Effects of Curbing the Illicit Cigarette Market in Brazil

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Jose Angelo Divino,† Philipp Ehrl,† Osvaldo Candido,† Marcos Valadão,‡ and German Rodriguez Iglesias§

†Graduate Program of Economics, Catholic University of Brasília, Brazil

‡School of Public Policy and Government, Getulio Vargas Foundation, Brasília, Brazil

§ Institute for Health Research and Policy, University of Illinois at Chicago, USA

Abstract

Background

The illicit cigarette market is a major concern for government authorities across Brazil. Due to its intrinsic illegality, the illicit cigarette market is not traceable through official statistics, and its size is a subject of discussion in the relevant literature. Illegal cigarette sales do not generate tax revenues, often involve other criminal activities in their production and distribution chains, and have greater impacts on the poorest segments of the population due to their lower price. Therefore, it is important for policy makers to understand the benefits of eliminating the illicit cigarette market. To this end, this research uses the most recent official microdata from the National Health Survey (PNS, 2019) to investigate the effects of curbing the illicit cigarette market in Brazil. We simulate the impacts on cigarette prices, consumption, and tax collection after partial reductions or complete elimination of illicit trade.

Methodology

We use nationally representative individual survey data from Brazil to estimate how smokers adjust their consumption pattern to price changes. This study focuses on the effects of an increase in illegal cigarette prices on consumption of both legal and illegal cigarettes. Our framework accounts for the pronounced regional differences in cigarette prices, extent of the illicit market, consumption patterns, and price elasticities. We simulate a variety of scenarios that differ regarding the extent of the illegal cigarettes' price increase and smokers' switching behavior. The terms licit/illicit and legal/illegal are used interchangeably across the text.

Results

The data show that higher illegal cigarette prices lead to a lower number of smokers and reduced consumption of illegal cigarettes. The higher prices also induce some consumers to buy legal products instead, raising cigarette tax revenue. Across all simulations, we find that the overall consumption of cigarettes is strictly lower when illegal cigarettes

become more expensive. The simulations indicate that the illegal market could be reduced by 98 percent if illegal prices were increased by about 55 percent. Even under conservative assumptions, the resulting tax revenue gain would be 7.5 billion BRL per year, equivalent to a 64-percent increase, and cigarette consumption would fall by 5.0 percent relative to the baseline.

Conclusions

It is highly advantageous for Brazil to invest in policy measures to fight the illicit cigarette trade by disturbing both production and sales, which would increase the cost of smuggling and raise the prices of illicit cigarettes. Furthermore, tobacco control measures—such as increasing tobacco taxation and raising the minimum legal price—should also be implemented, as both have proven to be powerful tools to reduce tobacco consumption.

Introduction

According to the latest information from the Brazilian Institute for Geography and Statistics and the National Health Survey from 2019, 27.4 million Brazilians smoke 353.6 million manufactured cigarettes each day. The enormous consumption of a harmful and addictive product creates additional costs for the affected individuals, their families, and the public health system due to the treatment of tobacco-related chronic diseases. At the same time, the tax revenue generated from legal cigarette sales amounts to 12 billion BRL per year—far less than the private and social costs of cigarette consumption (Fuchs et al., 2019, Macías et al., 2020, Divino et al., 2019). Increasing tobacco taxes is an effective tobacco control policy that simultaneously raises cigarette prices, reduces consumption, and increases tax collection. Tax revenues could be even greater if the market share of illicit cigarettes is continuously reduced through public policies that effectively fight illicit trade on different dimensions.

The extent of the illicit cigarette market is notoriously difficult to measure. Available data need to be assessed carefully because their sources, methods, and purpose are often questionable (Stoklosa & Ross, 2014; Gallagher et al., 2019). According to Goodchild et al. (2020), Brazil's illicit cigarette market accounts for 36 percent of total consumption and thus ranks second among 36 countries for which independent information is available over the last decade. Using four different survey methods, including littered-pack collection and face-to-face interviews, Szklo et al. (2020) even find that in some Brazilian cities the share of illegal cigarettes is greater than 50 percent.

Brazilian authorities seem to be aware of the problematic situation. Obviously, the Federal Revenue Service (RFB) is forgoing a huge amount of tax collection, notwithstanding other crime and health issues related to smuggled cigarettes. Brazil adheres to the WHO Framework Convention on Tobacco Control (FCTC), and it ratified the Protocol to Eliminate Illicit Trade in Tobacco Products in 2018. The country has invested in a sophisticated cigarette surveillance and tracking system (Scorpios). Another sign of Brazil's efforts to curb the illegal cigarette market is the increasingly intensive raids by police and RFB's Special Forces that led to a record high of 18 million confiscated packs

in 2021. The higher the pressure on illegal smuggling schemes, the higher the volume of illegal cigarettes seized, resulting in increases in the costs of smuggling and the price of illegal cigarettes.[1] In other words, these efforts to curb the trade of illicit cigarettes certainly make illicit cigarette trade more costly and tend to drive up the prices of these products.

The present paper simulates how increases in prices of illicit cigarettes affect the size of the illicit market, cigarette consumption, and tax collection in Brazil. In particular, we disentangle how smokers switch between the legal and illegal market, so that our framework provides estimates for consumption and prevalence of smoking both for illegal and legal cigarettes. These estimations and simulations are drawn from the most recent edition of the nationally representative National Health Survey (PNS, 2019) conducted by the Brazilian Institute for Geography and Statistics (IBGE), tax collection from the Internal Revenue Service (Receita Federal do Brasil, or RFB) and volume of cigarette seizure and destruction also from the RFB.

Our findings complement previous research from other countries such as Masi et al. (2021), Goodchild et al. (2020), Joossens et al. (2009), and West et al. (2008). The present framework accounts for the pronounced differences between federal states and yields specific results at the state level. The simulation can be seen as more realistic because we tend to avoid ad hoc assumptions by using our own estimations of price elasticities from the available microdata. Particularly, the use of cross-price elasticities that inform about the smokers' switching behavior between the illegal and legal market is a novel contribution. We hope that our results will be valuable for policy makers and other researchers who are interested in the economic effects of curbing the illicit market through tax policy-driven increases in illicit cigarette prices.

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[1] Many variables drive seizures beyond the actual level of illicit trade, but we use it in the simulation exercise only as a proxy. We do not condone it as a rigorous measure to understand levels of illicit trade.

Methodology

Simulations

The objective of this research is to simulate how increases in prices of illicit cigarettes affect the size of the illicit market, cigarette consumption, and tax collection in Brazil. Instead of addressing a selection of individual policy measures to curb the illicit market or assuming an exogenous reduction in this market—as is done by Goodchild et al. (2020), for instance—we posit that the efforts of combined public policies will eventually result in price increases of illicit cigarettes. The conceptual framework of smokers' behavior, on which our simulations are based, is illustrated in Figure 1. One can see that our simulations include three direct (first order) effects of higher illegal cigarette prices:

1. Some consumers will quit smoking, according to the estimates of the unconditional price elasticity of cigarette consumption.
2. Some of the remaining consumers will substitute illicit cigarettes for the licit ones. This pathway has two components. On the one hand, there will always be some smokers who will find illegal cigarettes unattractive enough and will migrate to licit products, according to the positive cross-price elasticity. On the other hand, if the price increase is sufficiently large, the resulting price is above the price of legal substitutes such that it is no longer reasonable to buy illegal cigarettes.
3. The consumers who continue to buy illicit cigarettes will decrease their consumption according to the estimates of the conditional price-elasticity of illicit cigarette consumption.

The following second-order effects arise from higher illegal cigarette prices, as can also be seen in Figure 1:

1. As a consequence of shifting demand from the illegal to the legal market, legal cigarette prices will increase, according to the positive price-elasticity of cigarette supply. This price increase again implies lower consumption

based on the conditional and unconditional price-elasticities of cigarette consumption.

2. As a consequence of shifting demand from the illegal to the legal market, tax revenue will increase.

Figure 1. Conceptual framework of smokers' behavior
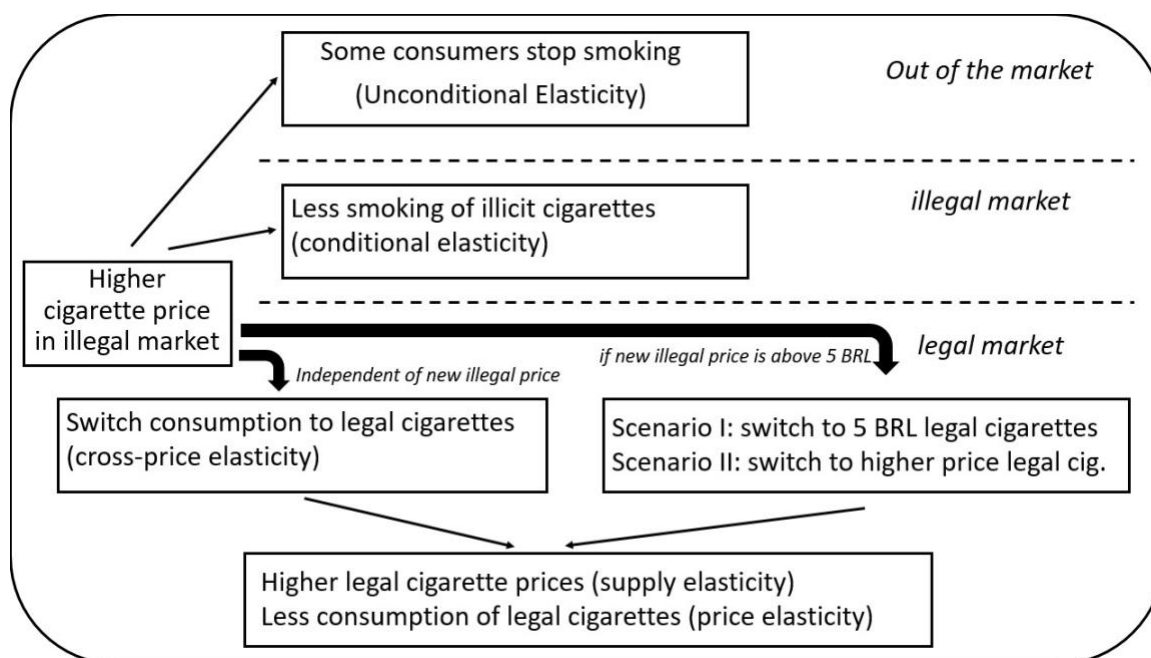
In order to quantify and interpret the simulation results, it is necessary to define a baseline scenario. This baseline replicates the current tobacco tax structure using the number and consumption patterns of smokers in both the legal and illegal market. We calibrate the baseline scenario to match the 2019 federal total cigarette tax collection. The parameter with the relatively highest degree of uncertainty is used as the margin of adjustment: the extent of the illicit market. Although the definition of illegal cigarettes stems directly from the IBGE's PNS data, the very nature of an illegal product and the information regarding cigarette brands may still provide an underestimation of the true size of the illicit market. Szklo et al. (2020), for instance, compared different approaches to calculate the size of the illicit cigarette market in Brazil and found substantial differences between them.

The present simulations consider a single shock caused by higher illegal cigarette prices. The rationale for this choice is that the efforts by the government and instances from the executive and legislative powers to curb the illicit market eventually culminate in higher illicit cigarette prices. The assumption is that if the illicit cigarette suppliers are continuously disrupted, the costs of selling in this market increase. Any measure from raids, illegal production shutdowns, and truck inspections on highways, among many others, that increases the costs of supplying illicit cigarettes to the final consumer should be reflected in higher product prices.

Another key hypothesis is about how the smokers in the illicit market will react after facing a price increase. The literature on illicit cigarette consumption seems to agree that the dominant reason for choosing illegal products is their lower prices (Szklo et al., 2020; Iglesias et al., 2017; Divino et al., 2021, 2022). According to Bate et al. (2019), the majority of survey respondents report that they were unaware that the purchased cigarettes were in fact illegal. Another frequently found argument, namely the loyalty to a specific taste/brand, seems to be much less important, as it is statistically insignificant compared to the economic price argument (Paraje et al., 2020).

In sum, it is reasonable to assume that the most relevant reason for people to smoke illicit cigarettes is the lower price. If the price is no longer lower than the one from the legal market, there is no reason to buy illicit cigarettes. Based on this notion, our preferred simulations incorporate the following assumption about smokers' brand loyalty and switching demand effect between the illegal and legal market:

Scenario I – If illicit cigarette prices become higher than the official minimum price, which is equal to 5.00 BRL, smokers migrate to the minimum price category. That is, a new Licit Price Category 1 (LPC1) is created to accommodate former smokers of illegal products. In this LPC1, the price per pack equals exactly 5.00 BRL, corresponding to the minimum legal price. Note that the price increases are proportional to the original prices, such that differences between federal states are preserved. If new illegal brand prices are higher than 5.00 BRL, smokers migrate from PC1 (illicit) to LPC1 (licit). Otherwise, they continue buying illicit cigarettes.

The assumption of considering proportional price increases in all states, instead of state-specific changes, is based on the following reasoning. The differences in illicit prices most likely reflect differences in distribution costs across the country, since the products stem from hidden factories in Brazil or are brought from other countries, mainly Paraguay. Thus, if the distribution chain is spread close to the border, places farther away will experience this shock to a similar or higher extent. Furthermore, the government authorities responsible for application of coercive measures and law enforcement are at both national and subnational levels. In fact, there is a more whole-of-government approach to the illicit trade issue. Beyond enforcement, it also requires bilateral cooperation between the two governments and engagement of the judicial branch.

As an alternative scenario that represents the other extreme behavior, namely smokers being completely loyal to a particular brand, we consider the following simulation:

Scenario II – Illicit market smokers continue consuming their preferred brand irrespective of the new higher price and disregarding other alternatives. Consequently, smokers can end up in either price category. That is, after an illicit price increase, if the new price is below 5.00 BRL the smokers stay in the illicit market (PC1); if the new price is above 5.00 BRL they pay this minimum price and move to the new low-price licit category (LPC1); if the new price is above the PC2, then they pay the price of PC2; and so on.

For both scenarios, three levels of efforts for curbing the illicit market are considered, taking as reference the prices in the baseline scenario. In the following simulations, these efforts are then expressed in terms of a relative price adjustment of the average price of illicit cigarettes. The first level sets the effort such that the nationwide average price of the illicit cigarettes (PC1) increases to 5.00 BRL, the minimum legal price. For the second level, the effort is set to match the overall average price of PC2, the medium price category. Finally, the third level considers the effort that is needed to fully eliminate the illicit cigarette market in Brazil.

Data

The primary data source of this research is the most recent version of the National Health Survey (Pesquisa Nacional de Saúde, or PNS) conducted by the Brazilian Institute for Geography and Statistics (IBGE) in 2019. The PNS is the most extensive individual health survey available in Brazil. It provides nationally representative information due to stratified sampling in three stages based on census tract units. See Souza-Júnior et al. (2015) for further methodological details.

The PNS provides socioeconomic information about the interviewed individuals and includes a section on smoking habits. If the person is a smoker, they are asked about the price, brand, and quantity of cigarettes chosen in their last purchase. Based on the information about the cigarette brand, the IBGE classifies the cigarettes as legal or illegal according to the official brand classification by the National Health Surveillance Agency (Agência Nacional de Vigilância Sanitária, or ANVISA). Illegal cigarettes comprise our lowest price category (PC1) and the remainder of the market is divided into two equal segments, being the legal price categories PC2 and PC3. The average price in each of the three categories in each federal state will be used in the simulation exercises.

For the simulations, we also use data about the population aged 15 or older and the gross domestic product (GDP) in each federal state from the IBGE. The current structure of cigarette taxes and the total cigarette tax revenue with its components IPI and PIS/CONFINS in 2019 were obtained from the Brazilian Internal Revenue Service (Receita Federal do Brasil, or RFB), and the ICMS (state tax) revenue was obtained from previous data calibration by Divino et al. (2022).

Finally, we use data on seizure and destruction of illegal cigarettes from the RFB and Ministry of Economy in order to give an example of how these efforts can be related to increases in the illegal cigarette prices, as posited in our simulations. Note that the original information is obtained in terms of the value of the seized and destructed cigarettes. We convert this monetary value into physical units by assuming that each pack contains 20 cigarettes and is sold at the minimum legal price (5.00 BRL).

Price elasticities

The price-elasticities estimates used in the simulation exercise are based on the PNS data and follow the methodology proposed by Divino et al. (2022). The authors derive the conditional and unconditional price elasticities that are specific for each one of Brazil's 27 federal states. Using a propensity score matching technique, the authors also estimate cross-price elasticities—that is, how the consumption of licit and illicit cigarettes is affected when illicit and licit cigarette prices change, respectively.

Figure 2 shows the total price elasticities, which result from the combination of conditional and unconditional own-price elasticities, when considering a price increase. Overall, they are inelastic, and thus in line with the literature (Gallet & List, 2003). It is worth noting that demand by smokers in the illicit market (PC1) is more inelastic than demand by smokers of legal products, in line with previous research by Divino et al. (2021, 2022). These elasticities also show substantial regional variation. In particular, price elasticities in the licit market (PC2 and PC3) are more inelastic in the North region than in the wealthier Southeast and South regions.

Figure 2. Total price-elasticity by price category across Brazilian states
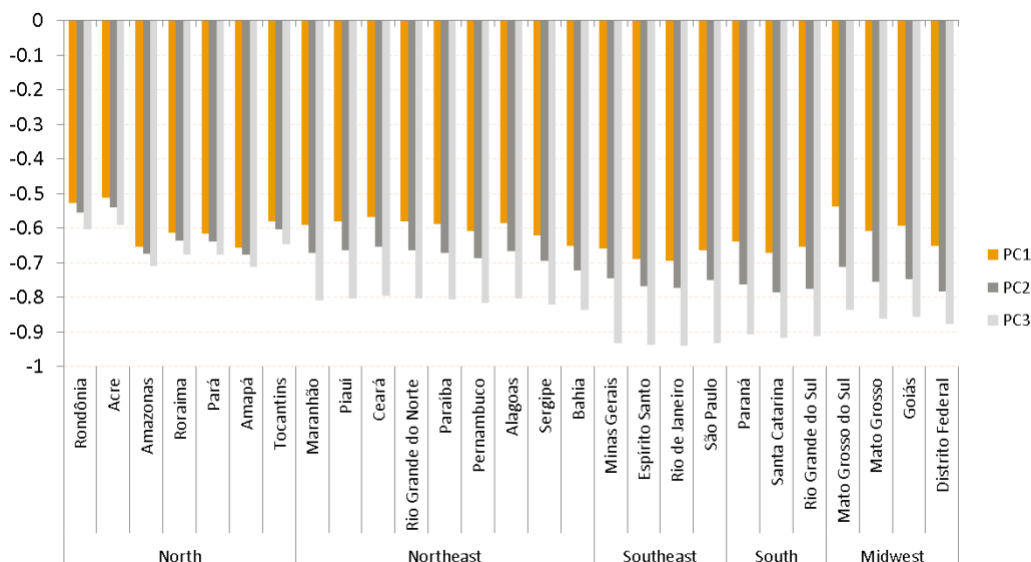
Concerning the cross-price elasticities, Divino et al. (2022) find a statistically significant cross-price effect from the illicit to the licit market but do not observe any statistically significant effect from the licit to the illicit market. Therefore, a price increase in the illicit

market leads to a consumption increase in the licit market but not the other way around. The estimated illicit-licit cross-price elasticity is 0.075, meaning a one-percent increase in the illicit market price (PC1) increases consumption in the licit market (PC2) by 0.075 percent. This switching demand effect is also included in the simulations.

In contrast to previous approaches, such as Goodchild et al. (2020) and Joossens et al. (2009), our simulations acknowledge that cigarette supply by the industry may not be perfectly elastic. In other words, it is common to assume that prices adjust only to tax changes but not through the interplay of demand and supply. We prefer to use a more realistic assumption and set the price elasticity of cigarette supply equal to 10. Although this value is still relatively high, our simulations indicate that once consumption of legally sold cigarettes increases, their prices might increase as well.

Results

The calibrated baseline scenario, per the definition, matches the 2019 total cigarette tax revenue, which accounts for 0.09 percent of the Brazilian GDP. As a first result, we find that based on the estimated total number of smokers in the population and their per capita cigarette consumption, it is indeed necessary to adjust the share of the illicit market upwards. In terms of the share of illicit cigarettes in the total consumption, the sample value based on the 2019 PNS data is 36.08 percent, while the calibrated value is 49.34 percent. The difference is due to underestimation by the PNS survey and simplifying assumptions required by the simulation strategy. Most likely, the true size of the illicit market is between these two values. Figure 3 shows the distribution of smokers by price category and federal state for the baseline scenario. It can be seen that the share of the illicit market is higher mostly in states that border Paraguay and Bolivia, confirming previous findings by Bate et al. (2019) and Masi et al. (2021), as these countries are the major suppliers of smuggled cigarettes to Brazil.

Table 1 shows a summary of the results for Scenario I. According to the definition of Scenario I in the previous section, the results indicate what would happen if measures

were implemented such that the average illicit price would equal either (a) 5.00 BRL, (b) the value of legal medium-price cigarettes at 6.81 BRL, or (c) a prohibitively high value such that illicit cigarettes would be completely unattractive to consumers.

In the first case, column (a), we find that the necessary policy effort in terms of a change of illicit cigarette prices is equal to a 13.65-percent increase relative to the baseline scenario prices. As a result, the illicit market share (PC1 – illegal) is reduced by 25.8 percent. That means that the extension of the illicit market in Brazil shrinks from 49.3 percent to 36.6 percent. The new Licit Price Category (LPC1) 1 accounts for 10.75 percent of the overall cigarette consumption. A closer look reveals that in 13 out 27 states the new illicit market average price (PC1) remains below 5.00 BRL. In the other 14 states, the relatively small price increase would be sufficient to eradicate the illicit market.

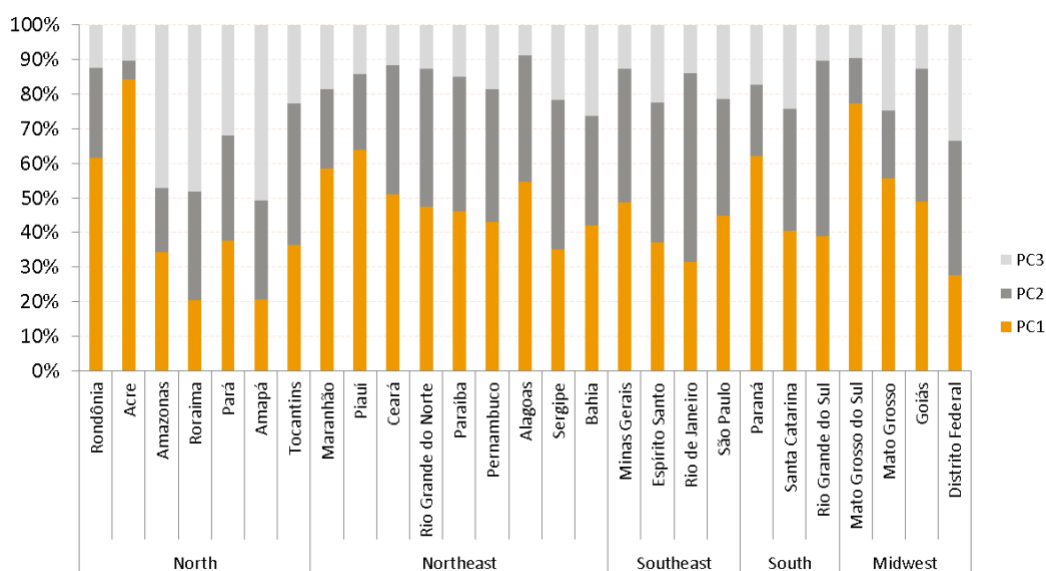**Figure 3.** Distribution of smokers by price category (PC) – baseline scenario

Table 1 also shows that Scenario I Column (a) increases by 0.95 percent the consumption of medium-price legal cigarettes (PC2), while the consumption and price of high-price cigarettes are unaffected. Finally, the total tax collection grows by 15.5 percent despite the total decreases of 3.12 percent in the cigarette consumption. This result is mostly

driven by the tax collection from the minimum-price legal cigarettes as compared to zero tax collection in the illegal market.

Regarding the second case, where the new average illicit cigarette price is equal to the average price in the medium-price category (PC2), we find that the necessary effort is equal to a price increase of 54.73 percent relative to the baseline scenario. Column (b) in Table 1 further shows that the consumption of illicit cigarettes will fall by 97.83 percent. That is, only 1 out 27 states will have an illicit price below the official minimum price (4.30 BRL). This outlier state is Mato Grosso do Sul, bordering Paraguay and located in the Brazil Midwest region. This state also currently has the second highest share of the illicit market in the country, above 75 percent according to Figure 3.

In our framework, the 54.73 percent illicit cigarette price increase in Scenario I(b) leaves the smokers of these products little choice but to buy one of the cheapest legal brands (LPC1). This price category will account for 44.15 percent of the cigarette consumption. As a consequence of the positive cross-price elasticity and the supply-side price adjustment, the medium-price category registers both a slight increase in consumption (3.83 percent) and in price (0.03 BRL). Overall, the tax revenue increases 62.3 percent while the total consumption decreases 5.06 percent, relative to the current baseline. Once again, this new scenario shows that it is possible to reap considerable gains for public health and public finance at the same time by curbing the illicit cigarette market.

Column I of Table 1 shows what would happen if the illicit cigarette market were completely eliminated. The present simulations indicate that illicit prices would have to increase by 79.7 percent on average in each state for this happen. Despite the large difference in price increases between scenarios I(b) and I(c), the outcomes are quite similar. This is the case because Mato Grosso do Sul is the only state with an illicit market in Scenario I(b) and consumers do not pay the higher illicit cigarette price but instead migrate to a minimum price legal brand.

Table 1. Results for Scenario I – migration to a minimum price category

	Baseline	(a) Illegal price chg. 13.65%	(b) Illegal price chg. 54.73%	(c) Illegal price chg. 79.73%
Tax revenue (billions BRL/year)	12.0351	13.9017	19.5329	19.8167
Change (baseline reference)	-	1.8666	7.4978	7.7816
% change	-	15.51%	62.30%	64.66%
Total consumption change (%)	-	-3.12%	-5.06%	-4.64%
Price category 1 (BRL) – illegal (PC1)	4.40	4.51	4.30	0.00
Standard deviation	0.57	0.46	0.00	0.00
Share of total consumption	49.34%	36.61%	1.07%	0.00%
Consumption (% change)	-	-25.80%	-97.83%	-100.00%
Price category 1 (BRL) – legal min. (LPC1)	-	5.00	5.00	5.00
Share of total consumption	-	10.75%	44.15%	44.83%
Price category 2 (BRL)	6.81	6.81	6.84	6.85
Standard deviation	0.27	0.27	0.27	0.27
Share of total consumption	35.06%	36.54%	38.34%	38.82%
Consumption (% change)	-	0.95%	3.83%	5.58%
Price category 3 (BRL)	10.96	10.96	10.96	10.96
Standard deviation	0.86	0.86	0.86	0.86
Share of total consumption	15.60%	16.10%	16.43%	16.36%

When the illicit cigarette market is fully eradicated, Brazil would experience a reduction in overall cigarette consumption by 4.6 percent and a gain of 44.8 percent increase in tax collection, equivalent to 7.8 billion BRL per year. For the remaining smokers, 45 percent would consume cigarettes sold at the minimum price of 5.00 BRL. Medium- and high-

price cigarette segments account for 39 percent and 16 percent, respectively, whereby only the medium-price segment is slightly larger than before the price adjustment.

Figure 4 shows the consumption variation by state for the three alternative subscenarios analyzed within the scope of the broader Scenario I. Two observations deserve detailed comments. The large decrease in consumption in states like Paraná and Mato Grosso do Sul has three causes. The illicit market is relatively large (see Figure 3), and thus there are relatively many consumers that will primarily be affected by the change in illegal cigarette prices. These states also happen to have lower illegal cigarette prices, and thus the absolute price gap between the initial illegal price and the minimum price is higher, leading to a larger decline in consumption. Finally, consumers of illicit cigarettes in the Midwest region are less price-sensitive (see Figure 2), and thus the illicit price increase causes relatively lower consumption reduction.

The second striking observation from Figure 4 is that states with the highest taxes and cigarette prices even register a mild increase in overall consumption, which is driven by our assumption that former consumers of illicit brands now buy cigarettes at the average price of the closest legal category. For example, it would be possible that someone in the Distrito Federal bought medium-price illicit cigarettes at 6.00 BRL. After the 13.65-percent increase in Scenario I(a), the new price would still be below the average of PC2, and thus the individual would move back to the LPC1. The new price of 5.00 BRL of the cigarette brand would thus be lower than before, and according to the price elasticity, consumption would increase.

So, the assumption in the simulations implies that consumers do not stick to their preferred brand but switch to brands sold at lower prices. Whenever the mean in the illicit price category is above the minimum price threshold, overall consumption increases. We think this assumption is most plausible because the initial price difference between 5.00 BRL and someone's preferred brand at the illegal price is much lower and thus more acceptable than after the 54-percent or 79-percent price adjustment.

Scenario I can be considered as conservative, despite the number of reasonable assumptions one is forced to incur in the simulations. In the following we briefly present

a comparison with the results from Scenario II, which might be seen mostly as a robustness check. Recall that the main difference between the two alternatives is that smokers of illicit cigarettes stick to their illicit brand and accept paying the new cost after price adjustment in Scenario II.

Figure 4. Results for Scenario I – migration to a minimum price category
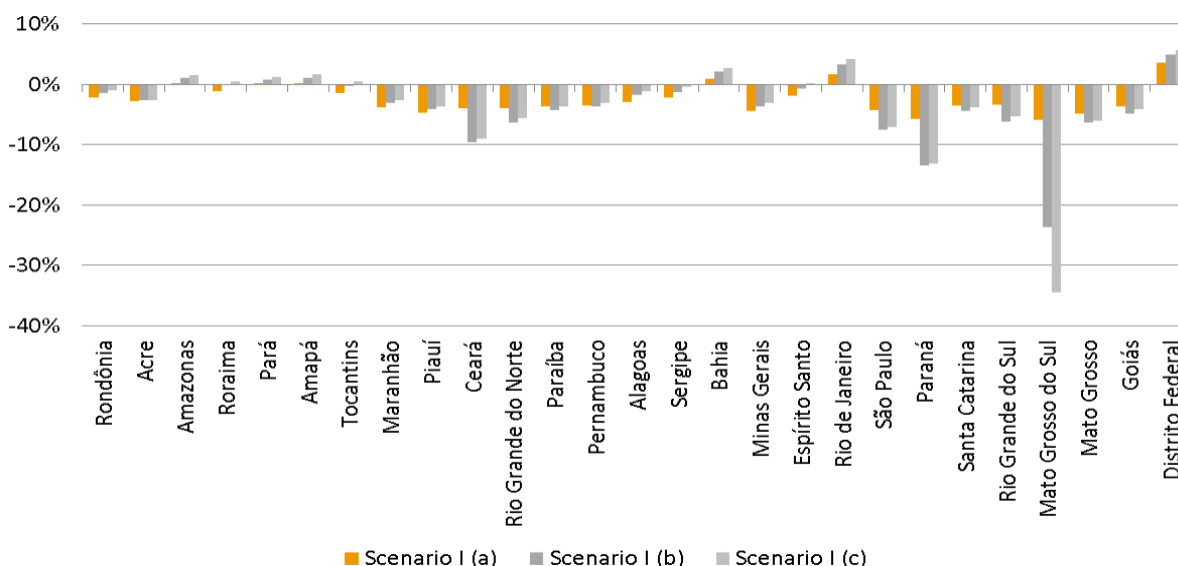
The summary of the results for Scenario II is reported in Table A1 in Appendix A. In any case, higher illicit prices lead to higher tax revenue and lower consumption. The difference here is due to the substantial price increase that smokers of illicit brands experience. The decline in consumption is much more pronounced (from 4 percent to 26 percent), while the increase in tax collection up to 51.5 percent is lower than in Scenario I but is still highly relevant to the government and society as a whole.

Data on public efforts to curb the illicit market

The fight against the illicit cigarette market is under the responsibility of federal and state governments. For the federal government, it relates to enforcement of criminal law (smuggling in general, which is federal crime), and tax crimes (tax evasion derived from IPI and PIS/COFINS). At the state level, the restriction of the illicit market is only for tax crimes (the ICMS is a state tax that is levied on cigarettes with higher tax rates). Federal

tax law brings specific rules to curb the illegal cigarette market, which is not only from smuggling, but also non-registered domestic cigarette manufacturers. At the federal level, there are three agencies that enforce anti-smuggling laws and anti-illegal cigarette laws in general. States, in general, do not deploy task forces or operations to tackle the illegal cigarette market, just regular tax auditing.

As a consequence, the seizure of illegal cigarettes is overwhelmingly conducted by federal authorities, as state seizures are insignificant in comparison to the federal actions (there is no available information on state seizures). Therefore, all the relevant data on the fight against the illegal cigarette market is federal. There are three federal agencies that can enforce laws against illegal cigarettes: Federal Police (PF), Federal Patrol Police (PRF), and the Federal Revenue Service (Federal Revenue Secretariat, or RFB). In Brazil the RFB is also the customs authority, responsible for controlling international trade. All the seized cigarettes are destroyed only by the RFB. There are facilities prepared to destroy cigarettes under specific protocols, which includes environmental concerns.[2] Therefore, the data on illegal cigarettes destruction is the most relevant and trusted information on the efforts of the federal government to curb the illegal cigarette market. Figure 5 reports the volume of seizures and destruction of illegal cigarettes (packs of 20 cigarettes) in years 2019 to 2021. The main reason for the lack of matching is because there is a delay between the seizure and the destruction.

Figure 6 shows the volume of seizure and destruction per state. It is worth mentioning that the border states with Paraguay, such as Paraná and Mato Grosso do Sul, show the highest volumes, just because these states are the main entrance gates of illegal smuggled cigarettes. The state of Sao Paulo is third in volume because it is the largest market, concentrating around 22 percent of the Brazilian population (for comparison Paraná and Mato Grosso do Sul represent 5.1 and 1.3 percent of the country's population, respectively).

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[2] Decree-law n. 1.593/1977, art. 14.

Figure 5. Volume of seizures and destruction of illegal cigarettes
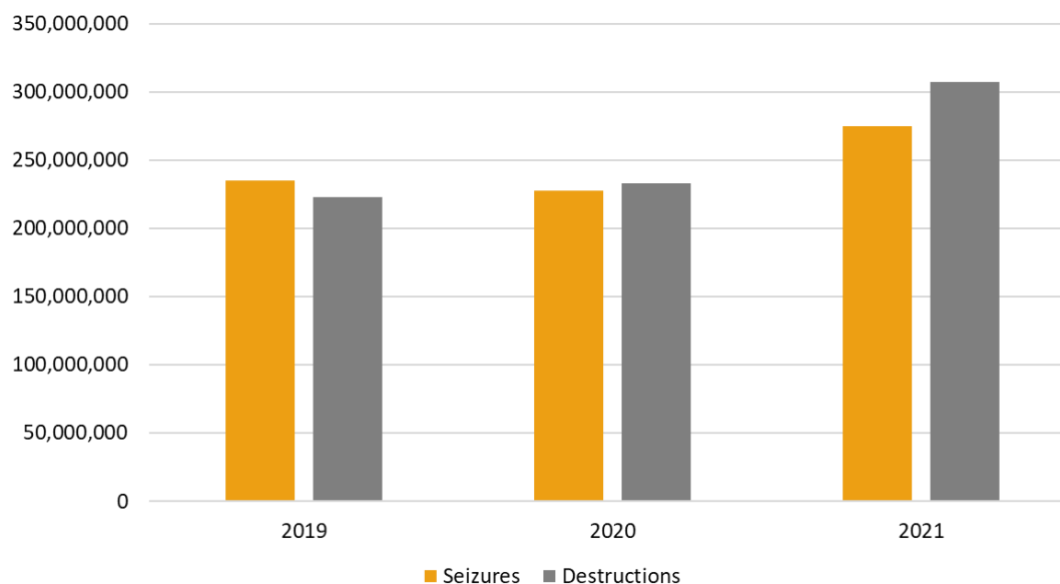

Figure 6. Volume of seizures and destruction by state

Table 2 reports the effects of the seizures/destruction on the size of the illicit market. The volume of seizures/destruction is a parameter of the effort of the federal government to

curb the illicit market. According to Table 2, the volume of seizures and destruction account for about 11 percent of the illicit market. By using our estimated price-elasticities of illicit cigarette consumption and assuming that the demand did not change, the reduction in supply due to the seizures would lead to an illicit cigarette price increase of 18.2 percent. Considering the volume of destroyed illicit cigarettes and applying the same reasoning, the impact on illicit prices would be equivalent to an increase of 17.23 percent at the aggregate country level. These levels of efforts and resulting impacts on illicit cigarette prices resemble the assumed price increase in Scenario I(a) of the simulations reported in Table 1 and Scenario II(a) of Table A.1 from the Appendix.

Table 2. Impact of seizure/destruction of illegal cigarettes on the illegal market

	Total (packs)	Country aggregate		State average	
		Decrease in illicit supply	Increase in illicit price	Decrease in illicit supply	Increase in illicit price
Seizures	235,262,541	-0.1119	0.1820	-0.0839	0.1416
Destruction	222,742,365	-0.1059	0.1723	-0.0689	0.1156

Conclusions

The present research exploits independent micro-level data from the PNS 2019 and simulates the effects of curbing the illicit cigarette market for cigarette prices, consumption, and tax collection in Brazil. The PNS 2019 data illustrate that the share of the illicit market is around 36 percent and thus among the largest in the world. The classification of cigarette brands as licit and illicit according to the ANVISA recommendation is highly reliable and directly available from the PNS survey. The official data show that illicit cigarette prices and the extent of the illegal market vary substantially across Brazilian states. It emerges as a general pattern that regions with lower taxes, lower legal cigarette prices, and bordering Paraguay, Bolivia, and Peru have a higher share of illicit cigarettes in the total cigarette consumption.

By using these data and previous results of own- and cross-price elasticities in estimations by Divino et al. (2022), we simulate alternative scenarios for curbing the illicit cigarette market in Brazil. The simulations showed that, even in the context of a middle-income country with a large illegal cigarette market, consumers are sensitive to price changes. In particular, we observe that higher illicit cigarette prices induce smokers to quit, to consume less cigarettes, and to switch to legal brands. It should also not come as surprise that the more that is invested in curbing the illicit market, the higher the tax collection at the federal and state levels. Brazil could gain as much as 7.9 billion BRL per year, corresponding to an increase of 65 percent in cigarette tax collection, when the illicit market is eliminated completely. On the other hand, the illegal market could be reduced by 98 percent if illegal prices were increased by about 55 percent. The resulting gain in tax collection would be 7.5 billion BRL per year, equivalent to a 64-percent increase. The cigarette consumption would decline by 5.0 percent relative to the baseline.

The following policy recommendations can be drawn from our simulations. It is highly beneficial for the country to invest in measures that disrupt illicit cigarette production and sales, as both tend to increase illegal cigarette prices. The WHO FCTC and the Protocol to Eliminate Illicit Trade in Tobacco Products provide useful guidelines to achieve these goals. Furthermore, tobacco control measures, such as increasing tobacco taxation and fighting illicit trade, would be much more effective if prices in the legal market had not been decreasing in real terms over the recent years (Divino et al., 2022). To this end, either cigarette taxes and/or the minimum price should be adjusted upwards, as both have proven to be appropriate tools to decrease tobacco consumption. Additionally, enforcement of laws against smuggling and the illegal cigarette market must be strengthened in order to reduce the size of the illegal market.

It is also important to add that, although beyond the scope of the present research, lower overall cigarette consumption will lower health expenditures and increase workers' productivity, as demonstrated in extended cost-benefit analyses by Fuchs et al. (2019), Gomes et al. (2020), and Divino et al. (2019).

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Appendix

Appendix A. Additional simulation results

Table A1. Results for Scenario II – migration to the closest price category with a lower price per pack

	Baseline	(a) Illegal price chg. 13.65%	(b) Illegal price chg. 54.73%	(c) Illegal price chg. 79.73%
Tax revenue (billions BRL/year)	12.0351	13.7794	18.2273	17.6847
Change (baseline reference)	-	1.7443	6.1923	5.6497
% change	-	14.49%	51.45%	46.94%
Total consumption change (%)	-	-3.97%	-16.14%	-26.37%
Price category 1 (BRL) – illegal (PC1)	4.40	4.51	4.30	0.00
Standard deviation	0.57	0.46	0.00	0.00
Share of total consumption	49.34%	36.93%	1.21%	0.00%
Consumption (% change)	-	-25.14%	-97.54%	-100.00%
Price category 1 (BRL) – legal (LPC1)	-	5.45	6.42	6.46
Standard deviation	-	0.41	0.37	0.99
Share of total consumption	-	9.96%	28.78%	7.63%
Price category 2 (BRL)	6.81	6.81	6.86	6.88
Standard deviation	0.27	0.27	0.25	0.26
Share of total consumption	35.06%	36.86%	51.40%	71.18%
Consumption (% change)	-	0.95%	22.93%	49.48%
Price category 3 (BRL)	10.96	10.96	10.96	10.96
Standard deviation	0.86	0.86	0.86	0.86
Share of total consumption	15.60%	16.24%	18.60%	21.19%

Figure A1. Results for Scenario II – migration to the closest price category with a lower price per pack