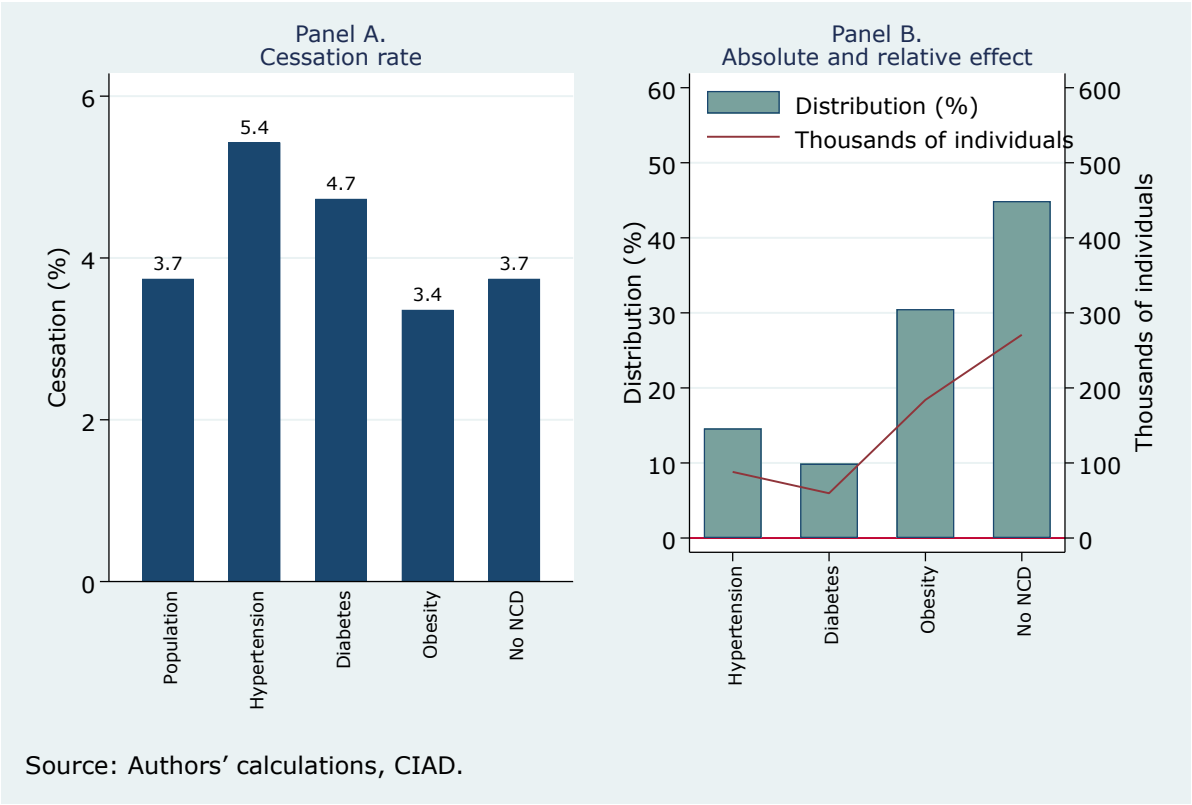
The authors calculate that by subtracting these former smokers, prevalence is reduced nationally by 0.714 percentage points, dropping from 19.07 percent to 18.36 percent once the fiscal measure has been implemented.

Table 20. Calculation of cessation in Mexico in the event of an additional 1-peso tobacco tax reform

Mexico	Prob[d=1 | X] (a)	Cessation (b)	Individuals (c)	Distribution % (d)
Population	2.907	3.587	577,361	100.0
Hypertension	1.608	5.113	88,070	15.3
Diabetes	1.400	4.577	57,692	10.0
Obesity	0.732	2.365	129,589	22.4
Without NCDs	0.291	3.587	302,010	52.3
Controlling for region				
Population	3.173	3.743	602,500	100.0
Hypertension	1.800	5.427	88,070	14.6
Diabetes	1.447	4.731	59,637	9.9
Obesity	1.090	3.359	184,057	30.5
Without NCDs	3.173	3.743	270,735	44.9

Source: Authors' calculations, CIAD

Figure 3. Smoking cessation response by health condition



Source: Authors' calculations, CIAD.

Figure 3 illustrates a summary of the results of Table 20, based on the cessation model with regional controls. Panel A indicates that a one-peso increase in the specific component of IEPS tax would yield a cessation rate of 3.7 percent among smokers without an NCD, while smokers with hypertension, diabetes, and who are overweight or obese would experience cessation rates of 5.4, 4.7, and 3.4 percent, respectively. In absolute terms, this translates to a total of 602,500 individuals who would stop smoking. Panel B of Figure 3 shows the distribution of the population that would quit smoking, by NCD.

Regional cessation rates also differ from the national figure. The regions with the highest levels of cessation in response to this fiscal measure are the Peninsula (4.1 percent), Pacific-North (3.6 percent), Center-North (3.58 percent), and Pacific-South (3.54 percent), while Mexico City (2.37 percent), the State of Mexico (2.47 percent), and the Border (2.58 percent) would see the lowest cessation rates (see third column of Table 21).

Table 21. Calculation of cessation in Mexico, nationally and by region, in response to an additional 1-peso tobacco tax reform

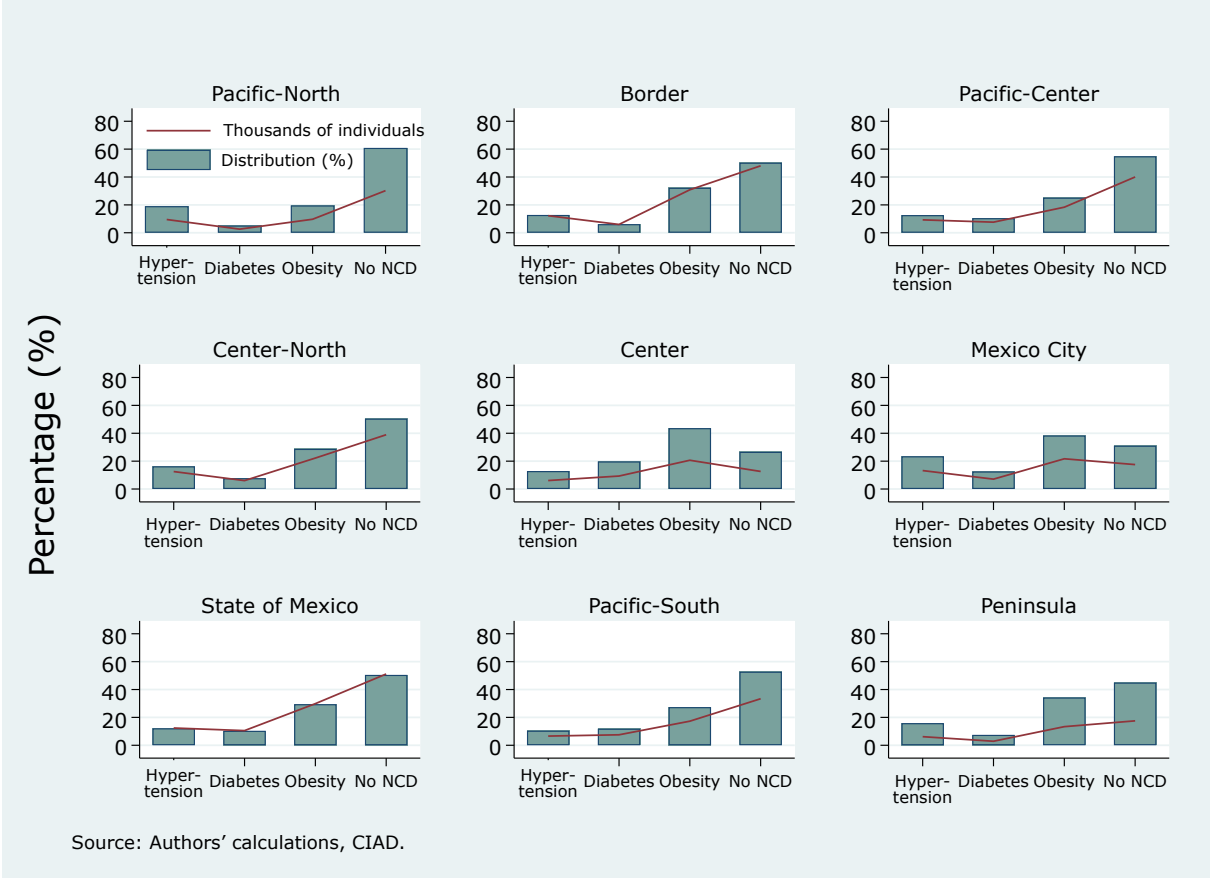
Regions	Smokers	Regional cessation rate (%)	Cessation -individuals- (a)	Distr. %	Cessation -individuals- (b)	Distr. %	Cessation -individuals- (c)	Distr. %
Pacific-North								
Total smoking population	**1,327,118**	**3.581**	**47,601**	**100.0**	**49,674**	**100.0**	**47,523**	**100.0**
With hypertension	175,064	5.718	8,951	18.8	9,502	19.1	10,011	21.1
With diabetes	55,082	4.958	2,521	5.3	2,606	5.2	2,731	5.7
With obesity	289,150	3.484	6,839	14.4	9,713	19.6	10,073	21.2
No NCD	807,822	3.581	28,975	60.9	30,237	60.9	24,708	52.0
Border								
Total smoking population	**2,553,582**	**2.579**	**91,592**	**100.0**	**95,580**	**100.0**	**65,848**	**100.0**
With hypertension	225,456	3.458	11,527	12.6	12,237	12.8	7,797	11.8
With diabetes	126,142	2.999	5,774	6.3	5,968	6.2	3,783	5.7
With obesity	918,642	1.829	21,727	23.7	30,858	32.3	16,799	25.5
No NCD	1,283,342	2.579	46,031	50.3	48,035	50.3	37,469	56.9
Pacific-Center								
Total smoking population	**1,947,746**	**2.576**	**69,862**	**100.0**	**72,904**	**100.0**	**50,170**	**100.0**
With hypertension	170,557	2.834	8,721	12.5	9,257	12.7	4,833	9.6
With diabetes	161,048	2.412	7,371	10.6	7,620	10.5	3,884	7.7
With obesity	546,736	1.628	12,931	18.5	18,366	25.2	8,900	17.7
No NCD	1,069,405	2.576	38,357	54.9	40,028	54.9	32,552	64.9
Center-North								
Total smoking population	**2,060,944**	**3.581**	**73,922**	**100.0**	**77,141**	**100.0**	**73,800**	**100.0**
With hypertension	231,200	5.544	11,821	16.0	12,548	16.3	12,817	17.4
With diabetes	127,601	4.814	5,840	7.9	6,037	7.8	6,143	8.3
With obesity	661,551	3.478	15,646	21.2	22,222	28.8	23,011	31.2
No NCD	1,040,592	3.581	37,324	50.5	38,949	50.5	31,830	43.1
Center								
Total smoking population	**1,262,012**	**3.546**	**45,266**	**100.0**	**47,237**	**100.0**	**44,745**	**100.0**
With hypertension	112,377	6.160	5,746	12.7	6,099	12.9	6,922	15.5
With diabetes	197,186	5.337	9,025	19.9	9,330	19.8	10,524	23.5

With obesity	615,002	3.686	14,545	32.1	20,659	43.7	22,672	50.7
No NCD	337,447	3.546	12,104	26.7	12,631	26.7	4,627	10.3
Mexico City								
Total smoking population	**1,509,140**	**2.369**	**54,130**	**100.0**	**56,487**	**100.0**	**35,747**	**100.0**
With hypertension	244,122	2.518	12,482	23.1	13,250	23.5	6,147	17.2
With diabetes	150,074	2.134	6,869	12.7	7,101	12.6	3,202	9.0
With obesity	646,023	1.428	15,279	28.2	21,701	38.4	9,228	25.8
No NCD	468,921	2.369	16,819	31.1	17,552	31.1	17,170	48.0
State of Mexico								
Total smoking population	**2,705,966**	**2.474**	**97,058**	**100.0**	**101,284**	**100.0**	**66,950**	**100.0**
With hypertension	228,265	2.488	11,671	12.0	12,389	12.2	5,680	8.5
With diabetes	222,363	2.103	10,178	10.5	10,521	10.4	4,676	7.0
With obesity	889,210	1.409	21,030	21.7	29,870	29.5	12,527	18.7
No NCD	1,366,128	2.474	49,000	50.5	51,134	50.5	44,066	65.8
Pacific-South								
Total smoking population	**1,688,371**	**3.541**	**60,559**	**100.0**	**63,195**	**100.0**	**59,785**	**100.0**
With hypertension	121,706	5.550	6,223	10.3	6,606	10.5	6,755	11.3
With diabetes	159,306	4.823	7,292	12.0	7,537	11.9	7,683	12.9
With obesity	515,071	3.472	12,182	20.1	17,302	27.4	17,884	29.9
No NCD	892,288	3.541	32,005	52.8	33,398	52.8	27,463	45.9
Peninsula								
Total smoking population	**1,041,912**	**4.080**	**37,371**	**100.0**	**38,999**	**100.0**	**42,507**	**100.0**
With hypertension	113,931	6.129	5,825	15.6	6,184	15.9	6,983	16.4
With diabetes	61,654	5.188	2,822	7.6	2,917	7.5	3,199	7.5
With obesity	397,919	3.687	9,411	25.2	13,367	34.3	14,670	34.5
No NCD	468,408	4.080	16,801	45.0	17,532	45.0	17,654	41.5
Total cessation with regional effects	**16,096,791**	**3.743**	**577,361**	**3.587**	**602,500**	**3.743**	**487,074**	**3.026**

a: Cessation levels are obtained by assuming the same national estimates of cessation across the regions.
b: Cessation levels are obtained by assuming the same national estimates of cessation with regional controls across the regions.
c: Cessation levels are obtained by using differentiated estimates of cessation across the regions, adjusted by regional prevalence and regional coefficient effects.

However, in light of the fact that, in absolute terms, the concentration of smokers in different regions varies widely, column 6 of Table 21 shows that the State of Mexico has the highest number of smokers who would quit (101,284 individuals), followed by the Border region (95,580 individuals), Center-North (77,141 individuals), Pacific-Center (72,904 individuals), and Pacific-South (63,195 individuals). Note that just three regions account for close to half of all smokers who would quit: State of Mexico (16.8 percent), Border (15.9 percent), and Center-North (12.8 percent).

Figure 4. Smoking cessation response by region and health condition



Source: Authors' calculations, CIAD.

Additionally, Figure 4 presents a more in-depth regional analysis by disaggregating by health condition the impact of a reform raising the specific component of the IEPS excise tax on cigarettes by one peso per stick. The highest proportion of people who would stop smoking do not have an NCD, followed by those who are overweight or obese. Also notable is the fact that in the Center and Mexico City regions, smokers with obesity account for a more significant share of the quitting population. Finally, in three regions (Center, Mexico City, and Peninsula), smokers with an NCD exhibit the greatest response, representing at least 69 percent of all individuals who would stop smoking.

5. Discussion

In a context in which the Mexican government needs more funding, health taxes are an efficient approach with a threefold effect widely documented in the literature: 1) a reduction in consumption, 2) an increase in fiscal resources, and 3) an increase in cessation. It is this last effect that is explored by this study, which has found that, to increase cessation, stronger fiscal measures are called for to effect an increase in tobacco prices of over 34.2 percent, like the example in this study.

Although this research offers, for the first time, a comprehensive analysis of responses to higher tobacco prices at a subnational (regional) level and smoking reduction behavior based on the most common comorbidities in the Mexican population, this work does have some limitations arising from the lack of state-level estimates, not available in the 2021 ENSANUT data. However, the regional approach taken is representative, making it possible to locate, within nine regions, likely increases in cessation and thus determine the total number of smokers who would quit as a consequence of the hypothetical fiscal measure employed in this study. Additionally, due to a measurement error caused by incorrect reporting of expenditure or actual quantity of cigarettes purchased in the surveys, cigarette prices were observed to be somewhat lower, in real terms, in 2021 than 2018. Nonetheless, correcting for these measurement errors does not yield inconsistent results, producing an even greater response to the price increase caused by higher tobacco taxation.

Understanding regional differences makes it possible to adopt more effective fiscal measures and determine the areas where these measures might have the greatest effects, such as the State of Mexico and the states that make up the Border region, while lesser effects may be observed in the Peninsula and Center regions. This would enable positive effects nationwide, with a significant increase in cessation across all regions, such that smoking prevalence could be brought back down to pre-pandemic levels, that is, 17 percent. This analysis is made possible through probability matching, whereby smokers with an NCD are pooled together.

In regions with a high density of smokers, like Mexico City and the State of Mexico, the effective cessation rates are lower in comparison to other regions. Importantly, in these two regions, there is a higher number of smokers with obesity. When smokers with hypertension and diabetes are also included, their

apparent distribution is much greater in terms of frequency. This points to the conclusion that this fiscal measure would help to improve the health of the Mexican population throughout the country.

6. Conclusions and Recommendations

The smoking epidemic affects Mexico's different regions, and smokers with different health conditions, to varying extents. While smoking prevalence at a national level rose from 17.94 to 19.07 percent between 2018 and 2021 in the population aged 20 years or older, the regions show different rates of prevalence. In 2021, the lowest prevalence was found in the Peninsula and Center regions, while the State of Mexico and Border regions exhibited the highest levels of smoking prevalence, followed by Mexico City and Pacific-Center.

Between 2018 and 2021, smoking prevalence fell among smokers with arterial hypertension, high cholesterol, and heart conditions, while an increase was observed in the same period for smokers with diabetes and who are overweight or obese.

Meanwhile, estimates of the price elasticity of demand indicate that a 10-percent increase in cigarette prices would reduce tobacco consumption by 6.9 percent. However, demand is less inelastic for smokers with a noncommunicable disease. The findings show that, given a 10-percent increase in the price of cigarettes, consumption would fall by seven percent among smokers who are overweight and obese, 7.3 percent among smokers with diabetes, and 7.2 percent among smokers with hypertension.

Increasing cigarette prices by 10 percent would achieve a significant, sharp decline in consumption in all geographical areas, ranging from 6.7 percent to 7.4 percent. This analysis shows that a policy introducing an additional one-peso tax per cigarette, increasing cigarette prices by 34.2 percent, would lead 602,500 smokers to quit. In so doing, the tax increase could also achieve a greater impact on smokers with an NCD, particularly those with hypertension and diabetes, and to a lesser extent those with overweight and obesity. Smokers with NCDs represent just over 55 percent of those who would stop smoking, or 331,765 individuals, compared to the remaining 45 percent or 270,735 smokers without NCDs who would also quit. This would enable the Mexican government to achieve a substantial reduction in the health care costs associated with treating these diseases, as well as the future costs of smoking-related conditions.

This measure would go some way to remedying Mexico's lagging deficiencies in tobacco tax policy. While fiscal policies to adjust for inflation are important in the short term, over time they lose their effect, and it becomes necessary to push for tax hikes in excess of increases in smokers' purchasing power in order to reduce the affordability of tobacco products. It is also important to take into account that there are no major regional differences but that they are responsive and strong enough to reduce tobacco consumption. These findings should be useful to better craft more effective fiscal policy nationwide.

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Appendix

Table A1. Propensity score matching with the nearest-neighbor approach: Estimation of treatment effects (ATE)

Matched surveys	Smoking	Coefficient	Standard error	t	P>t	[95% C.I.]	
2018 ENSANUT – 2018 ENIGH	ATE	0.081	0.001	83.56	0.000	0.079	0.083
2021 ENSANUT – 2020 ENIGH	ATE	0.150	0.002	67.97	0.000	0.146	0.154

Source: Authors' calculations based on ENIGH (2018, 2020) and ENSANUT (2018, 2021)

Table A2. Covariate balance test: By standardized mean difference

	Matched surveys (ATE)					
	2018			2021		
Variables: mean	Treatment	Control	Standardized difference	Treatment	Control	Standardized difference
Age	34.768	34.860	-0.005	35.743	35.871	-0.006
Male	0.485	0.484	0.002	0.481	0.479	0.004
Urban	0.650	0.657	-0.015	0.628	0.674	-0.102
Spouse or partner	0.204	0.204	0.000	0.199	0.201	-0.004
Child	0.370	0.368	0.003	0.371	0.366	0.011
Grandchild	0.050	0.050	0.001	0.052	0.054	-0.008
Child-in-law	0.023	0.024	0.000	0.023	0.023	0.001
Parent	0.009	0.009	-0.003	0.009	0.009	-0.007
Parent-in-law	0.004	0.004	0.000	0.004	0.004	-0.002
Other (state)	0.027	0.027	-0.001	0.026	0.028	-0.007
No relationship	0.007	0.006	0.011	0.004	0.005	-0.004
Speaks an indigenous language	0.067	0.067	0.001	0.064	0.054	0.043
Attends school	0.280	0.279	0.004	0.267	0.263	0.008
Refuse collection service	1.631	1.629	0.002	1.565	1.490	0.068
Homeownership	3.365	3.358	0.006	3.404	3.399	0.004
Water tank (rooftop)	0.568	0.568	-0.001	0.590	0.627	-0.079
Water tank (ground-level)	0.182	0.181	0.002	0.193	0.203	-0.025
Electricity meter	0.928	0.928	0.000	0.933	0.932	0.006
Air conditioning	0.182	0.180	0.004	0.200	0.187	0.034
Car	0.297	0.300	-0.006	0.313	0.321	-0.015
Van or truck	0.180	0.174	0.017	0.164	0.161	0.007
Motorcycle	0.116	0.117	-0.002	0.139	0.136	0.007
Pay television	0.476	0.476	0.001	0.461	0.473	-0.023
Computer	0.288	0.289	-0.002	0.312	0.335	-0.049

Blender	0.888	0.891	-0.009	0.904	0.921	-0.062
Refrigerator	0.881	0.881	-0.001	0.894	0.903	-0.031
Stove	0.896	0.899	-0.013	0.903	0.920	-0.063
Washing machine	0.708	0.707	0.001	0.733	0.743	-0.024

Source: Authors' calculations based on ENIGH (2018, 2020) and ENSANUT (2018, 2021)

Table A3. Covariate balance test: By variance ratio

	Matched surveys (ATE)					
	2018			2021		
Variables: variance	Treatment	Control	Ratio	Treatment	Control	Ratio
Age	415.591	403.809	1.029	432.366	412.765	1.047
Male	0.250	0.250	1.000	0.250	0.250	1.000
Urban	0.228	0.225	1.009	0.234	0.220	1.064
Spouse or partner	0.162	0.162	1.000	0.160	0.161	0.994
Child	0.233	0.233	1.002	0.233	0.232	1.006
Grandchild	0.047	0.047	1.002	0.050	0.051	0.969
Child-in-law	0.023	0.023	0.998	0.022	0.022	1.006
Parent	0.009	0.009	0.971	0.008	0.009	0.930
Parent-in-law	0.004	0.004	0.997	0.004	0.004	0.961
Other (state)	0.026	0.026	0.995	0.026	0.027	0.961
No relationship	0.007	0.006	1.171	0.004	0.005	0.940
Speaks an indigenous language	0.062	0.062	1.004	0.060	0.051	1.166
Attends school	0.202	0.201	1.004	0.196	0.194	1.009
Refuse collection service	1.481	1.475	1.004	1.424	1.177	1.210
Homeownership	1.186	1.219	0.973	1.166	1.202	0.970
Water tank (rooftop)	0.245	0.245	1.000	0.242	0.234	1.035
Water tank (ground-level)	0.149	0.148	1.004	0.156	0.162	0.962
Electricity meter	0.067	0.067	1.001	0.062	0.064	0.978
Air conditioning	0.149	0.148	1.006	0.160	0.152	1.052
Car	0.209	0.210	0.995	0.215	0.218	0.988
Van or truck	0.148	0.143	1.030	0.137	0.135	1.014
Motorcycle	0.103	0.103	0.996	0.119	0.118	1.015
Pay television	0.249	0.249	1.000	0.249	0.249	0.997
Computer	0.205	0.205	0.998	0.214	0.223	0.963
Blender	0.099	0.097	1.021	0.087	0.073	1.189
Refrigerator	0.105	0.105	1.002	0.095	0.088	1.082
Stove	0.093	0.090	1.033	0.087	0.074	1.189
Washing machine	0.207	0.207	0.999	0.196	0.191	1.026

Source: Authors' calculations based on ENIGH (2018, 2020) and ENSANUT (2018, 2021)

STATA Codes for estimation of cessation

```
cd "/Users/luishuesca/Dropbox/Tabaco_7/data/
use pool_matched_v2_cess.dta, clear
eststo clear
forvalues i=1/4 {

preserve
if `i' == 2 keep if hiperten == 1
if `i' == 3 keep if diabetic == 1
if `i' == 4 keep if obese    == 1

keep if pc_ing_cor!=.
keep if  luvtab>0
stepwise, pr(0.1): probit smok luvtab urbano sexo_1 edad i.region dheart
*margins
*margins, over(hiperten)
*margins, over(diabetic)
*margins, over(obese)
* Con regiones
margins region
margins region, over(hiperten)
margins region, over(diabetic)
margins region, over(obese)
eststo m_`i'
 /* urbano_* nivelaprob_* edo_conyug_*/

*Generate temporary variables

*The probability elasticity with respect to price or welfare
tempvar elap
qui gen `elap'  = 0

*Proportional change in price (Assume that prices increase by 10%)
tempvar  prop_ch
qui gen `prop_ch' = 0
tempvar  prop_change

*Probability from probits are stored
cap drop `pr1'
cap drop `pr2'
tempvar pr1 pr2
```

```
*Predict probabilities and add change in prices from model (from 0.59 to 1.59 per stick)
qui predict `pr1'
qui replace luvtab=log(exp(luvtab)*1.342)
qui predict `pr2'
qui replace luvtab=log(exp(luvtab)/1.342)

tempvar dif prdif

*The estimated change in the probability of use -or consumption- of the good
qui g `dif' = 0

*The estimated change in the price of use -or consumption- of the good
qui g `prdif' = 0

*Find margins vis-a-vis covariates
qui margins [aw=factor] , dydx(luvtab) atmeans
marginsplot

*Store elasticity of income
local mar1 = el(r(table),1,1)
if "`mar_1'" == "" {
local  local mar_`1' = 0
}

*Calculate price elasticity
qui sum mark_tab [aw=factor]
local elap1 = `mar1' / r(mean)

tempvar elap
qui gen `elap' = `elap1'

*Calculate average predicted probability and store in mu1
qui sum `pr1'  [aw=factor]  , meanonly
local mu1 = r(mean)

*Calculate average predicted probability and store in mu2
qui sum `pr2'  [aw=factor]  , meanonly
local mu2 = r(mean)

*Calculate difference in probabilities
qui replace `prdif' = `pr2'-`pr1'
cap drop dif100
qui gen dif100 = `prdif'*100
```

```
* Calculate the estimated change in the probability of use -or consumption- of the good
qui replace `dif' = `mu2'-`mu1'

*Calculate Proportional change in price
qui replace `prop_ch' = `dif'/`mu1'*100

**********************************
*Display variables from table 02*
**********************************

*Col (2)
dis `elap1'

*Col (3)
dis `pr1'

*Col (3)
dis `pr2'

*Col (6)
dis `dif'

*Col (7)
dis `prop_ch'

local elas_`i'   = `elap1'
local ch_ela_`i' = `elap1'*10
local ch_det_`i' = `prop_ch'

restore

}

local i=1
local list Population  hiperten  diabetic obese

foreach name of local list {
        dis "`name' : "  `elas_`i''  " " `ch_ela_`i'' " " `ch_det_`i''
        local i=`i'+1
}

esttab m_*, mtitle(Population  hiperten  diabetic obese)
```

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