SENSITIVITY OF CIGARETTE CONSUMPTION TO TAX INCREASES IN PERU

FINAL REPORT[1]

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1) Introduction

The use of tobacco is one of the main preventable causes of death around the world (WHO, 2017). It kills more than 7 million people each year, more than HIV/AIDS, tuberculosis and malaria combined, and the economic costs including the costs of healthcare and productivity losses associated with increased morbidity and mortality, are calculated at about 1.8% of global GDP, with a disproportionally large burden assumed by poor countries and families (Goodchild, Nargis and Tursan d'Espaignet, 2017).

Assumed as a global epidemic, WHO has been leading a global and comprehensive effort to prevent and ameliorate such enormous health, social, environmental and economic costs. In 1999, the WHO called member states to negotiate a treaty to define a Framework Convention on Tobacco Control (FCTC), with the first version of the treaty being adopted by the World Health Assembly in 2003[2]. The framework includes measures that attack the supply and demand for tobacco products: protecting people from smoking, offering help for smokers to quit, regulating the provision of information about health effects of smoking and advertising and promoting the use of taxes to discourage smoking initiation or encourage smoking cessation. The specific guidelines include the monitoring of tobacco use and the implementation of policies and laws promoted by the FCTC in the different countries, and have been periodically improved or expanded. The implementation of the FCTC has gained support outside the WHO over the years, and is now part of the sustainable development goals (SDG) promoted by the UN (target 3A), as part of the strategy to reduce in one-third the death rate associated with non-communicable diseases (Goal 3.4).

Although the implementation of tobacco control measures has increased worldwide, reductions in tobacco use have not progressed as quickly as hoped by tobacco control proponents (Irwin et. al., 2017). The proportion of smokers have decreased in the last few decades, but the number of smokers continue to grow slightly, especially in low and middle-income countries, which calls for a more integral approach to combat tobacco use worldwide. Thus, the FCTC guidelines have been upgraded over time, improving in the identification of the most effective policies and the specific implementation strategies required for maximum results. A key development has been the increased focus on tobacco tax policy reform, as one of the most effective policy measures to generate reductions in tobacco use (Jha et al., 2012). Increasing tobacco taxes is widely considered a win-win policy measure, as it not only reduces tobacco consumption, and improves public health in the long run, but also allows for a rapid increase in public resources to help afford treatment of smoking-related diseases or other key social policies. The use of tobacco taxes is already very important in developed countries, and is increasing in LMICs, and in the Latin American and Caribbean (LAC) region, in particular, and some key lessons have become clear to define a consistent tobacco control policy. The use of uniform, specific excise taxes is widely seen as the most effective tax policy strategy to drive down consumption and initiation, increase quitting, and to keep smokers from switching

[2] Since then, there has been four other sessions that has augmented and perfected the agreements, with the last one occurred in 2012.

cheaper brands. However, for its effects to be sustainable, there need to be clear rules for periodic adjustments to keep up with inflation and income growth to reduce affordability. Several countries in the LAC region have been progressing in the implementation of tobacco tax reform, generating opposition from the tobacco industry and a public debate that unfortunately have not relied on rigorous evidence.

In Peru, smoking is the 10th cause of mortality (Forouzanfar et al.,2016). Official statistics indicate that around 16,000 deaths a year can be attributed to smoking. Furthermore, each year almost 400'000 years are lost because of premature death and disability as a result of tobacco use (Bardach et al., 2016). Peru made limited progress with the implementation of the FCTC and its guidelines until relatively recently. Peru signed the FCTC in 2004, and in 2006, the government approved a law that regulated the size of the warning in each pack, restricted selling, promotion, advertising and sponsoring of cigarettes to minors. By 2010, a new law expanded the prohibition of smoking in closed public spaces to all public and work spaces. In that same year, the excise tax was raised significantly and changed from ad-valorem to a specific (quantity-based) tax, but no further adjustments were applied until 2016, the year in which we saw the largest increase in the tobacco excise tax, amid a major tax collection crisis that had reduced the tax burden by 3 percentage points to 13.5% of the economy's GDP (BCRP, 2018). The size of the tobacco excise tax was later adjusted in March 2018, together with several other taxes on unhealthy goods, including alcohol and sugar-sweetened beverages, among others. This was the first time the public health rationale was mentioned in such tax adjustments.

Not surprisingly, tobacco control measures have generated a public debate about their overall benefits and costs. However, as has happened in nearly every country, such discussion has often been based on conceptual arguments raised by groups associated to the tobacco industry, but without the support of rigorous empirical evidence. This study aims to contribute to the discussion about the potential effects of a tobacco tax reform in Peru, using the most relevant databases and methods available. Our analysis is heavily based on the use of the two main databases generated by the National Commission for Development and Life without Drugs (DEVIDA), an autonomous public office in charge of the design and implementation of the National Strategy for the Fight against Drugs, in coordination with the relevant offices of the Peruvian public sector, civil society and the international community. DEVIDA applies periodically one general population survey and another one for high school students, in which they utilize a large questionnaire with details about their use of different drugs, including cigarettes, alcohol, as well as other illicit drugs. We first use the 2010 general survey to estimate a reduced form of the demand for cigarettes, to check whether the estimated elasticities support the double-gain hypothesis, and if there are specific population groups for which such elasticity is significantly different. Second, we use the youth survey (four rounds) to analyze the patterns of smoking onset by Peruvian youth, with the help of a duration model with cigarette prices and income as time-varying explanatory factors.

Our results first confirm a price elasticity of tobacco consumption that is consistent with previous estimates for the region, and in Peru, and suggests the double-win hypothesis that makes the tobacco tax reform the most effective policy to control tobacco consumption. Our

simulations also show that such an estimate is consistent with the change in imports and tax collection after the excise tax raise of April 2016. Second, we find clearly that Peruvian youth do respond to price increases by postponing or avoiding their smoking onset. Doubling the price of cigarettes can delay smoking onset by 1.2 years (or 14 months), which is an important result, as such delay reduces the chance that these young individuals will become smokers as an adults. Also importantly, we find that such response is heterogeneous, with males and the poor being more sensitive to price changes. Overall, we interpret these results as supporting the importance of tax increases for cigarettes for tobacco control, with their positive consequences for the health of individuals and the productivity of the economy.

This report has the following structure. After this introductory section, section 2 characterizes tobacco consumption in Peru, and the policy interventions that have been tried within the FCTC. Section 3 describes the different data sources used in this study, not only the survey data mentioned above, but also price, poverty and trade data. Section 4 provides a detailed description of the econometric methods used for this study. Section 5 presents the results, the price elasticity estimates and the simulations tried for robustness. Section 6 concludes with a discussion of results and their policy implications.

2) Cigarette consumption patterns and tobacco control policies in Peru

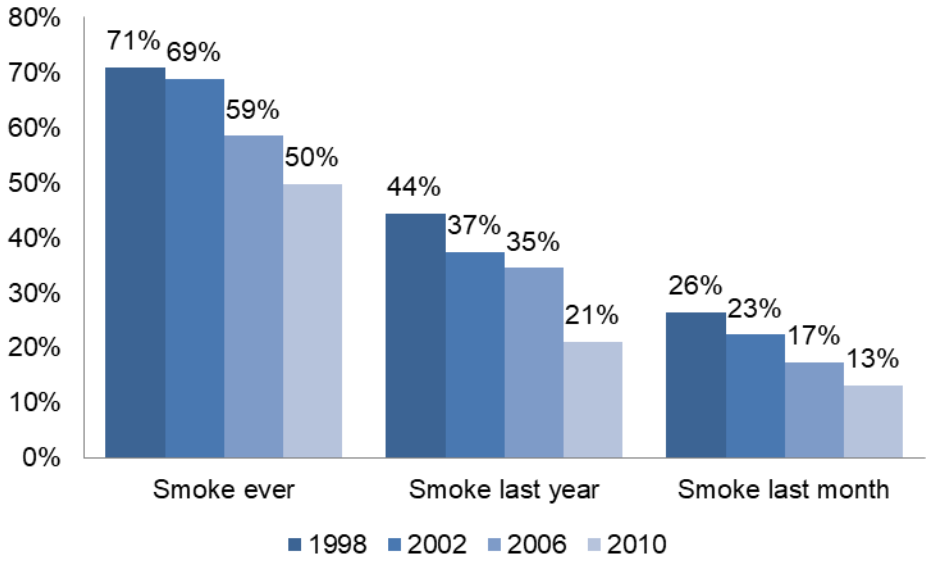
After several decades of political turmoil and economic stagnation, Peru has shown a strong economic recovery during this century, which has already reflected in several dimensions of social and economic development, as the country simultaneously progressed into the demographic transition. Such evolution is also reflected in an epidemiological transition as the effects of non-communicable diseases (NCDs) have been increasing while several communicable diseases still remain as key health risk factors, so that the pressures to the health system are especially complex. Globally, the largest risk factors are high blood pressure, smoking and high fasting plasma glucose (Forouzanfar et. al., 2016). In Perú, alcohol use and smoking ranked fifth and seventh, respectively, as risk factors, although heterogeneities are particularly worrisome because the magnitude of these risk factors varies among key sub-populations (Huicho et. al., 2009). In this section, we first present some key patterns of tobacco consumption in Peru, and identify some key relevant heterogeneities. We then present a timeline of the tobacco control policies that have been implemented in Peru, that are based on the FCTC.

2.1) Cigarette consumption patterns

For this characterization, we use the four rounds available of the National Survey of General Population of Drug Use (1998, 2002, 2006 and 2010) applied by DEVIDA. The representative sample was randomly chosen and included not only adults (up to 65 years old) but also teenagers (12 and older). Figure 1 shows the prevalence of smoking under alternative definitions, showing a clear decreasing trend. By 1998, 71% of the population had ever smoked, 44% had smoked the previous year, and 26% were current smokers, that is, they had smoked in the previous month. Such figures decreased to 50%, 21% and 13%, respectively, by 2010.

According to PAHO (2016), the 13% prevalence of smokers puts Peru in the group with low prevalence (10-20%) in the region, similar to Colombia, Paraguay and Brazil. The middle group includes Argentina and Uruguay (around 25%); whereas Chile and Ecuador are in the group of high prevalence (above 30%).

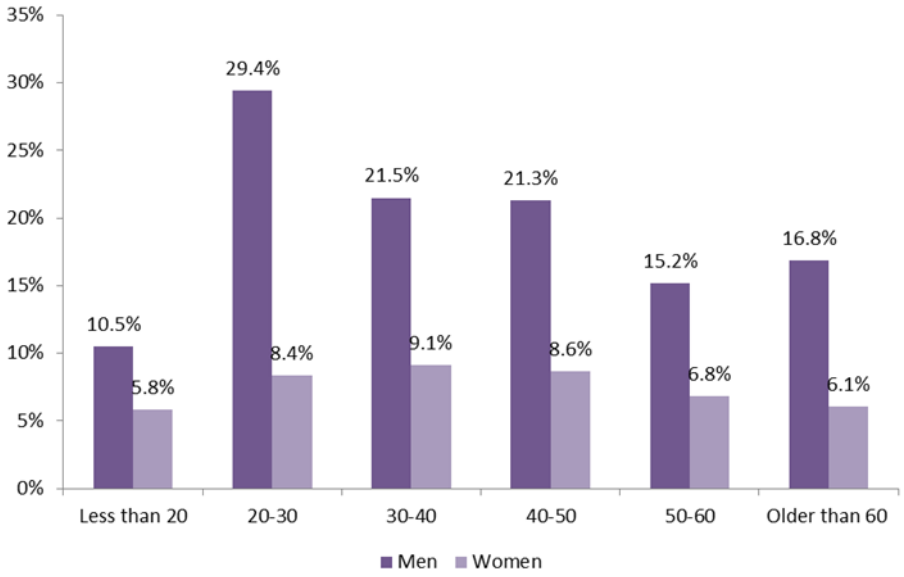
Figure 1: Smoking time trends, alternative definitions



Source: National Survey of General Population – 1998, 2002, 2006, 2010 (DEVIDA)
Elaborated by the authors

Although the decreasing pattern is important, the disaggregation by gender and age raise some concerns. First, the smoking rate among males is more than twice the one for females, reaching 20%, even in 2010, the last year of observation. Even more worrisome is that young males have even higher smoking rates than their older counterparts, which implies that smoking rates are not going to decrease as much as one might wish, considering health and economic costs. Figure 2 shows that 30% of young males (age 20-30) smoke, while only 15% of the individuals in their fifties smoke. In the case of women, the pattern is stable, with females in their twenties presenting similar smoking rates to those in their forties (around 8.5%). A possible explanatory factor for a relatively high smoking rate by male young adults is the marketing strategy boosted by tobacco industry in order to target these young men (USNCI, 2016).

Figure 2: Smoking rates 2010, by sex and age group

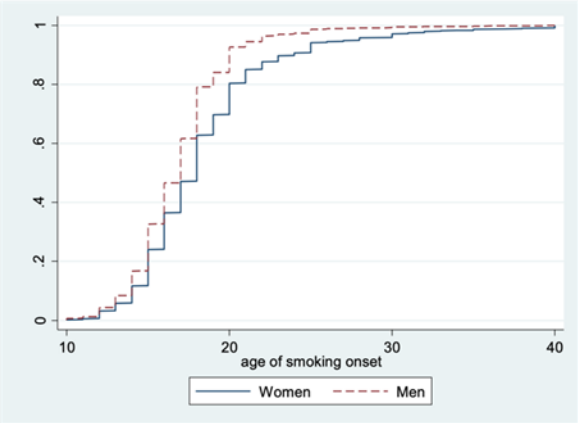


Note: Prevalence is defined as the percentage of people who declared having smoked in the last month
Source: National Survey of General Population – 2010 (DEVIDA)
Elaborated by the authors

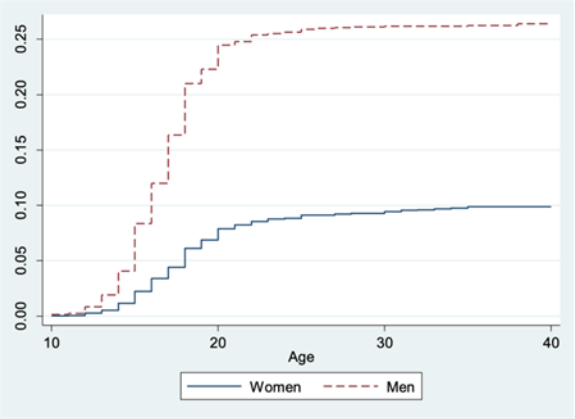
Another important related pattern to observe is smoking onset by gender. Panel (a) of Figure 3 shows that most current smokers start before age 20. About 80% of females and 92% of males are already smoking by age 20. Further, panel (b) shows that boys start differentiating from girls at age 14 in the age of smoking onset.

Figure 3: Smoking onset patterns, by gender

a. CDF



b. Hazard function

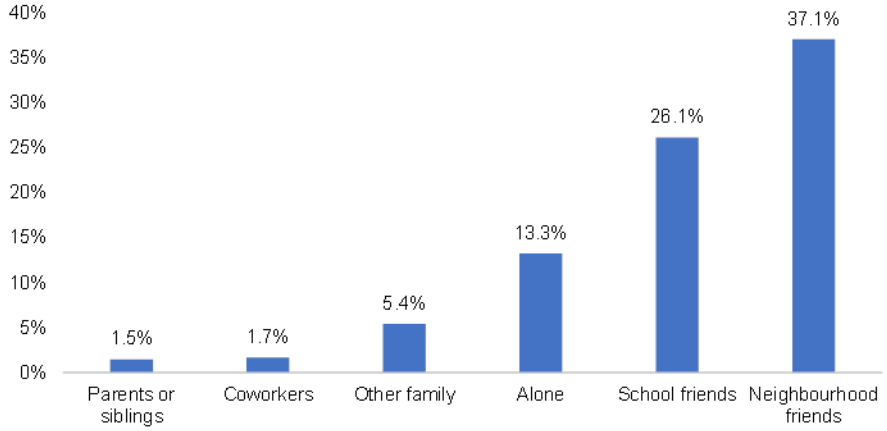


Note: Population base are individuals who declared having smoked in the last month
Source: National Survey of General Population –2010 (DEVIDA)

Smoking tends to be a social activity, and it is evident that the majority of smokers tends to start smoking with peers (Figure 4). The influence of peers on smoking behavior has been well documented (Distefan, Gilpin, Choi, & Pierce, 1998; Hoffman, Sussman, Unger, & Valente,

2006). These surveys show this pattern, too, with the majority (63%) having their first experience smoking with peers (school and neighborhood friends). Crawford (2001) finds that the most common reason for trying and /or starting to smoke is "fitting in" and the source of this pressure is peers (Crawford, 2001). However, smoking first with family can have an effect in future trends. Evidence finds that parent smoking behavior is a significant predictor of smoking, especially for females. (Chassin, Presson, Sherman, Montello, & McGrew, 1986).

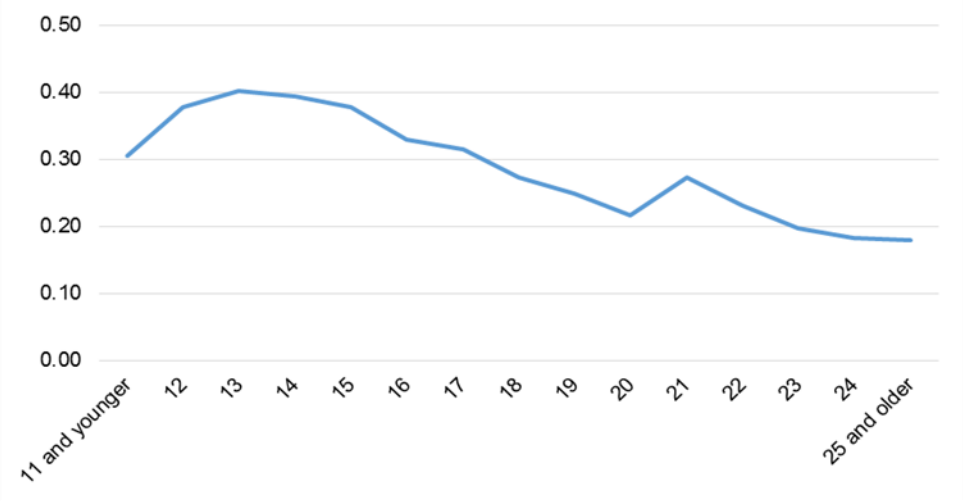
Figure 4: First smoking experiences



Source: National Survey of Secondary Students – 2007, 2009, 2012, 2017 (DEVIDA)
Elaborated by the authors

On Figure 5 we have the proportion of current adult smokers by the age at which they first tried a cigarette. Not everyone that tries a cigarette ends up being a smoker, but we can see a trend. The younger they start, the higher the current smoker proportion is higher. Therefore, it suggests that delaying that first experience just a few years could reduce smoking prevalence significantly. Initially, the proportion of smokers increases as they start older, with a breaking point around 13. From that age forward, the percentage of adult smokers drops with each year they delay to smoking initiation. Other studies show that the age of smoking initiation is a determinant factor of nicotine dependence. The younger they start to smoke, the higher the level of nicotine dependence and consequently, the number of daily-consumed cigarettes (Charkazi, Sharifirad, Zafarzadeh, & Shahnazi, 2016; Kendler, Myers, Damaj, & Chen, 2013).

Figure 5: Proportion of current smokers by starting age



Source: National Survey of General Population – 2010 (DEVIDA)
Elaborated by the authors

The other important disaggregation is the one by socio-economic status (SES), considering that the economic burden is understandably higher for the poor, as their consumption of cigarettes represent a higher proportion of their household budgets. Table 1 shows the prevalence of smoking by SES, using the DEVIDA 2010 survey of drug use, showing that prevalence among the poorer tercile (13.4%) is not statistically different from the prevalence among the richer tercile (14.5%). The intensity does show that poorer individuals smoke more cigarettes a month (21) than their richer counterparts (18). Unfortunately, we could not use the same survey to properly establish the proportion of the household budget that is allocated to smoking expenditures. However, we can use the ENAPREF 2010 to do such estimations because they collect such information from all household members. These data demonstrate significant differences by SES, as the poorer households allocate 5.2% of their budget to smoking, while the richer households allocate only 2% of their budget, confirming that these expenditures are regressive. However, raising tobacco taxes could still be progressive on a population level if the poor are more sensitive to prices than rich, as that would mean that their contribution to tax collection would be smaller. Moreover, tax revenues can be allocated toward providing resources to smoking cessation in lower SES populations.

Table 1: Prevalence and Intensity of Tobacco use, by SES groups

	Overall Population	First Tercile	Second Tercile	Third Tercile	P-values		
		(1)	(2)	(3)	(2)-(1)	(3)-(1)	(3)-(2)
Prevalence	13.27%	13.39%	12.21%	14.50%	0.034	0.068	0
		(0.004)	(0.004)	(0.005)			
# of cigarettes	18.306	21.134	14.145	18.477	0.000	0.166	0.035
per month		(1.120)	(1.337)	(1.558)			

Note: Prevalence is defined as the percentage of people who declared have smoked in the
Source: National Survey of General Population –2010

2.2) Policy interventions

As indicated in the introduction, WHO is leading an aggressive initiative to control tobacco consumption, especially in developing countries. A key instrument for this initiative is the Framework Convention on Tobacco Control (FCTC), that defines the key policies that need to be promoted, with specific guidelines for their implementation. Thus, we start this sub-section by describing this framework and its guidelines, and then follow with a description of the policies that Peru has been gradually adopted in support of the FCTC. A useful way to summarize some of these key guidelines is to use another acronym utilized by the WHO, MPOWER, which represents a set of recommended policies: i) **M**onitor tobacco use, ii) **P**rotect people from tobacco smoke, iii) **O**ffer help to quit, iv) **W**arn about the dangers, v) **E**nforce bans on advertising, and finally vi) **R**aise taxes. Below we review the evidence that supports specific policies.

Monitoring tobacco use

Available information about tobacco use is vital when implementing or modifying tobacco control policies. Every other year, WHO gathers data from country surveys to elaborate the "Report on the Global Tobacco Epidemic". It contains a large set of indicators at global, regional and country levels that is useful to monitor the evolution of tobacco use. Moreover, the Global Tobacco Surveillance System (GTSS) provides a large source of information about prevalence, knowledge and behavior through four periodic surveys.

However, both the biannual report and the GTSS sometimes provide limited or even fail to provide information at country-specific needs. This is why countries should implement recent, periodic and nationally-representative surveys that measure a broad set of indicators on tobacco use for both adults and youth (WHO, 2017).

Protect people from tobacco smoke

Banning smoking in all public places is an important policy to protect both smokers and nonsmokers from the health consequences, that is often more cost effective than cessation programs (Hopkins et. al., 2010). First, creating smoke-free environments reduces exposure to second-hand smoking (SHS), thereby reducing the amount of environmental tobacco smoke (ETS) particles in nonsmokers and reduces the quantity of related deaths, such as lung cancer or heart disease, among others (Hole, 2005; Valente et al., 2007). Second, evidence from workplace smoking bans also shows that they alter the amount and way smokers consume cigarettes, as smoking with bans implies moving towards public open space which increases time away from work, limit social interactions and induces guilt (Ritchie, Amos and Martin, 2010). Furthermore, smoking bans could also be beneficial for employers, as they induce savings in operation and maintenance of buildings, reduced absenteeism and fewer fires.

In sum, the evidence in developed countries shows that comprehensive smoke-free bans have an impact on indoor air quality and exposure to SHS (Hahn, 2010). However, information on the effects of smoke-free laws in lower and middle income countries is not as easy to come by. Uruguay and Mexico were the first two countries in Latin America to implement a smoke-free policy, and some studies show reduced exposure to SHS as a result,

although the effects have been undermined by high non-compliance, especially in bars and workplaces (Thrasher et al., 2013).

Offer to help people

Within this label, the FCTC promotes the implementation of publicly-funded cessation policies, including the use of pharmacotherapy as well as behavioral interventions, with a combined treatment being the most effective (Rigotti, 2002; Siu et al., 2015). The most cost-effective pharmaceutical interventions are those based on the use of bupropion or varenicline (non-nicotine medicines), and nicotine replacement therapies (NRT), including the use of gum and patches, that reduce withdrawal symptoms and block the reinforcing effects of nicotine without causing excessive adverse effects (Lemmens, et. al., 2008). Behavioral interventions include counselling sessions to provide advice, discussion and encouragement to those trying to quit smoking using motivation, self-efficacy and peer support/pressure techniques.

Warn about the dangers of tobacco

The understanding of the health risks associated with tobacco use has a strong influence on smokers' behavior. There have been significant improvements in the overall understanding of the dangers of smoking through the years, but there is still a gap affecting some specific groups (U.S. National Cancer Institute and World Health Organization, 2016). The FCTC guidelines are clear in identifying the use of health warning labels in cigarette packages, especially with the use of pictures with dramatic examples of health damages rather than plain text, as one of the most effective ways of informing about the health risks of tobacco use. Smokers who notice warnings are more likely to believe in the health effects associated, thus promoting a change in attitude and behavior towards smoking.

Enforce bans on tobacco advertising, promotion and sponsorship

The FCTC promotes the use of the most comprehensive advertising bans, considering tobacco manufacturers have traditionally used the most creative and intense marketing strategies to increase the social appeal of smoking, alter the social norms about it, and to dissociate its consumption from the dramatic health effects it has over time (WHO, 2008).

The evidence surrounding the impacts of bans on tobacco marketing finds a negative relationship between the comprehensive bans and consumption. However, studies also show that non-comprehensive advertising bans will have little to no effect, probably because in that case the tobacco industry is able to move the advertising dollars to the most effective legal marketing strategies. Thus, the legal framework needs to monitor the marketing strategies used by the tobacco industry to guarantee a sustained effect on smoking (Saffer & Chaloupka, 2000; Wakefield et al., 2002). As the first bans focused on advertising on the packs and in traditional media (newspaper, radio, TV), the industry moved to the sponsorship of popular events for specific target groups, for instance, women and the youth. Now, the industry moves towards the use of social media "influencers" to promote smoking by associating it to the idea of independence, autonomy, fashion and even weight control in the case of women. The use of

social media by the industry represent an important challenge as this media is still complicated to be regulated.

Raise taxes

Tobacco excise taxes are defined by the FCTC as the best tobacco control policy because it affects the tobacco epidemic in three ways. First and foremost, evidence from a growing number of countries shows that taxes are effective in reducing demand, which could typically reduce prevalence (US-NCI, 2016). As Chaloupka, Yurekli, & Fong (2012) show, significant increases in excise tobacco taxes can lead to tobacco use reductions and better public health as a result. In addition, global evidence suggests that younger people and people with lower income have a higher elasticity towards tobacco, that is, they are more responsive to tobacco prices increases than their older, richer counterparts (Barber, Adioetomo, Ahsan, & Setyonaluri, 2008). Finally, unlike every other tobacco control policy, it is a new revenue stream for governments. Although the elasticity is negative and high enough to generate sizable health effects, the demand for tobacco is still inelastic, that is, that the percentage reduction in quantity is less that the percentage increase in price, resulting in increased tax collection (Savedoff & Alwang, 2015).

The benefits of tobacco tax increases obviously exclude the tobacco industry. Thus, it is not surprising to see the industry representatives and experts highlighting the perils of raising tobacco taxes, the main one being that it induces illicit trade of cigarettes rather than the desired health and tax collection effects. While this can be true, the real problem is generally overstated by the industry. The general recommendation is not to eliminate tax increases, but to monitor smuggling and attack its associated factors such as corruption and economic informality such as casual (e.g., unlicensed) sellers (Chaloupka et al., 2012; World Bank, 1999).

Specific tax control policies introduced in Peru

As indicated above, Peru signed the FCTC in 2004, and the implementation of the corresponding guidelines started in 2006 with the General Law for the Prevention and Control of the Risks of Tobacco Consumption (Law No. 28705) that regulated smoking in closed public spaces; advertising in selling places, TV or radio; the inclusion of health information in cigarette packs; among others. Smoking was prohibited in schools, health facilities and public transportation units, but other public places were still allowed to include smoking areas. Cigarette products could not be termed “light’, could not be sold in packages of less than five cigarettes, and half of the “main side” of the cigarette pack had to include phrases and graphic warnings about the health damages of smoking. Advertising on public TV and radio was prohibited, but it is still permitted to advertise cigarettes on cable TV, selling places and magazines, although 15% of the ads needed to include health warnings. Also, the ads and sponsorships could not be specifically targeted to minors, for instance in events where minors participate, such as sporting events.

By 2010, the Law No. 29517 made a few adjustments to the 2006 law, first to explicitly state the goal to comply with the FCTC. In substance, the new law prohibited smoking areas in

all public closed spaces declaring them as smoke free zones, increased the minimum size of the cigarette packs to 10 sticks, and increased the area of the cigarette packs to include health warnings by requiring to include half of both main sides of the pack. With this final adjustment, the Peruvian law did increase its compliance with the FCTC guidelines, with the most questionable omission among the non-price measures being that advertisement of cigarettes is still allowed on cable TV, in magazines and through sponsorship of events targeting youth, such as concerts, music festivals or discos. There are only weak efforts to implement effective cessation policies. The Ministry of Health has recently implemented a toll-free quitline, providing information about the nearest healthcare facility where smokers could receive counselling about drug abuse and prescription medicines, such as nicotine substitutes. However, this type of therapy is not covered by the public health insurance (SIS), so there still exist important barriers to access to such services for the low-income population. Another weakness seems to be the enforcement of some of the regulations, for instance, the prohibition of single stick purchases/sales. The DEVIDA survey on drug use for Metropolitan Lima shows a worrying pattern, as 43% of current smokers reported buying single sticks.

With respect to the taxation of cigarette consumption, the Peruvian law had been moving slowly until recently[3], with two adjustments in the last 3 years (2016 and 2018) that has increased the tax burden to average levels in the South American region (see Annex 2). Taxation of cigarettes dates back to April 1999, when cigarettes were charged with a specific-tax of S/ 0.05 per stick. Quickly thereafter, though, the government changed towards heterogeneous amounts depending on the type of cigarette: dark-tobacco, standard blond, and premium blond, with the latter being the more heavily taxed (S/ 0.10 per stick). This structure was later challenged by the tobacco industry in 2001 arguing that it was discriminatory, as the premium blond was defined based on their presence in other markets, resulting in only the products of the multinational tobacco firms being more heavily taxed. The Constitutional Court agreed with them, and the government was forced to switch towards an ad-valorem tax, first based on the value ex-factory, and later on the retail price, by 2003.

As indicated above, Peru signed the FCTC in February of 2004, and although they gradually adopted several of the recommendations for tobacco control, these adjustments did not touch tobacco tax reform for a long time. It was only in 2010, that the government decided to switch again from an ad valorem excise tax to a specific excise tax, in compliance with a key recommendation of the FCTC. The tax was set at of 0.07 soles per stick, which at the time implied a total tax burden of 45% of the retail price[4]. Although, the FCTC also recommends to monitor the evolution of inflation and affordability to periodically adjust the specific tax, no adjustments occurred in the next six years, which implied a reduction of the tax burden for cigarettes over the years (because of both inflation and income growth). The next adjustment came in 2016, together with an adjustment in fuel taxes, and implied the largest increase in

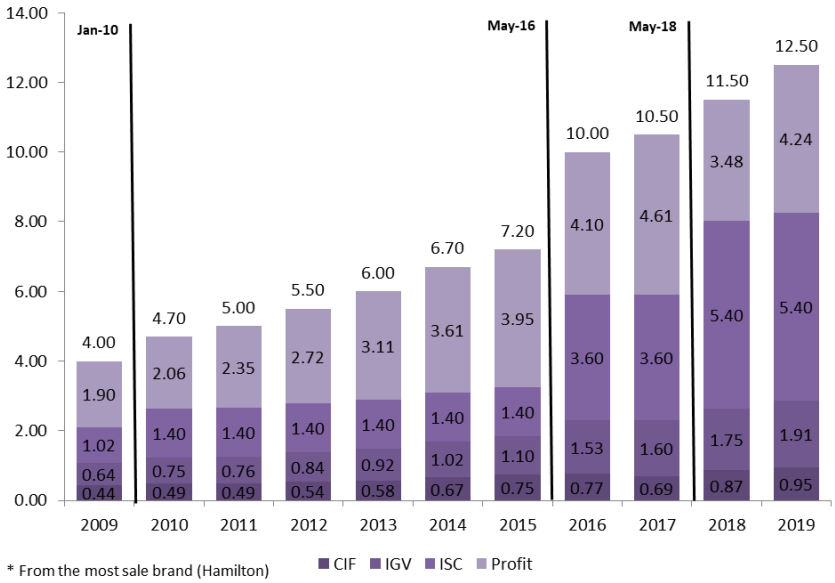
[3] Annex 1 summarizes every modification of tobacco taxes since 1999

[4] The total tax burden includes not only the specific tax but also the sales tax (18%) and the import tariff, although such tariff is cero in Peru, for the period under analysis. The FCTC guidelines establish a goal for the total tax burden of 75% for countries to approach it gradually (WHO, 2015).

history for the taxing of cigarettes, to 0.18 soles per stick, which increased the tax burden from 36% to 52% of the retail price. However, given the tax collection crisis, we cannot discard that the motivation was more to increase tax collection, rather than to align tax rates to the size of the substantial negative externalities of tobacco use (MEF, 2015). The crisis of the tax collection system only worsened in the next two years until 2017, so that we can say that the second large cigarette tax raise of April 2018 was also motivated by it. This one increased the specific tax to 0.27 soles per stick, resulting in a tax burden of 62% of the retail price, thus locating the country at about the average burden in the region. However, in this second case, the justification of the particular law included a specific reference to the negative health externality, plus the adjustment affected not only cigarettes but also sugar-sweetened beverages (SSBs), alcohol, fuel, and transactions with used cars.

Figure 6 shows the evolution of price structure of a 20-stick package of cigarettes from the most-sold brand in the country in 2016, Hamilton. First, we see that the retail price increased steadily over the last decade, from 4 soles per pack in 2009 to 11.50 soles by 2018. This increase of 187% occurred during a period in which inflation was just 29%, which means that the real price of the Hamilton pack more than doubled (123%). Interestingly, the upward trend in the retail price is steady also during the period without any increases in tax rates like in the 2010-2015 period. During this last period, the price increase was 9%, significantly above the average inflation rate (3.3%).

Figure 6: Price structure of a 20-sticks package* (S/)

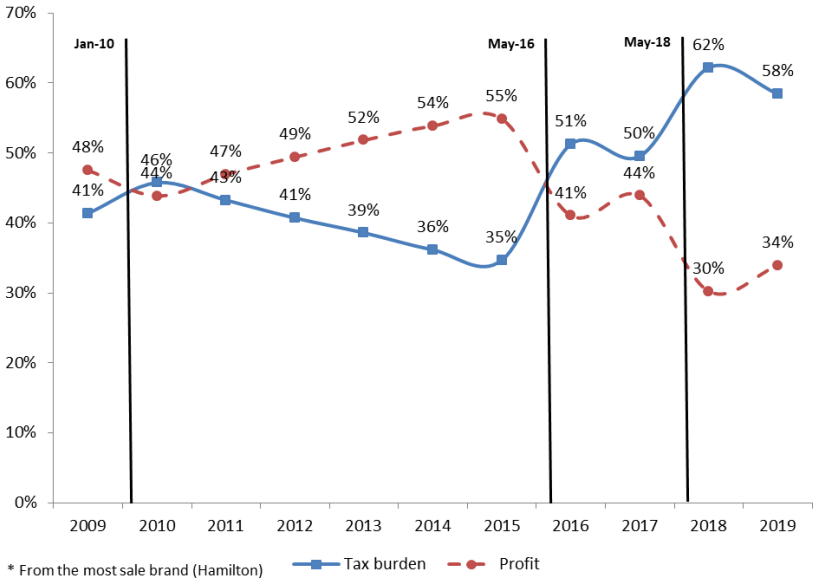


Source: Ministry of Economics and Finance (MEF)

Figure 7 provides an interesting way to characterize the evolution over time and the reaction of the industry to the increases in taxing. During the 2010-15 period, we see a

significant increase in the share of the margin in the retail price, from 44% in 2010 to 55% in 2015, and a reduction of the share of taxes (IGV+ISC) from 30% to 19%. Furthermore, we observe that the last two increases in the tax burden (May 2016 and May 2018) also show a pattern that the industry was gradually increasing producer prices to recover its margin rates.

Figure 7: Tax burden (IGV+ISC) and margins % del PVP 2009-18

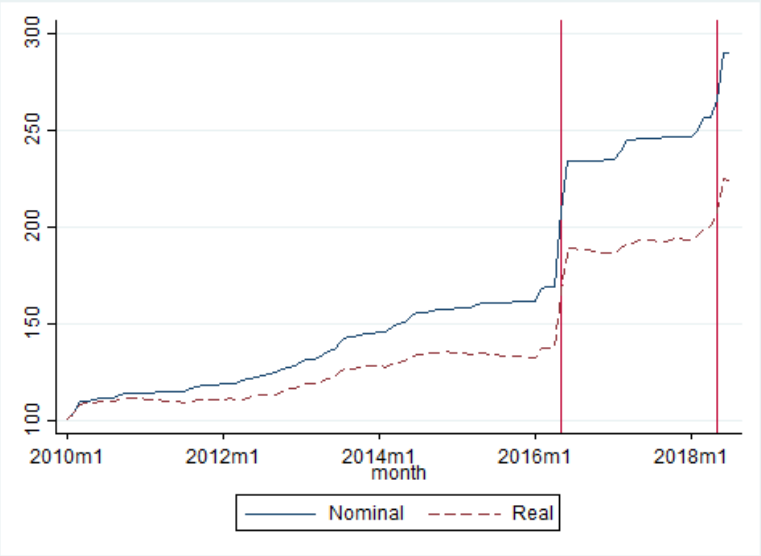


Source: Ministry of Economics and Finance (MEF)

Another question is whether such behavior is consistent with the hypothesis that tax increases' benefits are actually undone by the resurgence of cigarette smuggling that would likely mitigate price increases, reduce tax collection and manufacturers' profits. Under such a hypothesis, the industry is also affected, which would reduce their capacity to increase the retail price, as such behavior would allow smugglers to capture increasing shares of the market. In other words, with such large manufacturer-led price increases, it seems unlikely that they were contending with a significant increase in illicit trade.

The patterns in Figure 6 and Figure 8, among other things, confirm the need to periodically adjust the specific tax to sustain its impact, especially in environments of rapid economic growth. The key of such pattern is the increasing trend of the price of the cigarette pack over the period, even without any tax raises. However, the trend in Figure 6 refers only to one brand, with the possibility that marketing strategies would introduce more complicated pricing schemes to manage the effects of raising taxes. However, Figure 8 shows that average price of cigarettes had a similar increasing trend in the period of 2010-2015.

Figure 8: Evolution of CPI of tobacco products (2010-2018)

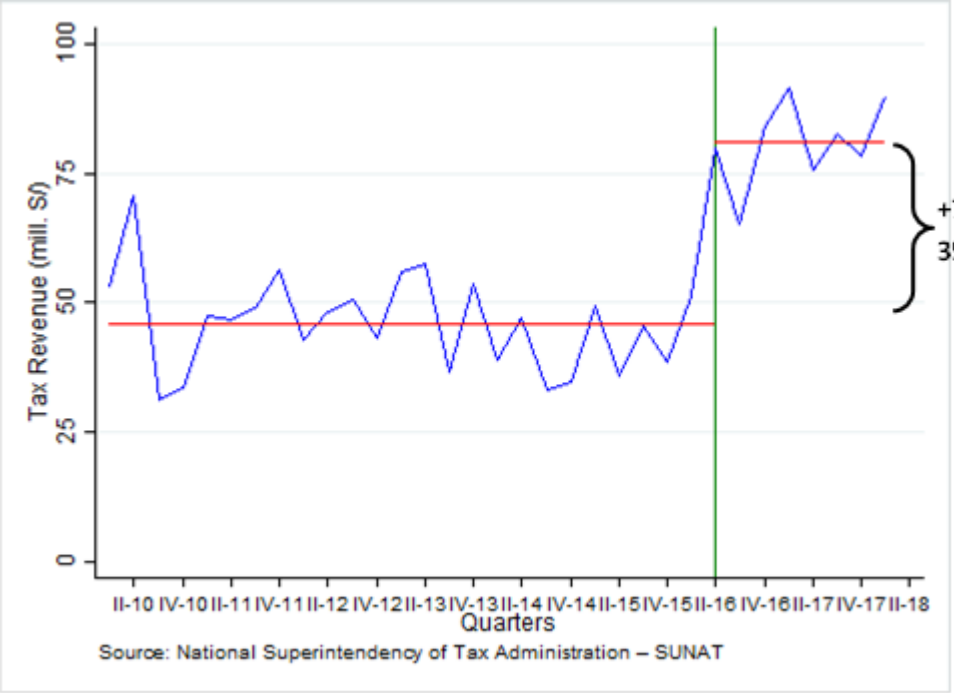


Source: National Institute of Statistics and Information (INEI)
Elaborated by the authors

Next, we look at the information on tax collection from the Superintendency of Tax Administration (SUNAT). Figure 9 shows a quarterly series of revenues generated by the specific tax (ISC) for cigarettes from the second quarter of 2010 to the second quarter of 2018, about two years after the tax increase of May of 2016. The series shows a stationary pattern with large fluctuations but also an apparent shift around the second quarter of 2016, precisely the one in which the tax increase started to work. Before the increase in the specific tax, the ISC collected on average about 46 million soles, and that average increased to about 81 million soles with the new rate. The 35 million soles per quarter, or 140 million per year, thus represents a 75% increase in the tax collection associated with the new rate for cigarettes[5]. Thus, the revenue effect seems to have initially worked with the tax increase of May 2016.

Figure 9: Tax collection – ISC for cigarettes (quarterly data)

[5] This number is not negligible. According to SUNAT, the tax collection for all specific taxes (ISC) sums to about 1400 million soles a quarter by 2016. That is, this increase represents about a 2.5% increase in total collection from specific taxes in Peru.



3) Data

The empirical analysis performed for this study is based on the information from two nationally representative surveys on drug use applied periodically by the National Commission for Development and Life without Drugs (DEVIDA): the general population survey and the secondary students' survey. In this section, we first describe the characteristics of these two surveys, and then describe the other secondary databases used in this study, namely the consumer price index (CPI) for the 15 main cities in Peru, the district-level Poverty Map, both generated by the National Institute of Statistics and Informatics (INEI), and the trade and tax information provided by the National Superintendency of Tax Administration (SUNAT).

General Population Survey – DEVIDA 2010

This survey follows the methodological guidelines recommended by the Inter-American System of Uniform Data on Drug Abuse (SIDUC) of the Interamerican Drug Abuse Control Commission (CICAD)[6]. It uses a nationally-representative sample of the urban population (ages range from 12 to 65 years old), coming from cities with a population over 20,000 people from the coast, highlands and jungle of Peru. The sampling uses a four-stage probabilistic sample with cluster-level stratification, and the selection of person to be interviewed was done following the Kish grid selection method. The initial design was comprised of 21,628 dwellings coming from 40 cities (most of them capitals of region/department) with a level of confidence of 95% and a margin error of ±4.0%. In the fieldwork, 20,275 people were interviewed.

[6] See Interamerican Observatory on Drugs (2011).

The questionnaire was applied by a surveyor through a direct personal interview. It includes basic socio-demographic information, and asks questions about historic and current consumption of all drugs, including cigarettes, alcohol, and other drugs, by the individual, as well as family and peer group backgrounds. The specific questions of our interest are: i) at what age did you smoke for the first time?, ii) on average, how many cigarettes per day did you smoked in the last 30 days?, iii) how many cigarettes did you bought in the last purchase?, and iv) how much money did you pay for that purchase?.

This survey was applied three times before 2010 (1998, 2002 and 2006) but the questions about quantity smoked and the frequency, purchasing patterns and expenditures were asked only in the 2010 round, which is the one we used for the econometric analysis reported here.

National Survey of Secondary Students – DEVIDA 2007, 2009, 2012, 2017

This survey also follows the methodological guidelines of the SIDUC, as the general survey population survey, but it actually uses different methods to select the sample and apply the questionnaire. The sampling frame is secondary students (1^{st} to 5^{th} grades) from public and private schools in cities with a population over 30,000 inhabitants from the three regions of the country. The sample is representative at national and natural region level (Lima Metropolitan Area, rest of the coast, highlands and jungle), selected by using a two-stage probabilistic sample with stratification by type of school management and regional domain. In the first stage, we consider the school and in the second the classrooms from first to fifth year. Once schools and classrooms are identified, all attending students answer the self-administered questionnaire. The number of schools varies by round, but ranging from 418 schools in 2012 to 509 in 2009. The number of students that filled out the self-administered questionnaire also varies from 48,025 in 2012 to 65,041 in 2007.

The questionnaire of this survey is very similar to the one used for the general population survey, with the difference that this one is self-administered. Other than that, the youth questionnaire includes questions about the social environment within the school regarding not only drugs use, but in some cases, discussing other social issues such as bullying in the school in the round of 2012. The issue that is not tackled in the questionnaire for youth is the set of questions associated with the purchasing patterns and expenditures that was applied in the round of 2010 of the general population survey. For this study, we focused on the following questions: i) at what age did you smoke for the first time?, ii) how many days have you smoked cigarettes in the last 30 days, and iii) approximately, how many cigarettes per day did you smoke in those days, in the last 30 days?

Prices of cigarettes and alcohol - Main Cities 1996-2017

As indicated above, the survey on drug use by secondary school students does not include information about the prices of cigarettes and key substitutes such as alcohol, paid by these young smokers. Thus, to analyze the impact of prices on the decision to start smoking, we needed to merge the survey database on drug use with another one that includes these prices for the time and place where the youngster is taking the decision to start smoking, or postpone it for a later time. For that, we use the monthly series of the price indexes of tobacco products

produced by the National Institute of Statistics and Informatics (INEI). They publish such index for the 15 main cities in the country, and we generated a series with December 1995 in Metropolitan Lima as the base period-city, with the help of a special price deflator.

Poverty Map

As mentioned above, the 2009 and 2012 rounds of the survey for secondary school students did not include a question to approximate the socioeconomic status (SES) of the household in the corresponding sample. We used the information of the school the students were attending to generate a time-invariant district-level indicator of SES for the students in the sample. We first used the school modular code to obtain the district in which a particular school was located, with the help of the Ministry of Education's school. We then used the poverty map produced by the INEI for 2013 to establish a SES measure for the students in the survey sample[7].

Imports and tariffs

Almost all the tobacco products sold in Peru are imported. Ignoring illicit trade issues, the Superintendent's Office of Tax Administration (SUNAT) keeps records of all tobacco products that enter to the country by customs at a disaggregated level and the amount of excise taxes paid. We obtained access to this information from 2010 to 2016 through the Ministry of Economic and Finance. Using this information, we constructed a monthly time-series dataset for quantity of cigarettes imported (in millions of sticks) and the excise tax revenue paid to the government.

4) Methodological framework

This study has two main objectives that use two distinct frameworks to analyze them. First, we want to estimate the price elasticity of tobacco consumption among the general population, checking whether such response supports the notion of the win-win situation for a policy to increase taxes for cigarettes; that is, such tax increases improve health, through the reduction in tobacco consumption, and also increase tax collection that can help finance tobacco control and treatment policies for smokers. The second objective is to evaluate whether cigarette prices affect smoking onset by Peruvian teenagers. In this section, we explain the empirical methods used to achieve both objectives, while locating the contributions of this paper in relation to recent related literature.

4.1) Demand of cigarettes

A key variable for understanding the potential role of raising cigarette taxes to control tobacco use is the sensitivity of consumption to the price individuals have to pay for them. Obviously, a tax increase would normally lead to an increase in retail price, which would reduce

[7] The poverty map is in turn based on the information from nationally representative household surveys with census information, allowing to estimate poverty indicators for minor administrative units such as districts (Elbers, Chris; Lanjouw, Jean O.; Lanjouw, 2003).

consumption thus also reducing its detrimental health effects on smokers and non-smokers alike. The issue is the absolute magnitude of such reduction. If the sensitivity of the demand is high enough, the drastically reduced consumption would mostly lead to sizable reductions in the treatment costs for the tobacco-related diseases. However, if the sensitivity is much lower, for instance due to some persistence in consumption patterns, then it could occur that the tax increase could lead to higher tax revenue because of a lower decline in consumption. The point then is that if the sensitivity, called price elasticity of demand, is at an intermediate level, we could have a win-win situation for tobacco tax increases with reduced tobacco consumption and increased tax revenue. Recent empirical studies that estimate the price elasticity of cigarette consumption have consistently corroborated the win-win scenario for tobacco excise tax reform.

However, the lack of data and/or the lack of researchers have limited the number of studies trying to provide evidence of the question about the sensitivity of the demand for cigarette to price and tax increases. Guindon, Paraje and Chaloupka (2015) conducted the most recent systematic review of studies approaching this question for Latin American and Caribbean countries. After their search and selection protocols, they reviewed thoroughly only 17 studies, fifteen of them using country-specific aggregate-level time series data and only two that used country-specific household-level cross-sectional data. They found no study that used individual level data like the one in the DEVIDA databases.

In general, the issue is that we are seeking to determine if there is a casual effect of a price increase on the consumption of cigarettes, and for that, we need to control for other potential factors affecting the level of consumption, such as average income. If income goes up simultaneously, it is more challenging to identify the price and income effects. We can control for income when estimating the price elasticity, but that would not identify the price effect unless we can identify some source of exogenous variation for the price. The identification strategies vary according to the type of data available: aggregate-level time series data or household or individual-level cross-sectional data.

In the case of aggregate-level time series data, the studies work with apparent consumption, average real prices, average real income and the exchange rate. Apparent tobacco consumption series can be obtained from registries of domestic sales, but are often also constructed by adding local production statistics and imports and subtracting exports. The key challenge is to define the periodicity of the series, depending on the level of aggregation of the different variables. Average real prices, and exchange rate come directly from national statistics, and the average income is often proxied by per capita GDP. The usual methodological complication related to the properties of the analyzed series, in particular, is whether they are stationary or cointegrated. Fortunately, there are some standard procedures to test these properties, and also for the estimation methods of the short-run and long-run elasticities (Enders, 2014).

On the other hand, the cross-sectional studies are based on household-level surveys, which are combined with average real prices of cigarettes or the implicit unit value of purchases. A key advantage of this approach is that we can explore the heterogeneity in the sensitivity of the demand for cigarettes to price changes, especially with respect to socio-

economic status (SES), or gender and age, if we have access to individual reports. The two studies of this kind reviewed in Guindon, Paraje and Chaloupka (2015) used repeated expenditure surveys to capture some measurement of cigarette expenditures, and analyzed the sensitivity of such variables to the price changes associated to the tax increases that were implemented in Mexico between 1995 and 2012. Both studies used the National Household Income and Expenditure Survey (ENIGH), which includes weekly levels of consumption and expenditures, allowing them to estimate the implicit unit value for cigarettes. They then use the average unit value by state and income level as a proxy for the price of cigarettes faced by each group of individuals of the same location and similar SES, smokers and nonsmokers. The key issue here is that this average unit value is not necessarily exogeneous but rather affected by the individual choice of brand, which would likely be associated with the district of residence and their SES. Still, the gradual implementation of the Mexican tax reform offers an exogeneous source of variation of prices over time.

Gonzales-Rozada and Ramos-Carbajales (2014) present another effort to estimate cigarette price elasticity, and is also located in Peru. They use the National Survey of Family Budgets (ENAPREF), which includes household expenses on cigarettes and quantities purchased, but a key difference with respect to the Mexican studies is that they use only one round of the ENAPREF, from 2008-09. That is, they are not able to use price changes over time as an exogenous variation to identify the sensitivity of cigarette consumption to price changes. Gonzales-Rozada and Ramos-Carbajales (2014) then use the methodology proposed by Deaton (1997) to obtain the price elasticity in the absence of an observed price of cigarettes, which is also what we do in this study. There are two differences in our empirical approach that we argue makes it worth the additional effort. First, we use an individual-level report of cigarette consumption instead of a household-level report. As mentioned in the previous section, the DEVIDA survey first selects the household and then proceeds to randomly select an individual who reports his/her individual consumption of cigarettes and other drugs. In the ENAPREF survey, the household head or the partner is the one reporting about the expenditures of the household, but there are additional self-administered questionnaires for the personal expenses for the other members of the household above 14, which includes expenditures on cigarettes. All these questionnaires are completed daily for a week. Under those circumstances, it is possible that some of the household members other than the head and the partner are reluctant to report accurately their patterns of consumption of cigarettes or alcohol and other drugs if they perceive such information can reach the household head or the partner. The other additional contribution of this effort is that we are able to analyze heterogeneities of the elasticity estimations by age and gender which were not possible with the ENAPREF, since the specific individual that smokes is not identified, only the one that makes the expenditure. In other words, one impetus of this study is to understand those age and gender differences better.

In what follows, we specify the way we use the methods developed by Deaton (1997) for the estimation of the price elasticity of cigarette consumption. As indicated above, the key argument is that the unit value for the cigarettes purchased is not necessarily a good measure of the price because it can be biased by the quality of cigarette or the preferences of consumer. However, under certain conditions, the unit value could be a good proxy of the price of

cigarettes. Deaton (1997) explains it by defining a simultaneous equations model to explain the demand for cigarettes (q_{ic}) and the unit value (v_{ic}). which are explained by total expenditures (or per-capita income) (x_{ic}), price (π_c), and individual (n_i) and household characteristics (n_h):

$$\ln q_{ic} = \alpha^0 + \varepsilon_x \ln x_{ic} + \varepsilon_c \ln \pi_c + n_i\delta_1 + n_h\delta_2 + f_c + u_{ic}^0 \quad (1)$$

$$\ln v_{ic} = \alpha^1 + \beta^1 \ln x_{ic} + \psi \ln \pi_c + n_i\delta_3 + n_h\delta_4 + u_{ic}^1 \quad (2)$$

Obviously, we cannot directly estimate the price elasticity ε_c in (1), as we do not observe the price π_c. And, in general, we cannot use the unit value v_{ic} as a proxy of the price, as (2) indicates the unit value is correlated with total expenditure, which would often imply that the unit value is affected by quality choice of the individual. Deaton argues that we can test such a situation by running (2) without π_c, and test whether $H_0: \beta^1 = 0$. If we cannot reject the null hypothesis, then estimating (1) with v_{ic} as a proxy for π_c would lead to an unbiased estimate of ε_c. We indeed do that estimating the following regression for current smokers[8]:

$$\ln q_{ic} = \alpha^0 + \varepsilon_p \ln x_{ic} + \varepsilon_c \ln v_{ic} + n_i\delta_1 + n_h\delta_2 + f_c + u_{ic}^0 \quad (3)$$

where we include as individual characteristics n_i, the age, gender, and schooling, and as household characteristics n_h household size, gender and age composition.

Deaton's model, however, refers to demand models for products that are consumed by almost all individuals, or households. In our surveys, though, we have many individuals that do not smoke at the time of the survey. Thus, we need to consider that part of the effect of price changes associated with tax increases may come by making some smokers to quit, implying that we should use a two-part model, one estimating the decision to smoke and the other estimating the amount smoked by smokers. The full elasticity then is the sum of the participation elasticity and the intensity elasticity. However, here we fall into the discussion about the use of the two-part model or the selection model (Madden, 2008). The key consideration is that the two-part model assumes no correlation between the error terms of both equations, and thus proceeds to estimate a probit model for participation decision and an OLS for the intensity decision. However, we know that the observation of nonsmoking may be associated to some latent variable, so that the restriction of the sample to smokers in the second part suffers some relevant selection bias, in which case we need to use instead a Heckman-type selection model for the estimation of the price elasticity (Heckman, 1979). This model assumes correlation of the error terms in both equations. Then, we use the first stage to estimate the inverse Mills ratio, and include it in the second stage to correct for the potential selection bias in (3). For that, though, we need to identify a valid instrumental variable, that is, a variable that can determine the decision to smoke but not the amount smoked in the period of reference. Chen et. al. (2013) considered this sample selection and used the presence of an elder smoker in the family as the identifying instrument. There is a long literature that shows the importance of the family environment on smoking initiation (Tyas and Pederson, 1998). In our case, we include an index of family cohesion, based on questions about how much family-

[8] Annex 3 presents the results of the corresponding test, and shows that such condition indeed holds for our dataset.

related violence, how they solve conflicts among family members and quality of the relationship among them, including the number of times a week the interviewee has a meal with other family members, of his/her trust on family members as a reliable safety net[9]. We present both estimates in section 5 and compare them as a robustness check. If they are similar, we can just choose one and continue with the analysis.

4.2) Smoking onset

As stated previously, we want to examine the decision to initiate smoking and whether prices have an impact on it. As shown in section 2.1, most of current smokers started smoking as teenagers. There are a number of environmental factors affecting their decision as they grow into adulthood, such as smoking background in the household or among his/her peers and role models. However, as a teenager, it is also important to understand their purchasing ability, which is related not only to household income but to the price of cigarettes. Of course, the younger the child, the lower the risk, as it is less likely for her to have smoking friends or enough disposable income. As they age, though, the situation changes as parents tend to give teenagers larger cash amounts, and their friends become more sensitive to the marketing strategies that connect smoking to teenagers' definition of social success. In a sense, one can imagine that a teenager is periodically evaluating the decision to start smoking, considering all these environmental factors, and we can consider a failure event when they actually decide to smoke. Thus, we can use a duration model with time-varying factors (cigarette prices and household income) to analyze the importance of prices on the smoking onset decision (Kiefer, 1988). There are a number of studies that have used duration models to analyze smoking onset: Douglas & Hariharan (1994); Guindon, Paraje & Chávez (2018); Guindon (2014) and (2013); Kostova, Chaloupka, & Shang (2015); Vellios & Van Walbeek (2016).

We analyze the smoking onset decisions of Peruvian secondary students using four rounds (2007, 2009, 2012, 2017) of the DEVIDA's National Survey of Drug Use by Secondary Students. The questionnaire included specific questions about the age of the student at the time of the survey and their age when they smoked a cigarette for the first time. Thus, we can observe the risk of smoking onset at different ages for different socio-economic groups. Furthermore, combining the samples of several rounds, we observe different cohorts at similar ages, which helps us to better identify the separate effects of prices and income on smoking onset. A key point for that is that each survey round provides not only information about the decision to smoke for the year in which a student first smoked, but also the previous decisions in which s/he decided not to smoke, since the start of the observation period.

For our empirical estimations, we first assume Peruvian students have a zero risk to start smoking before age 11. Thus, we start observing them at that age. In case he started smoking at age 15, we also assume he decided not to start smoking at age 11, 12, 13, 14. We use yearly intervals instead of monthly intervals like in previous studies such as Guindon, Paraje & Chavez

[9] See Annex 4 for a more detailed description of the questions in the module and the way the index is constructed.

(2018). The reason is that the survey database does not provide the exact date of birth nor the date of the interview, although we do know the 2-3 months in which the fieldwork occurred for each round. Thus, we can establish the year in which he/she decided to start smoking but not the month, and we connect such decision with the average price index for cigarettes for that year.

From figure 3, we know that 80% of adult smokers smoked for the first time before age 20. However, with the DEVIDA youth survey, we observe them at younger ages. If they had started smoking by the time of the interview, then we have no problem. The issue is that if we observe a 15-year old kid that have not started smoking, we cannot be sure he would not start smoking as a teenager. The issue is that we do not observe them again. Thus, we call this a right-censored observation[10]. Formally, we have the log likelihood of our sample,

$$logL = \sum_{i=1}^{n} \sum_{k=1}^{j} y_{ik}\, log h_{ik} + (1 - y_{ik}) \log(1 - h_{ik}) \quad (4)$$

where y_{ik} indicates whether the student started smoking on month k of the spell. This new binary variable is y_{ik} =1 if the student i smokes on month k and y_{ik}=0 otherwise. The conditional hazard rate is h_{ik} , for which we can choose a specific expression. We use a complementary loglogistic (cloglog) specification. We specify the cloglog link in order to transform the hazard into an asymmetric curve, with the risk of experiencing the event of occurrence being bigger as time passes. The hazard rate is as follows,

$$h_{ik} = 1 - e^{(-e^{\beta x_i + \gamma P_k + \delta})} \quad (5)$$

where P_k is the region-year k price index, our time-varying factor, x_i is the vector of covariates, δ is a duration specific parameter (we used a cubic polynomial). The vector of covariates includes first the gender and age of the individual, and four dummy variables indicating the poverty level of the district in which the school is located[11]. It also includes year, survey and regional fixed effects. When we analyze heterogeneous effects by gender, age and SES, we interact price indexes with each of the previously defined binary variables.

Furthermore, we conducted a number of sensibility checks. For the first one, we estimated the original complementary log logistic specification with a non-parametric form of the duration dependence. This means not using the cubic polynomial duration, just using dummies of the spell periods. We also analyzed the robustness of our results to different specifications of first age at risk. We ran checks with 10, 9 and 8 as being the first age at risk of smoking onset. The second part included heterogeneous effects by sex, age group and poverty quintiles. These were calculated as a semi elasticity of the cigarettes' prices over each one.

[10] A more detailed explanation about the duration model and censoring can be found in Annex 4

[11] We use district poverty levels as a measure of socioeconomic status (SES). As the survey did not include other usual measures of household-level SES, such as family's wealth, or educational attainment of the household head. Actually, the 2007 and 2009 survey rounds do include the education of the household head, but not the following ones.

5) Estimation results

This section presents the results for the two estimations proposed for this study. First, we show the estimation of the full price elasticity among the general population, also testing if there are differences when we separate the sample by groups (gender, age, income). Second, we present the results of the duration analysis to determine whether prices have an influence on smoking onset among teenagers.

5.1) Price elasticity of tobacco

As discussed in section 4.1, a key challenge for the estimation of the price elasticity of cigarettes is the absence of the price with enough variability when using a cross-sectional database. With the DEVIDA survey, the information we have is the implicit unit value paid in the last purchase, but such a measure may be biased by the individual's preference on the quality of the cigarette, which is turn also affected by their income level. Deaton (1997) provides a test to assess the importance of such potential bias, so that we first check if income affects the implicit unit value in the DEVIDA database. We include the results of such a test in annex 3, which shows no significant correlation between the implicit unit value and the income level of the reporting individual. Following Deaton (1997), we can then use the implicit unit value as a proxy of the price of cigarettes an individual face when deciding how much to smoke.

The second methodological issue is that many individuals do not smoke, and it is possible that the decision to smoke is qualitatively different from the one made by smokers on the number of cigarettes to smoke within a certain period. In that sense, one may want to separately analyze the two decisions. Table 2 shows the price elasticity for the two decisions. The participation equation has 17,830 observations, while the consumption equation has 2,571 current smokers as the sample. The first 4 columns use the two-hurdle approach, and gradually adds a set of controls at the individual, household and district levels. We first notice that the price elasticities are negative for both decisions and all specifications. However, the price elasticity for the participation decision fails to be statistically significant across all specifications. The price elasticity for the consumption decision is indeed negative, larger in absolute value, and statistically significant. For the full specification (column 4), the estimated elasticity is -0.42, falling from -0.51 when no controls are included. Column (5) then analyzes whether using a Heckman-type selection model alters the estimated elasticity significantly[12]. The selection-corrected estimate is -0.4, thus we conclude it is not too different in magnitude from the -0.42 in (4), though the selection correction is found to be significant (see annex 6). In sum, our preferred estimate implies that an increase of 10% in the price of cigarettes will cause a decline of 4.2% in the demand for cigarettes, which in the long run is relevant for its health effects. However, such an estimate is inelastic enough, meaning the reduction in consumption is proportionally lower than the price reduction, so that we can expect at the same time, that an

[12] Section 4.1 resumes the methodological discussions about the appropriateness of the use of the selection model. Appendix 5 shows the full results of the estimation of the selection model, which uses family integration as an instrumental variable.

increase in taxes would imply an increase in tax collection, provided the tax is significantly transferred to the consumer.

This estimate is relatively consistent with previous estimates using microeconomic cross-sectional data. Guindon et al. (2015), as mentioned in section 4.1, examined several studies and found that own-price elasticity for cigarettes are around -0.5 in most Latin American countries, also for those few that used repeated cross sections from Mexico. Indeed, Saenz de Miera Juarez et al. (2013) estimated a participation elasticity of -0.17 and a consumption elasticity of around -0.40. The estimates obtained by Jimenez-Ruiz et al. (2008) were -0.06 and -.45, respectively. On the other hand, our results differ more from the estimates obtained by Gonzales and Ramos (2014), that estimated the price elasticity for Peru using the ENAPREF 2009 and a similar methodological approach[13]. The elasticity obtained with their preferred specification was around -0.7. That is, they find a cigarette demand more sensitive to price changes than the estimate we report We cannot identify a definitive source for this difference, but we can observe the different nature of the consumption reports provided in the ENAPREF and the DEVIDA surveys. ENAPREF focuses on family budgets, so they ask for a household-level report on the consumption of the different consumption groups, included cigarettes, during a period of 7 days. They are supposed to be more precise as they ask for a daily report on each of the items. They do provide special sheets for individual reports, which are particularly relevant for consumption outside the home, such as those of cigarettes by individuals other than the household head and his/her partner. The DEVIDA survey is applied to an individual randomly chosen within the household roster, so that they are representative at the national level, and by gender and age. And they report to the number of cigarettes smoked in the 30 days prior to the survey, without any intermediation by the household head and the partner.

Table 2: Total price elasticity of tobacco for overall population

[13] Gonzales and Ramos (2014) estimated the price elasticity using both cross-sectional data and time series data. They reported similar elasticities for both approaches.

	Obs.	Two-part model				Selection model
		(1)	(2)	(3)	(4)	(5)
Participation elasticity	17,630	-0.085	-0.043	-0.040	-0.040	-0.042
		(0.104)	(0.105)	(0.100)	(0.100)	(0.097)
Consumption elasticity	2,571	-0.506***	-0.471***	-0.451***	-0.418***	-0.401***
		(0.101)	(0.095)	(0.093)	(0.080)	(0.082)
Total elasticity		-0.592***	-0.514***	-0.490***	-0.458***	-0.443***
		(0.201)	(0.141)	(0.137)	(0.128)	(0.127)
Individual covariates		No	Yes	Yes	Yes	Yes
Household covariates		No	No	Yes	Yes	Yes
Locality fixed effects		No	No	No	Yes	Yes

Note: Individual covariates include age, age square, gender, if person went to secondary and if person went to university. Household covariates include the household size, age and gender of household head, index of family support and the per capita income. Locality fixed effects are included as district dummies only for the estimation of consumption elasticity and index of cohesion is included only for the estimation of participation elasticity. Clustered standard errors in

Source: IV National Survey of Drugs Use in General Population of Peru, 2010

One advantage of using these cross-sectional data with individual reports is that they permit us to analyze heterogeneities in the price elasticity of the demand of cigarettes by, for instance, age, gender and socio-economic status (SES)[14]. Looking at age and gender differences is very important considering that the industry is focusing much of their marketing strategies on teens and women. Heterogeneities by SES are especially relevant in the discussion about the impacts of the tobacco tax reform, as such taxes tend to be regressive at the individual level, as they hit harder the poor, who pay a larger proportion of their budget on such taxes (Marquez and Moreno-Dodson, 2017; U.S National Cancer Institute & World Health Organization, 2016). However, considering the deleterious health effects of smoking, we can understand that smoking affects more the poor, as treating their related illnesses are more likely going to be catastrophic, especially if they are uninsured. Thus, a tax increase that increases retail prices and reduces cigarette consumption benefits the poorer more as they are less likely to fall into these related catastrophic illnesses. Furthermore, tax increases typically become undoubtedly progressive at the population level if the poorer has a higher price elasticity for cigarettes, as the health effects will be larger for them and their contribution to tax collection lower.

Table 3 and Table 4 present the price elasticities for cigarette consumption for these sub-groups. In the first panel, we see males having lower sensitivity to price increases than females (-0.39 vs -0.48), although the difference is not statistically significant. A similar pattern is found for age differences: teens have lower sensitivity to price increases than their older counterparts (-0.25 vs -0.44), but such differences are not statistically significant. We would like to compare these differences with previous efforts, but not many studies have been able to estimate

[14] ENAPREF is supposed to include individual reports by all members of the households in the sample, but they are not representative by gender and age, as it is the DEVIDA survey.

gender differences in price elasticity, as most studies have used aggregate time series data rather than individual-level data. Furthermore, when estimated, studies have not estalished a clear pattern for gender differences in price elasticities (USNCI-WHO, 2016). With respect to differences by age, the international evidence is clear in indicating that the price elasticity among the youth is much higher than among adults, in some cases, with elasticities below -1. However, it is important to clarify that most of such evidence is estimated using surveys exclusively applied to youth. In that sense, the DEVIDA survey offers an unusual opportunity to analyze such age differences within a survey that includes all age groups, and is representative of the population age distribution.

Table 3: Heterogeneous effects, by sex and age

	Elasticity of Demand	Standard Errors
General population	-0.418***	(0.080)
Sex		
Men	-0.387***	(0.075)
Women	-0.485***	(0.155)
P-value M vs. W	*0.511*	
Age		
12-20 years old (Y)	-0.246	(0.207)
20-40 years old (M)	-0.458***	(0.103)
40+ years old (O)	-0.431***	(0.109)
P-values		
Y vs. M	*0.328*	
M vs. O	*0.841*	
Y vs. O	*0.363*	

Note: See notes from Table 2. Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Source: National Survey of Drugs Use in General Population of Peru - 2010

Table 4 presents the price elasticities by tercile of household income. Again, we find no statistically significant differences by terciles (see p-values for the corresponding comparison tests). The poorest and the richest tercile have indeed very similar elasticities (-0.45 vs -0.49). Surprisingly, the price elasticity for the middle-income group is much smaller (-0.3), but the variance is too high so that differences are not statistically different from zero.

Table 4: Heterogeneous effects, by SES groups

	Elasticity of Demand	Standard Errors
General population	-0.418***	(0.080)
SES groups		
Tercile 1 (poorest)	-0.447***	(0.146)
Tercile 2	-0.289**	(0.129)
Tercile 3 (richest)	-0.493***	(0.135)
P-values		
T1 vs. T2	*0.437*	
T2 vs. T3	*0.248*	
T1 vs. T3	*0.822*	

Note: See notes from Table 2. Clustered standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Source: National Survey of Drugs Use in General Population of Peru - 2010

We next explore whether the price elasticity of tobacco products could be different by the intensity of the smoking of the individuals. While the model in (3) allows us to estimate the average effect of price changes in the consumption of cigarettes, quantile regression models allows us to measure the effect of a change in the price of cigarettes in a specific quantile of the distribution of smokers (Koenker, 2010). A quantile regression at the median measures the price elasticity for the median smoker, which can then be compared to the price elasticity for those that smoke more (say, quantile 75) or less (say, quantile 25). Table 5 presents the price elasticity at these specific quantiles: 25, 50, 75. We observe that the price elasticity is higher for those people that smoke more cigarettes per month. Indeed, the price elasticity for the quantile 25 is -0.33, and it increases to -0.46 for the median, and to -0.62 for the quantile 75. Furthermore, we observe that the difference between the price elasticities at quantiles 25 and 75 is statistically different from zero, which would suggest that heavier smokers are more affected by the hit to their pocketbook and habit strength is not enough to sustain the intensity of their consumption.

Table 5: Quantile Regression

	Elasticity of Demand	Standard Errors
OLS estimator	-0.418***	(0.080)
Quantiles		
q25	-0.334***	(0.067)
q50	-0.456***	(0.101)
q75	-0.621***	(0.111)
P-values		
q25 vs. q50	0.230	
q50 vs. q75	0.208	
q25 vs. q75	0.011	

Note: See notes from Table 2. Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: IV National Survey of Drugs Use in General Population of Peru, 2010

The results of this section are conclusive about the possibility of reducing cigarette consumption of current smokers, although not so clear about its ability to affect who smokes. Furthermore, the price elasticity estimates support the win-win situation associated with the fact that tax increases both reduce cigarette consumption, thus improving health in the long run, while also significantly increasing tax collection, which can then help fund preventive efforts as well as the treatment of smoking-related illnesses.

5.2) Price Semi elasticity of smoking onset

We next address another important question: do increases in cigarette prices affect the likelihood of teenagers initiating smoking? Environmental factors such as smoking background within the family, their peers and the relevant role models are key factors to explain teens' decision to start smoking. However, the affordability issue is, in principle, also important for them, considering that most of those attending school do not have a steady source of income other that the allowance offered by the father. On the other hand, their smoking may rely on alternative strategies to obtain the cigarettes they smoke, which they could get from their parents or peers. The relevance of this question is associated first to the increasing focus of the industry's marketing strategies on youth (Davis, et. al., 2008), but also to the evidence that early smoking initiation is associated with nicotine dependence during adulthood (Kendler et al., 2013) and lower probability of cessation as adults (Breslau, Fenn, & Peterson, 1993). As indicated in section 4.2, we report here the estimates of the effect of price changes on the decision to start smoking by Peruvian high school students.

Table 6 present the results of such effects with alternative functional specifications. The first panel presents the estimates when using the discrete time complementary log-logistic hazard function with a cubic duration dependence specification, as used in Guindon, Paraje and Chavez (2018). The second panel drops the duration dependence formulation in the cloglog,

while the third panel shows the estimates when using a Weibull distribution. The columns show different specifications for the set of control variables. The first column includes only regional fixed effects, while the next two add the year and surveys fixed effects. The final two models add controls for socio-economic status (SES) of the household and gender of the student. We do not observe major changes in the estimated price effect with any of the specifications. The semielasticity ranges from -0.55 to -0.66, implying that price increases reduce the risk of students initiating their smoking in a particular year, given that they had not started to smoke the year before. The hazard ratio for the specification with all controls and a Weibull distribution is 0.57, which means that an extra unit in the log of the price of cigarettes implies a reduction of 43% in the risk of a student to start smoking in a certain year given that they had not started to smoke the year before. Since we use the log of the price when estimating (4), we say that doubling the price of cigarettes leads to a 43% reduction in such risk. Considering that the tax increase of 2016 implied a 40% increase in the average price of cigarettes, our preferred estimate implied that the tax increase led to a 17% reduction in the risk of a student to start smoking given they had not started the year before.

Table 6: Discrete time complementary loglogistic results for overall population

	(1)	(2)	(3)	(4)	(5)
Panel A: Cloglog hazard model					
Semielasticity	-0.609***	-0.616***	-0.636***	-0.579***	-0.556***
	(0.125)	(0.200)	(0.195)	(0.191)	(0.191)
Hazard ratio	0.544***	0.540***	0.529***	0.561***	0.573***
	(0.068)	(0.108)	(0.103)	(0.107)	(0.110)
Panel B: Weibull hazard model					
Semielasticity	-0.585***	-0.638***	-0.640***	-0.573***	-0.559***
	(0.130)	(0.195)	(0.193)	(0.188)	(0.188)
Hazard ratio	0.557***	0.529***	0.527***	0.564***	0.572***
	(0.073)	(0.103)	(0.102)	(0.106)	(0.107)
Regional FE	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes
Survey dummies	No	No	Yes	Yes	Yes
SES districts	No	No	No	Yes	Yes
Sex	No	No	No	No	Yes

Note: Clustered standard errors in parethesis. Number of observations: 909,115; number of subjects: 217,520 ; number of failures: 17,425. Clologlog model controls for duration dependency including a cubic polinomic function while Weibull model already includes a parametrization of duration dependency. * significant at 10%, ** significant at 5%, *** significant at 1%.

Source: National Survey of Secondary Students – 2007, 2009, 2012, 2017.

We next explore the heterogeneity in the sensitivity of smoking onset to price increases. Table 7 present the results of heterogeneous effects of prices on smoking onset among by gender and socio-economic status (SES). We can see that the difference between men and women is significant. Although the average price effect is -0.57, the estimates of the second panel indicate that the elasticity for male students is -0.8 and highly significant while the one for females is not statistically different from zero. This result could be rooted in the fact that almost prevalence for men is almost twice as high as for women. However, societal norms and patterns could be the reason behind this lack of responsiveness. Women's consumption could be less linked to their income than their male counterparts.

Table 7: Heterogeneous effects

	Semielasticity of Smoking Onset	Standard Errors
General population	-0.568***	(0.186)
SES groups		
Tercile 1 (poorest)	-0.725***	(0.200)
Tercile 2	-0.569***	(0.192)
Tercile 3 (richest)	-0.507**	(0.208)
P-values		
T1 vs. T2	*0.124*	
T2 vs. T3	*0.537*	
T1 vs. T3	*0.047*	
Sex		
Men	-0.807***	(0.189)
Women	-0.052	(0.188)
P-value M vs. W	*0.000*	

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Source: National Survey of Secondary Students – 2007, 2009, 2012, 2017.

In turn, we do find differentiated effects by SES. The estimated parameter for the poorest tercile is -0.72 while the one for the richer terciles is around -0.5, and the difference is statistically significant. That is, the wealthier are less responsive to prices and the poor are more responsive. It is quite relevant to show these differences by SES, as we did not find such differences when estimating the demand for smokers. This higher sensitivity of poorer teens suggests that indeed tax increases are progressive in the sense that is more effective in preventing the poorer young to start smoking, which would have significant health impacts in the long run.

To show our results are robust to alternative specifications, we estimated price elasticity with different first age at risk and a non-parametric duration dependence, which is a more flexible approach to the cubic polynomial specification. On Table 8 we can see that the non-

parametric results show very similar estimates to the original one. This is important because it shows that the parametric form was well specified. We see that different specifications of initial age at risk do not change the estimates of the semi elasticity drastically, which restates the robustness of our results.

Table 8: Sensibility estimation

	Changing age at risk			Non-parametric duration dependence
	at 10	at 11	at 12	
Semielasticity	-0.581***	-0.553***	-0.532***	-0.554***
	(0.184)	(0.186)	(0.172)	(0.186)

Note: Standard errors in parethesis. Covariates included: Regional and annual FE, age, sex, school district poverty terciles, first experiences with family, survey dummies and cubic polynomial duration. Number of observations: 910,284 , number of subjects: 217,547 , number of failures: 18,414. * significant at 10%, ** significant at 5%, *** significant at 1%.

Source: National Survey of Secondary Students – 2007, 2009, 2012, 2017.

We present results of continuous specifications in Table 9. We are interested in these because the accelerated time failure model (AFT) time ratio results have a more intuitive interpretation. We also present a proportional hazards (PH) because it is the most similar specification to the discrete model previously shown. We see a similar result to the discrete model for the PH model. We use a Weibull distribution for PH and a Weibull distribution for the AFT. The AFT time ratio results can be interpreted as delayed or accelerated entry time. If the coefficient is more than 1, it means that it slows down the time to event, which means it delays entry. In our context, this means that at the mean starting age (13), doubling the price of cigarettes can delay smoking onset by 1.2 years (or 15 months). This interpretation is especially important when we see the effects of a 14-month delay on smoking onset. As we stated in section 2.1), the younger smoking initiation leads to a higher proportion of current smokers. Although the association is not casual, there is evidence that suggests that early nicotine exposure directly increases the levels of nicotine dependence later on (Kendler et al., 2013).

Table 9: Continuous models

	Weibull (PH)	Weibull (AFT)	
	Coefficient	Coefficients	Time ratio
Semielasticit	-0.626	0.244	1.276
	(0.188)***	(0.073)***	(0.093)***

Note: Standard errors in parethesis. Covariates included: Regional and annual FE, age, sex, school district poverty terciles, first experiences with family, survey dummies and cubic polynomial duration. Number of observations: 910,284 , number of subjects: 217,547 , number of failures: 18,414. * significant at 10%, ** significant at 5%, *** significant at 1%.

Source: National Survey of Secondary Students – 2007, 2009, 2012, 2017.

The results suggest that tobacco prices have a large and significant effect on the hazard of smoking onset. They are robust to alternative specifications. We find that women are statistically less responsive to prices than men. We found that wealthier individuals are less responsive to changes in prices than poorer individuals. However, we found no differences among age groups. This may be due to low variability of ages because it is a sample of teenagers.

6) Conclusions & policy recommendations

The negative effects of tobacco use not only among smokers but also among non-smokers (from secondhand smoke) are well established across decades of research. For this reason, governments are committed to implementing public policies in order to fight against it. The Peruvian government has signed and ratified the WHO Framework Convention on Tobacco Control (FCTC), which requires adequate internal legislation to fulfill a well-defined set of international goals to reduce tobacco use. In that context, we aimed to produce useful evidence for the Peruvian government to monitor the recent increases in the excise tax for cigarettes. Tax increases are globally referred to as the most effective policy to control tobacco use, as it has a double positive effect: it reduces tobacco use, with the implicit positive health effect (as well as economic effects from increased productivity), while it also increases tax revenues from tobacco products which can be used to fund policies to prevent tobacco use and or treat associated illnesses.

Our study has two components that make use of two key databases generated by the National Commission for Development and Life without Drugs (DEVIDA) that have not yet been used to analyze the connection between cigarette prices and tobacco consumption in Peru. This analysis is particularly relevant in today's Peru, considering the recent increases in the excise tax for cigarettes. Although Peru signed the FCTC in 2003, it was not only until 2010 that the Peruvian government made changes in taxation policies according to FCTC guidelines. Still the tax increases of 2016 and 2018 do seem to suggest the full adoption of the healthy taxes approach, considering the size of the increase and the number of products included (alcohol, sugar-based beverages, etc). The sustainability of this effort, however, requires the most

rigorous evidence about the effects of this policy, and this study hopes to contribute to an informed debate.

The first component of the study uses the 2010 DEVIDA's National Survey on Drug Use, a nationally representative sample of individuals. The 2010 round was unique in including not only patterns of consumption of cigarettes, but also key information about the last purchase, including the money spent by the smokers, that made it feasible to estimate the total price elasticity of tobacco use using Deaton's approach to adjust for the use of unit value from the last purchase. The second component uses several rounds of DEVIDA's National Survey of Secondary Students on Drug Use, which allows us to analyze the role of cigarette prices on smoking onset by Peruvian high school students. We merged the DEVIDA dataset with cigarettes price series data from the Peruvian National Institute of Statistics (INEI) to estimate the corresponding price semi-elasticity using a survival model with cigarette prices as the time-varying factor.

Focusing on the first component, we followed Deaton's approach to correct for biases associated with the use of the implicit unit value as a proxy for the price of cigarettes, and estimated a price elasticity of -0.46, which means that if prices increases by 10% (for example, due to higher taxes), demand for cigarettes would decrease by 4.6%. We tested the robustness of this estimate to several alternative specifications, and found that none of them make the estimate change substantially. This estimate supports the notion that raising taxes for cigarettes is a win-win policy as it reduces cigarette consumption, thus generating positive health and economic effects in the long run, while also increasing tax revenue that can help fund other tobacco control policies (although we know that these specific taxes cannot be earmarked in Peru). The use of an individual level cross-sectional database allowed us to analyze whether the price elasticity varied significantly across important dimensions such as age, gender and socio-economic status (SES). Rather surprisingly, we found no significant heterogeneities across these dimensions. The size of the price elasticity and the absence of significant differences by SES are consistent with previous studies in the region. On the other hand, when using a quantile regression, we do find that price effects are much larger for those that are more intensive smokers. The price elasticity at quantile 75 increases up to -0.62 while decreasing to -0.33 for quantile 25. This result suggests that the higher impact on personal finances that these heavy smokers experience can overcome their stronger habit.

Regarding the second component, we used different model specifications of a duration model with a time-varying factor, the price of cigarettes. The overall results suggest that increases in the price of tobacco can also reduce the risk of teenagers to start smoking. Our finding can be interpreted as delays in time to initiation. We find that a price increase of 100% will delay smoking initiation by about 15 months. This suggests that tax increases can delay the age of initiation for teenagers, but the important thing to consider is that for many people, such effect means many individuals are less likely to become a smoker as an adult. Furthermore, when analyzing heterogeneities in the sensitivity of smoking onset to prices, we do find higher sensitivity by those who are poorer and males. The sensitivity is lower for the richer and almost not significant for female teenagers. The fact that female teenagers do not have a response to tobacco prices come from the fact that their smoking rates are much lower, but it also suggests

that special nonprice protections are needed to discourage girls from initiating smoking. This recommendation is very relevant considering the new marketing techniques that the industry is using to target females and the young.

The analysis of these two components allows us to contribute to two relevant discussions when evaluating the effectiveness of tax raises for tobacco control: the regressivity of its effects and the countereffects as result of increased incentives for cigarette smuggling. First of all, it is clear that although cigarette taxes affect those who are poorer more, as it hits their budgets harder, tax increases have a progressive health effect in the long run, especially considering that they are more vulnerable in less ability to absorb the catastrophic costs of the treatment of tobacco-related illnesses as they are often uninsured, and even public health insurance is very restrictive to cover the required treatments. Nevertheless, it is true that the immediate costs hit the poorer harder in the short run. And in that sense, such burden would be less regressive if the poorer reduce more their consumption when facing a price increase. Our estimates do not support such hypothesis for adult smokers, as we do not find differences in price elasticities by socio-economic status. However, we do find that high school students from poorer neighborhoods are indeed more responsive to prices when deciding about smoking onset. This result may be related to lower habits or more restrictive budget constraints, but the point is that for the long run, we do see a progressive effect of increasing taxes for cigarettes.

With respect to the countereffect of cigarette smuggling, it is clear that this is an issue that needs to be rigorously monitored over time, so that we can learn early about any problematic trends. Conceptually, it is possible that increasing the difference between the producer price and the retail price provides an incentive for smugglers, although acting on this incentive requires building an illegal commercialization channel that has not been especially present for cigarettes in Peru for decades. The evidence provided in this study does not support the notion of an important increase in cigarette smuggling. First, the tax increase of May 2016 appears to have generated a sizable tax revenue effect. Second, the reaction of the industry of increasing prices to recover their sale margins after each tax increase suggests that they do not see a significant danger of increased smuggling. Indeed, what we see from the evolution of retail prices is that producers have been able to capture the extra purchase capacity that has resulted from steady growth of the Peruvian economy.

Finally, the overall interpretation of our findings is that higher tobacco taxes have a threefold positive effect. First and foremost, it reduces the consumption of tobacco products, which has positive health and economic effects in the long run. Reduced consumption improves overall health for smokers and non-smokers, while also reducing health care costs associated to the treatment of smoking-related illnesses. But healthier individuals are also more productive, which increases economic benefits of reduce tobacco use. Second, it contributes to increases in the total revenue collected by government in the short run, which can be used to further implement tobacco control policies. Third, it delays smoking onset, which can lead to fewer adult smokers in the long term. In conclusion, evidence supports higher tobacco taxes as an effective policy for tobacco control, which generates a win-win situation that the Peruvian government should consider when evaluating alternative tobacco control policies. Still, this policy discussion would benefit from improved and updated datasets with information about

tobacco consumption and purchasing patterns, as well as of a rigorous monitoring of cigarette smuggling channels.

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Annex 1: Changes in ISC for cigarettes 1999-2019

Date	Law	Tax rate	Other products included in tax reform package
05-Mar-99	DS N° 045-1999-EF	S/. 0.05 per stick	fuel
25-Sep-99	DS N° 158-1999-EF	S/. 0.025 per stick of dark tobacco	fuel, alcohol
		S/. 0.05 per stick of standard-blond tobacco	
		S/. 0.10 per stick of premium-blond tobacco	
06-May-01	RM N° 115-2001-EF	S/. 0.026 per stick of dark tobacco	
		S/. 0.053 per stick of standard-blond tobacco	
		S/. 0.106 per stick of premium-blond tobacco	
29-Jul-01	DS N° 128-2001-EF	100% of ex-factory value	
27-Nov-01	DS N° 222-2001-EF	125% of ex-factory value	
06-Feb-04	DS N° 025-2004-EF	30% of retail price	
13-Jan-10	DS N° 004-2010-EF	S/. 0.07 per stick	
04-May-16	DS N° 112-2016-EF	S/. 0.18 per stick	fuel
09-May-18	DS N° 092-2016-EF	S/. 0.27 per stick	fuel, sugar-sweetened beverages, alcohol, used-cars

Annex 2: MPOWER measures in Latin America

MPOWER	Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	Peru
P-Protect people from tobacco smoke	Smoke free environment for all public spaces	Smoke free environment for some public spaces (not includes universities, officies, restaurants and bars)	Smoke free environment for all public spaces	Smoke free environment for all public spaces	Smoke free environment for all public spaces	Smoke free environment for all public spaces	Smoke free environment for all public spaces
O-Offer help to quit tobacco use	Toll free quit line and covers partial cost of nicotine replacement therapy	Nicotine replacement therapy not covered	Toll free quit line and covers total cost of nicotine replacement therapy	Nicotine replacement therapy not covered	Nicotine replacement therapy not covered	Nicotine replacement therapy not available	Toll free quit line and Nicotine replacement therapy not covered
W-Warn about the dangers of tobacco	Large warning (average of at least 50% coverage the front and back of the package) with all appropriate charateristics	Large warning (average of at least 50% coverage the front and back of the package) with all appropriate charateristics	Large warning (average of at least 50% coverage the front and back of the package)	Large warning (average of at least 50% coverage the front and back of the package)	Medium warning (average of between 30% -49% coverage)	Large warning (average of at least 50% coverage the front and back of the package)	Large warning (average of at least 50% coverage the front and back of the package)
E-Enforece bans on tobacco advertising, promotion and sponsorship	Ban on national TV, radio and print media and some direct and indirect adversting.	Ban on national TV, radio and print media and some direct and indirect adversting	Ban on all forms of direct and indirect advertising	Ban on national TV, radio and print media and some direct and indirect adversting	Ban on all forms of direct and indirect advertising	Ban on national TV, radio and print media and some direct and indirect adversting	Ban on national TV, radio and print media only.
R-Raise taxes on tobacco	Taxes are 51% -75% of price	Taxes are between 26%-50% of price	Taxes are 51% -75% of price	Taxes are more than 75% of the price	Taxes are between 26%-50% of price	Taxes are 51% -75% of price	Taxes are 61% of the price

Best practices — **Worst practices**

Annex 3: Validity of unit value as proxy of price

	(1)	(2)	(3)	(4)
ln(Income pc)	-0.019	-0.016	-0.008	0.000
	(0.013)	(0.013)	(0.017)	(0.014)
Individual covariates	No	Yes	Yes	Yes
Household covariates	No	No	Yes	Yes
Locality fixed effects	No	No	No	Yes

Note: Clustered standard errors at locality levels in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Annex 4: Creation of family cohesion index

First, we create dummy variables from the following questions and answers:

1. When a problem or conflict arises with the members of your household, how do you solve it?

1	They talk and try to agree
0	They sometimes talk, but not always
	Never talk neither try to agree
	Don't know

2. How good is the communication between the members of your household?

1	Very good
	Good
0	Regular
	Bad
	Very bad

3. How much aggressiveness or violence is there among the members of your household?

0	Much
	Regular
	Few
1	None

4. How concerned are the members of your household about what you do in your personal live?

1	Very concerned
	Pretty concerned
0	Little concerned
	Nothing concerned

5. In a typical week, how many days do you sit down to eat and talk about family or personal issues with one or more members of your household?

0	Never
	1-4 days
1	5-7 days

6. How would you rate the relationship you have with the other members of the household?

1	Very good
	Good
0	Regular
	Bad
	Very bad

7. Do you feel you can trust the members of your household when you have problems or personal issues to solve?

1	Yes
0	No
	Don't know

Then, we standardized each variable, add them in one indicator and standardized it again. The result is the family cohesion index.

Annex 5: The duration model

Following the specification by Jenkins:

The discrete hazard is

$$h_{ij} = Pr(T_i = j | T_i \geq j)$$

Where we T_i as the discrete random variable, and j is a spell month at which point is either complete (ci=1) or right censored (ci=0). Therefore, for a censored spell the likelihood contribution is:

$$L_i = Pr(T_i \geq j) = \prod_{k=1}^{j}(1 - h_{ik})$$

And the likelihood contribution for each completed spell is given by the discrete time density function:

$$L_i = Pr(T_i = j) = \frac{h_{ij}}{1 - h_{ij}} \prod_{k=1}^{j}(1 - h_{ik})$$

So, the likelihood for the complete sample is:

$$L = \prod_{i=1}^{n}[Pr(T_i = j)]^{ci}[Pr(T_i \geq j)]^{1-ci}$$

$$L = \prod_{i=1}^{n}[\frac{h_{ij}}{1 - h_{ij}} \prod_{k=1}^{j}(1 - h_{ik})]^{ci}[\prod_{k=1}^{j}(1 - h_{ik})]^{1-ci}$$

$$L = \prod_{i=1}^{n}[\left(\frac{h_{ij}}{1 - h_{ij}}\right)^{ci} \prod_{k=1}^{j}(1 - h_{ik})]$$

This can be rewritten as:

$$logL = \sum_{i=1}^{n} c_i log\left(\frac{h_{ij}}{1 - h_{ij}}\right) + \sum_{i=1}^{n}\sum_{k=1}^{j} \log(1 - h_{ik})$$

Now we add the case that the smoker completed their spell on month k. This new binary variable is y_{ik}=1 if the student i smokes on month k and y_{ik}=0 otherwise.

ci=1	y_{ik}=1 for k=Ti	y_{ik}=0 otherwise
ci=0	y_{ik}=0 for all of k	

Therefore, we now have:

$$logL = \sum_{i=1}^{n}\sum_{k=1}^{j} y_{ik}\, log\left(\frac{h_{ik}}{1-h_{ik}}\right) + \sum_{i=1}^{n}\sum_{k=1}^{j} \log(1-h_{ik})$$

$$logL = \sum_{i=1}^{n}\sum_{k=1}^{j} y_{ik}\, log h_{ik} + (1-y_{ik})\log(1-h_{ik})$$

We can choose the functional form for the hazard with either logistic or complementary log logistic (or cloglog). We choose the cloglog which looks like this:

$$h_{ik} = 1 - e^{(-e^{\beta x_i + \gamma P_k + \delta})}$$

Which is exactly the model Stata estimates.

Annex 6: Heckman selection model

	Heckman Selection Model	
	Pr(smoke=1)	ln(Quantity)
	(1)	(2)
Unit Value	-0.081	
	(0.185)	
ln(Unit Value)		-0.401***
		(0.082)
Income per-capita	0.000	
	(0.000)	
ln(Income per-capita)		-0.040
		(0.039)
Age	0.058***	-0.019
	(0.004)	(0.014)
Age^2	-0.001***	0.000***
	(0.000)	(0.000)
Gender	-0.633***	0.162*
	(0.035)	(0.094)
Education level		
Up to secondary	0.461***	0.053
	(0.053)	(0.116)
University	0.194***	-0.076
	(0.046)	(0.074)
HH size	0.004	-0.036
	(0.011)	(0.024)
HH head's age	0.004***	0.002
	(0.001)	(0.003)
HH head's gender	0.129***	0.140
	(0.032)	(0.080)
Family support index	-0.163***	
	(0.017)	
Constant	-2.391***	2.512***
	(0.121)	(0.398)
Observations	17,630	2,571
Wald Chi^2	37.130	
Locality Fixed Effects	No	Yes

Note: Clustered standard errors at locality levels in parentheses. *** p<0.01, ** p<0.05, * p<0.1