The Distributional Effects of a Tobacco Tax Reform in Mexico:
Social welfare improvements from fiscal reforms
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Abstract

Background

Despite considerable evidence supporting tobacco excise tax increases, policy makers have been slow to adopt such measures. This failure is largely driven by concerns about the economic consequences of tax increases, including the tax incidence of the increase and its potentially regressive impacts. In this paper, we examine the incidence and the distributional effects of a potential tobacco tax reform in Mexico.

Methodology

We implement a before-and-after analysis and a threefold welfare analysis with concentration curves (a concentration approach, order-in-dominance criteria, and a stochastic dominance approach) to evaluate the distributional effects of tobacco tax increases in two tax reform scenarios for Mexico that increase the price of cigarettes. We analyze the impact by income group.

Results

Although the tax burden on tobacco expenditure increases for all terciles, a large increase in the specific component of the tobacco tax is slightly progressive. A tax increase reduces the gap between the tax paid by the first tercile and that paid by the third tercile. Under the Lorenz scheme, a concentration curve of the tax shows that increasing tobacco taxes is a marginally progressive policy, since the tax burden is reduced among the lower-income groups and increased among the higher-income groups. The progressive impact of higher tobacco taxes is consistent, and the higher the tax increase, the more progressive the impact. Notably, increasing tobacco tax by one peso per cigarette stick yields the greatest extended Kakwani index value, with 8.37 points more progressivity compared to the current situation, which only adjusts for inflation.

Conclusions

A higher tobacco tax proportionally reduces the tax burden on the poor population, improving income distribution and social welfare in Mexico. If policy makers have concerns about inequality in Mexico, an increase on tobacco taxes would be progressive and should be seriously considered as part of a pro-poor strategy.

JEL Codes: H22, H23, H51, I14

Keywords: Tobacco taxation, tax incidence, excise tax, distributive effects

Introduction

Worldwide, more than 8.2 million people die each year from tobacco-related diseases, with 80 percent of smokers living in low- and middle-income countries (WHO, 2021). This problem is increasingly drawing the attention of policy makers including legislators, civil society, and academics to the harmful effects of tobacco use on the health of the population and the budgetary effects of tobacco consumption.

Global evidence shows that tax increases reduce overall tobacco use, lead current users to quit, prevent youth from taking up tobacco, and reduce health and economic consequences (WHO, 2021). Increasing tobacco taxes is the most effective and cost-effective tobacco control policy (WHO, 2021). Tobacco tax increases create incentives to reduce tobacco consumption, but also have effects in delaying initiation (Gospodinov et al., 2007). In addition, there is significant evidence of tobacco taxation contributing to reductions in the incidence of disease and premature deaths due to smoking, hospitalizations for heart failure, and childhood asthma (Chaloupka et al., 2019).

Despite the considerable evidence supporting tobacco excise tax increases, policy makers have been slow to adopt such measures. This failure is largely driven by concerns about the potential economic consequences of tax increases. Tax regressivity and fiscal incidence of the reforms are among the main concerns when considering increasing tobacco taxes. Both concepts are very closely related, as the tax incidence refers to the share of household expenditure taken up by cigarette tax and the tax burden by expenditure group, while tax regressivity occurs when tobacco tax accounts for a higher share of the expenditure of poor people than the rich.

The myth of tobacco tax regressivity

In the conventional approach in studies on tax progression, the tax system is progressive when the average rate of tax rises further up the income scale (the marginal tax rate exceeds the average rate) and regressive when the average rate falls with rising income (the marginal tax rate lies below the average rate) (Musgrave & Thin, 1948). Although this definition is based on the tax system

considering the aggregate level, it is consistent with the conventional approach in the analysis of tobacco taxes. Considering this, we assume that a tobacco tax is regressive when the less wealthy spend a higher proportion of their income on tobacco tax than richer smokers.

Warner (2000) discusses the myth of tobacco tax regressivity, which is based on the idea that in most countries, the proportion of expenditure on cigarettes and tobacco among lower income groups is higher than for wealthier consumers. Indeed, globally, the poor consume proportionally more tobacco than higher income groups. Furthermore, in most low- and middle-income countries, the highest prevalence is found in low-income groups (Chaloupka et. al., 2018). However, what happens when tobacco taxes increase? Chaloupka and Warner (2000) point out that the increase's effects may not be regressive due to the poor's greater sensitivity to higher cigarette prices; whenever lower income groups are more sensitive to higher prices, they may reduce their consumption to a greater extent and face a lower tax burden. This largely depends on behavioral responses.

Verguet et al. (2021) highlight that tax regressivity among income groups should consider the prevalence of tobacco use, the price elasticity of demand, and the level of price increases due to higher tobacco taxes. In a mathematical simulation model of tobacco taxes implemented for middle- and high-income countries, they show cases of tobacco tax progressivity based on the distribution of spending on tobacco. Their results show that, in the face of relatively high elasticities of demand, significant increases in cigarette prices (50 percent and higher) could be progressive. This implies that the impact of higher tobacco taxes on tax incidence is an empirical question.

Case studies from across the world support the thesis that a significant increase in tobacco excise taxes reduces consumption significantly for lower income strata. For example, in South Africa, Bosch and Koch (2014) show that higher responsiveness to higher cigarette prices among lower-income groups results in a marginal progressive impact. Another example is the case of the tobacco tax reform in Turkey (Önder & Yürekli, 2016). These empirical results confirm the findings of Gospodinov and Irvine (2009) who address the discussion on tax

progressivity in the context of optimal taxation theory, where the "optimal" level can be very high.

Mexico exhibits some tobacco consumption behaviors that are different from most countries in the world, appearing to show a distinct pattern, according to Huesca et al. (2019). In the first (lowest) decile, only four percent of households spend money on tobacco products, while in the tenth decile 17 percent of households purchase tobacco products. With individual data, the Global Adult Tobacco Survey (GATS, 2015) shows the same patterns: 13.1 percent of adults in the first quintile of the socioeconomic index are current smokers, while the prevalence of current smoking is 18.3 percent for the fourth and fifth quintiles. Therefore, in the case of Mexico, tobacco consumption is concentrated among the highest income groups, who, in turn, consume the most expensive cigarettes. Global evidence suggests that cigarette price elasticity shows variation across income groups (US National Cancer Institute & World Health Organization, 2016). Recent findings from Mexico (Huesca et al., 2019, 2020, 2021; CIEP, 2020) found some variation across income groups.

For a country with high levels of income inequality, as is the case in Mexico, the question is whether a higher tobacco tax results in a greater tax burden on poor population groups, meaning that the tax ends up worsening income distribution. This is key to determining the feasibility of a policy reform.

Impact of higher tobacco taxes on social welfare

There is another dimension of tax progressivity that decision makers should keep in mind: the impact on social welfare. Even though excise duties are sometimes paid in a higher proportion by the poor, it is relevant to assess the impact of tax reform on income distribution. In economics, when a tax reform is of greater benefit to the poorer population, it is said to be a welfare-dominant tax policy. Gini index and Lorenz curves have been used extensively to evaluate the impact of public policies on welfare, and this is no less true in the case of tobacco taxes. Yitzhaki and Thirsk (1990) calculated progressivity curves combining tax payments for the most consumed products in Côte d'Ivoire, and they found that an increase in tobacco taxes may be progressive

since tobacco products are mostly consumed among higher-income households and tobacco expenditure carries little weight in the country's basket of goods.

An extension of the conventional Gini index makes it possible to assign weights depending on the public policy's effect on the distribution of individuals' resources. This extended Gini index allows for a distributional approach that includes a normative criterion (parameter ρ) that weights each point of the Lorenz curve and shows the degree of inequality aversion. Following this distributional approach, Younger et al. (1999) contrast the level of progressivity of different types of taxes for Madagascar, including tobacco taxes, in what is to the best of our knowledge the only study using the extended Gini index for tobacco products. They conclude that tobacco taxes exhibit the fifth highest degree of progressivity (after gasoline, transportation, automobile, and wage taxes), considering a basket of fourteen types of taxes.

The objective of this work is to quantify the level of progressivity or regressivity of two scenarios of tax reform for Mexico that increase the price of cigarettes. The first is an adjustment for inflation, while the second scenario increases the specific component by 1 peso (the specific component reaches 1.50 pesos per cigarette). We implement a tax burden and welfare analysis with concentration curves through a stochastic dominance approach to evaluate the distributional effects of tobacco tax increases.

Methodology

We assume a baseline scenario and two tax reform scenarios. The baseline scenario (S0) replicates the cigarette tax structure in 2020, which is made up of an ad valorem tax rate of 160 percent, a specific component of 0.4998 pesos (MXN) per stick,[1] a value-added tax of 16 percent, and a 10.72 percent retailer's margin (Waters et al., 2010) on the retail price net of the value-added tax (VAT). We assume an average price of 64.7 pesos for S0.[2]

Scenario 1 (S1) consists in adjusting the specific component for inflation to 2021 at 0.5108 pesos. In Scenario 2 (S2) we assume an increase in the specific component of the tax of 1 peso (the specific component of the tax increases to 1.50 pesos per cigarette). In both scenarios the ad valorem component remains fixed at a 160-percent rate.

To estimate the impact of the tax increase on Mexican households, we combine the scenarios with household data obtained from the National Survey of Household Income and Expenditure 2018 (ENIGH). ENIGH microdata is cross-sectional and collected by INEGI (National Institute of Statistics and Geography) every two years. The surveys follow a two-stage probability sampling design based on primary sampling units (PSUs), in which the home is the selected unit and the household the observed unit. In addition, the survey stratification considers the size of localities (urban or rural). The ENIGH surveys are therefore representative, and results can be extended to the whole population. Although cigarette prices are not collected in the survey, quantities of cigarettes are provided. As the unit of measurement for quantities is expressed in kilograms in the survey itself, we adopt a standard conversion criterion used in Mexican literature, whereby each cigarette is equal to 1.25 grams (Jimenez-Ruiz et al., 2008).

To evaluate the impact of the tax reform on cigarette consumption, we follow Huesca et al. (2020), who estimate price elasticities for cigarettes by tercile

[1] Value of the specific component adjusted for cumulative inflation from 2011 to 2020.
[2] Calculated based on consumption reported by households with smokers in ENIGH 2018, adjusted for 2020 prices.

using household expenditure survey data. To define terciles, the authors divide the population based on per capita household expenditure (Table 1).

Table 1. Estimates of price elasticity and expenditure elasticity of demand for cigarettes in Mexico, 2010–2018

Variables	Total	Tercile 1	Tercile 2	Tercile 3
$\widehat{\varepsilon_{Price}}$	**-0.662*****	**-0.479*****	**-0.726*****	**-0.594*****
	[0.043]	[0.052]	[0.058]	[0.052]
	(-0.745, -0.578)	(-0.581, -0.376)	(-0.840, -0.611)	(-0.696, -0.492)
$\widehat{\varepsilon_{Income}}$	**0.272*****	**0.293***	**0.684****	**0.231**$^{+}$
	[0.041]	[0.129]	[0.244]	[0.122]
	(0.191, 0.353)	(0.040, 0.546)	(0.206, 1.163)	(-0.007, 0.469)

Notes: Bootstrapped standard errors in brackets. 95 percent confidence intervals in parentheses.

$^{+}$p<0.10, * p<0.05, ** p<0.01, *** p<0.001. 1/ Smoking household

Source: Based on Huesca et al. (2020).

Price elasticities by tercile in Mexico show an inverted-U pattern, with greater responsiveness to price within the second tercile of expenditure. All elasticities by tercile are statistically significant with coefficients within the ranges indicated by the literature for middle-income countries. This inverted-U pattern is different from what the global literature has recently shown, and even from some evidence in Mexico: CIEP (2020) describes a gradient with higher elasticity for lower-income groups and lower elasticity for higher-income groups. For this reason, the elasticities used in this analysis will be considered as a conservative scenario.

In order to consider the increase in purchasing power of tobacco consumers and the level of prices, ENIGH 2018 data for household expenditures were updated considering the consumer price indexes (CPIs), and household earnings were updated following the increase in minimum wage (for a discussion on this point, see Llamas & Huesca, 2020). Table 2 displays the main input data sources for this analysis.

Table 2. Main indicators to compute tobacco tax incidence in Mexico

Variable	Sources
Tax rate (pesos per stick): 0.4998, 0.5108, 1.50	Various Official Federal Gazettes
Consumption of cigarettes: **Unit value**: $\mathbf{exp_{t,h}/q_{t,h}}$	ENIGH 2018 income & Expenditure Survey (INEGI, 2018)
Price level (CPI): **Average CPI 2019 September** Average CPI 2020 September	Average prices of tobacco published monthly by INEGI (2021)
Minimum wage: **Growth rate national level** Growth rate border cities	Comisión Nacional de Salarios Mínimos www.conasami.org.mx

We estimate the tax incidence of a cigarette tax reform in Mexico considering both the impact on the tax burden and the impact on the distribution of economic welfare.

Impact of the tax reform in terms of the tobacco tax burden

To estimate the impact of the tax reform in terms of the tax burden we implement a comparative static analysis, where S0 is estimated by deconstructing the average unit price for a pack of cigarettes. Then the ex-factory price is used to reconstruct the tax reform (S1 and S2). This static approach has been consistently used in Mexico to estimate the potential impact of a tobacco tax reform (for example, see Saenz de Miera et al., 2013, and CIEP, 2020). Additionally, we use the MEXMOD V1.1 microsimulation model. We estimate the changes in prices considering expenditure on cigarettes reported by smoking households. Under the MEXMOD microsimulation approach, the cigarette prices for the tax reform scenarios S1 and S2 are not obtained by deconstructing the average unit value but by reconstructing the equilibria behind the Mexican fiscal system as a result of the tax reform. In other words, MEXMOD will identify the cigarette price that combines an increase in revenue collection as an effect of the tax increase (funds that will be allocated

by the government to households as part of government spending, so that families will have additional funds to use), and a reduction in tobacco expenditure (for a discussion on this point, refer to Llamas & Huesca, 2020).

To estimate the change in consumption (quantity of cigarettes), the analysis considers the price elasticity for each income group estimated by Huesca et al. (2020). Following Huesca et al. (2020), income groups are defined according to per capita household expenditures. Finally, the new expenditure on tobacco is obtained by multiplying the new price with the new quantities consumed (these steps are fully described in Appendix 1).

To estimate the tobacco tax burden by income group, we obtain the tobacco tax paid with respect to the total household expenditure in each scenario—that is, the ratio of tobacco tax paid to the total consumption of families in each scenario. As the goal is to analyze the impact of a tax reform, we analyze the proportional changes in the tobacco tax burden derived from changes in tobacco tax, calculated with respect to total expenditure.

Impact of the tax reform on the distribution of economic welfare

We analyze the impact of the tobacco tax reform in terms of welfare dominance. We analyze both the concentration approach (Yitzhaki & Slemrod, 1991) and the order-in-dominance criteria (Khaled et al., 2018). In the concentration approach, we analyze the redistributive effects of tax increases, based on the traditional Lorenz curve. The Lorenz curve is constructed through ascending ordering of the percentiles of total household spending. We compare this with the concentration curve, which is a curve of smoking households that demonstrates the concentration of tobacco spending. When tobacco spending is more concentrated in high-income percentiles, an increase in tobacco tax will have a progressive effect because higher-income groups will bear most of the increase in prices and taxes. Graphically, a greater distance (or gap) will be found between the concentration curve and the Lorenz curve for the percentiles (population) that enjoy greater well-being. We will measure this gap with the Kakwani index.

We analyze how tobacco taxes are more (or less) concentrated among the rich (or the poor) by first depicting concentration and progressivity curves. When tax

reforms are disproportionately more beneficial to the poor, they are said to be welfare-dominant tax policies. This concept uses improvements in a social welfare function that relies on changes in income distribution (Musgrave & Thin, 1948: 510). The concept of welfare dominance captures the degree of progressivity or regressivity for any tax reform, and whether tax induces changes along the whole distribution and not only for groups located in the lower tail. As Musgrave and Thin (1948: 511) stated, "effective progression may also be applied to smaller income ranges; but, since it refers to changes in income distribution, it is not applicable—solely—to a mere income point." In fact, more concentrated taxation in the upper tail translates into more tax progressivity and improved social welfare.

The concentration approach: Lorenz and concentration curves

Considering the three scenarios, we estimate the Lorenz curve ($Lp_{(x)}$) for total expenditure in smoking households. With this estimation we obtain the concentration curve for tobacco expenditure $C_{(t)}$. We display both curves in the same graph and verify the distance between them. The first condition for progressivity is that the $C_{(t)}$ curve should be farther away from the $Lp_{(x)}$ curve.

Then we estimate the concentration curves (Cp_{ti}) for tobacco taxes in each scenario (S0, S1, and S2). To determine how much the gap widens between the tobacco tax reforms considered (how much of the tax increase falls on the poor or non-poor groups), the following step is to obtain the differences between the concentration curves with respect to the Lorenz curve of household expenditure as $\left(Cp_t - Lp_{(x)}\right)$.

The more positive the differences on the curve along the percentiles, the more progressive the tax reform. This can be verified as:

$$Cp_t - Lp_{(x)} > 0 \quad \forall\, p[0,1] \tag{1}$$

For robustness, confidence intervals (CI) across percentiles of consumers are built along the curves at the 95-percent confidence level, with bootstrapping for both upper and lower bands (bootstrapped CI over all the percentiles (p) of the per capita expenditure distribution, calculated by dividing the monetary expenditure of households by the size of the household). The CI will define a

rule to determine loss of progressivity in certain percentiles of tobacco users—that is, if the lower bound crosses the neutral effect (horizontal line).

As an additional analysis, we extend the traditional concentration approach by estimating extended Gini indices weighted by a social welfare parameter. The S-Gini family of concentration and inequality coefficients makes it possible to capture the degree of the tax impact by applying percentile-dependent weights (known as ρ) that represent society's concern for the poor and tolerance of inequality. As ρ increases, society becomes more intolerant of inequality, with higher ethical values assigned to ρ as a result of social concern about the poor: "The higher is ρ, the greater is the emphasis on the bottom of the income/expenditure distribution" (Yitzhaki et al., 1991). Therefore, our measure for progressivity avoids arbitrariness in preferences within alternative tobacco tax reforms in terms of income distribution.

The extension of the conventional Gini index, which has normative properties similar to those of Atkinson's (1970) index, allows for the assignment of weighting values on the distribution. The weights are different depending on the section of the income distribution. The extended Gini index formula is as follows:

$$G_\rho = 1 - \rho(\rho - 1)\int_0^1 \left(1 - Lp_{(x)}\right)^{\rho-2} Lp_{(x)}\, dLp \qquad \rho > 1 \qquad (2)$$

Where G_ρ is the extended Gini index, ρ is the welfare parameter, and $Lp_{(x)}$ is the Lorenz curve for per capita expenditure. Like the classical Gini, the extended Gini index is bounded between a value of zero (no inequality) and one (high inequality) and is composed of $Lp_{(x)}$ and the parameter ρ reflecting the relative preference towards equality. When $\rho = 1$, the index will reflect an indifference towards inequality. When $\rho = 2$, the index obtained turns out to be equal to the conventional Gini index. The higher the value assigned to ρ, the more sensitive it will be to measure the impact of taxes among the poor. This suggests that the lower the value assigned to the parameter ρ, the lower the sensitivity of the extended Gini and the less sensitive it will be in explaining the impact among wealthier individuals.

Using this index has several advantages. For instance, it can be used to determine the impacts of tax reforms for a wide range of groups with specific characteristics (such as gender or ethnicity) in the distribution and validate the estimates of proposals for various alternative tax reforms by providing greater robustness and veracity for the expected results of such reforms.

To complete our measurement of tobacco progressivity, we calculate the Kakwani (1976) index, which is obtained as the Gini index of the income distribution (expenditure in our case) minus the tax payment concentration index as:

$$K_{t(\rho)} = C_{\rho t} - G_{\rho} \tag{3}$$

The extended Kakwani index (henceforth Kakwani index) makes it possible to obtain a simple and complete estimate of the progressivity (or regressivity) levels corresponding to each part of the distribution for tobacco consumers, because they actually pay the tobacco taxes, and this is an index of tax progressivity. The idea behind this index is to test if part of the distribution can be negatively (or positively) affected by the tax reform on tobacco. When the difference in the curves is higher and positive with respect to the origin (the horizontal axis) and there are no negative changes—that is, when $K_{t(\rho)}$ does not cross the horizontal axis and both tax measures maintain their positivity, the tobacco tax reform can be defined as progressive for the whole distribution and for any social welfare function considered in the entire expenditure distribution. To test the components of the tobacco tax, we decompose the consumption tax on tobacco into its parts.

The Kakwani index exhibits a positive relationship with respect to the assigned sensitivity value of ρ. If tobacco taxation is intended as a tool to bring about positive redistributive effects, the higher the ρ, the more redistributive the tobacco tax policy is. Thus, the largest share of tobacco tax in household spending will be borne by the non-poor—that is, the distribution of the tax burden will be more progressive. As the value of inequality aversion (ρ) increases, the level of progressivity is higher. With the extended Gini index it becomes possible to incorporate normativity by choosing the degree of aversion

to inequality. There have been few exercises of this type applied to the effects of a tobacco tax.

Results

Impact of the tax reform in terms of the tobacco tax burden

Variation in cigarette prices

Table 3 decomposes the average cigarette price for the three scenarios as a comparative static analysis. The average price in reform S0 is 64.72 pesos per pack while the adjustment for inflation in S1 increases the price to 65.01 pesos, an increase of 0.285 pesos per pack. In S2, the price would increase to 90.41 pesos per pack (approximately 4.50 US dollars). In S2, tax as a share of retail price increases to 74.5 percent, very close to the 75-percent minimum threshold proposed by the World Health Organization.

Table 3. Structure of the average price of tobacco in Mexico and tax reform scenarios

Price structure	Baseline scenario (S0)		Scenario 1 (S1)		Scenario 2 (S2)	
	Pesos	%	Pesos	%	Pesos	%
Ex-factory price (taxable base)	15.54	24.00	15.54	23.90	15.54	17.20
Excise tax		53.90		54.00		60.70
Ad valorem	*24.86*	*38.40*	*24.86*	*38.20*	*24.86*	*27.50*
Specific*	*10.00*	*15.40*	*10.22*	*15.70*	*30.00*	*33.20*
Retailer's margin	5.40	8.30	5.43	8.30	7.55	8.30
Value-added tax	8.93	13.80	8.97	13.80	12.47	13.80
Price	64.72		65.01		90.41	

*/Note: Excise tax has two components: 1) a specific component given in Mexican pesos per cigarette and 2) an ad valorem tax fixed at a rate of 160 percent. Finally, value-added tax is 16 percent.
Source: ENIGH 2018.

Table 3 presents the effect of the tax increase. Under this comparative static analysis, the taxable base is the same, and higher taxes result in a higher retail price. However, when considering the effect of higher cigarette prices on cigarette consumption, household expenditure, revenue collection, and

government expenditure, the impact may be even higher, as these interactions also lead to a change in the ex-factory price. Considering a more dynamic structure, the taxable base changes when estimated using MEXMOD, and the average retail price in S2 is 109.80 pesos per pack (Table 4).

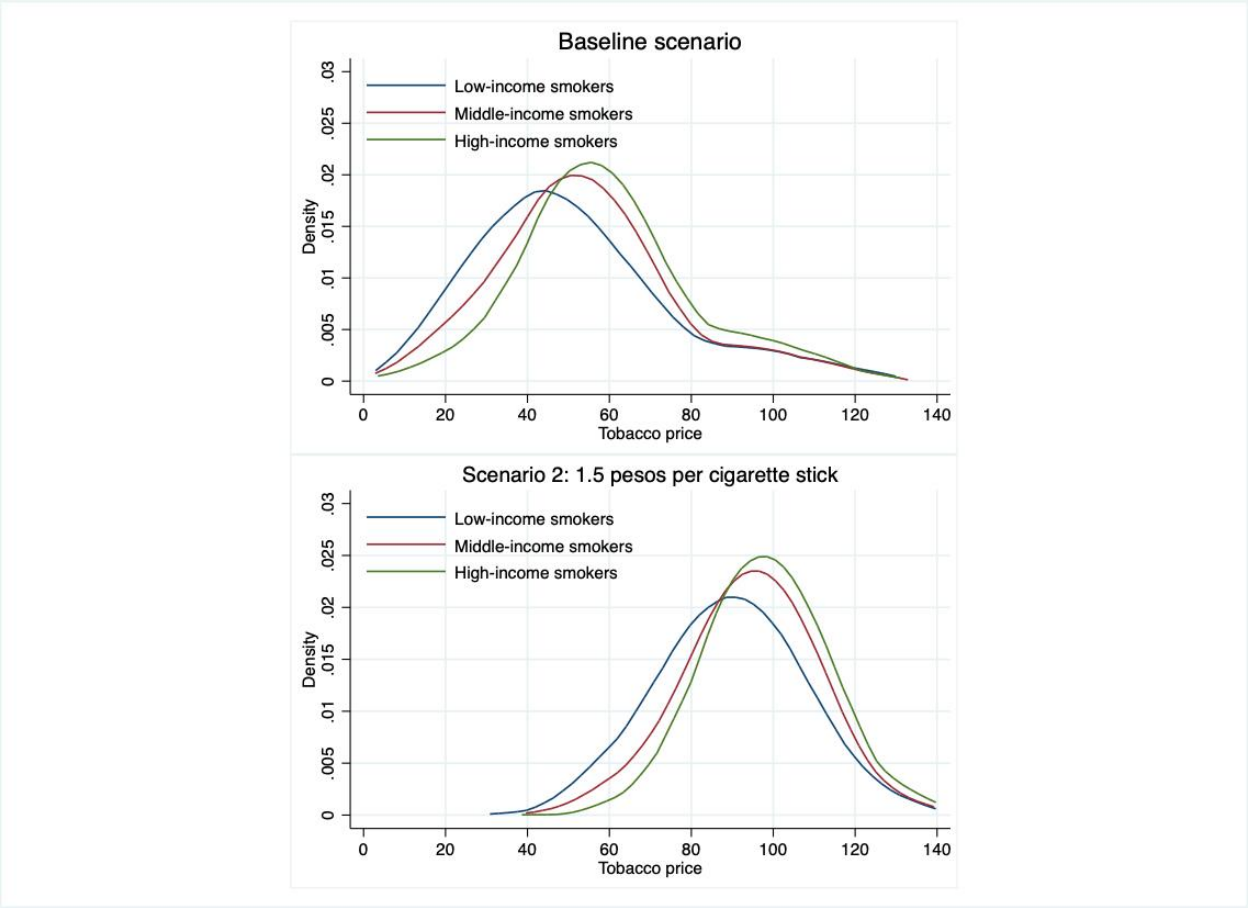
Table 4. Structure of the average price of tobacco in Mexico and tax reform scenarios (comparative dynamic analysis)

Price structure	Baseline scenario (S0)		Scenario 1 (S1)		Scenario 2 (S2)	
	Pesos	%	Pesos	%	Pesos	%
Ex-factory price (taxable base)	15.54	24.01	15.58	23.91	21.34	19.44
Excise tax	34.86	*53.85*	35.14	*53.95*	64.15	*58.42*
Ad valorem	*24.86*	*38.41*	*24.92*	*38.26*	*34.15*	*31.10*
Specific*	*10.00*	*15.44*	*10.22*	*15.68*	*30.00*	*27.32*
Retailer's margin	5.40	*8.35*	5.44	*8.35*	9.16	*8.35*
Value-added tax	8.93	*13.79*	8.98	*13.79*	15.14	*13.79*
Price	64.72		65.13		109.80	

*/Note: Excise tax has two components: 1) A specific component given in Mexican pesos per cigarette, and 2) An *ad valorem* tax fixed at a rate of 160 percent. Finally, value-added tax is 16 percent. reforms S1 and S2 consider a database with no negative taxable bases. Simulations allowing for negative taxable bases show no significant difference (available on request).
Source: ENIGH 2018 using MEXMOD V1.1.

It is important to note that not all smokers would face the same price. The tax increase would have a differential effect depending on the characteristics of each smoker. This is especially true for different income groups, which microdata modeling allows us to consider. Figure 1 shows the distribution of consumption by average price paid per pack of cigarettes for each tercile of expenditure. The upper graph presents reform S0. In this scenario, for the lowest spending tercile, the number of smokers peaks at around 45 pesos per pack, before tapering off as the price increases. By contrast, the largest number of smokers in the second tercile is concentrated around the 55-peso mark, with the modal price paid only slightly higher for the richest tercile.

Figure 1. Tobacco price variability across terciles of expenditure in Mexico



Note: Figures report unit values as a proxy of prices. Source: ENIGH 2018 using MEXMOD V1.1.

Figure 1 also shows the impact of the tax increase for each tercile. S1 (increase for inflation) results in very little variation with respect to S0 and therefore is not shown in the figure. S2 (1 peso increase per stick), however, shows a different pattern in the post-reform prices. All three terciles show a significant increase in the prices paid. However, the wealthiest tercile clearly registers a modal price paid as high as 102 pesos, while the second tercile is somewhat lower at around 98 pesos and the first tercile is around 90 pesos, with a significant number of smokers who pay an average price of around 70 pesos. S2 shows that a large increase in the specific component of tobacco tax leads to a greater increase in price paid across all income groups, but particularly reduces the price gap between the brands consumed by each income group.

Variation in cigarette consumption

Considering the variations in the average prices under the static approach (as presented in Table 3) and cigarette price elasticities, S1 (adjustment for

inflation) results in a 0.29 percent decrease in cigarette consumption, while S2 reduces cigarette consumption by 26.28 percent.

Alternatively, Table 5 shows the reductions in cigarette consumption considering the impact for different income groups (as described in Figure 1). S1 (adjustment for inflation) would reduce consumption by 0.4 percent; in contrast, S2, which would bring prices close to 110 pesos per pack, would cause a drop of 36 percent in total consumption, a higher reduction than observed when considering the overall elasticity in a static context.

Table 5. Cigarette consumption in percentage terms for tax reform scenarios, by income groups

Tercile	Baseline scenario (S0)	Scenario 1 (S1; adjustment for inflation)		Scenario 2 (S2; 1 peso tax increase per stick)	
	Cigarette consumption distribution	Cigarette consumption distribution	Variation on cigarette consumption	Cigarette consumption distribution	Variation on cigarette consumption
1	8.05%	8.04%	-0.45%	7.47%	-40.53%
2	19.28%	19.27%	-0.44%	18.12%	-39.83%
3	72.67%	72.69%	-0.38%	74.40%	-34.45%
Total	100%	100%	-0.40%	100%	-35.98%

Source: Authors' calculations using ENIGH 2018 and adjustments with CPI and minimum wages in 2019 and 2020 and MEXMOD V1.1.

The adjustment in cigarette prices in S1 reduces cigarette consumption by 0.45 percent, 0.44 percent, and 0.38 percent for tercile 1, 2, and 3 respectively. The increase in cigarette prices in S2 reduces cigarette consumption by 40.53 percent for tercile 1, 39.83 percent for tercile 2, and 34.45 percent for tercile 3. In relative terms, the share of total consumption taken up by the first tercile drops from 8.5 to 7.47 percent. The same happens for the second tercile, which falls from 19.28 to 18.12 percent, while the richest tercile increases its share from 72.67 to 74.4 percent.

Tobacco tax burden by income group

Table 6 shows the effect of the tax reform on tobacco tax burden by expenditure tercile. In the tax reform S0, tobacco taxes represent on average 1.69 percent of Mexican households' expenditure, meaning that the average amount of tax levied on cigarettes purchased by Mexican households, 1,214 pesos, accounts for less than two percent of the average household expenditure (a proxy for household income). The tobacco tax burden is higher for lower-income households. Tobacco taxes represent almost three percent for smokers in tercile 1, compared to almost 1.5 percent for tercile 3.

While S1 results in a minor change in household expenditure and tobacco tax (less than 0.05 percent and less than 1 percent, respectively), S2 increases total expenditure by about 0.7 percent and tobacco tax by about 34 percent, resulting in an overall increase in the tax burden of 33.6 percent. That means that those who continue to smoke after the tax increase will face a higher tax burden, with tercile 1 seeing its tobacco tax burden increased by 32.14 percent, tercile 2 by 31.16 percent, and tercile 3 by 32.86 percent; the increase in the tax burden is slightly higher for higher-income groups than for the lower-income group.

However, the number of smokers is different in the baseline S0 and in S2 reforms, as a result of some smokers quitting after the tax increase. If we compare the same set of households, including households that smoked in the baseline scenario but no longer do so in S2, some households would report a higher tobacco tax while others would report zero tobacco tax in S2. In this case, the tax burden for poor households would increase by 30.29 percent, while higher income households would experience a 31.44-percent increase. Therefore, in Mexico, the cigarette tax increase would be marginally progressive as it would cause a higher increase in the tax burden among higher income groups; this trend is even clearer when considering the effect from households that quit smoking after the tax increase.

Table 6. Average tobacco expenditure and tax burden per tercile simulations in Mexico (shares in percent)

Tercile	Baseline scenario (S0)			Scenario 1 (S1; adjustment for inflation)			Scenario 2 (S2; 1 peso tax increase per stick)			Scenario 2.1 (S2.1; 1 peso tax increase per stick, including households that quit smoking)		
	Household expenditure	Tobacco tax	Ratio	Household expenditure	Tobacco tax	Ratio	Household expenditure	Tobacco tax	Ratio	Household expenditure	Tobacco tax	Ratio
1	15,798	470	2.98%	15,803	473	3.00%	15,990	629	3.93%	15,990	620	3.88%
2	31,049	718	2.31%	31,055	723	2.33%	31,329	950	3.03%	31,329	936	2.99%
3	114,332	1,748	1.53%	114,345	1,759	1.54%	115,055	2,337	2.03%	115,055	2,312	2.01%
Total	71,993	1,214	1.69%	72,002	1,222	1.70%	72,490	1,622	2.24%	72,490	1,601	2.21%

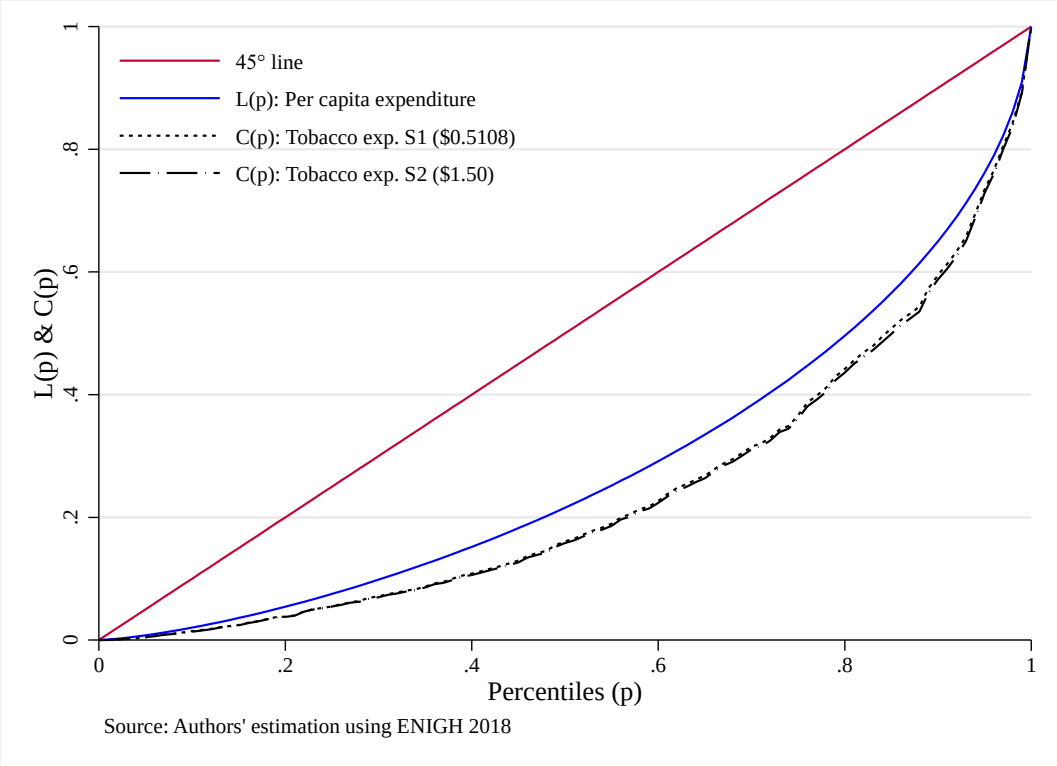
Source: Authors' estimation using ENIGH 2018 and MEXMOD V1.1.

Impact of the tax reform on the distribution of economic welfare

Lorenz curve and tobacco expenditure concentration curve: tobacco tax

Figure 2 shows the Lorenz curve and the concentration curves of tobacco expenditure in the baseline scenario. In Mexico, tobacco expenditure is more heavily concentrated than the total distribution of household expenditure, for any level of expenditure across any percentile level. In Mexico, at any level of expenditure, the distributions of tax payments are below the Lorenz curve of total household expenditure, which means that taxes are mostly paid by the higher-income groups.

Figure 2. Lorenz curve of expenditure and concentration curve for tobacco in Mexico



Source: Authors' estimation using ENIGH 2018 and MEXMOD V1.1.

This seems to be a different pattern from other countries. For example, in Turkey, the tobacco expenditure concentration curve is located above the Lorenz curve, a sign that households experiencing greater deprivation and poverty consume more tobacco products in their basket (Önder & Yürekli, 2016). In South Africa (Bosch & Koch, 2014), the evidence also shows tobacco consumption is even more regressive than income distribution.

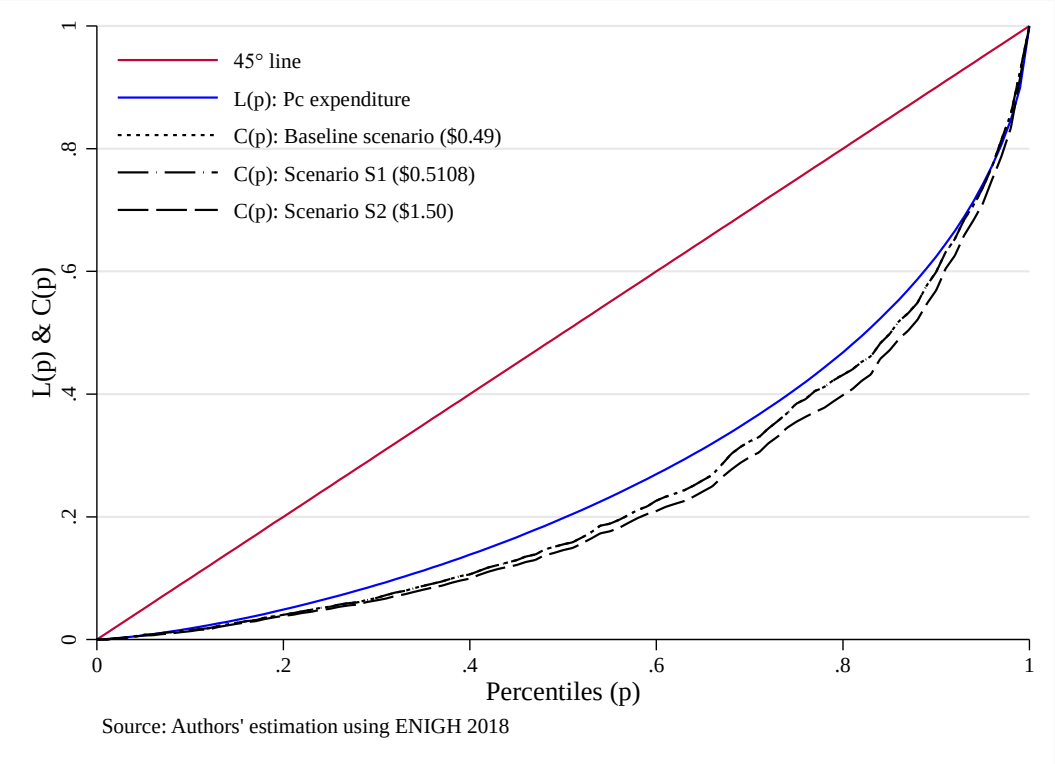
Lorenz curve and tobacco expenditure concentration curve: tobacco tax increase

Figure 3 analyzes the case of a tax increase. At any level of expenditure, the distributions of tax payments are below the Lorenz curve of total household expenditure, which means that taxes are mostly paid by the higher-income groups. This is the same conclusion observed in Turkey (Önder & Yürekli, 2016) and South Africa (Bosch & Koch, 2014), where the tobacco tax increases produce more unequal concentration curves, meaning that tobacco tax

increases would result in non-poor households paying more of the new tax burden of the tobacco tax reforms than poor smokers.

Figure 3 shows that in Mexico an increase in the specific tobacco tax is mostly progressive in distributional terms. As the impact of the tax reform increases for the middle- and high-income groups, this higher burden falls on non-poor smokers. Increasing the specific tobacco tax can thus be interpreted as a marginally progressive policy.

Figure 3. Lorenz curve of expenditure and concentration curves of tobacco excise tax reforms in Mexico



Source: Authors' estimation using ENIGH 2018 and MEXMOD V1.1.

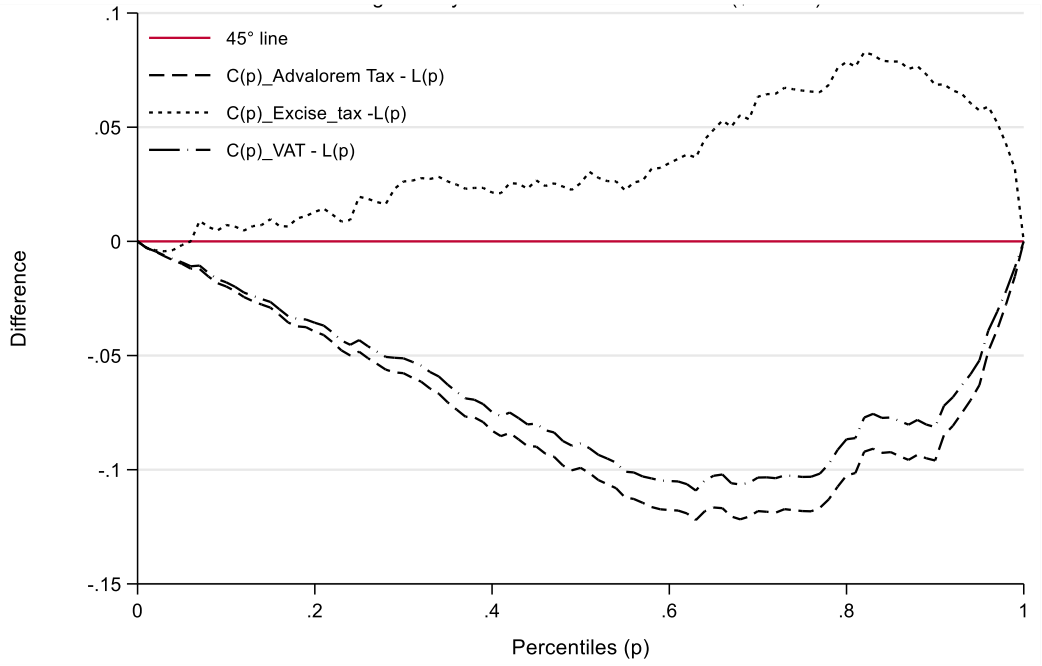
The burden of large tax increases falls less on lower-income groups and to a greater extent on higher-income groups. For example S1 (like the tax reform introduced in 2020 and 2021) has a very similar effect in capturing the inflation adjustment, with no relevant effects on burdens across the distribution of household spending. Meanwhile, a significant increase in excise tax—raising the flat, specific, component in 1 peso per stick (to 1.50 pesos per cigarette)—would lead to a heavier tax burden for high-income households. This is proven

when their differences are greater between the curves (that is, they are more positive), as the S2 reform is located above the curves of the current S0 and inflation-adjusted S1 reforms.

Differences between concentration curves

Figure 4 shows the decomposition for the total tobacco tax burden and illustrates how the ad valorem components are below the zero line and the specific component is above zero. This can be interpreted as regressivity and progressivity in the two components respectively. The figure also shows how VAT induces regressivity too, while the specific part of the tax—which is the one that will be modified in the two scenarios we consider—has a strong progressive effect on distribution.

Figure 4. Decomposition of the tax burden on tobacco in Mexico, 2020, progressivity curves in baseline scenario (S0)

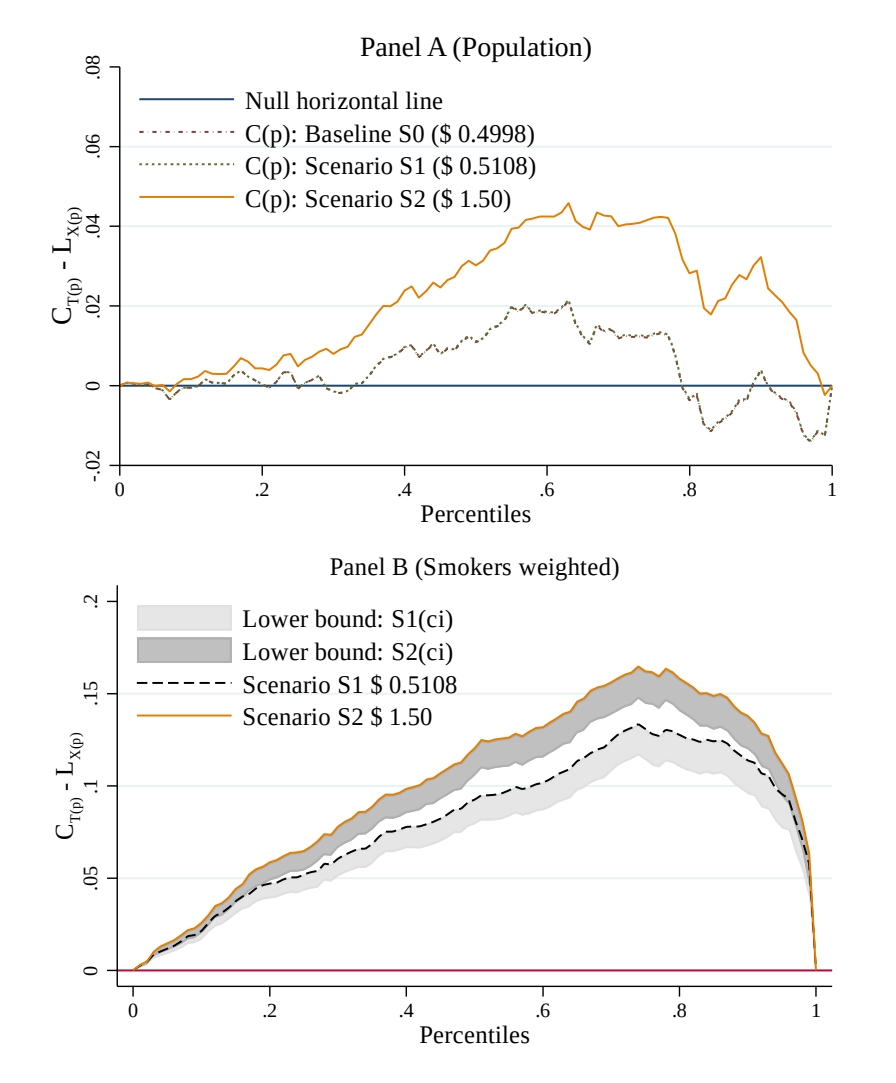


Source: Authors' estimation using ENIGH 2018 and MEXMOD V1.1.

Figure 5 shows the tax reforms considered. The estimation always uses the total population, and smokers are depicted according to their corresponding place in the same population distribution. Progressivity curves emerge as the

differences between the concentration curves with respect to the Lorenz curve of per capita household expenditure weighted with the population (Panel A) and considering the incidence of taxes paid by smokers in the same total distribution (Panel B), with respective lower confidence intervals as well. Tax reform S1 is located below the tax reform with the highest tax burden (S2) for any spending percentile level and is closer to the horizontal axis of the graph.

Figure 5. Progressivity curves of tobacco tax reforms in Mexico, population and sample weighted with smokers (95 percent CI)



Source: Authors' estimation using ENIGH 2018 and MEXMOD V1.1.

In neither tax reform do the lower confidence intervals cross the horizontal axis of the graph, which is the reason they are progressive tax measures—but to different extents. In both reforms, the greatest tax burden falls on non-poor groups.

The solid line relating to the 1-peso tax increase (to 1.50-peso tax in S2 is farther away, leading to a higher level of progressivity. When the consumer faces a higher tax change, larger shifts of the curve are observed at higher levels of expenditure (above the 40th percentile) and as a result, the higher tax burden falls more on middle-income and wealthier individuals than it does on lower-income smokers.

The distance between the curves (S1 vs. S2) is greater and more positive due to the existence of a higher level of tax progressivity, with S2 the preferred option in terms of welfare. This reform is a good sign of greater progressivity than in the S0 or in S1 and, as a result, revenue increases and the fall in cigarette consumption is much higher (see Table 5). There is a difference between the curves at any expenditure percentile level, but the distance is greater among non-poor consumers.

Progressivity index for tobacco tax policy reforms

Table 7 presents the progressivity of the Kakwani index using the extended Gini index of the tobacco excise tax. Considering the standard Gini index (that is, taking $\rho=2$ as a reference parameter), scenarios S0, S1, and S2 exhibit a Kakwani index of 0.0480, 0.0483, and 0.0747, respectively. This means S2 improves progressivity by 55.6 percent with respect to S1, adding up to 2.67 percentage points of distributive improvement.

Table 7. Kakwani welfare progressivity index of tobacco excise tax, Mexico, 2020, and policy reforms (Smokers according to total population weights)

Sensitivity analysis	*Share of exp.* [/b]	*Extended Gini* $G_{\rho i}$	*Concentration index* $C_{\rho t}$	*Kakwani* $K_{t(\rho)}$
Baseline scenario (S0)				
$K_{t(\rho)}$ (ρ =1.5)	3.04	0.338**	0.3660**	0.0279 *
$K_{t(\rho)}$ (ρ =2.0)	3.04	0.4718*	0.5198**	0.0480 *
$K_{t(\rho)}$ (ρ =3.0)	3.04	0.5928*	0.6537**	0.0608*
$K_{t(\rho)}$ (ρ =3.5)	3.04	0.6268**	0.6886*	0.0618*
Scenario 1 (S1; adjustment for inflation)				
$K_{t(\rho)}$ (ρ =1.5)	3.01	0.338*	0.3663**	0.0283*
$K_{t(\rho)}$ (ρ =2.0)	3.01	0.4718*	0.5201**	0.0483*
$K_{t(\rho)}$ (ρ =3.0)	3.01	0.5928*	0.654**	0.0612*
$K_{t(\rho)}$ (ρ =3.5)	3.01	0.6268*	0.6889**	0.0621*
Scenario 2 (S2; 1 peso tax increase per stick)				
$K_{t(\rho)}$ (ρ =1.5)	3.63	0.338*	0.3904**	0.0524*
$K_{t(\rho)}$ (ρ =2.0)	3.63	0.4718*	0.5465**	0.0747*
$K_{t(\rho)}$ (ρ =3.0)	3.63	0.5928*	0.6765**	0.0837*
$K_{t(\rho)}$ (ρ =3.5)	3.63	0.6268*	0.7095**	0.0827*

[/a] ρ is a parameter that affects the weights of each unit of observation on the income distribution.

[/b] Tobacco tax is modified considering only the specific component, as described for the three scenarios.

*** 0.001 significance; ** < 0.01; * < 0.05.

Source: Authors' calculations using ENIGH 2018 and updates of ENIGH to 2019 & 2020 and MEXMOD V1.1.

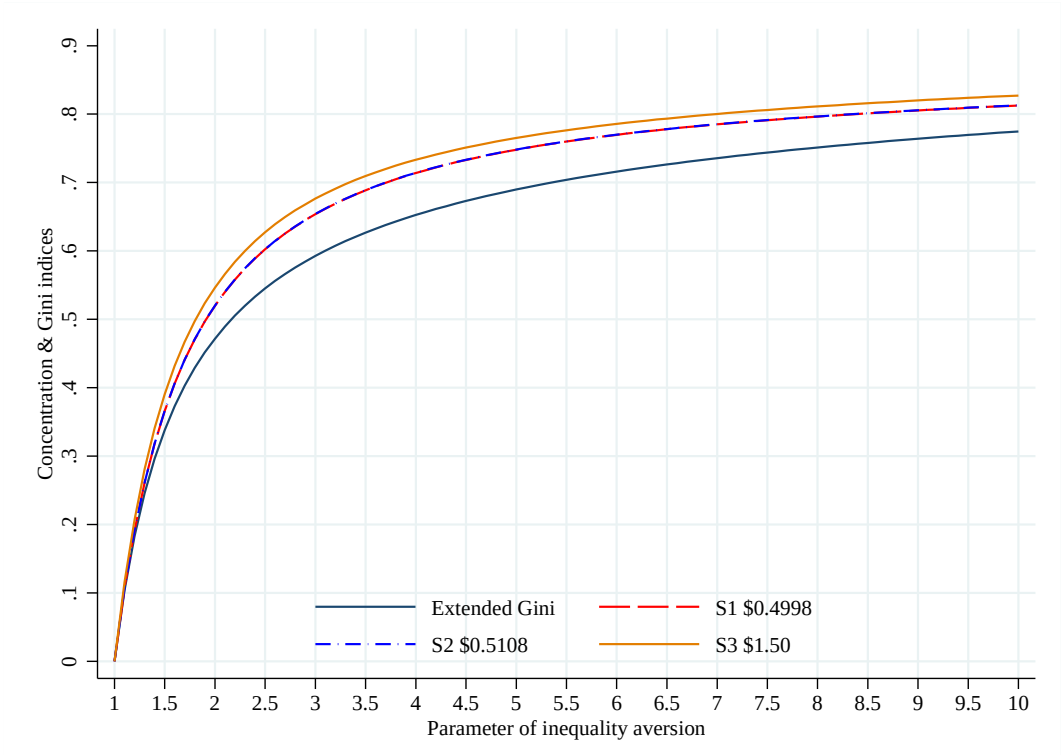
Note: Per capita expenditure does not change across scenarios. This means the extended Gini remains the same for all three scenarios.

The higher the level of the aversion parameter, the more consideration and weight given to the measurement of the effect of tobacco taxes on the poor. For S2, when considering a higher aversion to inequality, the extended Gini concentration for tobacco reaches 0.6765 for ρ = 3 and 0.7095 for ρ = 3.5. This implies that the higher the aversion to inequality conveyed by society, the more progressive the cigarette tax reform will be for Mexico. These results are

consistent with those found by Young et al. (1999: 315) when computing an extended Gini concentration for tobacco in Madagascar of 0.6861 with parameter ρ = 2 and 0.8770 with ρ = 4.

Figure 6 presents the range of normative Gini and concentration indices estimated by varying the inequality aversion parameter to detect levels of progressivity. It highlights that, for any assigned value of sensitivity, the extended Gini of the expenditure distribution is lower and lies below any tax measure. This indicates that S1 and S2 are progressive in normative terms, resulting in tax burden levels that are less harmful for individuals in lower-income households.

Figure 6. Extended Gini and concentration indices of tobacco tax reforms in Mexico with inequality aversion



Source: Authors' estimation using ENIGH 2018 and MEXMOD V1.1.

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Table 8 presents the dominance analysis of the extended Kakwani indices in terms of welfare dominance. Reform S1 only shows a clearer dominance of

their effect on progressivity when high values of aversion (3 and 3.5) are used, and that implies weighting mostly the poor. The most aggressive tax reform (S2) dominates the rest of the reforms based on an aversion parameter with a value of 2, and its impact is clear in terms of dominance.

As the specific tax on tobacco increases and the weighting factor towards the poor also increases, the progressivity measurement becomes more robust and fiscal reform S2 dominates in terms of welfare with respect to the other reform, which induces a lower tax burden in S1. Thus, S2 dominates the welfare effect regardless of the value of the weight (ρ) when the higher tobacco tax is implemented. Therefore, a higher tax on cigarettes would not be regressive in Mexico.

Table 8. Kakwani dominance results for tobacco tax and fiscal reform scenarios in Mexico

Reform	**S2; 1 peso tax increase per stick**				
S1 (adjustment for inflation)	***ρ***	***1.5***	***2***	***3***	***3.5***
	1.5	D	D	D	D
	2	D	D	D	D
	3	ND	D	D	D
	3.5	ND	D	D	D

D = S2 is dominant over S1.

ND = S2 is not dominant over S1 (S1 is dominant).

Source: Authors' calculations using Table 5.

Discussion

Globally, tobacco use produces a wealth of adverse health and economic effects, which can be tackled with carefully designed, aggressive tax policies. However, concerns among policy makers about their impact on the poorest in society are a major deterrent, especially in countries with a high level of income inequality, as is the case in Mexico. While changing the distributional incidence is not the main goal of excise taxes on tobacco, global evidence has shown

consistently that increases in tobacco taxes can be progressive (Warner, 2000; Bosch & Koch, 2014; Önder & Yürekli, 2016; Chaloupka et al., 2019), meaning that higher income groups, less price sensitive, bear a greater share of the burden of the tax increase. This is even more salient in the case of Mexico, as we previously showed.

While it is true that at an individual level, any tax increase would result in higher prices for consumers, this increase would be felt differently across income groups. In addition, while some individuals—fueled by addiction—would continue to smoke as before, and thus bear the highest tax burden (Remler, 2004), many would reduce their consumption or quit altogether, resulting in a further differential impact.

Indeed, together with Georgia, Mexico is one of the rare cases where consumption of tobacco increases with income (Verguet et al., 2021). This means that lower-income smokers will be less impacted by a tax increase, lending further weight to the progressive nature of tobacco tax reform in Mexico. In this context, given the nature of price elasticity of demand by income level, Verguet et al. (2021) report that any regressivity in tobacco tax can be prevented with sufficiently large increases in price. Our research supports and builds on their findings, as we conclude below.

Conclusions

In line with Verguet et al. (2021), this research demonstrates empirically that a tax increase in Mexico is progressive, producing a greater increase in the tax burden for higher income groups while reducing consumption for the entire population. But our findings go further still, showing that when a tax reform is implemented based on an increase in the specific component of excise tax—as opposed to an *ad valorem* reform—a tax reform will be progressive even when the elasticity trend does not change linearly with income or is unclear, calling into question the long-held belief that tobacco taxes are uniformly regressive from both a standard income-share accounting and a welfare-based perspective.

The evidence is clear: the structure of tobacco excise taxes greatly affects price, and thus, smoking behavior. In contrast to *ad valorem* tax reforms, specific excise taxes reduce price variability and are more effective in raising prices and reducing consumption. Furthermore, specific tax reforms are easier to implement, manage, and control, so they constitute the best tobacco control practice. A tobacco tax reform should, therefore, rely on an increase on the specific component to maximize its progressive impact as proven in this novel distributional approach in the Mexican context.

Finally, the additional revenue generated can be used to promote fiscal equity. Additional funding can be allocated to help smokers to quit, in a measure that can be specifically targeted at low-income smokers, further boosting progressivity. In a country still reeling from the effects of the pandemic, the additional 20 billion pesos (approximately 1 billion US dollars at 2022 exchange rates) raised by the tax reform each year in S2 alone would be sufficient to build approximately 20 new, fully-equipped hospitals, or to procure a year's supply of COVID-19 vaccines, setting Mexico on a path of increased equity and better health outcomes.

References

Atkinson, A. B. (1970). On the measurement of inequality. *Journal of Economic Theory*, *2*(3), 244–263. https://doi.org/10.1016/0022-0531(70)90039-6

Becker, G. S., & Murphy, K. (1998). A theory of rational addiction. *Journal of Political Economy*, 96, 675–700. https://doi.org/10.1086/261558

Becker, G. S., Grossman, M., & Murphy, K. (1994). An empirical analysis of cigarette addiction. *American Economic Review*, 84, 396–418.

Bosch, A., & Koch, S. (2014). *Using a natural experiment to examine tobacco tax regressivity*. Working Papers, University of Pretoria, Department of Economics, 201, 424. https://EconPapers.repec.org/RePEc:pre:wpaper:201424

Chaloupka, F. J. (1991). Rational addictive behavior and cigarette smoking. *Journal of Political Economy*, 99, 722–742. http://dx.doi.org/10.1086/261776

Chaloupka, F. J., & Warner, K. (2000) Chapter 29: The economics of smoking. In A. Culyer & J. Newhouse, *Handbook of Health Economics.* Vol1. Part B, 1539–1627. Elsevier.

Chaloupka, F. J., & Blecher, E. (2018). *Tobacco & poverty: Tobacco use makes the poor poorer; tobacco tax increases can change that*. Tobacconomics. https://tobacconomics.org/uploads/misc/2018/03/UIC_Tobacco-and-Poverty_Policy-Brief.pdf

Chaloupka, F. J., Powell, L. M., & Warner, K. (2019). The use of excise taxes to reduce tobacco, alcohol, sugary beverage consumption. *Annual Review of Public Health,* 40, 187–201. http://dx.doi.org/10.1146/annurev-publhealth-040218-043816

Chaloupka, F. J., Drope, J., Siu, E., Vulovic, V., Stoklosa, M., Mirza, M., Rodriguez-Iglesias, G., & Lee, H. (2021). *Tobacconomics cigarrete tax scorecard: Scoring component policy note – tax structure*. Tobacconomics. https://tobacconomics.org/files/research/696/uic-tobacco-scorecard-component-policy-note-tax-structure-v2.0.pdf

Choi, S. E. (2016). Are lower income smokers more price sensitive? The evidence from Korean cigarette tax increases. *Tobacco Control*, 25, 141–146. http://dx.doi.org/10.1136/tobaccocontrol-2014-051680

Gómez, A.G., Macías, A., Páez, H.J.V., & Méndez, J.S.M. (2020). Extended Cost-Benefit Analysis of Tobacco Consumption in Mexico [Report]. CIEP. https://www.tobacconomics.org/files/research/605/extended-cost-benefit-analysis-tobacco-ciep-en.pdf

Colman, G. J., & Remler, D. K. (2008). Vertical equity consequences of very high cigarette tax increases: If the poor are the ones smoking, how could cigarette tax increases be progressive? *Journal of Policy Analysis and Management*, *27*(2), 376–400. http://dx.doi.org/10.1002/pam.20329

Duclos, J. Y., Makdissi, P., & Wodon, Q. (2008). Socially improving tax reforms. *International Economic Review*, *49*(4), 1505–1537. https://www.jstor.org/stable/20486846

Gopodinov, N., & Irvine, I. (2007). Tobacco taxes and regressivity. *Journal of Health Economics*, *28*(2). http://dx.doi.org/10.1111/j.1468-2354.2008.00520.x

Huesca, L., Araar, A., Llamas, L., & Calderón, C. (2019). *Acelerando la fiscalidad efectiva al tabaco en México: Impuestos especiales, desigualdad y pobreza*. Serie Documentos de Base del Proyecto Impuestos al Tabaco en América Latina. Estudio País No.7/2019. Red Sudamericana de Economía Aplicada Red Sur/ Institute for Health Research and Policy. https://www.redsudamericana.org/programas/otros/acelerando-la-fiscalidad-efectiva-al-tabaco-en-m%C3%A9xico-impuestos-especiales-consumo

Huesca, L., Llamas, L., Araar, A., & Molina, O. (2020). *Análisis del impuesto al tabaco en México y simulaciones de reforma usando LATINMOD*. [Documento de estudio]. CIAD-CONACYT.

Huesca, L., Araar, A., Llamas, L., & Lacroix, G. (2021). The impact of tobacco tax reforms on poverty in Mexico. *SN Business & Economics*, 1, 142. https://doi.org/10.1007/s43546-021-00141-x

Ibarra, X., De la Fuente, X., & Miravete, X. (2021). La incidencia del impuesto especial sobre producción y servicios al tabaco en México. *Contaduría y Administración, 66*(1), 1–30. http://dx.doi.org/10.22201/fca.24488410e.2021.2385

Jimenez-Ruiz, J., Sáenz de Miera, B., Reynales-Shigematsu, L. M., Waters, H. R., & Hernández-Ávila, M. (2008). The impact of taxation on tobacco consumption in Mexico. *Tobacco Control, 17*(2), 105–110. http://dx.doi.org/10.1136/tc.2007.021030

Kakwani, N. (1977). Measurement of tax progressivity: An international comparison. *The Economic Journal, 87*(345), 71–80. Doi:10.2307/2231833

Kakwani, N., & Son, H. H. (2021). Normative measures of tax progressivity: An international comparison. *Journal of Economic Inequality,* 19, 185–212. https://doi.org/10.1007/s10888-020-09463-6

Khaled, M. A., Makdissi, P., & Yazbeck, M. (2018). Income-related health transfers principles and orderings of joint distributions of income and health. *Journal of Health Economics*, (57), 315–331. http://dx.doi.org/10.1016/j.jhealeco.2017.06.004

Llamas, L., & Huesca, L. (2020). *MEXMOD Country Report – Mexico*. El Centro de Investigación en Alimentación y Desarrollo, A.C. (CIAD). https://www.ciad.mx/mexmod/

Mayshar, J., & Yitzhaki, S. (1995). Dalton-improving indirect tax reform. *American Economic Review*, 85, 793–807.

Musgrave, R., & Thin, T. (1948) Income tax progression, 1929-48. *Journal of Political Economy*, 56, 498–514.

Önder, Z., & Yürekli, A. A. (2016). Who pays the most cigarette tax in Turkey. *Tobacco Control*, 25, 39–45. http://dx.doi.org/10.1136/tobaccocontrol-2014-051639

Remler, D. K. (2004). Poor smokers, poor quitters, and cigarette tax regressivity. *American Journal of Public Health*, 94, 225–229. http://dx.doi.org/10.2105/AJPH.94.2.225

Sáenz de Miera Juárez, B., Guerrero López, C. M., Zúñiga Ramiro, J., & Ruiz Velasco Acosta, S. (2013). *Impuestos al tabaco y políticas para el control*

del tabaco en Brasil, México y Uruguay: Resultados para México. Fundación Interamericana del Corazón.

US National Cancer Institute, & World Health Organization. (2016). The Economics of Tobacco and Tobacco Control: National Cancer Institute Tobacco Control Monograph 21. https://cancercontrol.cancer.gov/brp/tcrb/monographs/monograph-21

Verguet, S., Kearns, P., & Rees, V. (2021). Questioning the regressivity of tobacco taxes: A distributional accounting impact model of increased tobacco taxation. *Tobacco Control*, 30, 245–257. doi:10.1136/tobaccocontrol-2019-055315

Warner, K. (2000). The economics of tobacco: Myths and realities. *Tobacco Control*, 9, 78–89. http://dx.doi.org/10.1136/tc.9.1.78

Waters, H., Ross, H., Sáenz de Miera, B., & Reynales, L. (2010). *La economía del tabaco y los impuesto al tabaco en México.* Unión Internacional Contra la Tuberculosis y Enfermedades Respiratorias. https://docplayer.es/836362-La-economia-del-tabaco-y-los-impuestos-al-tabaco-en-mexico.html

WHO. (2021). *WHO technical manual on tobacco tax policy and administration*. Geneva: World Health Organization. https://www.who.int/publications/i/item/9789240019188

Yitzhaki, S. (1983). On an extension of the Gini inequality index. *International Economic Review, 24*(3), 617–628. Doi:10.2307/2648789

Yitzhaki, S., & Thirsk, W. (1990). Welfare dominance and the design of excise taxation in the Cote d'Ivoire. *Journal of Development Economics*, *33*(1), 1–18. http://dx.doi.org/10.1016/0304-3878(90)90002-S

Yitzhaki, S., & Slemrod, J. (1991). Welfare dominance: An application to commodity taxation. *American Economic Review*, 81, 480–96.

Younger, S. D., Sahn, D. E., Haggblade, S., & Dorosh, P. A. (1999). Tax incidence in Madagascar: An analysis using household data. *The World Bank Economic Review*, 13, 303–331 http://dx.doi.org/10.1093/wber/13.2.303

Appendix

Appendix 1

Estimation of change in tobacco consumption and expenditure.

Given that an increase in tax leads to an increase in cigarette prices, the elasticity model makes it possible to determine the extent to which consumption will be reduced in tax reforms S1 and S2.

As a result, household cigarette consumption will change, and these new distributions will replace the cigarette consumption originally reported by the household in MEXMOD to provide a new estimate of taxes for each reform scenario. Consequently, this study reports two microsimulation processes: a) static and non-behavioral, for S0; and b) static and behavioral, for S1 and S2.

Based on the static non-behavioral microsimulation, MEXMOD estimates tobacco expenditure for the three scenarios. The rate of change in price Δp_s is obtained with the following formula:

$$\Delta p_s = (exp_{s1,2} - exp_{s0})/exp_{s0} \quad (1A)$$

The next stage is to estimate the reduction in consumption (measured by the quantity of cigarettes). To this end, elasticities by tercile ε_i were employed in the following maximization function:

$$\Delta q_{t,h} = \max\left(q_{t,h} * \varepsilon_i * \Delta p_s, -q_{t,h}\right) \quad (2A)$$

As a result, the change in the quantity consumed $\Delta q_{t,h}$ makes it possible to identify the new quantities of cigarettes the household will continue to purchase:

$$nq_{t,h_{S1,2}} = q_{t,h} - \Delta q_{t,h} \quad (3A)$$

And the new unit price $up_{t,h}$:

$$up_{t,h} = \left(\left(b_{t,h} * ieps_{adv} + \left(nq_{t,h_{S1,2}} * ieps_{spe_{s1,2}}\right)\right) * VAT\right)/nq_{t,h_{S1,2}} \quad (4A)$$

Finally, the new expenditure on tobacco $nexp_{t,h_{S1,2}}$ is calculated based on expression (5A), producing new values for quantities ($nq_{t,h_{S1,2}}$) and expenditure

($nexp_{t,h_{S1,2}}$) that correspond to the new distributions MEXMOD requires for the static behavioral microsimulation.

$$nexp_{t,h_{S1,2}} = up_{t,h_{S1,2}} * nq_{t,h_{S1,2}} \quad (5A)$$