Taxing for Health in Latin America*

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Abstract

We present a model that provides insights into the optimal structure of sin taxes, considering the varying health risks of different product variants and the presence of internalities and externalities. Then, we compare its predictions with the tax policies on tobacco, alcoholic beverages, and sugar-sweetened drinks in Latin America and the Caribbean. Our framework confirms the intuition that taxes should be levied based on the health risks these products impose on individuals. Nevertheless, we show evidence from Latin America demonstrating that sin taxes on these products are often not established in proportion to the harm they produce. Our model also suggests that consumption response to taxes is weaker when there is a higher subjective misperception of the health risk, necessitating further tax increases. A key policy issue that relates to the theoretical framework is the potential trade-off between health and revenue objectives that the government may face. Authorities may be worried that increasing these taxes for health purposes may reduce tax revenue if the demand falls to a greater extent than the taxes increase. Our model shows that the revenue argument for taxing sin products may imply higher taxes for all variants (though relatively lower for less harmful versions).

1. Introduction and main objectives

Selective consumption taxes on goods like tobacco, alcohol, or sugar-sweetened beverages (SSB) that negatively affect health outcomes are usually named "sin taxes". The arguments for such government interventions are based on both internalities and externalities. The first concept is related to behavioral biases, habit formation, lack of self-control, or disinformation (about the negative consequences on health), which makes individuals consume too much of these products from the point of view of their welfare. Externalities are associated with extra costs that this type of consumption forces on society, which are not considered by consumers, like increasing healthcare expenditures that need to be financed in part by all taxpayers.

Governments worldwide have been applying these types of taxes for many years, for example, in the case of tobacco and alcohol, and have recently extended them to SSB products and even to fat or high-calorie types of food. Increasing public concerns about the health consequences of these products have implied reforms to raise these levies in the last years; this was the case for tobacco as a response to fight the "tobacco epidemic" (WHO, 2021a; IARC, 2011) associated with growing cancer and heart diseases among the smoking population. The same has happened

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with SSB products, as shown by indicators of obesity and diabetes among young people in many countries (Farhangi et al., 2022) and also with alcohol intake, which is also related to many diseases and injury conditions such as cancer, stroke, liver cirrhosis, among others.

Latin America has not been absent from these global trends. Tobacco taxes, as a share of the most sold brand, increased by around 10% between 2008 and 2020 (WHO, 2021a). Also, some countries like Chile and Mexico have reformed their taxes on SSB products, raising their levies and broadening the covered products.

The taxation of these products is particularly relevant in the region because of the high consumption levels of potentially harmful products. For example, tobacco consumption is high, with most countries above 500 cigarettes per capita per annum (Muller, 2008). Soft drink consumption is also prominent, with Mexico having the world record (163 liters per capita in 2011). Regarding alcohol intake, though, the region has consumption levels that are below OECD countries (6 and 9 liters per capita, respectively, in 2016), there is evidence that in some countries (i.e., Peru, Saint Lucia, Grenada, Saint Kitts and Nevis, and Trinidad and Tobago) around half of all drinkers report heavy drinking behavior (WHO, 2018 and GBD 2016 Alcohol Collaborators, 2018). While there are several examples of estimations of the effects of tax changes on the consumption of these products (Miracolo et al., 2021) the discussion of optimal sin taxes in Latin America is relatively scarce.

Because of more public awareness of the health consequences of the consumption of sin goods and the higher prices due to taxation, the industry in recent years has developed variants of these products that presumably imply lower health risks. This has been noticeable in tobacco, where E-cigarettes containing nicotine or other non-nicotine substances (ENDS and ENNDS), or Heated Tobacco Systems (HTS), which avoid combustion. As a consequence, ENDS, ENNDS and HTS contain lower levels of harmful and potentially harmful constituents (HPHCs; see FDA, 2020). In the case of SSB products, there is a proliferation of diet or low-calorie soda beverage varieties. For alcoholic beverages, many producers have launched some non-alcoholic versions of these drinks, like beer.

A critical question that policymakers face is how to treat these new products in terms of general regulation and taxes. This issue is related to a general principle that applies to all these taxes: whether they consider health risks in their implementation. There are also redistributive issues associated with low-income families consuming more of these goods (Alcott et al., 2019; Fuchs et al., 2019).

This paper's main objective is to evaluate the establishment of sin taxes in Latin America from actual policy practices and theoretical points of view. The discussion of actual practices of these taxes in the region focuses on tobacco, alcohol, and SSB products. Within each main product category, we look at coverage of these levies -including the new varieties that have appeared in the market-, the type of taxes that have been established – excise fixed-value amounts and/or ad-valorem rates –, and the definition of the tax bases. With all these elements, we assess to what extent the application of these taxes has been designed considering health risk issues. For some selected countries, we also look at consumption patterns across income strata and how they have been affected by implementing these taxes. We then develop a simple model that considers some of the features already described to analyze the factors that affect the optimal

structure for these taxes in a more controlled environment. We discuss to what extent the model gives new insights into policy issues that could be relevant to the region.

2. Some conceptual and practical issues regarding the design and implementation of sin taxes

Before discussing the details of the application of sin taxes in Latin America, it could be helpful to discuss in more general terms the relevant factors that should be considered in the design and implementation of excise taxation applied to these products.

2.1 Externalities and internalities and optimal taxes

A first consideration is that these taxes do not have a prime objective of generating public resources but of changing behavior. In other words, they are corrective, Pigou-type levies (Pigou, 1920). The effect of these levies on consumption patterns and prices results from an equilibrium response where supply and demand factors interact.[1] The link between taxes and perceived price is also relevant in practice. For example, when the tax is not displayed on the shelf and is only added to the bill, the effects on consumption are lower or nonexistent (Colantuoni and Rojas, 2015).

As indicated above, the arguments for such government interventions are based on internalities and externalities. Internalities result from biases towards the present utility and misperceptions about the future costs of harmful consumption. Externalities can arise because of the effects of deteriorated health on the government budget (increased health care costs), among other effects. Where social costs exceed private costs, negative externalities exist, and where consumers undervalue private costs, negative internalities happen. The role of the excise is to tax these externalities and internalities and, thereby, raise prices so the market price reflects social costs plus the potentially undervalued private costs (van Oordt, 2021).

The theoretical literature has proposed to look at internalities as a problem originating from self-control problems (for example, hyperbolic discounting) that drive the over-consumption of unhealthy items (O'Donoghe and Rabin, 2006). Allcott and Rafkin (2021) build on this idea and propose a dynamic model with heterogeneous consumers of habit-forming goods that reduce health. Habit-forming goods such as tobacco or alcohol could be a strong force affecting consumption behavior. When this is the case, the literature has found an inelastic response to price changes (Miracolo et al., 2021).

Externalities in these models are usually included as a negative component in the government budget constraint due to, for example, government-sponsored health care or reduced social security payments due to early death. In general, this externality is imposed when consumption occurs (Allcott and Rafkin, 2021), but it may also be considered to take place in the future as health problems are revealed later in an individual's lifetime.

[1] Under the standard assumption of competitive markets and constant returns to scale, taxes would be fully passed through to consumers. While the evidence is limited, some empirical studies have found a high pass-through (see Kenkel, 2005, for an estimate for alcoholic beverages with a pass-through higher than one).

These models emphasize the importance of regulating the consumption of harmful products. Government intervention is based chiefly on taxes. Optimal taxes depend on the marginal uninternalized costs (both internalities and externalities) derived from consumption, on the response of demand to changes in prices or taxes, and on the possibility of substitution between goods. In this sense, the price elasticity of consumption of harmful goods is a crucial parameter. The cross-price elasticity with respect to other types of goods is also relevant as it determines substitution effects. These elasticities are a key ingredient in the design of taxes. Substitution between different harmful goods can make taxes ineffective. As an example, it has been found that SSB taxes have not reduced children's weight due to substitution in consumption towards other high-calorie drinks such as whole milk (Fletcher, Frisvold, and Tefft, 2010).[2]

The empirical literature has devoted considerable effort to estimating own-price and cross-price elasticities of unhealthy goods. It has also exploited tax variations to identify taxes' effects on consumption, public revenue, and health outcomes. The consensus is that there is an inverse relationship between tax levels and consumption, with different effects according to the type of good, the design of the tax, and the type of consumer.

For example, at the global level, various studies have estimated elasticities for alcohol sales. On average, elasticities are -.46 for beer, -.69 for wine, and -.80 for spirits (Wagenaar et al., 2009). More recent estimates using household survey data, for example, for the case of Chile, which we will review below, also found negative responses, but they are lower for spirits and wine than for beer. In addition, when considering heavy drinking, these elasticities are estimated at -0,28, a much lower value reflecting strong habit formation that is difficult to change.

As discussed below, sin taxes should be set as a function of the potential health risk they produce, and if they work well, they may generate smaller revenues because they significantly reduce the tax base upon which they are applied. This is a significant difference from Ramsey-type taxation (Ramsey, 1927), where the optimal tax increases the lower the response of the tax base. In addition, given the corrective nature of these taxes, it could be justified to partially earmark their revenue in public programs that collaborate with the tax objective, for example, on educational or informational campaigns explaining the harm produced by the excessive consumption of some of these products, especially among more vulnerable population groups (i.e., young, low-income household).[3]

2.2 Sin taxes in practice

Sin taxes are implemented through selective levies applied to the "sin goods." General consumption taxes such as VAT (or other broader sales taxes) cannot change the relative prices between these goods and the rest of the consumption basket, which is necessary to reduce the quantity demanded.

Excise taxes can be levied as an amount-specific tax, an ad-valorem proportional rate, or a combination of both. The amount-specific duty is applied as a certain sum of money per unit

[2] For these reasons, the literature has also focused on identifying whether harmful goods are substitutes or complements. An important example is the case of alcohol and tobacco (Cameron and Williams, 2001) or alcohol and cannabis (Chaloupka and Laixuthai, 1997; Cameron and Williams, 2001; Williams et al., 2004).

[3] In the case of people with self-control problems, it has been argued that taxes are not necessarily the best instrument to reduce consumption (Schmacker and Smed, 2020), so informational health campaigns to prevent heavy consumption could be an able instrument.

(volume of liquid/package of cigarettes) or may be based on the product's characteristics (e.g., sugar or alcohol content). In contrast, the ad-valorem is applied as a percentage of the product's value. Excise amount-specific duties have several advantages over selective ad-valorem rates when the objective is to reduce the consumption of specified products. For example, targeted amounts of specific taxes reduce incentives to switch to less expensive brands. In addition, ad-valorem excise taxes applied upstream in the value chain are more exposed to abusive transfer pricing, in which producers or distributors set artificially low prices at the point where the tax is applied (for example, at the producing stage) and then increase them throughout the distribution chain. That can be particularly problematic when the industry is vertically integrated (OPS, 2021).

One problematic aspect of amount-specific taxes is that they must be increased periodically; otherwise, they will be eroded by inflation, and their effectiveness will be reduced. One way to resolve this issue is to provide by law for their automatic adjustment for inflation. Finally, some consider ad-valorem selective taxes more equitable than specific taxes because the amount of tax collected is higher in the case of more expensive brands, which are more likely to be chosen by wealthier consumers. However, ad-valorem taxes widen the gap between the cheapest and the top brands, inducing consumers to opt for the cheaper ones and thereby undermining the potential benefits of the tax for health (OPS, 2021).

Specific and ad-valorem excise taxes can be implemented as a uniform tax structure with the application of a single tax rate or as a tiered structure where the tax rate varies according to some of the product's characteristics, for example, according to the content of substances (HPHCs in the case of tobacco, sugar and alcohol) that cause harm to health. The next section elaborates on this.

2.3 Tax implementation and risk

A third key issue related to health taxes or other government interventions oriented to correct externalities and internalities in consumption is that they should be concentrated on risk reduction. Thus, any excise tax should be set to increase the cost per unit of risk rather than for the volume or price of the good. For example, if the negative effect on health of consuming alcoholic drinks is related to alcohol intake, the risk-based excise tax should be set per unit of alcohol rather than per volume (van Oordt, 2021). Similarly, there is a substantial gain in taxing sugar content instead of volume (liter) of beverage in the SSB. This is because there could be additional substitution from high-sugar to low-sugar SSBs. The gains of this change in SSB tax (from volumetric to risk-based taxation) would depend on the variation in sugar content in SSB products, the price elasticity of demand, and the health effects of sugar consumption. Considering all of this, these gains can be significant; they could boost tax health benefits by 30% (Grummon et al., 2019). Risk- and weight-based taxation ensures that emerging products are adequately taxed, thereby preventing market distortions and encouraging consistency in tax treatment across all product categories. A unit-based system would create tax loopholes, encouraging the introduction of larger consumable units with a higher content of the harmful substance.

While these risk-based taxation criteria are evident within a set of goods, e.g., alcoholic drinks, they are less useful when comparing different sets of goods, e.g., alcoholic beverages vs. tobacco. The consumption of alcohol and HPHCs included in tobacco products generates very different health effects. Excise taxes should also reflect the relative harm of these goods.

Risk is one component of the optimal tax. As Allcott and Rafkin (2021) showed, the optimal tax should consider the uninternalized harms of each consumption, consumption's response to tax changes, and substitution for other types of goods. Thus, even concentrating on the health impact of consumption, the optimal tax may not be proportional to harm when there is a differential response in consumption or substitution with other healthy or unhealthy goods.

The issue of considering substitution with other products with different levels of risk is very relevant in the context of low-harm varieties that the industry in each sector has developed to sustain demand when facing higher taxes or health campaigns. For example, in the case of tobacco in the last decade, there has been a surge of Heated-Tobacco- Systems (HTS) that avoid combustion so that they are less harmful or E-cigarettes containing nicotine (ENDS) and/or non-nicotine chemical substances with different flavors (ENNDS). In the case of SSB, the industry long ago launched diet or low-calorie versions of these beverages; the same is valid for low-fat food or low alcoholic content of certain alcoholic drinks. A key issue with these products, some relatively new (i.e., HTS or E-cigarettes), is that there is no long-run hard scientific evidence to evaluate the health consequences of these supposedly low-risk substitutes (Gotts et al., 2019).

But even if the low harm evidence of some of these products is scientifically validated, there is the problematic issue that if taxes on these products are too low, so final prices are cheap, they can serve as a gateway for consumption initiation for people that have been out of the market because of their high-risk perception of the more traditional alternatives of these products and/or the high prices due to taxes (Chaloupka et al., 2015). This could be the case for younger individuals. If this happens, then the total consumption of these products (including their low-harm variants) will increase. Moreover, there is some evidence that consuming low-risk products, once the habit has been adopted, could lead to a shift to high-risk substitutes (WHO, 2021a).

A critical point regarding implementing a risk-based sin tax is that how the levy is defined is relevant to achieving this objective. As seen before, excise taxes can be amount-specific or selective ad-valorem levies (or a combination). The best way to set the tax according to health risk is to put the amount-specific tax by the relative risk or harm within a category of excisable goods. A risk-based tax cannot be ad-valorem since the relative risk is generally not linearly related to price, and in many markets, there are low-cost, high-harm excisable goods. Thus, for example, a risk-based tax on alcohol should raise the cost of beer by a much smaller amount than the price of spirits, reflecting the difference in risk associated with these products (van Oordt, 2021).[4]

One last aspect associated with the principle of setting sin taxes according to the level of risk is that their expected results may be weakened because, as we indicated above, actual and potential consumers fail to be aware of the consequences of consuming these products on their health. This can be due to the lack of information, misperceptions, habit formation, and lack of

[4] One example of successful risk-based alcohol taxation is the Minimum Unit Pricing (MUP) policy implemented in Scotland in 2018. This policy sets a minimum price per unit of alcohol (50 pence per unit), to reduce alcohol consumption and related harms. The price per unit is based on the alcohol content of the beverage, meaning that products with higher alcohol content are subject to a higher minimum price. Studies show that the MUP led to a 13.4 percent reduction in deaths attributable to alcohol consumption, and hospitalizations attributable to alcohol consumption decreased by 4.1 percent (Wyper et al., 2023).

self-control, among other causes. Thus, a complementary policy to make taxes more effective in reducing consumption is to develop health prevention campaigns and control measures to sensitize citizens about this problem. This strong complementarity could justify that the government earmarks part of the revenue of these taxes to finance these prevention and control activities. As we will see below, this has been the case in various countries, at least in the case of tobacco.[5]

2.4 Distributional consequences of sin taxes and illegal trade

A fourth issue that needs to be considered when designing sin taxes relates to the distributional consequences and the impact on specific population groups. Particular attention has been given to the effects on the young and the poor (Wright et al., 2017). Some evidence shows that families with low socioeconomic status have greater exposure to the consumption of these products, which implies that their expenditure share in total household outlays is larger compared to wealthy families. This has been observed for tobacco (Fuchs et al., 2019) and SSB (Alcott et al., 2019). Nevertheless, this negative consequence on the poor can be more than compensated if the establishment of these taxes improves the health condition of these families (implying less expenditure on health care and higher future labor market participation and income). For such an effect to arise, consumption of high-risk products must be more responsive to price changes for these families than more affluent households (Alcott et al., 2019). Evidence supports this assumption for LAC (Fuchs et al., 2019; Cruces et al., 2023). Another alternative is subsidizing healthy products while increasing taxes for unhealthy items to compensate for regressive taxation and improve the health impacts. This positive redistribution result can be reinforced if the resources collected from these taxes are returned to these families in the form of, for example, public programs aimed at improving their information and strengthening self-control out of the consumption of these high-risk products, as was indicated before (see footnote 5).

A final practical issue regarding implementing sin taxes is related to smuggling and illegal trade. This is particularly relevant for Latin America, where cross-border illicit trading to take advantage of different taxes or other regulations has been a usual practice. This is especially the case with cigarettes and alcohol. For example, in the case of Tobacco, some independent studies have estimated the share of the illicit market in Brazil at almost 29% of the total market (Iglesias et al., 2017); 16,5% for the Metropolitan Area of Santiago, Chile (Paraje, et al., 2020), and 8.8% for Mexico´s largest five cities (Saenz de Miera Juarez et al., 2021) and between 10% and 15% in Argentina (World Bank, 2019)[6,7]For alcoholic beverages, the estimated average for Latin America

[5] It has also been argued that earmarking is one way to improve the political economy of sin-goods taxation. In the case of tobacco, by linking the payment of taxes to benefits consumers will receive through the funding of complementary tobacco control programs, such as cessation support, or through increased funding for health programs on which they will rely disproportionately. Another way earmarking improves the political economy of tobacco taxation is by safeguarding against any perceived or potential negative ramifications of the tax itself. For example, the Philippines earmarks the bulk of the additional revenues from sin taxes for the health insurance premiums of the poor. In addition, a portion of the country's tobacco tax revenues is earmarked to provide for the economic well-being of tobacco growers and tobacco growing regions, with the general aim of promoting economically viable alternatives to tobacco farming and manufacturing as a safeguard against the potential for reduced domestic tobacco demand WHO (2021a).

[6] Industry-supported studies come up with larger values in most cases (WHO, 2021b)

[7] Not all illegal commercial transactions are implemented through cross-border illicit trading. In some countries, like Argentina, there is evidence of tax fraud by some local producers (World Bank, 2019).

is 15% of the total market, with the Dominican Republic (30%), Ecuador (29%), and Peru (26%) at the top of the list (Euromonitor, 2024).

If not properly controlled, this phenomenon of illicit trade could limit what countries can do to set these taxes at the socially optimal level. Some studies have found that recent tax reforms applied in some LAC countries aimed at increasing excise levies, for example, on tobacco, have been associated with a rise in the consumption of illegal products (Miracolo et al., 2021).[8] That is why reforms in sin taxes should include policies to reduce the prevalence of illicit products through preventative, detective, and corrective administrative tax and border controls.

We will analyze the consequences of many of the issues discussed above for establishing optimal sin taxes in the model we will develop in Section 4, but before this, it could be useful to examine the practical evidence of some of these factors in the context of applying these levies in Latin America.

3. The extent of application of sin taxes in Latin America

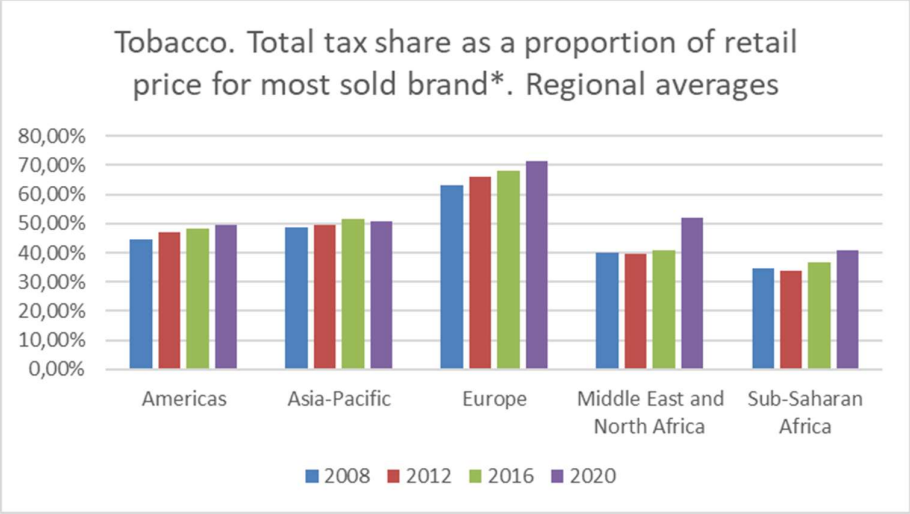
The application of sin taxes in Latin America will be described in terms of three product items: tobacco, alcohol, and sugar-sweetened beverages. In each case, we will examine the coverage of included goods, how taxes distinguish between fixed values per unit and /or ad-valorem proportional levies, and whether taxes are set considering health risk. We will also review the existing evidence regarding the impact of these taxes on consumption.

3.1 Tobacco taxation.

Figure 1 shows the rising trend in tobacco taxation on a global basis. Between 2008 and 2020, most regions of the world increased the share of taxes of the most sold brand within the final price. The only region that did not follow this trend was Asia. The leading region was Europe, where taxes went from 63% to 70% of the final price. In the Americas, the increase was lower, rising from 45% to 49%.

[8] Still, even in countries where illicit trade is relatively large, like Brazil, tax increases applied to sin products like tobacco have been shown to raise public revenues and decrease consumption (Iglesias, 2016).

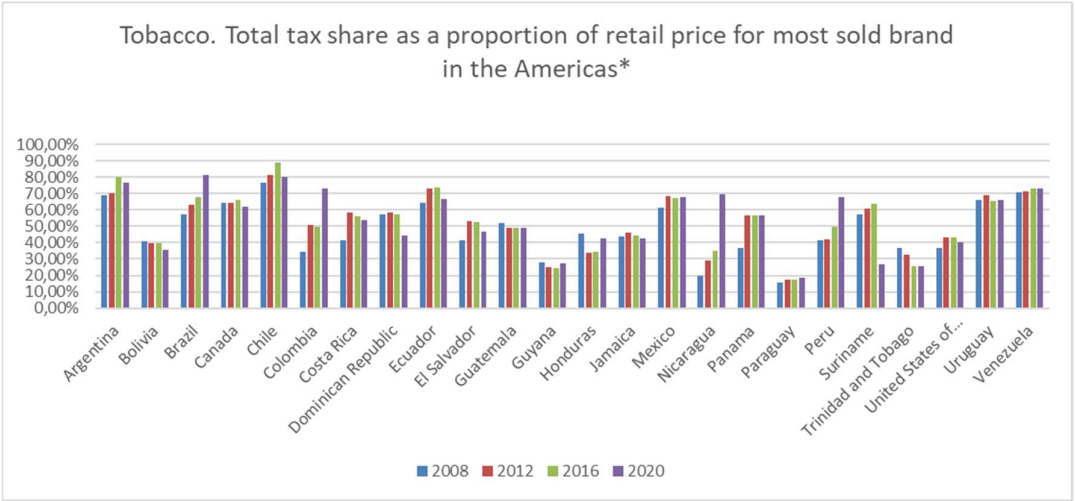
Figure 1



*Pack of 20 cigarettes. Source: WHO (2021a).

As illustrated in Figure 2, there is a great deal of heterogeneity within the region. For example, in 2020, Argentina, Brazil, Chile, Ecuador, Colombia, Mexico, and Venezuela have values close to or above 70%, the average level for Europe. Conversely, Paraguay and Trinidad and Tobago (T&T) have taxes representing 17% and 26% of the final price, respectively; in some cases, as in Bolivia and T&T, taxes have declined over time. Taxes are relatively low in the USA and Canada (43% and 63% in each case).

Figure 2

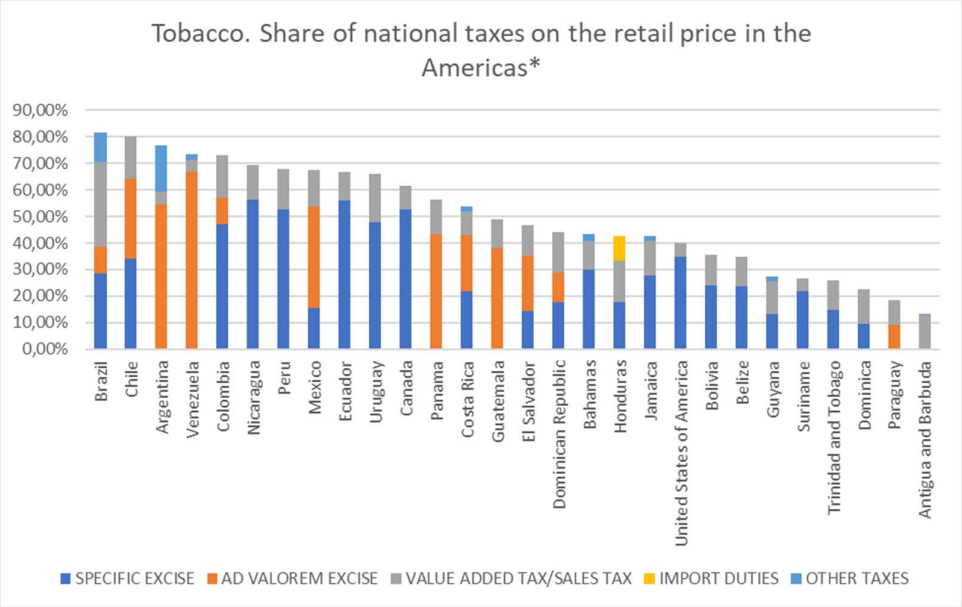


*Pack of 20 cigarettes. Source: WHO (2021a).

The type of taxes applied to cigarettes also varies widely across countries. The usual decomposition is between selective excise taxes and other general levies. Within the first class of taxes, we can distinguish between excise ad-valorem rates and a fixed monetary amount-specific component. Among other general taxes, the most important are the VAT tax and import duties. As shown in Figure 3, most countries use excise, amount-specific levies in a greater proportion, though there are exceptions. Among the high-taxing countries, Argentina applies mainly an ad-valorem tax, Chile combines both amount-specific and ad-valorem in similar proportions. At the same time, Mexico also uses selective ad-valorem levies to a greater extent. On the other hand,

the low-tax countries apply the general VAT or sales taxes, which, as mentioned before, does not have any role in reducing tobacco consumption relative to other goods (the same tax rate is applied to all products).

Figure 3



*Pack of 20 cigarettes. Source: WHO (2021a).

Table 1 provides more detailed information about regulations affecting the taxation of cigarettes in LAC for the year 2020. Beyond the type of excise tax and its share in retail prices (first two columns), other regulations are relevant. Namely, (i) if there are varying rates depending on the characteristics of the product (or prices), (ii) whether -within a mixed regime- there is greater reliance on amount-specific duties; (iii) if there are minimum thresholds for these taxes (both in ad-valorem or amount-specific regimes); (iv) if in the case of ad-valorem taxes the tax base is the retail price (net of VAT); (v) if the specific component is automatically adjusted by inflation; (vi) the level of price dispersion across brands which in part could be originated by the tax regime (when, for example, reduced amount-specific duties are charged); and, finally, (vii) whether countries earmark some of the tax collection to finance prevention and consumption control measures for these products.

Table 1. Tax regime details applied to cigarettes in the Americas

COUNTRY (2020)	Excise tax proportion of price	Type of excise tax applied.	Uniform excise tax applied Yes (Uniform), No (Tiered/varying rates)	Greater reliance on specific tax in mixed excise regime	Minimum specific tax applied in ad valorem or mixed excise regime	Retail price used as base of ad valorem component in ad valorem or mixed excise regime (or retail price exclusive of VAT)	Specific tax component automatically adjusted for inflation (or other)	Price dispersion: Share of cheapest brand price in premium brand price (the higher the % the smaller the gap)	Allocation of part of tax collection for prevention and health programs
Antigua and Barbuda	0.00	No excise	—	—	—	—	—	0.62	. . .
Argentina	0.55	Ad valorem excise	Yes	—	Yes	No	—	0.19	Yes
Bahamas	0.30	Specific excise	Yes	—	—	—	No	0.61	. . .
Barbados	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Belize	0.24	Specific excise	Yes	—	—	—	No	0.50	. . .
Bolivia	0.24	Specific excise	No	—	—	—	No	. . .	. . .
Brazil	0.39	Mixed excise	Yes	Yes	No	Yes	No	0.61	. . .
Canada	0.53	Specific excise	Yes	—	—	—	Yes	0.64	. . .
Chile	0.64	Mixed excise	Yes	Yes	No	Yes	Yes	0.29	. . .
Colombia	0.57	Mixed excise	Yes	Yes	No	Yes	Yes	0.31	Yes
Costa Rica	0.43	Mixed excise	Yes	Yes	Yes	No	Yes	0.68	Yes
Cuba	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Dominica	0.10	Specific excise	Yes	—	—	—	No	0.87	. . .
Dominican Republic	0.29	Mixed excise	Yes	Yes	No	No	Yes	0.76	. . .
Ecuador	0.56	Specific excise	Yes	—	—	—	Yes	0.89	. . .
El Salvador	0.35	Mixed excise	Yes	No	No	No	No	0.77	Yes
Grenada	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Guatemala	0.38	Ad valorem excise	Yes	—	No	No	—	0.66	Yes
Guyana	0.13	Specific excise	Yes	—	—	—	No	0.40	. . .
Haiti	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Honduras	0.18	Specific excise	Yes	—	—	—	Yes	0.45	. . .
Jamaica	0.28	Specific excise	Yes	—	—	—	No	0.62	. . .
Mexico	0.54	Mixed excise	Yes	No	No	No	Yes	0.83	. . .
Nicaragua	0.56	Specific excise	Yes	—	—	—	Yes	0.63	. . .
Panama	0.43	Ad valorem excise	Yes	—	Yes	No	—	. . .	Yes
Paraguay	0.09	Ad valorem excise	Yes	—	No	No	—	0.25	Yes
Peru	0.52	Specific excise	Yes	—	—	—	Yes	0.60	. . .
Saint Kitts and Nevis	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Saint Lucia	0.39	Specific excise	Yes	—	—	—	No	0.52	. . .
Saint Vincent	0.07	Specific excise	Yes	—	—	—	No	0.89	. . .
Suriname	0.22	Specific excise	Yes	—	—	—	No	0.85	. . .
Trinidad and Tobago	0.15	Specific excise	Yes	—	—	—	No	. . .	. . .
United States of America	0.35	Specific excise	Yes	—	—	—	No	. . .	Yes
Uruguay	0.48	Specific excise	Yes	—	—	—	No	0.94	. . .
Venezuela	0.67	Ad valorem excise	. . .	—	No	Yes	—	. . .	Yes

Sources: WHO (2021a); *www.tobaccofreekids.org

The evidence suggests that, as mentioned above, most countries use amount-specific or mixed regimens, and among the latter, there is a greater reliance on the amount-specific. In many cases, the tax base for the levies in ad-valorem selective duties is the retail price minus the general VAT. More interesting in various countries like Argentina, Chile, and Paraguay, there is a significant price dispersion, with cheaper brands having prices well below the top ones. This, of course, could imply a substitution of consumption towards these low-price products, reducing the impact of taxes on overall consumption. Finally, some countries have earmarked tax collection for health prevention and tobacco consumption control programs. For example, in the case of Costa Rica, all revenues from the specific excise tax are used to fund programs for the prevention and treatment of diseases related to tobacco use, cancer treatment, and harmful use of alcohol. The case of Panama is also interesting because, in addition to allocating resources for health programs, it also funds the Customs office to fight illicit trade in tobacco products.

Regarding the regulation and taxes applied to the new tobacco products, the first thing to note is that the market for these products is still beginning in the region. While at the global level (especially in Asia, North America, and Europe), the consumption of HTS, ENDS, and ENNDS has been increasing - though they still have a low share of the entire tobacco market (around 5% in 2020)- in Latin America the consumption of these products has been growing at a slower pace (market share of 0,58%). However, it should be said that ENDS and ENNDS had a much higher penetration among consumers compared to HTP (market share of 0,50 and 0,08, respectively).[9]

[9] See Perucic et al., 2022.

This is explained in part by strict regulations. For example, as shown in Table 2, HTP use is explicitly banned in Brazil, Mexico, and Panama. Regarding ENDS and ENNDS, Table 3 shows that Brazil, Mexico, Panama, Uruguay, and Venezuela banned both products, while Argentina explicitly does not allow the commercialization of ENDS.[10,11] Where they are allowed, countries impose excise taxes on those products. These are the cases of Colombia, Costa Rica, Ecuador, Paraguay, and Peru, countries that apply taxes on HTPs; Ecuador explicitly taxes ENDS, and Costa Rica charges taxes on both ENDS and ENNDS.

Regarding the type of taxes applied to these tobacco products (see Table 2), amount-specific excise taxes on HTPs are used in Peru (the base unit is the stick), and ad-valorem excise taxes on the final retail price are implemented by Costa Rica, Ecuador, and Paraguay. Colombia has a combination of amount-specific and ad-valorem excise taxes on HTPs, where the specific component tax base is the stick, as in Peru. In six countries (Argentina, Bolivia, Dominican Republic, El Salvador, Honduras, and Venezuela), even though their legislation has not yet explicitly included taxation on HTPs, the broad definition of taxation applying to tobacco products suggests that they could implement excise taxes as they do for the regular cigarettes (but not necessarily at the same rate). Ad-valorem excise taxes are applied on ENDS in Ecuador. Costa Rica applies ad-valorem excise taxes on ENDS and ENNDS products (see Table 3). The remaining three countries that regulate ENDS/ENNDS as tobacco products (Bolivia, Honduras, and Paraguay) could eventually implement excise taxes for these goods as they do for regular tobacco products.

[10] The new government in Argentina has just sent to Congress a very ambitious package of reforms that include many changes in the state regulations and taxes. Within those changes, there is a proposal to lift the ban that applies to the commercialization of electronic cigarettes (both ENDS and ENNDS) and to set a tax of 20% on the retail prices of these products. See https://aldiaargentina.microjuris.com/wp-content/uploads/2023/12/PROYECTO-PEN-Bases-y-Puntos-de-Partida-para-La-Libertad-de-los-Argentinos.pdf

[11] As indicated in the text, Mexico banned both HTP and ENDS, but judiciary orders have allowed the commercialization of both products. See https://www.jornada.com.mx/noticia/2023/12/06/politica/otorga-scjn-amparo-contra-prohibicion-de-cigarros-electronicos-1147.

Table 2. Tax policy on HTP tobacco products in LAC*

HTP	
Bans	type of taxes
Brazil *Mexico* *Panama*	Specific Excise base units: sticks *Peru* Ad-valorem Base: retail price *Costa Rica* *Ecuador* *Paraguay* Mixed taxes Base for excice: sticks Base for Ad-valorem: retail price *Colombia*

*As of 2020. Source: own elaboration based on Perucic et al (2022) and WHO (2021a)

Table 3. Tax policy on ENDS and ENNDS products in LAC*

ENDS and ENNDS		
Bans	Taxing only ENDS products	Taxing ENDS and ENNDS
Brazil *Mexico* *Panama* *Uruguay* *Venezuela* *Argentina***	Ad valorem Base: retail price *Ecuador*	Ad valorem Base: retail prices *Costa Rica*

*As of 2020.**Banned ENDS but not ENNDS. Source: own elaboration based on Perucic et al. (2022).

The risk assessment of tobacco taxes faces the problem of the lack of updated data on prices, taxes, and tobacco equivalent content for each product variety. In principle, from the description of the data presented in Table 2, we know that, for example, taxes of HTP in Peru and Colombia are based on sticks and not on the concentration of tobacco/nicotine as is the case in developed economies like Canada, Denmark, Sweden or the United Kingdom. The relationship between taxes and tobacco content is even weaker in the other countries that applied ad-valorem taxes (Costa Rica, Ecuador, Paraguay, and Colombia). Likewise, in the case of ENDS and ENNDS, taxes should be related to the amount of liquid content of the device (per ml). They should be higher if the liquid has a more significant nicotine concentration, as in Denmark, Sweden, and Italy, among other countries. Nevertheless, as Table 3 describes, the ad-valorem tax in Ecuador and Costa Rica is applied to the retail price with no distinction on liquid volume or nicotine concentration.

A final issue regarding risk analysis is whether taxes on new tobacco products, which, in principle, are less harmful to health, are lower than traditional cigarettes. The information available so far

is scant, making a general assessment difficult. In Colombia and Paraguay, ad-valorem taxes on HTS are the same as those for regular cigarettes. At the global level, the evidence shows that the participation of taxes within the final product price is much lower for all the new tobacco products; moreover, for ENDS, the final price is much cheaper than cigarettes (Perucic et al., 2022). Though from a risk analysis that considers only the health consequences on current smokers, this pricing is the right approach to promote substitution away from higher risk products, it could nevertheless incentivize the initiation from non-smokers, especially from youth. Thus, this extensive margin response should also be considered when setting taxes on these new tobacco varieties (Chaloupka et al., 2015).

What is the evidence about the effect of tobacco taxes on consumption in LAC? There have already been various papers that evaluate specific reforms in tobacco taxes in the region and whether this has implied gains in terms of health outcomes. In some cases, taxing a harmful good could be counterproductive if the substitution is for an even more harmful product. For example, introducing an excise tax in Brazil in 2012 implied a reduction in smoking prevalence but increased illicit consumption that tended to amplify over time (Iglesias et al., 2017; Szklo et al., 2018). Another example of substitution is the case of Uruguay, where it was reported that an increase in the price of cigarettes would increase about 5% in the consumption of roll-your-own cigarettes (Miracolo et al., 2021).

In the case of Argentina, González Rozada (2020) analyzed the reform in tobacco taxes that took place in May 2016, which implied an increase in the selective ad-valorem rate of internal tobacco taxes from 60% to 75%. The reform also changed the minimum amount-specific tax (to avoid underreporting retail prices). It went from a monetary equivalent of 75% of the tax applied to the most sold brand to a fixed amount adjusted by the CPI every three months. As a consequence of these changes, the tax share on retail prices increased and reached almost 80%, and so did the market retail rice, which increased in real terms by 22% (World Bank, 2019). The paper estimates the long-run demand price elasticity after the reform, which approached a value of -0,44. The simulation results show that the rise in cigarette excise taxes in 2016 implied a reduction in consumption per capita of cigarettes from 68 to around 50 packs per year, a decline of about 26%.[12] Furthermore, the paper shows that public revenues rose after the tax increase and that, given the estimated elasticity, there is further room for the government to raise taxes and income.[13]

Distributional issues associated with tobacco taxation have been studied for Argentina in the paper by Cruces et al., 2023. The authors conclude that tobacco tax increases are not regressive. They show estimates suggesting that those individuals with a higher price elasticity of cigarette demand are the less affluent ones in Argentina. Thus, they will decrease consumption more following price increases and bear relatively less tax burden. This trend toward more progressive tobacco taxes is heightened when considering the long-run effects of a tax increase. Higher taxes discourage consumption and save on future medical expenses associated with smoking-related diseases. They also increase lifetime earnings due to a lower risk of premature death. When these factors are considered, increasing tobacco taxes is a progressive policy.

[12] The application of the new tax structure was later affected by judicial appeals that allowed some local producers to avoid paying the minimum amount—specific tax. This generated greater disparities in tobacco cigarette prices (substantially lower prices for low-quality brands), which in turn implied that consumption did not fall any further (World Bank, 2019).

[13] Palacios et al., 2023 find similar results even after considering illicit tobacco trade.

3.2 Alcohol.

Most countries in the region apply excise taxes on alcohol products, including beer, wine, and spirits. The only two exceptions are Argentina and Uruguay, which do not tax wines (in addition to Cuba, Antigua, and Barbados, which do not tax alcoholic beverages). The type of taxes charged for alcoholic beverages in the region is described in Table 4. As usual, we group them into two main categories: ad-valorem rate applied to retail or producer prices and amount-specific excise taxes. This last category varies depending on the tax bases used: it could be applied to beverage volume or, alternatively, charged depending on alcohol content. The implication of these different forms of taxation is clear. In the last case, the tax applied raises the beverage price as the alcohol content increases, but this may not be the case with the other two forms of taxation. Table 4 shows that most countries in the region do not apply taxes based on alcohol content when looking at all types of beverages. However, when considering the combination of ad-valorem and specific taxes, in the case of spirits, twelve countries appear to be setting taxes according to that criterion.

Because of this structure of taxes, it is not always the case that the share of taxes on the final retail price increases with the alcohol content. Table 5 shows this information for the most sold brands of beers (330ml and 750ml), wine, and spirits. In many cases, taxes vary very little across beverages despite their apparent different content of alcohol (see, for example, El Salvador and Peru). In the case of Paraguay, besides having similar tax levies across beverage categories, their level is among the lowest. In some other countries, like Bolivia, taxes decline with alcohol content. In any case, the overall picture suggests that even when taxes rise across beverage types (from beer to spirits), they don't rise in proportion to the alcohol content (spirits usually triple the alcohol concentration of beer and double that of wine). This evidence suggests that alcoholic beverage excise taxation in Latin America is inadequate when considering risk issues.

A final point regarding alcohol excise taxes is whether revenue collection is in part earmarked for health practice and prevention programs. Data from the WHO (The Global Health Observatory[14]) show that this is the case for nine countries in the region. For example, in Colombia, a sixth part of the tax on beer consumption is destined to finance health, while in the case of wine and spirits, 37% of the tax revenues go to the same item.[15]

[14] https://www.who.int/data/gho/data/indicators/

[15] An extra-regional example is the case of Iceland, where 1% of alcohol taxes are dedicated to public health funds for prevention and health promotion works.

Table 4. Excise tax type for beer, wine and spirits in the Region of the Americas in 2020

Country	Beer	Wine	Spirits
Antigua and Barbuda			
Argentina	Ad valorem		Ad valorem
Bahamas	Ad valorem & Specific/Volume	Ad valorem	Specific/Alcohol content
Barbados	Specific/Volume	Specific/Volume	Specific/Volume
Belize	Specific/Volume	Specific/Volume	Specific/Volume
Bolivia	Ad valorem & Specific/Volume	Specific/Volume	Ad valorem & Specific/Volume
Brazil	Ad valorem	Ad valorem	Ad valorem
Canada	Specific/Volume	Specific/Volume	Specific/Alcohol content
Chile	Ad valorem	Ad valorern	Ad valorem
Colombia	Ad valorem	Specific/Volume/ Alcohol content	Specific/Volume/ Alcohol content
Costa Rica	Ad valorem & Specific/Alcohol content	Ad valorem & Specific/Alcohol content	Ad valorem & Specific/Alcohol content
Cuba			
Dominica	Specific/Volume	Specific/Volume	Specific/Volume
Dominican Republic	Ad valorem & Specific/Alcohol content	Ad valorem & Specific/Alcohol content	Ad valorem & Specific/Alcohol content
Ecuador	Ad valorem & Specific/Alcohol content	Ad valorem & Specific/Alcohol content	Ad valorem & Specific/Alcohol content
El Salvador	Ad valorem & Specific/Alcohol content	Ad valorem & Specific/Alcohol content	Ad valorem & Specific/Alcohol content
Grenada	Specific/Alcohol content	Specific/Volume	Specific/Alcohol content
Guatemala	Ad valorem	Ad valorem	Ad valorem
Guyana	Specific/Volume	Specific/Volume	Specific/Volume
Haiti	Ad valorem	Ad valorem	Ad valorem
Honduras	Specific/Volume	Ad valorem & Specific/Volume	Ad valorem & Specific/Volume
Jamaica	Specific/Alcohol content	Specific/Alcohol content	Specific/Alcohol content
Mexico	Ad valorem	Ad valorem	Ad valorem
Nicaragua	Ad valorem & Specific/Alcohol content	Ad valorem & Specific/Alcohol content	Ad valorem & Specific/Alcohol content
Panama	Specific/Alcohol content	Specific/Volume	Specific/Alcohol content
Paraguay	Ad valorem	Ad valorem	Ad valorem
Peru	Specific/Volume	Ad valorem OR Specific/Volume	Ad valorem OR Specific/Volume
Saint Kitts and Nevis	Ad valorem	Ad valorem	Ad valorerm
Saint Lucia	Specific/Volume	Specific/Volume	Specific/Volume
Saint Vincent and the Grenadine	Specific/Volume	Specific/Volume	Specific/Volume
Suriname	Specific/Volume	Specific/Volume	Specific/Volume
Trinidad and Tobago	Specific/Volume	Specific/Volume	Specific/Volume
United States of America	Specific/Volume	Specific/Volume	Specific/Alcohol content
Uruguay	Specific/Volume		Specific/Volume
Venezuela	Ad valorem	Ad valorem	Ad valorem

Source: own elaboration based on Roche et al. (2023)

Table 5. Share of taxes for the most sold brands of different alcoholic beverages in the Americas, 2020

Country/Beverage	Beer 330ml	Beer 750ml	Wine 750ml	Spirits 750ml
Antigua and Barbuda	0.0%	0.0%	0.0%	0.0%
Argentina	9.8%	9.8%	0.0%	18.6%
Bahamas	19.6%	19.1%	21.3%	15.9%
Belize	18.4%		11.0%	57.1%
Bolivia	15.1%	17.5%	10.1%	7.4%
Brazil (São Paulo State)	2.5%	2.5%	5.8%	15.1%
Canada (Ontario Province)	5.8%	5.3%	2.9%	12.2%
Chile	17.2%	17.2%	17.2%	26.5%
Colombia	16.3%	17.1%	17.1%	35.2%
Costa Rica	12.8%	12.8%		22.7%
Dominican Republic	18.4%	25.0%	20.6%	36.2%
Ecuador	14.5%	0.6%	24.0%	34.4%
El Salvador	19.6%	16.1%	19.3%	19.1%
Grenada	2.1%	2.1%	3.7%	5.0%
Guatemala	5.1%	5.1%		
Guyana	7.4%	18.6%	5.6%	17.4%
Honduras	12.1%	12.1%	3.0%	25.1%
Jamaica	11.0%			22.3%
Mexico	18.1%	18.1%		29.9%
Nicaragua	20.5%	19.6%	23.3%	21.7%
Panama	6.3%	7.3%	7.7%	13.8%
Paraguay	6.3%	6.3%	4.4%	7.6%
Peru	20.5%	24.8%	16.9%	21.2%
St. Kitts and Nevis	4.9%	4.6%	8.2%	24.4%
St. Lucia	2.9%	3.0%	17.7%	23.1%
St. Vincent and the Grenadines	5.7%	6.8%	14.6%	17.1%
Suriname	14.2%	19.7%	14.6%	44.6%
Trinidad and Tobago	24.2%	38.6%		
Uruguay	15.6%	14.9%	0.0%	21.1%
Venezuela	11.2%		22.3%	28.7%

Source: Roche et al. (2023)

Not many studies consider the impact of taxes on alcohol consumption in Latin America. One of the few papers that performs this analysis (see Araya and Paraje, 2018) estimates demand price elasticity (own-price, cross-price, expenditure, and quality) for three groups of alcoholic beverages in Chile: spirits, wines, and beers. The study uses data from the VII Encuesta de Presupuestos Familiares (Family Budget Survey) 2011–2012 conducted by the National Institute of Statistics. The estimated elasticities were more inelastic for spirits (-0.14, $P<0.01$), followed by wines (-0.77, $P<0.01$) and beers (-0.93, $P<0.01$). These results differ somewhat from the international evidence reported in previous studies in which spirit demand was more elastic (higher response) than beer and wine.

In addition, in this study done for Chile, spirits reported less sensitivity to changes in the total budget, while wines reported the most sensitivity to changes in the total budget (expenditure elasticity). Wines also reported the most sensitivity related to quality for changes in the total budget (0,20, meaning that a 10% increase in a household's total expenditure increases the "quality" of purchased wines by 2%). Although own-price elasticities for spirits are more

inelastic, their quality elasticity is more positive and greater. This could be explained by the more significant price dispersion of spirits and the fact that spirits (and wine) are consumed more than beers in Chile. This may be because consumers can switch to cheaper, Chilean-produced spirits such as pisco and wines when prices rise. These relatively broad quality elasticities point to the need to change the alcohol tax structure from the current ad-valorem tax to a specific tax that could reduce price dispersion and curb total consumption.

In another study (see Chávez, 2016), the price elasticity of demand for alcohol is estimated for Ecuador (the paper also does it for cigarettes) using cross-sectional data from the 2011-2012 National Survey of Urban and Rural Household Income and Expenditures (ENIGHUR, Spanish acronym). As expected, the price elasticity of demand for alcohol is negative and relatively inelastic (-0,44). Furthermore, contrary to what was found in other studies, the low-expenditure group, meaning poor households, would not be as responsive to price changes. The author concludes that a policy of tax increases applied to cigarettes and alcohol could positively affect public health by reducing the consumption of both goods. However, given the difference in price elasticity and a relatively high share of expenditure by low-income families on these goods (cigarettes and alcohol), these taxes have the potential to be regressive. Thus, these measures would not be sufficient to bridge gaps in prevalence measures and health outcomes between population groups. Informational campaigns are also necessary to inform low-income families about the health costs associated with the excessive consumption of these products.

3.3 Sugar-sweetened beverages (SSB).

In most countries of the region, the excise tax on SSB products covers soda, carbonate, and energy beverages. To a lesser extent, it also applies to fruit-based drinks and powders, concentrates, and syrups. Much less is the case of excise taxes on sweetened milk and bottled water.

As shown in Table 6, the type of excise taxes applied to SSB in the region can be classified into ad-valorem, amount specific, and a third category that combines both types of taxes. These taxes could be uniform as the same rate is applied to all products, or there could be varying rates across products; this variation could be related to sugar content. In the case of ad-valorem taxes, it is relevant where the tax base is defined in terms of the retail or the producer price or other definition of value (i.e., net of VAT). Finally, regarding amount-specific excise taxes, whether this tax is based on volume and if it is adjusted for inflation is relevant. All this information for a sample of Latin American countries is shown in Table 6. As we see, most countries use either ad-valorem levies or amount-specific taxes. We see only a combination of both instruments in a couple of cases, Dominica and Ecuador. Still, some conspicuous cases exist where no excise tax exists, like Colombia, the Dominican Republic, and Trinidad and Tobago.

Table 6. Tax types applied to sweetened sugar beverages (SSB)

Country	Type of excise tax applied	Uniform excise tax applied Yes (uniform) No (tiered/varying rates)	excise tax based on sugar content	Retail price used as base of ad valorem component for locally produced beverages in ad valorem or mixed or combined excise regime (or retail price exclusive of VAT and/or excise)	Amount-specific tax component automatically adjusted for inflation (or other economic indicator) on a periodic basis
Argentina	Ad valorem	No	No	Retail price excluding VAT	
Barbados	Ad valorem	Yes	No	Producer price	
Belize	Amount-specific	Yes	No		No
Bolivia	Amount-specific	No	No		Yes
Brazil	Ad valorem	Yes	No	Producer price	
Chile	Ad valorem	No	Yes	Retail price excluding VAT	
Colombia	No excise				
Costa Rica	Amount-specific	No	No		Yes
Dominica	Combined (volume based for amount specific)	No	No	Producer price	No
Republica Dominicana	No excise				
Ecuador	Combined	No	Yes	Retail price excluding VAT and excise	Yes
El Salvador	Ad valorem (mixed on energy drinks)	No	No	Retail price excluding VAT and excise	No
Guatemala	Amount-specific	No	No		No
Honduras	Amount-specific	Yes	No		Yes
Mexico	Amount-specific (mixed on energy drinks)	Yes	No	Producer price	Yes
Nicaragua	Ad valorem	No	No	Retail price	
Panama	Ad valorem	Yes	No	Retail price	
Paraguay	Ad valorem	Yes	No	Producer price	
Peru	Ad valorem	No	Yes	Retail price excluding VAT and excise	
Saint Kitts and Nevis	Ad valorem	Yes	No	Retail price excluding VAT	
Saint Vincent	Ad valorem	Yes	No	Retail price excluding VAT	
Suriname	Amount-specific	Yes	No		No
Trinidad & Tobago	No excise				
Uruguay	Amount-specific (volume based)	No	No	Fixed tax base "precios fictos"	No
Venezuela	No excise				

Source: OPS (2022)

Around half of the countries applied different rates across products, but as we saw in Table 6, this is not induced by the objective of making the tax vary by sugar content. Only Peru, Ecuador, and Chile have rates that obey this criterion. In the case of Ecuador, there is an amount-specific, volume-based tax that depends on sugar content above a certain threshold (below this limit, a common ad-valorem tax is applied).[16] In the case of Peru and Chile, increasing ad-valorem levies are charged depending on sugar concentration for different thresholds.[17] Most ad-valorem taxes are applied on retail prices excluding VAT, and, in many cases, amount-specific excise taxes are not automatically adjusted for inflation.

Table 7 shows the participation of excise taxes in the final price of various SSBs. The first observation is that compared to Tobacco and Alcohol, the share of taxes on these products is much lower and covers a lower quantity of goods. This is partly explained by the fact that only recently have some countries established these levies. On the other hand, it is unsurprising that among the four countries in LAC that have the highest share of taxes – being amount-specific or ad-valorem- within the final retailing prices, three of them, Ecuador (12,7 for a 335ml carbonated SSB), Chile (15,1%) and Peru (16,9), have levies that are based on the sugar content of the beverages. In the case of Belize, which also has a high share of taxes (18,2% for an SSB carbonate

[16] Ecuador uses a tax structure with a specific selective tax of 18 cents or $0.18 per 100 g of sugar on beverages with >2.5 g of sugar/100 ml and a lower level for those with <2.5 g of sugar/100 ml, to which an ad-valorem selective tax of 10% is applied (OPS, 2021).

[17] Chile in 2014 created a graduated ad-valorem selective tax increasing its tax rate on sugary beverages from 13% to 18% for those with high sugar content (i.e., >6.25 g of sugar/100 ml) and reducing the rate from 13% to 10% in those with low or no sugar content (that is, those with <6.25 g of sugar/100 ml, including all drinks with unsweetened sugar). In Peru there is a similar tax structure, but with three different tax rates of the selective ad-valorem tax (25%, 17% and 12%) defined according to the sugar concentration thresholds (respectively: >6 g of sugar/100 ml, 0 .5 g–6 g and <0.5 g sugar/100 ml) (OPS, 2021).

drink, 335ml), is somewhat remarkable that it also has a high tax on bottled water (19,2%), thus impairing the possibility of shifting from SSB sugar intensive drinks toward a healthy substitute. Finally, Mexico is an interesting case where an amount-specific tax of one peso per liter was adopted on SSB beverages (see below), but given that it was not established taking into account the sugar content, the share of taxes within the final retailing price is much lower than the cases just mentioned of Ecuador, Chile, and Peru.

We can summarize the above discussion by concluding that, as with alcoholic beverages, SSB taxes in Latin America, with very few exceptions, do not consider risk as a critical factor when setting tax rates.

Table 7. Share of taxes for an internationally comparable brand of sugar-sweetened carbonated drinks and other beverages

Country/Beverage	Sugar-sweetened carbonated drink small (355 ml)	Sugar-sweetened carbonated drink large (1000 ml)	Most sold brand of fruit drink 1000 ml	Energy drink 225ml	Sugar-sweetened most sold milk drink 1000 ml	Bottled water 500 ml
Barbados	6.5%	6.5%	6.5%	0.8%	6.5%	0.0%
Belize	18.2%	16.5%	0.0%	4.3%	0.0%	19.2%
Brazil*	2.3%	2.4%	0.0%	2.3%	0.0%	0.0%
Chile	15.1%	15.1%	15.1%	7.0%	0.0%	0.0%
Colombia	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dominica	4.0%	0.0%	0.0%	0.7%	0.0%	0.0%
Republica Dominicana	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ecuador	12.7%	22.4%	5.9%	8.1%	0.0%	0.0%
El Salvador	8.0%	8.0%	4.2%	21.7%	0.0%	0.0%
Guatemala	1.5%	1.8%	1.4%	0.9%	0.0%	1.8%
Honduras	2.6%	4.5%	3.6%	0.6%	0.0%	0.0%
Mexico	5.3%	6.5%	6.5%	2.8%	0.0%	0.0%
Panama	5.0%	5.0%	0.0%	1.7%	5.0%	0.0%
Paraguay	3.6%	3.6%	3.6%	1.1%	0.0%	0.0%
Peru	16.9%	16.9%	16.9%	16.9%	16.9%	0.0%
Saint Kitts and Nevis	1.3%	2.0%	0.0%	2.2%	0.0%	0.0%
Suriname	4.0%	7.1%	4.3%	2.5%	0.0%	9.2%
Trinidad & Tobago	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Uruguay	6.2%	9.8%	3.4%	1.8%	0.0%	2.0%
Venezuela	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Source: OPS (2022)

Some papers have already estimated the impact of these taxes on consumption for some countries in the region. For example, Mexico in 2014 adopted a significant excise tax on SSBs: one peso per liter. This caused an SSB price increase of about 11%. The effect was a reduction in consumption of about 6% on the taxed goods with higher reductions (-9%) in low-income households and an increase in bottled water purchases (Carriedo et al., 2015; Colchero et al, 2016; Colchero et al 2017).[18] Similarly, in 2014, Chile (see footnote 17) increased tax rates on SSB products with high sugar levels from 13% to 18% and decreased tax rates for beverages with reduced sugar content. The impact on consumption was relatively significant, lowering 3.4% of the former's SSB consumption volume and increasing 11% of the latter (Caro et al., 2018; Nakamura et al., 2018).

[18] Also, a similar response was found after the implementation of an 8% ad-valorem tax on non-essential and energy foods in Mexico. The reduction was about 5%, while for low-income households the effect was even stronger (-10%). The effects seem to increase after two years of the introduction of the tax (Taillie et al., 2017).

4. A simple model for understanding the main determinants of "sin products" demand

In what follows, we will lay out the basic structure of a simple model intended to allow us to capture some of the features mentioned in the previous sections while, at the same time, enabling us to derive some implications for tax policy towards sin products.

Our basic setup intends to incorporate a number of differentiated sin products that, in addition, inflict different levels of damage on consumer health. This damage may not be perceived adequately by the consumer -it could be underestimated. Furthermore, in the next section, we will include an extra cost that society as a whole bears if health levels are lower. We will then have an *internality* generated by consumer misperception, and an *externality* due to additional health costs. We describe below the model and, in the next section, we derive some of its implications for tax policy.

We use a discrete-time, two-period framework.[19] There is a representative consumer who, in each period, derives utility from her consumption of a composite commodity *c*, which will be the *numeraire*, as well as from her consumption of a vector of sin products $(q_1,\dots,q_N)$. Additionally, utility depends on a composite health variable *H*. We take the following form for utility in any given period *t* (*t=0,1*)

$$c_t + V(q_{1t},q_{2t},\dots,q_{Nt}) + H_t,$$

where H_0 is given and

$$H_1 = \mu H_0 - (1-\Theta)\, F(q_{10},q_{20},\dots,q_{N0}).$$

Then, health deteriorates with the passage of time ($\mu<1$) and also with the consumption of sin products. The impact of sin-product consumption on health is given by $F(q_{10},q_{20},\dots,q_{N0})$: period-1 health falls with period-0 sin-product consumption. However, that impact may be misperceived, as we mentioned, by the consumer. The perceived impact is $(1-\Theta)$ times the real impact, where $0\leq\Theta\leq1$. Higher values of Θ reflect a larger behavioral bias in consumer choice.

Below, we take the case where *N=2*, but all of our results below hold for any *N*. We also select two specific functional forms so as to have a simple, tractable model. First, we have

$$V(q_{1t},q_{2t}) = v.(q_{1t}+q_{2t}) - \frac{1}{1+m}\left[q_{1t}^2 + q_{2t}^2 + \frac{m}{2}(q_{1t}+q_{2t})^2\right],$$

where $v>0$, $m\geq0$. This is a standard function to model differentiated goods demand with quasilinear consumer utility.[20] It has the advantage of yielding linear demands. Parameter *m* reflects how close substitutability is between both sin goods. If *m=0*, goods are independent, and if $m\to\infty$, goods become perfect substitutes.

Second, we assume that the impact of sin-goods consumption on consumer health is linear, and not necessarily symmetric. i.e.,

$$F(q_{10},q_{20}) = \alpha_1 q_{10} + \alpha_2 q_{20}.$$

[19] The basic structure of the model is a simplification of that in Anauati et al. (2015).
[20] It was first proposed in Shubik and Levitan (1980).

Then, we allow for the damaging effect of consumption on consumer health to be heterogeneous. In general, we may have any number of goods and effects on health, and still keep the qualitative results described below.

The basic choice that our representative consumer will then face is,

$$\max_{q_{10},q_{20},q_{11},q_{21}} c_0 + V(q_{10}, q_{20}) + H_0 + \beta[c_1 + V(q_{11}, q_{21}) + H_1]$$

subject to

$$c_0 \leq Y_0 - p_1 q_{10} - p_2 q_{20}$$
$$c_1 \leq Y_1 - p_1 q_{11} - p_2 q_{21}$$
$$H_1 = \mu H_0 - (1-\theta)(\alpha_1 q_{10} + \alpha_2 q_{20})$$

where Y_t is the consumer's exogenous time-t income, *t=0,1*, and β is the discount factor. We simplify by assuming that the consumer cannot transfer wealth across periods. Given her quasilinear utility, though, her consumption of sin goods should not be affected by such transfers. In addition, prices are taken as given by the consumer. As we will mention below, we are assuming that they are exogenous throughout our excise -as would happen if sin goods were provided competitively with a constant-return-to-scale technology. Furthermore, we also assume that the consumer's exogenous wealth in each period is large enough so that corner solutions for sin products never obtain.

Straightforward computation yields the following inverse demand functions for the representative consumer:

$$p_i = v - \frac{1}{1+m}\left[2q_{i0} + m\left(q_{i0} + q_{j0}\right)\right] - \beta(1-\theta)\alpha_i$$
$$p_i = v - \frac{1}{1+m}\left[2q_{i1} + m\left(q_{i1} + q_{j1}\right)\right]$$

which, in turn, yield demands

$$q_{i0}(p_i, p_j, \alpha_i, \alpha_j) = \frac{1}{2}\left[v - (1+m)p_i + \frac{m}{2}\left(p_i + p_j\right) - \beta(1-\theta)\left((1+m)\alpha_i - \frac{m}{2}\left(\alpha_i + \alpha_j\right)\right)\right]$$
$$q_{i1}(p_i, p_j) = \frac{1}{2}\left[v - (1+m)p_i + \frac{m}{2}\left(p_i + p_j\right)\right]$$

i=1,2, i≠j.

Note that, at *t=0*, the consumer takes into account the negative effect that consumption of any of the two sin goods will have on her period-1 health, although she does so in a partial way as long as Θ>0. A larger value of Θ implies a stronger behavioral bias for the consumer, i.e. a larger underestimation of sin-product consumption on health. Correspondingly, the agent consumes more in the first period when Θ grows. Finally, if one of the sin goods becomes more damaging, naturally, its own demand falls, but demand for the other sin good grows.[21]

5. Social welfare maximization and implications for optimal taxation

We move on now to examine sin-good consumption from a social welfare perspective. We first set up the social planner's problem and then identify the tax policy that solves it.

[21] As long as we have a representative agent, both sin products will be demanded by the consumer. Allowing for consumer heterogeneity may lead to cases where some consumers do not purchase both sin goods.

Clearly, the social planner will maximize the representative consumer's welfare. However, his objectives will differ from those of the consumer in two dimensions. First, the planner will aim to correct the internality that follows from the consumer's misperception of how the consumption of sin products negatively affects her health. In other words, the planner will consider such impact as it is, without misperception. Then, the relevant health level for the planner in period t will be H_t^o, where

$$H_0^o = H_0,$$
$$H_1^o = \mu H_0^o - (\alpha_1 q_{10} + \alpha_2 q_{20}).$$

Second, we incorporate the possibility that the consumer's lower health generates an *externality* by imposing an additional health-care cost on society. Specifically, that cost will be given, in period *t*, by

$$k(\overline{H} - H_t^o),$$

where *k>0* and $\overline{H}$ is a constant. Once again, we assume linearity to have a simpler framework.

Notice that, in our setting, first-period sin-good consumption generates a social cost through its impact on second-period health costs. That is the channel where the externality appears. Therefore, to further simplify the analysis, we will assume from now on that $H_0 = H_0^o = \overline{H}$ and μ=1, so that all health costs that remain in our model are those associated with sin-good consumption. This allows us to have a closer focus on sin goods, and does not affect our results below.

We set up now the social planner's problem. He chooses tax levels which we will describe below. Any revenue that exceeds health-care costs will return to the representative consumer as a lump-sum subsidy. We will start by assuming that, if sin-tax revenue, net of health costs, is negative, the planner will cover the deficit resorting to a lump-sum tax. At the end of this section, we will examine what may happen if the planner cannot cover the deficit with lump-sum taxes.

The specific form the problem takes depends on how many goods the planner can tax and on what information those taxes can be conditioned to. We examine a few different cases in what follows, starting with a benchmark that will allow us to better understand optimal tax policy.

5.1 Benchmark: period-dependent taxes on both sin products

Suppose first that the planner can choose specific taxes τ_{it}, *i=1,2, t=0,1.* In essence, this implies taxing both sin goods in a way that depends on whether the consumer is "young" (and her consumption has implications for her future health) or she is "old" (and there are no such implications). Clearly, this is an unrealistic case, which we anyway study so as to have a benchmark for the following cases.

The consumer will have to pay $p_{it}+ \tau_{it}$ to purchase a unit of sin product *i* in period *t*. Again, we assume prices are given, perhaps because they equal production costs under a competitive market structure.

The planner's problem will now be

$$\max_{\tau_{10},\tau_{20},\tau_{11},\tau_{21}} c_0 + V(q_{10}, q_{20}) + H_0^o + \beta[c_1 + V(q_{11}, q_{21}) + H_1^o]$$

subject to

$$c_0 \leq Y_0 - p_1 q_{10} - p_2 q_{20}$$
$$c_1 \leq Y_1 - p_1 q_{11} - p_2 q_{21} - k(\bar{H} - H_1^o)$$
$$H_1^o = H_0^o - (\alpha_1 q_{10} + \alpha_2 q_{20})$$
$$q_{i0} = q_{i0}(p_i + \tau_{i0}, p_j + \tau_{j0}, \alpha_i, \alpha_j)$$
$$q_{i1} = q_{i1}(p_i + \tau_{i1}, p_j + \tau_{j1})$$

For simplicity, we have assumed away any intertemporal considerations by not allowing the planner to transfer wealth across periods.

In the planner's problem, the role of taxes is to influence consumer choice. Since those taxes revert to the consumer as transfers and result in changes in consumption of the composite good, they do not appear in budget constraints (the first two constraints).

Since all wealth will be spent, the planner's problem can be expressed as

$$\max_{\tau_{10},\tau_{20},\tau_{11},\tau_{21}} \quad \begin{array}{c} V(q_{10}, q_{20}) + H_0^o + Y_0 - p_1 q_{10} - p_2 q_{20} \\ +\beta[V(q_{11}, q_{21}) + H_1^o + Y_1 - p_1 q_{11} - p_2 q_{21} - k(\bar{H} - H_1^o)] \end{array}$$

subject to the last three constraints above.

Solving this problem yields the following taxes:

$$\tau_{i0} = \beta \alpha_i (\theta + k) \qquad \tau_{i1} = 0 \qquad \textbf{(1)}$$

i=1,2. The planner sets taxes to correct the internality (as reflected by Θ) and the externality (as reflected by *k*) that consumption in period 0 generates on health and health costs. However, there is no such effect in period 1, so taxes are set at zero. In period 0, taxes are set at a level that, for each good, depend on how much damage that product causes on consumer health.

Note that the solution to this problem does not depend on *m*, which reflects how substitutable sin products are. Taxes make the private marginal utility of sin good consumption coincide with its social marginal utility, which is the same as that of the composite commodity (i.e. 1) once the internality and the externality are accounted for.

5.2 Constant taxes on both sin products

Assume now, as would seem natural, that even though the social planner may want to tax differently "young" and "old" consumers, she may not be able to do so. As compared to our previous problem, now only two tax levels must be selected by the planner, τ_1 and τ_2. Following the same steps as above, the planner's problem now is

$$\max_{\tau_1,\tau_2} \quad \begin{array}{c} V(q_{10}, q_{20}) + H_0^o + Y_0 - p_1 q_{10} - p_2 q_{20} \\ +\beta[V(q_{11}, q_{21}) + H_1^o + Y_1 - p_1 q_{11} - p_2 q_{21} - k(\bar{H} - H_1^o)] \end{array}$$

subject to

$$H_1^o = H_0^o - (\alpha_1 q_{10} + \alpha_2 q_{20})$$
$$q_{i0} = q_{i0}(p_i + \tau_i, p_j + \tau_j, \alpha_i, \alpha_j)$$
$$q_{i1} = q_{i1}(p_i + \tau_i, p_j + \tau_j)$$

i=1,2.
The solution to this problem is given by

$$\tau_i = \frac{\beta}{1+\beta}\alpha_i(\theta + k) \quad \textbf{(2)}$$

i=1,2. This tax level may be interpreted naturally when comparing it to the two corresponding tax levels on the same good in our benchmark case: it is the weighted average of the tax levels that the planner would choose if taxes could vary over time, where weights are provided by how utility is discounted in each period. Again, taxes make the private marginal utility of sin products equal their social marginal utilities, but now they do so on average at any given period. Then, the optimal tax for each product depends on the damage that product causes on health, and on how large the internality and externality are.

5.3 A constant tax on only one sin product

One feature of the cases we have examined is that all sin products can be taxed. We constraint further now the number of tax levels that the planner may select. Specifically, only one of the sin goods can be taxed, and the tax has to be constant over time.

Suppose then that only good 1 is taxable. This means that the planner is restricted to set

$$\tau_1 = \tau, \quad \tau_2 = 0.$$

The planner's problem now is

$$\max_{\tau} \quad \begin{array}{c} V(q_{10}, q_{20}) + H_0^o + Y_0 - p_1 q_{10} - p_2 q_{20} \\ +\beta[V(q_{11}, q_{21}) + H_1^o + Y_1 - p_1 q_{11} - p_2 q_{21} - k(\bar{H} - H_1^o)] \end{array}$$

subject to

$$\begin{array}{c} H_1^o = H_0^o - (\alpha_1 q_{10} + \alpha_2 q_{20}) \\ q_{i0} = q_{i0}(p_1 + \tau, p_2, \alpha_1, \alpha_2) \\ q_{i1} = q_{i1}(p_1 + \tau, p_2) \end{array}$$

*i=1,*2. The optimal tax level is now

$$\tau = \frac{\beta}{1+\beta}(\theta + k)\left(\alpha_1 - \frac{m}{2+m}\alpha_2\right) \quad \textbf{(3)}$$

Now the degree of substitutability between both sin products, as reflected by *m*, is important. Note that the tax level falls with α_2. If the untaxed good becomes more damaging, the planner reacts by taxing less the other sin product, so as to favor more substitution towards the latter. The same happens when *m* grows: a given tax level has more impact on substitution, so a lower tax becomes optimal.

5.4 A tax revenue constraint

So far, we have assumed that the planner could cover any deficit in health-care costs by resorting to lump-sum taxation. We do away with that assumption now, and consider instead a case where there is a minimum-revenue constraint for the planner. Since, in our basic model, all period-0 sin-product consumption has consequences on period-1 health care costs, we impose an intertemporal budget constraint on the planner:

$$q_{10}\tau_1 + q_{20}\tau_2 + \frac{1}{1+r}[q_{11}\tau_1 + q_{21}\tau_2] \geq \frac{1}{1+r}k(\overline{H} - H_1^o) + R,$$

where *r* is the interest rate and *R* is the minimum required net tax revenue (e.g. zero).

We take the case discussed in subsection 5.2, where taxes on both sin goods are allowed but they are constant over time. The planner's problem now is

$$\max_{\tau_1,\tau_2} \quad \begin{array}{c} V(q_{10}, q_{20}) + H_0^o + Y_0 - p_1 q_{10} - p_2 q_{20} \\ +\beta[V(q_{11}, q_{21}) + H_1^o + Y_1 - p_1 q_{11} - p_2 q_{21} - k(\overline{H} - H_1^o)] \end{array}$$

subject to

$$H_1^o = H_0^o - (\alpha_1 q_{10} + \alpha_2 q_{20})$$
$$q_{i0} = q_{i0}(p_i + \tau_i, p_j + \tau_j, \alpha_i, \alpha_j)$$
$$q_{i1} = q_{i1}(p_i + \tau_i, p_j + \tau_j)$$
$$q_{10}\tau_1 + q_{20}\tau_2 + \frac{1}{1+r}[q_{11}\tau_1 + q_{21}\tau_2] \geq \frac{1}{1+r}k(\overline{H} - H_1^o) + R,$$

i=1,2.

Assuming that the representative consumer's discount factor β equals *1/(1+r),* this problem yields a first-order condition with respect to τ_i given by

$$-(1+m)[(1+\beta)(1+\sigma)\tau_i + \beta\alpha_i(\theta + k(1+\sigma))] + \sigma(q_{i0} + \beta q_{i1}) \qquad \textbf{(4)}$$

$$+\frac{m}{2}\left[(1+\beta)(1+\sigma)(\tau_i + \tau_j) + \beta(\alpha_i + \alpha_j)(\theta + k(1+\sigma))\right] = 0$$

where *σ* is the new constraint's multiplier. Of course, if the constraint is not binding, we have *σ=0* and optimal taxes coincide with those in subsection 5.2. If the constraint is binding, though, how the optimal tax levels differ from those we found before is uncertain. This is because, depending on demand elasticities, total revenue may rise by increasing or lowering taxes, starting from the levels chosen without the revenue constraint. In the former (latter) case, the planner may choose higher (respectively, lower) taxes than those described above. Thus, we see how a "Ramsey-type" argument is added to the policy choice of the government. If the amount of revenues matters due to budget deficit considerations, the optimal tax would be higher (lower) than the level that solves the internalities and externalities if higher taxes (reduce) raise tax revenues. As we will discuss below, this is a critical issue in actual policy practice.

5.5 Extensions

The framework described above resorts to a representative agent and does not allow for heterogeneity among consumers. We intend to explore such heterogeneity by modifying our basic model, to incorporate simultaneous sin-product consumption by different age groups. Other forms of heterogeneity are possible, such as income-level or gender differences in sin product consumption decisions.

In general terms, though, the key insights of our basic framework will still be relevant when carrying out those extensions. Take, for example, a simple form of heterogeneity where individual consumers face different costs of starting to consume sin products. Those facing a low enough cost will become sin-product consumers, while those for whom the cost is large enough will not. In essence, each type of consumer will face a choice of whether to become a consumer or not. That individual choice may include, as in our basic structure, an internality given by

underestimating the health impact of sin-product consumption, and an externality through health costs. Optimal tax policy should take into account internalities and externalities in this initial choice, just as it does in our basic case.

In addition, we will extend the model to allow for changes in the levels of harm caused by legally available products. For example, one variety may be prohibited, or a new good may be introduced.

6. Discussion

The model in Section 5 is intentionally simple. Its assumptions allow for closed-form and linear solutions with transparent interpretations. This framework is a valuable initial step for analyzing harmful goods and sin taxes. In Section 5, we consider two periods and two goods, enabling a discussion of several cases according to the planner's taxing options.

Taxing each good, each period

In the first case, the planner can tax each of the two goods in every period. This case offers an interesting benchmark. Optimal taxes per unit of consumption are proportional to the impact on health. Taxes are, in fact, the uninternalized health harm, recovering the present value of the utility cost (internalities) and the social costs (externalities) of harmful consumption. Consequently, any consumption of the harmful good is taxed in the initial period when there are future health consequences. Still, there is no taxation in the last period, when health consequences are assumed away. This implies that the relevant health harm is not the immediate one, but the long-term effect of current consumption, properly discounted for the time between the consumption and the cost of health effects. This approach calls for setting sin taxes after considering all present and future harmful effects of each unit of consumption. By this reasoning, the sin tax for the "young" should be higher than for the "old". Given that this type of tax is not implementable, a more relevant analysis is the one of a unique tax per good, independent of time or consumer type.[22]

Taxing each good

In the second case, a maximizing welfare planner taxes each harmful good with a sin tax. This restricts the planner to one tax per unit of consumption without distinguishing by consumer type. In this case, the optimal tax is a weighted average of the tax for different types or different periods, so that $\tau_1 = \frac{\beta}{1+\beta}\alpha_1(\theta + k)$.

New products

This setup is useful to analyze an innovation or new product. We consider the following example. In an initial situation, there are two identical goods, so that $\alpha_1 = \alpha_2$. In that case, $\tau_1 = \tau_2 = \frac{\beta}{1+\beta}\alpha_1(\theta + k)$. Consider, now, that an innovation allows for a substantial reduction on the harm level of good 2. What should the government's response be to this new product? Risk-based

[22] When consumers are heterogeneous, sin taxes should be different for each type of consumer. As in the literature, we consider this alternative interesting only as a benchmark and not as an implementable policy. In our case, the heterogeneity is related to time, or stage in life.

taxation formulas suggest that the government should leave the tax on good 1 unchanged and decrease the tax of good 2, so that the difference between the two tax levels is related to the differential harm.

Notice that this response is independent on costs (or prices) of both goods. In other words, good 2 could have increased or decreased its production cost (price) without any implication in taxes. In this sense, risk-based taxation is a specific tax (as opposed to an ad-valorem tax) because its purpose is to internalize (explicitly account for) internalities and externalities.[23]

Notice, also, that after this new product is introduced and its tax reduced, the government's total revenue would go down. Some clarifying comments are in order. First, it is important to take into account that the derivation of these formulas does not include any consideration of total revenue and is exclusively focused on correcting for internalities and externalities. For this reason, there is no direct consideration of any objective of the government regarding the overall level of tax revenues. Second, while total revenue can be reduced, it is also true that total health costs will also be lower due to the innovation. Lower taxes on the low harm good would induce substitution towards less harmful consumption, reducing both revenue and health costs. Third, even when revenues would be matched with health cost, there is a transition period. In the period of the innovation, health costs would be related to the (past) consumption of high-harm goods, while revenue would be related to low-harm goods. If the government imposes a budget constraint so that sin taxes are set to finance health costs within each period, then, the level of both taxes should be set in order to satisfy that restriction during the transition period. But if revenue becomes a restriction, the tax levels are not necessarily related to the above formulas. We will discuss this case further below.

Taxing only one good

In the third case, a maximizing welfare planner can tax only one of the two harmful goods. This imposes a significant constraint to the planner. The reason is that taxing a good would result in more consumption of the other harmful good, a consumption that excise taxes cannot regulate. For that reason, the level of the tax that can be imposed is lower. This is the case, for example, of a government that would like to tax tobacco when smuggling is present: a high tax on tobacco could lead to the consumption of counterfeit cigarettes, possibly more harmful, limiting the ability of the government to increase the excise tax.

Equation (3), can be written as:

$$\tau = \frac{\beta}{1+\beta}\alpha_1(\theta + k) + \frac{\beta}{1+\beta}\alpha_2(\theta + k)\left(-\frac{m}{2+m}\right)$$

This formula is the optimal sin tax to harmful good 1 when harmful good 2 cannot be taxed. It is related to equation (10) in Allcott and Rafkin (2022) and shares its interpretation. The first term is the average distortion across types of consumers, weighted by the discounted type's own-price response. In our model, linearity of demand implies identical own-price responses between age groups, so the discount factor is the only relevant weight. The second term is the average

[23] While we do not present the case of an ad-valorem tax, the result of that case arises clearly from the government's problem. The objective function of the problem is identical to the one presented in section 5.1 or 5.2. Thus, allocations should be identical and the tax rate should be τ_i/p_i.

uninternalized distortion of good 2, weighted by each type's cross-price response. Given that the tax for the good 2 is imposed to be zero, the uninternalized distortion is the whole term $\frac{\beta}{1+\beta}\alpha_2(\theta+k)$. The term in parenthesis, $-\frac{m}{2+m}$, is the cross-price response.

Interestingly, this equation highlights why the elasticity does not arise in the formulas for previous cases. When every sin good can be taxed, there is no reason for the cross-price elasticity to appear, because any harmful effect of consumption of the other good is already corrected by the sin tax applied to that good: the distortion of good 2 is internalized through τ_2. In other words, once the consumption of good *j* is optimized by the sin tax, there is no reason to consider the effect of the quantities consumed of good *j* in the tax imposed to good *i*.

Elasticities or consumption responses are relevant when some goods cannot be optimally taxed, as in this case, or when the government incorporates total revenue as a restriction to satisfy. We discuss that case at the end of this section.

To gain intuition, consider the effect of marginally increasing τ. A higher tax would imply a reduction in consumption of good 1 but would also affect good 2 consumption, so that the change in taxes would imply affecting future health by $-\alpha_1\frac{dq_{10}}{d\tau}-\alpha_2\frac{dq_{20}}{d\tau}$. We focus on a case in which the effect of taxes is strictly negative on the demand of good 1, $\frac{dq_{10}}{d\tau}<0$. For every unit of good's 1 consumption cut due to tax increase, the total impact of health is $\alpha_1+\alpha_2\frac{dq_{20}}{dq_{10}}$, where the second term depends on the response of the consumption of good 2 to the increase in the tax. In our setup, this response depends on m, so that $\frac{dq_{20}}{dq_{10}}=-\frac{m}{2+m}$, as derived from the demand formulas.[24] As an example, with $m=1$, for every unit of good 1 reduced by the increase in taxes, consumption of good 2 increases by 1/3. In total, the tax per unit of good 1 is set to the product of health change of one additional unit consumed times the value of the internalities and externalities per unit of health. This means,

$$\tau=\left[\alpha_1-\frac{m}{2+m}\alpha_2\right]\times\left[\frac{\beta}{1+\beta}(\theta+k)\right].$$

Back to the formula

We now present the above formula in a simple graph. We rewrite equation (3) as

$$\tau=\alpha_1(\theta+k)\frac{\beta}{1+\beta}\left(1-\frac{m}{2+m}\gamma\right)$$

where $\gamma=\alpha_2/\alpha_1$. This allows us to plot taxes according to values of m and γ. When *m=0*, so that both goods are independent, this equation subsumes to (2), that defines τ_1, the optimal tax when both goods can be taxed. Figure 4 plots this case in the red solid line, showing that the optimal tax is proportional to α_1, the risk generated by the consumption of a unit of good 1. The slope of this line is related to the uninternalized private utility effects of the consumption of the

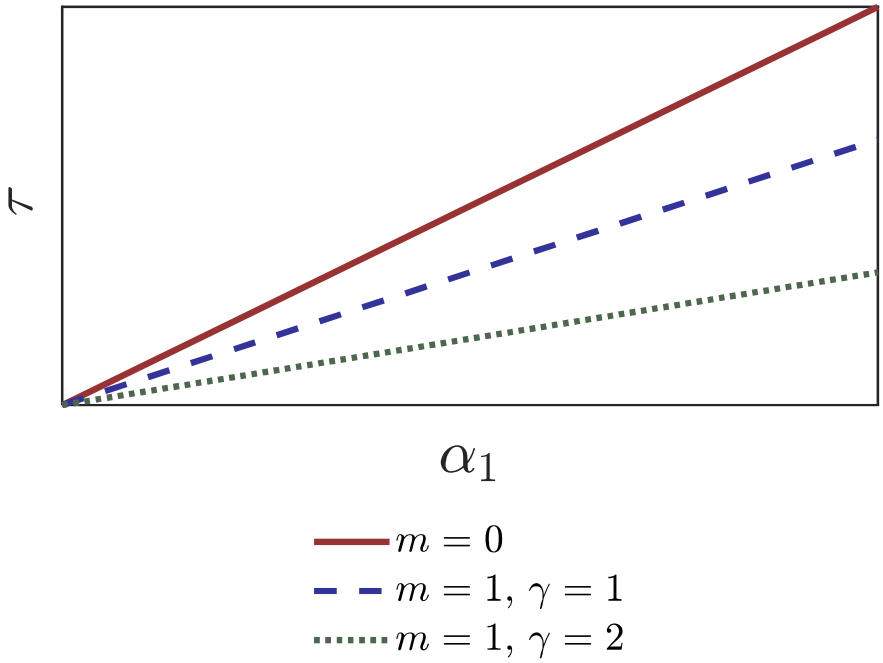
[24] Notice that health effect is only related to changes in consumption in the initial period. From demand functions, the effect of tax on consumption is $\frac{dq_{10}}{d\tau}=-\frac{1+m}{2}+\frac{m}{4}$, which is the own-price effect, and $\frac{dq_{20}}{d\tau}=\frac{m}{4}$, cross-price effect.

good ($\beta\theta$) and the social externalities generated by the consumption (βk). These two components arise also in equation (1), when the planner can tax each period. As emphasized above, the factor $1/(1+\beta)$ arises because the tax is a weighted average of the initial and last period's optimal taxes for each good.

When $m > 0$, both harmful goods are substitutes and the good 1 tax is affected by the risk of the good 2, α_2. The blue dashed line in Figure 4 plots the case in which $m = 1$ and $\alpha_2 = \alpha_1$. In this case, the tax is also proportional to α_1, but is now lower. This is, again, because any increase of the excise tax for good 1 generates substitution in consumption towards good 2 which is equally harmful. Of course, if good 2 was more harmful than good 1 the tax should be even lower. This is what the dotted green line plots, using the example $m = 1$ and $\alpha_2 = 2\alpha_1$.

More generically, for given risk of good 2 relative to good 1 (i.e., given α_2/α_1), larger substitution implies a lower tax to good 1. In the extreme case of perfect substitution, excise tax for good 1 should be zero if both goods are equally harmful, and should be negative (subsidy) if good 2 is more harmful than good 1. Additionally, for given $m > 0$, the riskier the good 2 the lower the tax to good 1. Again, in the case of a relatively very harmful good 2, the excise tax could be negative.

Figure 4. Good 1 sin tax when good 2 cannot be taxed



This formula helps us understand different cases that are relevant for the determination of sin taxes.

Inability to tax a variety

This exercise helps us understand the restrictions that a government can face if a variety of a good cannot be taxed. This would be the case if similar products are produced by two types of firms, where only one type can be taxed. Consider the case where $\alpha_1 = \alpha_2 = \alpha$. The formula gives

$$\tau = \frac{\beta}{1+\beta}\alpha(\theta + k)\left(\frac{1}{1+m/2}\right)$$

which coincides with τ_1 in equation (2) only when both goods are independent (when $\mathrm{m} = 0$); when the varieties are substitutes, the tax is strictly lower. The intuition is clear: the inability to tax a variety restricts the government. The government cannot completely account for internalities and externalities. This is because a high tax would imply more consumption of the other variety, worsening the health outcome.

Smuggling interpretation

Alternatively, this formula in equation (3) is useful to consider the existence of substitutes of the taxed good that cannot be taxed. An example is a good that can avoid paying taxes. Smuggling, counterfeit goods, black markets, etc. are different forms of this possibility. Usually, these types of goods are of lower quality, and possibly more harmful. Thus, in this interpretation of the formula we can consider $\alpha_1 < \alpha_2$. In this case, the tradeoff is the same as before, but whenever there is substitution between the two goods, the government has now stronger limitations than in the previous case. Now each rise in the tax increases the consumption of the more harmful good.

Importantly, this logic is independent of the relative prices between both goods. Even if good 2 is expensive due to transaction costs, or cheap due to low quality, the optimal tax per unit of good 1 is determined by the same equation.

Banned product

Consider now that good 2 is a new harmful product that can substitute good 1. The government, perhaps due to the uncertainty about its harmful effects, bans the commercialization of the new good. We assume that this new good is less harmful than the other, so that $\alpha_1 > \alpha_2$. We assume that, even with the government restriction, the product can be consumed due to smuggling.

In this case, again, the tax is lower compared to the counterfactual in which both goods can be taxed. The mechanism is the same as in the other cases: a higher tax increases the consumption of good 2 which is harmful.

Of course, in our context, banning one harmful good is not justified. On the contrary, the government should allow the consumption of good 2, but should use taxes to correct for its internalities and externalities. This is because of two reasons. First, the government can regulate the consumption of good 2 by using a tax to that good; there is no need to ban consumption when the tax could be set to totally eliminate consumption of good 2. Second, a tax to good 2 could contribute to government revenue.

Tax revenue constraint

We turn, now, to discuss the case in which the government uses these taxes for revenue purposes, so that revenue is a restriction in the government's problem. In other words, our point is to study the problem of a government that wants to set sin taxes but, at the same time, must maintain a revenue level (net of health costs) with these particular taxes.

We can discuss the implementation of taxes under this restriction by using equation (4). After considering both goods, and letting $Q_i \equiv q_{i0} + \beta q_{i1}$, we get

$$-(1+m)[(1+\beta)(1+\sigma)(\tau_1-\tau_2)-\beta(\alpha_1-\alpha_2)(\theta+k(1+\sigma))]+\sigma(Q_1-Q_2)=0$$

We turn to use this equation to discuss different situations.

Consider, first, the case in which the restriction is not active, so that $\sigma = 0$. In this case the difference in taxes is only related to the difference in health risks, as in previous cases:

$$(\tau_1-\tau_2)=\frac{\beta}{1+\beta}(\alpha_1-\alpha_2)(\theta+k)$$

Take now the case in which the constraint is binding, so that $\sigma > 0$. If there are no internalities or externalities (i.e., if $\theta = k = 0$), we have a standard Ramsey problem of optimal taxation, where the planner maximizes the representative consumer's welfare subject to a minimum required tax revenue *R*. Using (4) again, it follows that

$$\frac{\left[\tau_i\left(1+\frac{m}{2}\right)+\tau_j\frac{m}{2}\right](1+\beta)}{Q_i}=-\frac{\sigma}{1+\sigma}$$

In words, the fall in Q_i generated by taxation as a percentage of consumption has to be the same for all taxed goods, as the planner minimizes distortions.[25] Once internalities and externalities appear, the optimal tax incorporates those effects as well, and we have

$$\frac{\left[\tau_i\left(1+\frac{m}{2}\right)+\tau_j\frac{m}{2}\right](1+\beta)+\left[\alpha_i\left(1+\frac{m}{2}\right)-\alpha_j\frac{m}{2}\right]\beta(\theta+k(1+\sigma))}{Q_i}=-\frac{\sigma}{1+\sigma}$$

Even though this condition seems harder to interpret, we can still gain intuition by resorting to a special case. Assume that health considerations do not affect tax differences because $\alpha_1 = \alpha_2$ (both goods are equally harmful). Then, the formula implies

$$\tau_1-\tau_2=\frac{\sigma}{1+\sigma}\left(\frac{1}{\eta_1}-\frac{1}{\eta_2}\right)$$

where $\eta_i \equiv (1+m)(1+\beta)/Q_i$. In particular, η_i is related to the response of consumption in both goods to a change in price of good *i*.[26]

If we assume $\eta_1 > \eta_2$, this implies $\tau_1 < \tau_2$. This relates to standard optimal taxation principles: the higher tax is set on the good for which demand is less sensitive to its own price, so that distortions are minimized. This is because in this case (when both goods are equally harmful) the difference in taxes only reduces welfare due to the distortion of consumption.

Finally, the case in which the constraint binds and goods are different would imply:

$$\tau_1-\tau_2=\frac{\beta}{1+\beta}(\alpha_1-\alpha_2)\left(\frac{\theta+k(1+\sigma)}{1+\sigma}\right)+\frac{\sigma}{1+\sigma}\left(\frac{1}{\eta_1}-\frac{1}{\eta_2}\right)$$

[25] In strict terms, it is the fall in compensated demand generated by taxation that has to be the same across taxed goods (see, for instance, Myles, 1995, ch.4). In our setting, there are no wealth effects on sin-product demand, so compensated and uncompensated demands coincide.

[26] $\eta_i \equiv (1+m)(1+\beta)/Q_i = -2\frac{\frac{\partial Q_i}{\partial p_i}-\frac{\partial Q_j}{\partial p_i}}{Q_i}$.

Now, the difference in health risk is less important to determine taxes. Notice, for example, that a higher σ reduces the importance of internalities in the above equation through the factor $\frac{\theta+k(1+\sigma)}{1+\sigma} = \frac{\theta}{1+\sigma} + k.$

This formula, then, could suggest that taxes could greatly differ from the optimal risk-based ones. Nevertheless, if the more harmful good is also the one with lower η, this formula is not ad odds with the risk-based criteria.

Limitations

In this section, we have emphasized our model's main results. The results are clearly expressed in simple formulas, and the model is useful for different analyses. Nevertheless, we must acknowledge that some cases deserve to extend the model to capture issues that have not been considered. Heterogeneity in consumers, addictive goods, and complementarity in consumption are important extensions. For example, in our analysis, new, less harmful goods should be taxed less, according to their risk. However, in an extended model, this good could imply future consumption of the riskier good, and taxes should consider this complementarity in future consumption.

Additionally, we assume away the supply side by considering representative firms that operate a constant returns-of-scale production function in competitive markets. While considering new products, though, it could be important to model innovation costs. In that case, it is possible that taxes should be set to provide incentives to generate new, less harmful goods, and optimal taxes could deviate from the static risk-based optimality criteria.

6.1 Putting it together: what can this framework tell us about sin taxes in Latin America

The model described above can help analyze policy issues regarding sin-good taxes in Latin America, which were already summarized in section 4. This framework formally derives an expression where optimal taxes should be levied as a function of the health risk these products impose on individuals, a principle we have used for evaluating regional tax policies and which is recommended as a good policy practice (WHO, 2021a). Nevertheless, we have described evidence from Latin America demonstrating that sin taxes on these products are often not established in proportion to the harm they produce.

The model also shows that under the assumption that harm risk is linearly associated with physical consumption, the use of amount-specific excise taxes entirely eliminates the distortion in social welfare produced by the internalities and externalities as their magnitude directly affects the level of optimal taxes. Thus, the theoretical framework brings in an argument in favor of using amount-specific levies as a part of the fiscal package to deal with the consumption of harmful goods. We have already seen that many countries in the region have applied this mechanism to tax these goods, though ad-valorem taxes are also used in many other cases. This last mechanism could be more straightforward to apply but, as we indicated in section 2, has some limitations for calibrating it to the level of harm.

Moreover, as we said before, the tax depends positively on the subjective misperception of the health risk in addition to the fiscal externality. The model nicely integrates two complementary policies to fight sin-good consumption: taxes and informational initiatives to correct these misperceptions. Thus, this suggests, for example, that part of the tax collection obtained could be earmarked to finance health campaigns and other initiatives to discourage risky health

consumption among the vulnerable (i.e., young) population. The changes in perceptions would make taxes more effective in reducing the demand for these products. Consequently, the required taxes could be lower. The evidence for LAC showed that tax revenues are partly allocated for this health preventive purpose in very few cases.

The model also highlights other complementary policies that should be established with sin taxes. These policies are associated with improved tax administration, control, and enforcement. When this is not the case, the introduction of sin taxes could incentivize illegal production and trading of these products, which, of course, limits the ability of this instrument to reduce harmful consumption. The model revealed that when one variant of the harmful good cannot be taxed due to, for example, poor tax enforcement, the optimal tax on the taxed variant should be lower to avoid substitution. This is a relevant issue when designing excise taxes in LAC, given the evidence we described, which shows that illegal markets for both tobacco and alcoholic beverages are significant in some countries of the region.

If, because of technological development, a new variant of a sin good that produces less harm is introduced into the market, as is expected, the model indicates that lower taxes should be charged to allow substitution away from the high-harm variant. A relevant example is the surge of the (supposedly) low-risk product varieties like ENDS, ENNDS, and HTM in the tobacco market. Within the few countries of LAC where these products were authorized to be commercialized, some apply the same tax rates as regular cigarettes (i.e., Colombia and Paraguay with HTS). This is different from what is seen in Europe, where, in general, these products have lower excise taxes complying with the normative prediction of the model.[27]

In some countries of the region, some presumably low-harm variants of sin goods have been banned, as was the case with END and ENNDS tobacco products. This is an extreme form of regulation. As we saw in the model, if the health risk of these products is accurately known, taxes would be a better way to regulate them. As mentioned above, the presence of these products with relatively lower taxes could help reduce the consumption of high-risk variants and, at the same time, generate revenues for the government to eventually deal with the externalities that this consumption generates on health expenditures, even if they are now reduced. Eventually, if the government feels that the evidence about their low-harm characteristic is inconclusive or that there may be complementarities in consumption (see other arguments in note 27 below) with high-risk variants, the optimal regulation could be to set a similar level of taxes instead of a ban. This is the case with the diet variant for sugar-sweetened beverages (SSB) in most countries of the region.

A final relevant policy issue introduced by the theoretical framework is the potential trade-off between health and revenue objectives that the government may face. On the one hand, some governments in the region have been cautious about increasing sin taxes (say, to cigarettes or alcoholic beverages) because of the probable loss of revenue (if the demand parameters determine they are at the peak of the corresponding "laffer-curve"). These worries, for example, were put forward by some actors in Argentina in the case of the tobacco industry (see Gonzalez Rozada, 2020). Nevertheless, the evidence about estimated demand price elasticities in LAC shows that taxes on these products could be increased in many circumstances, and revenues

[27] The model must be extended to accommodate the extensive margin of demand (initiation of new smokers, say, young people), potential complementarities, and addictive characteristics to properly evaluate the optimal relative taxes between traditional and new low-harm variants.

could still rise. On the other hand, some governments may resist introducing new low-harm varieties with lower taxes because substitution away from traditional high-risk varieties (say, ENDs against cigarettes in the case of tobacco) could decrease tax revenue. In this regard, it should be noted that, as shown above, the Ramsey principle suggests that taxes should be higher for the product/variant with lower price elasticity. In the case of alcoholic beverages, evidence shown for Chile indicates that spirits have lower price elasticity than beer. In this case, the Ramsey rule goes in the same direction as health risk-based taxes. Some studies suggest the same results for tobacco (Allcott and Rafkin, 2021; WHO, 2021b)). Thus, we can say that the revenue argument for taxation of sin products may imply higher taxes (for all variants) but not necessarily disrupt the health harm-related taxation criterium. Therefore, countries in LAC may not face such a "trade-off" between revenue raising and health prevention objectives.

7. Concluding remarks

Selective consumption taxes on goods like tobacco, alcohol, or sugar-sweetened beverages (SSB) that negatively affect health outcomes are usually named "sin taxes". Governments worldwide have been applying these types of taxes for many years, for example, in the case of tobacco and alcohol, and have recently extended them to SSB products and even to fat or high-calorie types of food.

Because of more public awareness of the health consequences of the consumption of sin goods and the higher prices due to taxation, the industry has developed variants of these products that presumably imply lower health risks in recent years. This has been noticeable in tobacco, where E-cigarettes containing nicotine or other non-nicotine substances (ENDS and ENNDS), or Heated Tobacco Systems (HTS), which avoid combustion. In the case of SSB products, there is a proliferation of diet or low-calorie soda beverage varieties. For alcoholic beverages, many producers have launched some non-alcoholic versions of these drinks, like beer.

A critical question that policymakers face is how to treat these new products in terms of general regulation and taxes. This issue is related to a general principle that applies to all these taxes: whether they consider health risks in their implementation. The theoretical framework we developed confirms the intuition that taxes should be levied based on the health risks these products impose on individuals. Nevertheless, we have described evidence from Latin America demonstrating that sin taxes on these products are often not established in proportion to the harm they produce.

The model also indicates that the larger the subjective misperception of the health risk, the stronger the government intervention should be, and the higher taxes should be set. Alternatively, this result suggests complementary policies of informational initiatives with the aim of correcting these misperceptions. This may justify that part of the tax collection obtained could be earmarked to finance health campaigns and other initiatives to discourage risky health consumption among the vulnerable (i.e., young) population. The evidence we showed for LAC is that tax revenues are partly allocated for this health preventive purpose in very few cases.

A key policy issue introduced by the theoretical framework is the potential trade-off between health and revenue objectives that the government may face. Authorities may be worried that

increasing these taxes for health purposes may reduce tax revenue if the demand falls to a greater extent than the increases in taxes. Nevertheless, the evidence for LAC shows relative inelastic demands, so taxes on these products could be increased in many circumstances, and revenues could still rise. On the other hand, some governments may resist setting low taxes on new low-harm varieties because substitution away from traditional high-risk varieties (say, ENDs against cigarettes in the case of tobacco) could decrease tax revenue. Nevertheless, the usual rule for maximizing tax revenues is to set higher taxes for those products/variants with low price elasticity, which doesn't contradict the tax risk principle if the low-risk variants have a more price-elastic demand behavior as the evidence seems to suggest for the case of alcoholic beverages and tobacco. Thus, the model shows that the revenue argument for taxing sin products may imply higher taxes for all variants (though relatively lower for harmless versions).

The above conclusions need to be taken with caution. On one hand, the policy implication of differentiated taxes for different sin-good variants depending on the health risk must be supported with reliable scientific evidence. Secondly, exploring some extensions of the basic framework could be useful to capture issues that have not been considered which could affect the results obtained so far. For example, heterogeneity in consumers could help look at the extensive margin of consumption demand, allowing us to introduce initiation and cessation responses to tax changes. Also, potential complementarities in consumption among variants (as opposed to the substitution assumption we have considered) could be relevant. Finally, we have taken away the supply side by considering representative firms that operate a constant returns-of-scale production function in competitive markets. While considering new products, though, it could be important to model innovation costs. In that case, it is possible that taxes should be set to provide incentives to generate new, less harmful goods, and optimal taxes could deviate from the static risk-based optimality criteria.

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