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The incidence of the special tax on tobacco production and services in Mexico

La incidencia del impuesto especial sobre producción y servicios al tabaco en México

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Abstract

Tobacco products in Mexico are levied with the excise and value added taxes. The former has and ad-valorem component at 160%, and a per unit component at $0.35 per cigarette. One of the objectives of tobacco taxes is to reduce its consumption, so that tobacco related diseases are also reduced. That depends, however, of how the tax is shifted into the price paid by the consumers. Using monthly data from January 1994 to June 2017, in this paper, we estimate the incidence of the excise tobacco tax. We find that both, the ad-valorem and the specific components of the excise tax have a positive and statistically significant relationship to the tobacco price index, but the tax is not shifted to the consumers. Price changes are explained by increases in production costs faced by tobacco producers. This result diminishes the effectiveness of fiscal policy aimed to reduce tobacco consumption.

JEL Code: H22, I18, L66
Keywords: tax incidence; tobacco tax; IEPS; Mexico

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Resumen

Los productos de tabaco en México están gravados con el IEPS y el IVA. El primero tiene un componente ad-valorem de 160% y otro específico de $0.35 por cigarrillo. Uno de los objetivos de los impuestos es reducir el consumo de tabaco para así bajar la incidencia de enfermedades asociadas al tabaquismo. Esto depende, sin embargo, de que el impuesto sea trasladado al precio que pagan los consumidores. En este artículo estimamos la incidencia del IEPS al tabaco en México usando una base de datos mensuales de enero 1994 a junio de 2017. Encontramos que, si bien el componente ad-valorem y el específico del IEPS guardan una relación directa y estadísticamente significativa con el índice de precios de productos de tabaco, la carga del IEPS no es trasladada a los consumidores. Las modificaciones en precios se explican primordialmente por los aumentos en costos que enfrentan las empresas que fabrican productos de tabaco. Este resultado resta efectividad a la política fiscal que tiene por objeto reducir el consumo de tabaco.

Código JEL: H22, I18, L66
Palabras clave: incidencia impositiva; impuesto tabaco; IEPS; México

Introduction

Tobacco taxes are considered a tool that can be used to reduce tobacco consumption and, consequently, the diseases associated with smoking. The World Health Organization Framework Convention on Tobacco Control (FCTC)[1] recognizes taxation as an effective and important means of reducing tobacco consumption. In Mexico, it has also been recognized that excise taxes often pursue extra-fiscal purposes beyond the collection of tax revenues, as they can potentially affect tobacco consumption (CEFP, 2002). When it was proposed to increase the tax rate and introduce a specific component to the tax on manufactured tobacco, it was stated that this initiative, in addition to its tax collection purpose, was intended to contribute to the fight against smoking.[2]

The effectiveness of tobacco taxes depends, nevertheless, on the passing-on of the taxes to the prices consumers pay. If the increase in taxes does not increase the prices consumers pay, this tool is no longer effective in reducing smoking. Determining the magnitude of the transfer to prices paid by the consumer after tax increases is, therefore, vital to determine how effective taxes are in reducing tobacco consumption. In Mexico, the oligopolistic structure of the tobacco industry, the diversity of brands and market segmentation inherent to the industry, and the magnitude of the illegal tobacco trade may mean that taxes are not fully passed on to the prices consumers pay.

The effect of taxation is an important issue in tobacco economics, as it can influence the welfare of smokers and non-tobacco users, the companies involved in the industry, and public policy toward the

[1] https://www.who.int/fctc/text_download/es/
[2] Reasons for increasing the STPS on processed tobacco in 2010. Available at: http://www.diputados.gob.mx/PEF2010/temas/expo_motivos/ingresos/iniciativa_lieps.pdf

industry. This, together with the effect on companies' profits, is compared with the tax revenue to determine the excessive tax burden, which measures the inefficiency the tax measure may cause.

Studies on tobacco taxes in Mexico have assumed that taxes are fully passed on to the prices consumers pay. Apparently, the incidence of tobacco taxes has not been estimated.

The objective of this article is to analyze the incidence of STPS on processed tobacco. Incidence refers to how the tax burden is distributed between producers and consumers in the market for a product. In the case covered in this article, the aim is to find out how changes in the STPS affect tobacco prices. In other words, the purpose is to determine whether the tax increases have been passed on to the prices consumers pay for tobacco products.

A reduced-form model was specified and estimated using 282 monthly observations (January 1994 to June 2017) to meet this objective. The equations, which relate the price of tobacco products and taxes, the determinants of tobacco demand, the production costs of tobacco products, the market structure of the tobacco industry, and the trends and seasonality of tobacco prices, were included as control variables.

From a public policy perspective, shifting taxes to the prices consumers pay is expected to reduce the demand for tobacco and, therefore, smoking-related diseases. In other words, the incidence study will enable an assessment of the effectiveness of taxation as a tool to reduce smoking.

The results show that, although the STPS has a direct and statistically significant relation with the price index of tobacco products, the latter is not very sensitive to changes in the ad-valorem and specific components of the STPS. Production costs are the main factor influencing the evolution of tobacco prices in Mexico.

In the following sections, a brief overview of the status and evolution of tobacco taxation in Mexico is presented, the literature on tobacco tax incidence is discussed, the methodology is presented, the results are presented, and finally, the conclusions are presented.

Smoking and tobacco taxation in Mexico

The National Institute of Public Health, in a study of the epidemiological situation associated with smoking (INSP, 2011), notes that tobacco consumption and exposure to tobacco smoke are the most common preventable cause of death worldwide (Kuri et al.,2006). National surveys on addictions show that smoking in Mexico is a public health problem, especially among adolescents (Reynales et al., 2009), young adults, and women (Reynales et al., 2011). According to the Ministry of Health (SSA, 2011), among the top ten causes of mortality are diseases related to smoking and exposure to tobacco smoke (acute myocardial infarction, cerebrovascular diseases, chronic respiratory diseases, and lung cancer).

Consequently, it has been documented that tobacco consumption causes more than 60 thousand deaths per year (Sáenz de Miera et al., 2012); that it negatively affects the family economy (World Bank, 1999); that it reduces labor productivity (Guerrero et al., 2012); and that it imposes significant costs on the health sector (Reynales et al., 2006).

The 2011 National Addictions Survey reports a prevalence of active tobacco use of 21.7% (17.3 million people): 12 million are men, and 5.3 million are women. 26.4% (21 million) reported being ex-smokers, 20.1% being occasional ex-smokers, and 51.9% (41.3 million) had never smoked. It was also found that, on average, smokers between 12 and 65 years of age start daily tobacco use at 20.4 years, and they smoke an average of 6.5 cigarettes per day. 11.4% of active smokers (1.5 million people) light up their first cigarette 30 minutes after waking up and, according to this criterion, are considered nicotine addicts. It is also reported that 30.2% (12.5 million people) have never smoked and are exposed to environmental tobacco smoke (ETS).

CONADIC (2011), after presenting the results of the monitoring system of smoking in Mexico, concludes, among other aspects, that: if the smoking trend is not reversed, half of the active smokers (17.3 million) will die from tobacco-related diseases; 60 thousand people die each year from tobacco-attributable causes; the problem of smoking among young people represents a challenge for public health in Mexico. According to CONADIC, the great challenge is implementing public policies to halt the observed trends since the epidemic of diseases associated with tobacco consumption over the next 20 to 30 years will represent a difficult burden to cope with for the National Health System.

In response to the national smoking problem, Mexico signed and ratified the FCTC in 2003, published in the DOF in May 2004. This global treaty contains the basis for implementing and managing programs to control tobacco consumption and production. Consequently, the General Law for Tobacco Control was enacted in Mexico, strengthening the institutional apparatus to enforce the corresponding regulation. With the signing of the FCTC, a set of regulatory measures have been implemented for the industry in Mexico. On the demand side, a more aggressive tax policy has been adopted combining specific and ad-valorem taxes; tobacco product advertising has been restricted; cigarette labeling and packaging has been regulated to include printed warnings and pictograms; there is a system of prevention programs; measures have been adopted to protect non-smokers; and measures have also been taken to restrict supply (CONADIC, 2011; COFEMER, 2012).

Cigarettes in Mexico are subject to STPS and Value Added Tax (VAT). The STPS may be specific or ad-valorem. In the first case, a fixed tax per unit of product is charged to the manufacturer, producer, or importer. Second, a tax is imposed on the manufacturer, producer, or importer as a percentage of the production price. On the other hand, VAT is passed through the production chain to the final

consumer[3]. The process is as follows: first, the STPS is added to the retail price; then, the retailer adds its profits and costs, equivalent to about 10.72% of the retail price after STPS, and finally, the VAT is added to the retail price. In addition to the STPS and VAT, imported tobacco products pay another ad-valorem tax. The current rate for imported cigarettes is 67% of the price to the importer (Sáenz de Miera, 2013).

Currently, the STPS rate on cigarettes is 160% of the retail price, and the specific STPS is MXN$0.35 per cigarette. The VAT rate is 16% of the retail price. The last time cigarette taxes were modified was in 2011. As shown in Figure 1, the retail price of a pack of cigarettes was made up as follows: the wholesale price, which includes the factory price, the profit, and general expenses of the wholesaler, represents 22.86%; the ad-valorem STPS represents 36.58%, and the specific component of this tax represents 18.42%; 8.35% corresponds to the profit and general expenses of the retailer; and the VAT represents 13.79%.

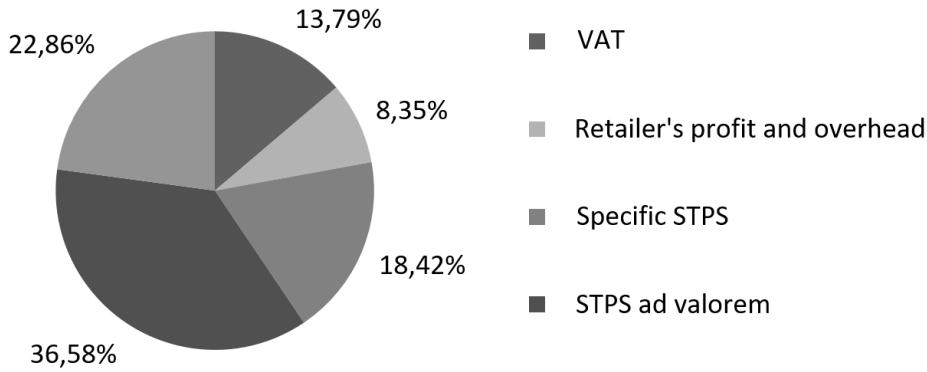

Figure. 1. Price composition of a pack of cigarettes in Mexico (2011)
Source: Created by the authors with data from COFEMER (2012)

Table 1 compares the STPS tax collection on manufactured tobacco with other federal taxes. In 2016, tax income from the STPS on processed tobacco was MXN$38 billion. This amount represented 9.2% of total STPS collection, 4.8% of VAT collection, and 2.7% of income tax (IT) collection.

[3]http://www.sat.gob.mx/informacion_fiscal/preguntas_frecuentes/Paginas/ieps.aspx
http://www.sat.gob.mx/informacion_fiscal/obligaciones_fiscales/personas_morales/no_lucrativas/Paginas/concepto_iva.aspx

Table 1
Tax revenues from STPS on manufactured tobacco compared to other taxes, 2016 (millions of pesos)

	Collections	Proportion
Income Tax	$ 1 425 794.3	2.670 %
Value Added Tax	791 700.20	4.812 %
Total STPS	411 389.60	9.261 %
STPS processed tobacco	38 097.10	

Source: Created by the authors with data from SHCP (Federal Government Budgetary Revenues, www.shcp.gob.mx)

The STPS on processed tobacco came into effect in 1981 with a rate of 139.4%. The highest rate of this tax was recorded during 1986-87 (180%), after which it fell to 85% in 1995-99. Since 2000, the STPS rate has risen to 160% and has remained at that level since 2011 (Figure 2).[4]

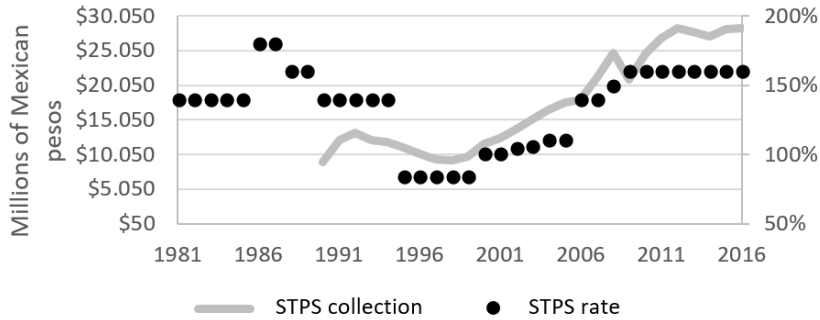

Figure. 2. Evolution of STPS collection on processed tobacco (millions of pesos in 2008) and STPS rate on filtered processed tobacco (percentages), 1981-2016
Source: Created by the authors with data from SHCP (Federal government budget revenues, www.shxp.gob.mx), Ramírez-Barba et al. (2008), Sáenz de Miera (2013) and INSP (2012).

Among the explanations that have been offered to understand the variations in the STPS rate on processed tobacco, Sáenz de Miera and Iglesias (2010) and Sáenz de Miera (2013) attribute the increase in that rate to 180% in 1986 to the need to improve tax collection in that year of severe economic crisis. On the other hand, Meneses González et al. (2002) suggest that, together with other measures, the lowering of the STPS rate observed in the 1990s would reduce tobacco smuggling. Reviewing the evolution of the tobacco tax, Sáenz de Miera (2013: p. 144) notes that "this tax has undergone several changes since its creation in 1981, but it was not until about ten years ago that it began to be linked to public health purposes." The latter coincides with Mexico's signing and ratification of the FCTC.

[4]CEFP (2002), Sáenz de Miera, et al. (2013) and Sáenz de Miera and Iglesias (2010) study the evolution of tobacco taxes in Mexico. CEFP (2018) describes the legal framework and fiscal effects of the tobacco industry.

Interestingly, different studies argue that interest groups are also behind the changes in the STPS rate on tobacco. Madrazo Lajous and Guerrero Alcántara (2012: p. 316) suggest that the companies that make up the tobacco industry can influence fiscal policy toward the industry. They refer, for example, to an agreement signed in 2004 between the federal government and the industry, which "established a common agreement to avoid imposing new or increased tobacco taxes." According to these authors, the industry seeks that "taxes be kept at the lowest possible level as a percentage of the final price to the consumer or, failing that, that the increase in taxes be gradual and not ad-valorem." Ochoa (2013) explains the work of civil society organizations in the process, which during 2009 led to the increase of the STPS rate to 160% and the setting of the specific component of such tax.

In addition to the reduction in the STPS rate in the mid-1990s, economic conditions contributed to the actual reduction in STPS collection toward the end of the 1990s. Although in nominal terms, the collection of this tax went from MXN$2,407 million in 1992 to MXN$4,990 million in 1998, when inflation was considered, it was reduced by 30% in real terms, a drop of 4.3% on average per year. In the decade from 1998 to 2008, STPS revenues grew steadily from MXN$4.99 billion to MXN$24.76 billion. This represented a growth of almost 170% in real terms: an annual average of 15.4%. This period was associated with an increase in the STPS rate and moderate growth in average consumer income. Subsequently, due to the financial crisis, tobacco STPS collection suffered a 16% real reduction in 2009, to recover in subsequent years to reach MXN$38.097 billion in 2016, as reported in Table 1 and Figure 2.

The executive branch proposed applying a fixed quota to tobacco products, depending on their weight, to progressively increase the price of all brands and presentations.

Including a security code on each pack was also proposed to prevent smuggling. After several modifications to this proposal by the Treasury Commission of the Chamber of Deputies, as well as the Treasury Commission of the Senate, a reform was approved to include a fee of ten cents per cigarette (0.75 grams), although it would be gradual, starting at 4, 6, and 8 cents per cigarette in 2010, 2011 and 2012, respectively.

In 2010, a gradual increase in the specific tax from $0.04 to $0.40 per cigarette and other adjustments to the STPS ad-valorem were proposed. The ad-valorem STPS increases were not approved, as the Treasury Commission of the Chamber of Deputies considered that they would encourage substitution by lower-priced tobacco products, making the measure ineffective. The approved reform increased the fixed fee from MXN$0.04 to MXN$0.35 per cigarette, starting in 2011. Figure 3 shows the evolution of the specific component in pesos per pack of 20 cigarettes.

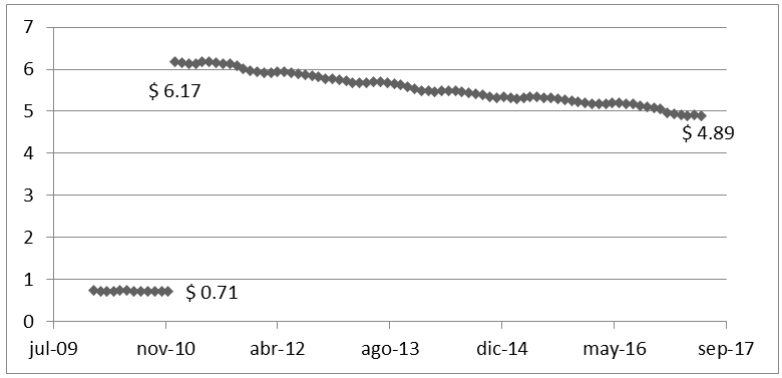

Figure. 3. Evolution of the specific STPS for processed tobacco, January 2010-July 2017 (real 2010 pesos)
Source: created by the authors with data from Ramírez-Barba et al. (2008), Sáenz de Miera (2013), and INSP (2012)

Figure 4 shows the quarterly behavior of per capita cigarette consumption (C) in Mexico and the price index of tobacco products. In addition, the STPS tax on processed tobacco has been included. As can be seen in this figure, with a permanent growth in tobacco prices, tobacco consumption remained between 110 and 160 cigarettes per capita between the first quarter of 1994 and the third quarter of 2005. Since that quarter, and after an upturn in the first quarter of 2006, when consumption peaked at 191 cigarettes per capita in the period under consideration, consumption has shown a somewhat irregular downward trend. Per capita consumption went from an all-time high of 191 in the first quarter of 2006 to 80 around the middle of 2013[5]. It is interesting to note the increasing trend shown by the price index of tobacco products, even though the STPS rate was reduced from 150% to 85% in 1995. On the other hand, the 25% increase in this index in the first quarter of 2011 is noteworthy since, although the tax rate remained at 160%, the specific component of the STPS for processed tobacco was adjusted, as described in previous paragraphs. Controlling for other variables that may influence the prices of tobacco products, the objective of this article is precisely to determine how important the evolution of both components of the STPS on processed tobacco has been in explaining the behavior of tobacco product prices.

[5]For an analysis of the determinants of tobacco demand, using time series, Ibarra Salazar et al. (2019) and Oliviera Chávez et al. (2010) is recommended.

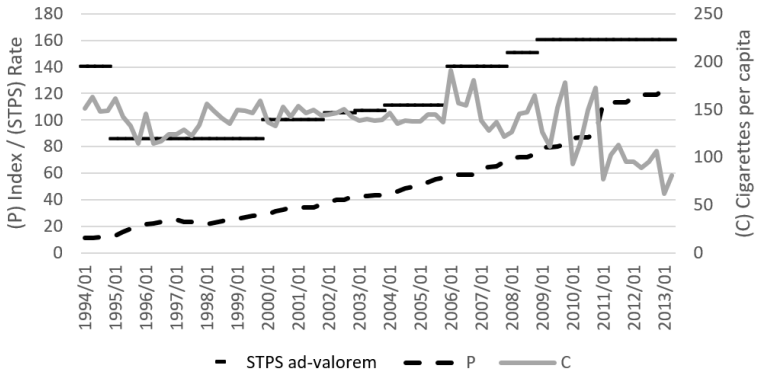

Figure. 4. Evolution of the price index of tobacco products (P), ad-valorem STPS (percentage), and consumption of tobacco products (C, cigarettes per capita)[6]. First quarter 1994-Second quarter 2013 (Quarterly data).
Source: created by the authors with data from Ramírez-Barba et al. (2008), Sáenz de Miera (2013), INSP (2012), Olivera et al. (2010), Ibarra Salazar et al. (2019), Sistema de información arancelaria de la Secretaría de Economía (http://200.77.231.38/siavi4/fraccion.php), and Encuesta Mensual de la Industria Manufacturara de INEGI (www.inegi.gob.mx)

Despite the importance of fiscal policy toward the tobacco industry, both in extra-fiscal and fiscal terms, the literature on the subject in Mexico is scarce. Among existing studies, Sáenz de Miera (2013) notes that progress has been made in implementing a more aggressive fiscal policy. The author considers that tax increases have had an impact on sales prices to the end consumer. She argues that the most recent adjustment led to an increase in the sales price of about 25%. In addition, she considers that the reduction in consumption could have been 13% since the price elasticity of demand is -0.52.

Waters et al. (2010) perform simulations that quantify the projected reductions in consumption prevalence, premature mortality, and increases in government revenues generated according to different combinations of taxes. Assuming a price elasticity of demand equal to -0.52, the base simulation indicates that adjusting the ad-valorem component and the specific component of the STPS according to inflation, so that together they make up 75% of the final price per pack[7], would reduce the number of smokers by 2.58 million and prevent approximately 903,000 deaths.

Using data from the National Household Income and Expenditure Survey (ENIGH) from 1994 to 2005, Jiménez et al. (2008) estimate that if taxes on cigarettes increase by 10% (percentage over price),

[6]Consumption of tobacco products was calculated as the sum of domestic tobacco production and net tobacco imports. The information on domestic production for the years 1994 to 2004 includes only information on filtered cigarettes, since no information related to unfiltered cigarettes was published for the years 2001 to 2005. For the years 2005 to 2013, the variable comprises cigarettes of all types. Since the information on domestic production is expressed in packs, while that related to net imports is expressed in kilograms, it was necessary to apply a conversion factor to standardize the units of measurement. One pack is equivalent to 20 cigarettes and one kilogram is equivalent to 800 cigarettes.
[7]This is the amount recommended by WHO (WHO, 2015).

then the price would increase by 12.4%, consumption would decrease by 6.4%, and tobacco tax revenue would increase by almost 16%.

COFEMER (2012) considers the alternative of increasing tobacco taxes in Mexico so that they represent 75% of the retail price. According to their estimates, this would reduce consumption by 19.3% and increase revenue by 20.6%.

Studies on incidence

Studies on tax policy toward the tobacco industry agree that tobacco taxes are one of the most effective policy tools to reduce smoking and thus the health conditions caused by smoking (WHO, 2015). Tobacco taxation has a range of issues that are subject to analysis from an economic perspective. While the literature is extensive, tax-related issues are contained in, among other works, Chapter 4 of U.S. National Cancer Institute and World Health Organization (2016), Chapter 11 of Samet and Yoon (2010), Chaloupka and Warner (2001), and Chaloupka et al. (2000). Regarding the World Health Organization's view, the WHO (2015) report focuses on tax management to contain smoking.

On the incidence of tobacco taxation, these general treatises on tobacco economics agree that the transfer of taxes to the prices paid by consumers depends on several factors: the type of tax, the addictive nature of tobacco, the industry's market structure, the industry's own brand diversity and market segmentation, the extent of illegal tobacco trade, and the extent of tax avoidance, among other strategies that consumers may use to avoid taxes.

The basis of the empirical literature on tax incidence in the tobacco industry comes from, among others, the seminal studies by Poterba (1996) and Besley and Rosen (1999). The essential issue is whether taxes on products are fully passed on to the prices consumers pay. This question is also essential in public finance, where it is known as tax incidence, which consists of determining how the tax burden is distributed among the agents participating in the markets.

The works that have addressed the tax incidence on the tobacco industry can be divided according to different criteria, including the dimensions of tobacco tax incidence, the type of data used (time series aggregate data, panel data, microdata), the approach to estimating the tax effect (structural or reduced form), and the results found regarding the transfer of the tax to cigarette consumers.

Regarding dimensions that may make tax incidence non-uniform, the following have been considered: regional or geographic differences (Chiou & Muehlegger, 2014; Delipalla & O'Donnell, 2001; Harding et al., 2012); cigarette brands (Cevik, 2016; Brock et al., 2015); cigarette characteristics - premium, economy, low price, filter, regular, menthol, light - (Wang et al., 2015; Xu et al., 2014; Chiou & Muehlegger, 2014; Espinosa & Evans, 2013; Gilmore et al., 2013; Sullivan & Dutkowsky, 2012;

Hanson & Sullivan, 2009); distribution channels - retail chain, independent trade, internet - (Brock et al., 2015; Pesko et al., 2013; Hanson & Sullivan, 2009); consumer characteristics - income and education - (Harding et al., 2012); and cigarette packaging type (Wang et al., 2015; Chiou & Muehlegger, 2014; Xu et al., 2014; Pesko et al., 2013).

As for the transfer of the tax to prices, the results are mixed. Ashenfelter and Sullivan (1987) and Delipalla and O'Donnell (2001) found that tax increases do not necessarily lead to price increases. Studies by Sumner and Ward (1981), Harding et al. (2012), Pesko et al. (2013), Chiou and Muehlegger (2014), and Cevik (2016) found that cigarette prices increase less than the tax, while Sumner and Wolgenant (1985), DeCicca et al. (2013), and Espinosa and Evans (2013) show evidence that, in general, the tobacco tax is fully passed on to consumers. The results of Sumner (1981), Harris (1987), Sung et al. (1994), Barnett et al. (1995), Keeler et al. (1996), Hanson and Sullivan (2009), Sullivan and Dutkowsky (2012), Gilmore et al. (2013), Xu et al. (2014), Brock et al. (2015), and Wang et al. (2015) show evidence that cigarette prices increased more than the tax (over-shifting). As discussed above, Xu et al. (2014) indicate that the magnitude of the tax pass-through to the selling price may vary by brand, type of retailer, market power of producers, distance to lower-priced retailers, and the type of cigarette tax.

The first studies on incidence under imperfect competition for the tobacco industry were conducted in the 1980s. The work of Sumner (1981), with extensions by Bulow and Pfeiderer (1983), Sullivan (1985), Ashenfelter and Sullivan (1987), and Harris (1987), stands out.

The works of Barnett et al. (1995) and Delipalla and O'Donnell (2001) propose structural models of the industry to analyze tax incidence. These models address incidence by expressing separately the conditions associated with the industry's market structure, the demand for the product, and the participating companies' cost structure.

Regarding data structure, the studies by Sung et al. (1994) and Sullivan and Dutkowsky (2012) use data that combine time series with cross-sections. The most recent work has estimated the incidence of tobacco taxes using microdata. In some cases, data come from consumer surveys (Xu et al., 2014; DeCicca et al., 2013; Pesko et al., 2013), scanner data at the UPC level (Wang et al., 2015; Chiou & Muehlegger, 2014; Harding et al., 2012), or data by retail outlet, over time, and for different cigarette brands (Cevik, 2016; Brock et al., 2015; Gilmore et al., 2013; Espinosa & Evans, 2013; Sullivan & Dutkowsky, 2012; Hanson & Sullivan, 2009). Harding et al. (2012) is among the studies on tax incidence in the tobacco industry that have employed the most detailed data for illustration purposes only. This is scanned data from Nielsen on household purchases at the UPC level for 2006 and 2007. The data provide details on the type of product purchased and the location of the purchase, which can be used to identify both the characteristics of the area and the sociodemographic characteristics of the consumers. It covers 160,969 transactions made by 10,784 households in 48 states and the District of Columbia in the USA.

Wang et al. (2015) also use scanner data at the convenience store level (1 865) corresponding to 560 counties in 48 US states from 2011-2012. Since the data are at the UPC level, it was possible in this study to control price variations using product characteristics and to analyze how tax incidence interacts with product heterogeneity. Wang et al. (2015) define a reduced-form model in which price is a function of tax, controlling for product attributes, socioeconomic conditions, and county demographics (percentage of males, blacks, Asians, and Hispanics in the population; per capita income; unemployment rate; and percentage of high school and college graduates), as well as incorporating county fixed effects. Indeed, product attributes include whether the cigarette is regular, menthol or other flavor; whether it is filtered or unfiltered; whether it is regular, light, or ultra-light; whether it is a premium or discount brand; and whether the packaging is a pack of 20 cigarettes or a carton of ten packs. The authors found that, on average, a $1 increase in the cigarette tax would result in a price increase of more than $1, ranging from 5 to 19 cents per pack of cigarettes. This effect is different for different types of cigarettes. They find that the tax shift for cigarettes sold in cartons is 13 cents higher than for packs, while premium cigars are taxed 7 cents higher than discount brands. In a highly concentrated industry, such as the tobacco industry, the pass-through to price above the amount of the tax suggests the existence of market power and strategic behavior of firms in the industry.

Xu et al. (2014) and different treatises on tobacco economics (U.S. National Cancer Institute & World Health Organization, 2016; Samet & Yoon, 2010; Chaloupka & Warner, 2001; Chaloupka et al., 2000) indicate that the transfer of taxes to prices paid by consumers depends on several factors: the type of tax, the addictive nature of tobacco, the industry's market structure, the industry's own brand diversity and market segmentation, the extent of the illicit tobacco trade, and the extent of tax avoidance.

This article falls within the area of tobacco tax incidence studies that use time-series aggregate data, such as Galbraith and Kaiserman (1997), Stehr (2005), Keeler (1993), Hu et al. (1994), Hu et al. (1995), and more recently Cetin (2017), as well as those that specify a reduced form for estimating tax incidence in the tobacco industry (Delipalla & O'Donnell, 2001; Keeler et al., 1996; Harding et al., 2012: Wang et al., 2015; DeCicca et al., 2013; Pesko et al., 2013).

As noted in the introduction, there does not seem to be any other study that estimates tax incidence on the Mexican tobacco industry.

Methodology

To analyze the incidence of tobacco taxes in Mexico, a reduced-form model is specified and estimated using 282 monthly observations from January 1994 to June 2017. Based on the reduced forms, which are used in most of the related literature (Poterba, 1996; Besley & Rosen, 1999; Delipalla & O'Donnell, 2001;

Keeler et al., 1996; Harding et al., 2012; Wang et al., 2015; DeCicca et al., 2013; Pesko et al., 2013), a model to explain monthly variations in tobacco product prices (Pt) is defined as:

$$P_t=\beta_1+\beta_2\tau_t + X'_t\delta+\varepsilon_t \quad (1)$$

Where τ represents the taxes on tobacco products in Mexico (ad-valorem STPS and specific STPS), and X is a vector that includes variables to control for the determinants of tobacco demand (GDPPC, RLEY, RPIC), the production costs of tobacco products (IPP, SAL), the market structure of the tobacco industry (HHI), as well as the trend (T) and seasonality (EST) that the variable P_t may observe. ε represents the error term. The description of the variables, descriptive statistics, and sources of information is presented in Table 2.

Table 2
Description of variables and descriptive statistics

Group	Variables	Description	Mean	Minimum	Maximum	Remarks	Source
Dependent variable	P	Tobacco products price index (2008 = 100)	46.308	0.0091	202.543	01/1994-06/2017 282	INEGI at www.inegi.com.mx
Tax	STPS ad-valorem	Rate of excise tax on production and services	134.986	85	180	01/1994-06/2017 282	Ramírez-Barba *et al*. (2008) and Sáenz de Miera (2013)
	Specific STPS	Specific STPS in real pesos (2008 = 100) per pack of 20 cigarettes	1.007	0	6.182	01/1994-06/2017 282	Ramírez-Barba *et al*. (2008), Sáenz de Miera (2013) and INSP (2012)
Demand	GDPPC	GDP per capita in millions of 2008 pesos. GDP is quarterly. Linear behavior was assumed to obtain GDP per month. The per capita figure was obtained by dividing GDP by the population over 18 years of age.	0.104	0.0816	0.122	01/1994-01/2017 324	INEGI at www.inegi.com.mx and CONAPO at http://www.conapo.gob.mx
	RLEY	Binary variable that takes the value of one (1) since the publication of the General Law for Tobacco Control in Mexico (2008 M06)	0.387	0	1	01/1994-06/2017 282	Created by the authors
	RPIC	Binary variable that takes the value of (1) since the implementation of pictograms on cigarette packs in Mexico (2009 M09)	0.333	0	1	01/1994-06/2017 282	Created by the authors

Costs	PPI	Producer price index of generic prices for total cigarette production (2008 = 100)	68.909	15.066	128.447	01/1994-06/2017 282	INEGI at www.inegi.com.mx
	SAL	Cigarette processing/manufacturing wages in millions of pesos at current prices adjusted to millions of pesos at 2008 prices	109.750	42.903	288.615	01/1994-12/2012 228	CMAP, EMIM and SCIAN 2002 of INEGI at www.inegi.com.mx
Market	HHI	Herfindahl-Hirshman Index of the Mexican tobacco industry It was calculated as the sum of the squared market shares of the companies. The market shares of the companies participating in the market are annual. A linear growth rate was assumed for each year to obtain the monthly data.	5 151.581	4 742.210	5 518.540	01/2007-01/2016 109	Euromonitor International Tobacco: Euromonitor from trade sources/national statistics
Time	T	Trend variable	NA	NA	NA	Variable	Created by the authors
	EST_j	Seasonality variables for j = 1 (January), 2 (February), 11 (November). ESTj is a binary variable that takes the value of one (1) in month j of each year and zero (0) in any other case.	NA	NA	NA	Variable	Created by the authors

Source: created by the authors

The dependent variable is the monthly price index of tobacco products. The tobacco tax is measured by the STPS rate and the specific amount of this tax per pack of 20 cigarettes, which was introduced in January 2010.

The independent variables associated with tobacco demand are: Gross Domestic Product per capita (GDPPC), two variables indicative of regulations that could influence demand (the General Law for Tobacco Control in Mexico (RLEY), and the entry into force of health warnings with pictograms on cigarette packs (RPIC)).

The variables used to control for changes in the production costs of tobacco products are the producer price index for cigarettes (PPI) and wages related to cigarette manufacturing (SAL).

To measure the market structure in the tobacco industry, the Herfindal-Hirshmann Index (HHI) was calculated based on the annual market shares of the companies that make up the industry.

Finally, a trend variable (T) and binary variables associated with each month of the year) were included as controls to recognize possible seasonality in the tobacco product price index. As Greene (2008, p. 108) indicates, the explicit inclusion of time variables is a way of deseasonalizing the data.

All data used in the estimations are published monthly, except for the market shares of the companies that make up the industry, which are used to calculate the HHI variable, and GDP. Market shares have an annual frequency and GDP has a quarterly frequency. In both cases, and following Gaynor and Kirkpatrick (1994), a linear projection was made to calculate the monthly data in each period.

Depending on the availability of data to approximate the independent variables and seeking to assess the consistency of this study's results, the estimation strategy and the different empirical models were defined. Two criteria are considered in these estimates. In the first instance, data availability for the period under study was considered. There are observations from 01/1994 to 06/2017 for all variables, except SAL, available from 01/1994 to 12/2012, and HHI, with observations from 01/2007 to 01/2016. In that case, four models were estimated, including all the independent variables and three others alternating the SAL and HHI variables.

The second criterion was the variables comprising each group (demand, costs, market structure, and time). The relation between the price of tobacco products and the tobacco tax was estimated by sequentially including the independent variables for each group. In addition, linear models and variables in natural logarithms are specified. The linear model is specified as follows:

$$P_t = \beta_0 + \beta_1 \text{ STPS ad-valorem} + \beta_2 \text{ STPS specific} + \delta_1 \text{ GDPPC} + \delta_2 \text{ RLEY} + \delta_3 \text{ RPIC} + \delta_4 \text{ PPI} + \delta_5 \text{ SAL} + \delta_6 \text{ HHI} + \delta_7 \text{ T} + \sum_{j=1}^{11} \delta_{7+j} \text{ EST}_j + \varepsilon_t \quad (2)$$

The logarithmic model is specified as:

$$P_t = \beta_0 + \beta_1 \text{ STPS ad-valorem} + \beta_2 \ln(\text{STPS specific} + \delta_1 \ln(\text{GDPPC}) + \delta_2 \text{ RLEY} + \delta_3 \text{ RPIC} + \delta_4 \ln(\text{PPI}) + \delta_5 \ln(\text{SAL}) + \delta_6 \ln(\text{HHI}) + \delta_7 \text{ T} + \sum_{j=1}^{11} \delta_{7+j} \text{ EST}_j + \varepsilon_t \quad (3)$$

The estimation method was ordinary least squares (OLS), using the Newey-West correction, which estimates robust errors in autocorrelation and heteroscedasticity. VIF (variance inflation factor) was used to detect multicollinearity. Generally, a VIF greater than 10 indicates severe multicollinearity, which requires some corrective action.[8]

Results

Tables 3 to 5 contain the results of the estimations. Table 3 shows the models estimated by varying the number of observations by alternating the SAL and HHI variables. As can be seen, the results show evidence of severe multicollinearity in all the estimated models. Specifically, the T and PPI variables show VIFs ranging from 253 to 726 for the first variable and between 233 and 780 for the second. The presence of multicollinearity can cause abrupt changes in the values and signs of the estimated parameters, as can be seen, for example, between models 2 and 3 in Table 3. Likewise, multicollinearity may lead one not to reject hypotheses of statistical significance, which should be rejected when correcting the problem. Both situations would lead to erroneous conclusions regarding the effect of the tax on the price of tobacco products.

To correct this problem, the trend variable (T) was eliminated in estimating the models. Although the problem decreases, it persists. The producer price index (PPI) and the Herfindahl-Hirshman index (HHI) seem to be the variables causing the problem. Another alternative to reduce multicollinearity was to estimate the models by converting the variables into natural logarithms, although this did not help reduce the multicollinearity problem. Again, the logarithmic variables of PPI and HHI, among others, continued to cause this problem.

Following the strategy of including the independent variables in blocks helps obtain estimates that show an acceptable degree of multicollinearity for statistical inference and interpretation of the estimated parameters (Tables 4 and 5). In these estimates, both the ad-valorem STPS rate and the specific STPS show a direct relationship, which is also statistically significant in models 3, 4 and 5 in Table 4. According to the estimated parameter of the specific STPS variable, in model 3 of Table 4, an increase of MXN$1 per pack in the specific component of the STPS would increase the price index of tobacco

[8] Kutner et al. (2004) and in 2.4 - Detecting Multicollinearity Using Variance Inflation Factor. https://onlinecourses.science.psu.edu/ stat501/ node/ 347

products by 6.1 points, which is equivalent to an increase of 3% taking as a base the June 2017 data (202.5).

Logarithmic model 3, in Table 5, indicates that the price index of tobacco products is inelastic for both the specific STPS and the ad-valorem STPS. Indeed, the estimated elasticity relative to the ad-valorem STPS is 0.003 and relative to the specific STPS is 0.113. Using this model, a 20.4% increase in the specific component of the tax would cause an increase in the price index of tobacco products of 2.3%. Regarding the ad-valorem component of the STPS, if the rate were to increase by 20 percentage points, then consumer prices of tobacco products would increase by 0.05%. This result is like those reported in the related literature. Sumner and Ward (1981), Harding et al. (2012), Pesko et al. (2013), Chiou and Muehlegger (2014), and Cevik (2016) found that cigarette prices increase less than the tax.

As for the control variables, it can be seen in Table 4 that the binary variable of the linear model to indicate the validity of the General Law for Tobacco Control (RLEY) shows a direct relation with the price index of tobacco products, which is also statistically significant in models 2 and 3. The various regulatory measures implied in the Law would appear to have resulted in higher tobacco prices.

The results in Table 4 also show that the variable indicating the regulation of labeling on cigarette packs through pictograms (RPIC) shows an inverse and statistically significant relation in models 3, 4 and 5. Whenever such regulation may have reduced demand for tobacco products, as inferred from Thrasher et al. (2007) and Thrasher et al. (2012), and as demonstrated in Ibarra Salazar et al. (2019), the industry may have responded by reducing prices to counteract this effect. Although this is deduced from the estimation of the linear model, the results of the estimation of the model in logarithms do not confirm these results. As shown in Table 5, in models 3, 4 and 5, it is impossible to reject the hypothesis that the parameters of the variables associated with industry regulation differ from zero.

According to the price-market concentration hypothesis (Bresnahan, 1989), higher concentration in the industry would be expected to lead to higher prices. The results in Table 4 indicate that the HHI is not statistically significant, although the variable shows high multicollinearity, as noted above. For this reason, it is impossible to determine what role the market structure plays in the evolution of tobacco product prices.

Finally, as expected, the cigarette producer price index (PPI) also shows a direct and statistically significant relation with tobacco product prices.

In summary, the estimation results show that:

- The STPS rate and the specific STPS have a direct and statistically significant relation with the price index of tobacco products.
- The price index for tobacco products is not very sensitive to changes in the ad-valorem STPS and the specific STPS.

- It is impossible to consistently determine the effect that the market structure and the regulatory measures considered in the study (General Law for Tobacco Control and the regulation of health warnings with pictograms) have on the prices of tobacco products.
- The elasticity of tobacco product prices relative to the cigarette producer price index is approximately equal to one.

Table 3
Results of the linear model estimations

	Model 1			Model 2			Model 3			Model 4		
Variable	Parameter	p value	VIF	Parameter	p value	VIF	Parameter	p value	VIF	Parameter	p value	VIF
Constant	-96.256***	0.000	NA	-97.371***	0.000	NA	7.603	0.257	NA	-14.278*	0.058	NA
STPS ad valorem	0.303***	0.000	34.213	0.325**	0.000	19.943	0.110***	0.000	17.296	0.120***	0.000	14.903
Specific STPS	5.640***	0.000	41.770	5.662***	0.000	66.573	6.330***	0.000	6.094	6.149***	0.000	2.522
GDPPC	25.039	0.855	67.849	51.689	0.583	48.343	-306.077***	0.000	13.338	-349.376***	0.000	11.717
RLEY	0.137	0.798	9.722	0.204	0.628	7.487	4.244***	0.006	22.179	4.846***	0.001	30.891
RPIC	-3.515***	0.007	59.201	-3.400***	0.002	73.432	-2.087**	0.034	5.567	-1.356*	0.080	3.638
PPI	1.1487***	0.000	365.587	1.145***	0.000	779.945	1.418***	0.000	233.417	1.104***	0.000	393.130
SAL	-0.009	0.612	8.200							-0.003	0.630	10.903
HHI	-0.004	0.392	194.658	-0.003	0.268	76.022						
T	0.166	0.132	629.031	0.144***	0.005	726.292	-0.011	0.736	252.720	0.093***	0.009	392.668
January	-1.827*	0.079	17.121	-1.300**	0.045	6.947	-0.535	0.394	3.056	-0.710	0.432	6.897
February	-0.662	0.555	29.466	-0.333	0.627	21.237	-0.301	0.657	7.981	-0.269	0.793	16.194
March	-0.504	0.642	36.400	-0.119	0.858	35.197	-0.019	0.977	10.458	-0.067	0.943	17.320
April	-0.596	0.565	54.760	-0.247	0.697	35.655	0.048	0.944	12.006	-0.047	0.962	20.829
May	-0.775	0.433	34.719	-0.417	0.486	35.190	0.053	0.937	10.498	-0.132	0.894	16.854
June	-0.916	0.331	35.939	-0.515	0.366	23.334	-0.187	0.767	10.815	-0.506	0.567	22.153
July	-1.027	0.230	44.909	-0.658	0.225	25.862	-0.373	0.575	11.454	-0.733	0.397	21.223
August	-1.322	0.163	18.798	-0.877	0.122	13.371	-0.208	0.737	10.928	-0.507	0.560	21.111
September	-0.898	0.361	13.847	-0.639	0.291	10.655	0.142	0.811	9.610	-0.197	0.820	17.551
October	-0.937	0.364	21.378	-0.742	0.283	22.275	0.487	0.390	8.006	0.163	0.828	12.549
November	-0.787	0.387	19.673	-0.502	0.348	12.370	0.464	0.264	3.548	0.034	0.957	6.688
R^2adjusted		0.999			1.000			0.999			0.998	
Observations		72			109			277			228	
m		3.12			3.58			4.889			4.58	

Estimates applying the ordinary least squares method using the Newey-West correction that estimates robust errors in autocorrelation and heteroscedasticity. $m = (0.75)\sqrt[3]{T}$ is Stock and Watson's truncation parameter, http://www.eviews.com/help/helpintro.html#page/content/Regress2-Robust_Standard_Errors.html. * p-value < 0.10, ** p-value < 0.05 and *** p-value < 0.01
Source: created by the authors

Table 4
Results of the linear model estimations

	Model 1			Model 2			Model 3			Model 4			Model 5		
Variable	Parameter	p value	VIF	Parameter	p value	VIF	Parameter	p value	VIF	Parameter	p value	VIF	Parameter	p value	VIF
Constant	55.895***	0.000	NA	-238.568***	0.000	NA	-1.480	0.767	NA	-79.436***	0.000	NA	-68.011***	0.004	NA
STPS ad valorem	-0.158	0.223	1.892	0.038	0.627	3.795	0.122***	0.000	11.491	0.367***	0.000	28.414	0.384***	0.000	23.140
Specific STPS	26.768***	0.000	1.892	6.674***	0.000	2.269	6.099***	0.000	2.708	5.666***	0.000	55.071	5.774***	0.000	44.789
GDPPC				2893.955***	0.000	2.485	-233.238***	0.000	7.159	210.269***	0.001	4.393	155.435**	0.038	11.899
RLEY				33.752***	0.000	14.718	5.268***	0.001	30.238	0.704	0.289	7.371	0.427	0.464	9.267
RPIC				6.085	0.446	13.320	-1.914**	0.011	3.023	-4.110***	0.002	45.074	-3.980***	0.001	33.996
PPI							1.330***	0.000	15.367	1.401***	0.000	74.462	1.376***	0.000	48.642
SAL							0.003	0.615	5.001	-0.008	0.591	2.627	-0.021	0.144	3.778
HHI										-0.001	0.691	110.729	-0.002	0.538	85.835
January													-2.427***	0.006	6.174
February													-1.368*	0.069	14.404
March													-1.074	0.173	16.757
April													-1.081	0.141	23.745
May													-1.108	0.163	13.412
June													-1.224*	0.090	14.698
July													-1.149*	0.096	21.298
August													-1.503*	0.059	7.891
September													-1.033	0.197	7.231
October													-1.070	0.214	10.269
November													-0.699	0.405	8.845
R^2adjusted	0.730			0.970			0.998			0.999			0.999		
Observations	438			289			228			72			72		
M	5.70			4.96			4.582			3.12			3.12		

Estimates applying the ordinary least squares method using the Newey-West correction that estimates robust errors in autocorrelation and heteroscedasticity. $m = (0.75)\sqrt[3]{T}$ is Stock and Watson's truncation parameter, http://www.eviews.com/help/helpintro.html#page/content/Regress2-Robust_Standard_Errors.html.* p-value < 0.10, ** p-value < 0.05 and *** p-value < 0.01.
Source: created by the authors.

Table 5
Results of the logarithmic model estimations

	Model 1			Model 2			Model 3			Model 4			Model 5		
Variable	Parameter	EE	VIF	Parameter	EE	VIF	Parameter	EE	VIF	Parameter	EE	VIF	Parameter	EE	VIF
Constant	5.979***	0.608	NA	19.440***	1.470	NA	-2.064***	0.31	NA	-3.848**	1.663	NA	-3.472**	1.543	NA
STPS ad valorem	-0.028***	0.006	6.24	-0.005**	0.002	7.39	0.003***	0.0003	9.21	0.003***	0.0009	24.72	0.003***	0.0008	25.28
ln (STPS spec)	2.048***	0.265	6.24	-0.013	0.034	2.39	0.113***	0.006	4.54	0.093***	0.005	8.44	0.091***	0.006	20.51
ln (GDPPC)				6.522***	0.576	4.28	-0.412***	0.093	10.74	0.183**	0.085	7.76	0.339***	0.096	18.74
RLEY				0.639***	0.175	17.40	0.009	0.0199	17.70	-0.0097	0.009	10.85	-0.001	0.006	8.87
RPIC				-0.0003	0.151	13.63	0.019	0.013	7.40	-0.005	0.013	25.18	-0.003	0.012	35.44
ln (PPI)							1.199***	0.017	16.06	1.086***	0.073	24.92	1.029***	0.075	41.03
ln (SAL)							0.029*	0.016	12.90	-0.015	0.012	3.69	-0.014*	0.008	4.11
ln (HHI)										0.447	0.188	50.09	0.467**	0.204	78.57
January													-0.002	0.013	10.44
February													0.005	0.011	15.34
March													0.005	0.010	24.37
April													0.004	0.010	17.72
May													0.003	0.009	33.05
June													0.001	0.009	28.55
July													0.001	0.009	34.20
August													-0.005	0.009	24.21
September													-0.009	0.010	22.28
October													-0.012	0.009	23.82
November													-0.008	0.008	15.61
R^2adjusted	0.296			0.928			0.998			0.997			0.997		
Observations	438			289			228			72			72		
m	5.70			4.96			4.582			3.12			3.12		

Estimates applying the ordinary least squares method using the Newey-West correction that estimates robust errors in autocorrelation and heteroscedasticity. $m = (0.75)\sqrt[3]{T}$ is Stock and Watson's truncation parameter, http://www.eviews.com/help/helpintro.html#page/content/Regress2-Robust_Standard_Errors.html.* p-value < 0.10, ** p-value < 0.05 and *** p-value < 0.01.
Source: created by the authors

Conclusions

In this paper, it was proposed to correlate the price index of tobacco products with the STPS through a reduced form that, in addition to the tax on tobacco products, includes as independent variables the determinants of demand, production costs, and market structure, as well as variables to recognize the trend and seasonality. The STPS is measured with the ad-valorem STPS rate and the specific tax amount per pack of 20 cigarettes.

To ameliorate the multicollinearity problem, the models were estimated by varying the number of observations according to the availability of data on the independent variables, including blocks of independent variables and applying different functional forms to the causal relationship of interest.

The results, with an acceptable degree of multicollinearity, show evidence that the ad-valorem and the specific STPS have a direct and statistically significant relation with the price index of tobacco products. Particularly, the linear model indicates that an MXN$1 increase in the specific component per pack, which would represent 20.4% of the real specific component as of June 2017, would increase the price index of tobacco products by 6.1 points, which is equivalent to 3% taking as a base the June 2017 data (202.5). Using the logarithmic model, a 20.4% increase in the specific component of the tax would cause an increase in the price index of tobacco products of 2.3%. Regarding the ad-valorem component of the STPS, if the rate were to increase by 20 percentage points, then consumer prices of tobacco products would increase by 0.05%.

In terms of tax incidence, these results indicate that tax increases have not translated into increases of the same magnitude in the price index of tobacco products. One of the conditions for taxes to reduce smoking is that their upward adjustments are passed on to the prices consumers pay, thus reducing demand. According to these results, although a direct relation between tobacco taxes and the price index of tobacco products is found, the magnitude of price increases is smaller than the increase in the STPS. This result undermines the validity of studies that have estimated the effect of tax adjustments on cigarette prices and tobacco tax revenues since they have assumed that tax adjustments are passed on to consumers through prices.

Consistent with the literature on tobacco industry tax incidence, this result is similar to those of Sumner and Ward (1981), Harding et al. (2012), Pesko et al. (2013), Chiou and Muehlegger (2014), and Cevik (2016) in the sense that, as the tax on tobacco products increases, prices for consumers increase by a smaller proportion.

As discussed above, Xu et al. (2014) indicate that the magnitude of the tax transfer to the selling price may vary by brand, type of retailer, the market power of producers, distance to retailers with lower prices, and the type of cigarette tax. In Mexico, the containment of the price index for tobacco products

in the face of tax adjustments can be explained by the downward trend in tobacco demand in the presence of the illegal tobacco trade.

The incidence analyzed in this article is related to the price index of tobacco products. It would be interesting to find out whether the effect of changes in the taxation of tobacco products is different depending on regional characteristics, the market structure of the industry, and the types of cigarettes marketed in Mexico.

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