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How increasing tobacco prices affects the decision to start and quit smoking: evidence from Argentina

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Abstract

We study empirically the role of cigarettes' prices on smoking onset and quitting in Argentina, using a continuous-time split population model. The findings in this paper suggest that increasing cigarettes' prices, using taxes, has a larger effect on the starting age of smoking than on the quitting age. In particular, at the mean starting age of 15 years an increase of 20% in real cigarettes' prices is expected to delay smoking onset by 3 years. On the other hand, the same policy is less effective to reduce the duration of the habit because, while negative, the relationship between the duration of the smoking habit and the real price of cigarettes is weak. A policy recommendation that emerges from this evidence is that for people with a developed addiction a combination of an increment in taxes and other public health policies, like cessation therapies, could be implemented to accelerate the time of quitting smoking.

Keywords: smoking onset, quitting smoking, split population model, cigarettes' prices and taxes, survival analysis

1. Introduction

Abundant evidence has been presented over the past decades on the noxious effects that tobacco can have on people's health. It is the leading cause of preventable premature death in the world: a recent report of the World Health Organization (WHO) on global trends in tobacco smoking (2015) estimates tobacco use to be the cause of death of about six million people across the world each year. Tobacco use and exposure to tobacco smoke have been identified as risk factors for numerous cancers, notably lung cancer, as well as for heart disease, tuberculosis, hearing loss, osteoporosis, diseases of the skin, the respiratory and digestive system, and miscarriage, among a myriad of other health conditions. According to the Argentinean National Ministry of Health, tobacco use is the main cause of preventable premature death in Argentina, taking over 40,000 lives every year, including 6,000 non-smokers who die as a consequence of exposure to tobacco smoke. More than 20 million pesos (about 2.2 million dollars) are spent annually to deal with diseases caused by tobacco addiction, about 12% of Argentina's annual health expenditures (Pichon-Riviere et al., 2013).

The importance of addressing the tobacco epidemic through control policies is evident. Even delaying the age at which individuals start smoking or accelerating the time of quitting can have substantial health benefits. Research suggests that people who start smoking in their teens and continue for two decades or more will die 20 to 25 years earlier that those who never start (WHO 2004, Brigham 1998). For studies on the effect of smoking onset and cessation on health, see for example Breslau et al. (1993), Sherrill et al. (1994) and Critchley et al. (2003).

In a global effort to prevent premature avoidable mortality from non-communicable diseases, a target of a 30% reduction in tobacco use of those aged 15 and older was set at the World Health Assembly in 2013. This initiative was part of a global strategy to fight against the tobacco epidemic, formalized in the Framework Convention on Tobacco Control (FCTC), the first international public health treaty signed by 170 countries in 2003. Argentina is notably the only South American country to have signed but not ratified the FCTC.

Of the six measures to control and reduce tobacco demand suggested by the WHO (MPOWER package measures) in the context of the FCTC, one is the raise of taxes on tobacco. In this respect, a study by IECS (*Instituto de Efectividad Clínica y Sanitaria*, 2011) found evidence that if prices of cigarettes were incremented 50%, around 17 to 45 million deaths would be avoided in Latin America, between 1,226 and 3,236 in Argentina. Within the existing literature, a number of studies have addressed the impact that higher prices can have on smoking onset and quitting. Of these, many use a discrete binary choice framework to model smoking behavior (Probit, Logit, linear probability models). See for example Glied (2002), Kim and Clark (2006), Zhang et al. (2006), De Cicca et al. (2008) and Liu (2010), on the relationship between prices of, or taxes on, tobacco and smoking initiation. Other papers that analyze the impact of prices on smoking participation and intensity and the decision to quit include Lewit et al. (1981), Lewit and Coate (1982), Chaloupka and Wechsler (1997), Evans and Farrelly (1998), Harris and Chan (1999), Liang and Chaloupka (2002), Laxminarayan and Deolalikar (2004), Tauras (2005), De Cicca et al. (2008) and Liu (2010). In general, though not unanimously, results suggest a negative relationship between the price of tobacco products and the decision to initiate smoking, but some papers are inconclusive to assess the impact of a raise in prices on smoking initiation, since the significance and the sign of estimations suggest large effects for some specifications but not for others. Results regarding quitting do not provide unanimous evidence of a straightforward relationship between the raise of prices and quitting; some authors find that higher prices may not necessarily encourage quitting. The quoted papers use data either from the US, Canada or Vietnam.

An alternative approach to modeling smoking habit is to use duration (or survival) analysis, which concentrates not only on whether but on when an event occurs. Cawley et al. (2004), Nonnemaker and Farelly (2011) and Kenkel et al. (2009), for example, use traditional duration analysis to model the hazard of starting and quitting smoking. Some of them found evidence that prices have a statistically significant impact on smoking onset, although, again, conclusions could vary by gender, ethnicity and other indicators; others concluded smoking is not strongly related to the price of cigarettes. These studies were conducted using data from the US and China.

Yet, when analyzing smoking onset (or quitting) through the use of standard duration models, the assumption is made that each individual will eventually start (or quit) smoking. Such an assumption is understandable in survival studies where the failure event under analysis is death, but when smoking onset is the outcome of interest there is a possibility that people who report to never have initiated in the addiction by the time of the survey will indeed never incur in the habit. Similarly, smokers who did not quit smoking by the time of the interview might never quit. A way to avoid such a restrictive assumption from traditional duration analysis is through the use of a split population model, which explicitly accounts for the possibility that some individuals will never start (or quit) smoking and treats the probability of eventual smoking onset or quitting as an additional element to be estimated. Douglas and Hariharan (1994) used a split population model applied to data from the US (1954-1987) and didn't find evidence that higher prices would have a significant impact on smoking initiation. Forster and Jones (2001) used a continuous-time split population model to measure the impact of tobacco taxes on smoking onset in Great Britain (1920-1984); they found statistically significant positive effects of the impact of tobacco prices on smoking onset. More recently, Guindon (2014) conducted both traditional duration analysis and a continuous-time split population model on data from Vietnam to analyze the effect of taxes on smoking onset and found evidence of a relatively large and significant effect of prices on the age individuals take on the habit. López Nicolás (2002), using data from Spain, Kidd and Hopkins (2004), using data from Australia, and Madden (2007), using data for Irish women, found small to moderate effects sizes on smoking onset, not statistically significant in some cases; with regard to quitting, Kidd and Hopkins' results suggest prices don't play a significant role to encourage the termination of the habit. For a detailed account of other papers in the existing literature that analyze the impact of tobacco prices on smoking onset, and an assessment of their data and methodological issues, see Guindon (2014). In the case of Latin American countries, a very recent work by Guindon, Paraje and Chávez (2015) is the only one so far to have undertaken the analysis of the impact that tobacco prices can have on smoking onset. They used data from Argentina and the methods they employed include discrete-time hazard models, a complementary loglog specification and a discrete-time split population model. Their results suggest a large, negative and statistically significant relationship between the prices of tobacco products and the hazard of smoking onset. Although a limitation in their analysis is that they do not allow for explanatory variables in the participation equation of the split population model. No study, to the best of our knowledge, has yet been conducted to measure the effect of prices on quitting using data from Argentina. In addition, we allow for covariates in the participation component of the continuous-time split population model that we use to analyze smoking onset and quitting, as outlined in the Methodology section.

The aim of this paper is to examine the role of tobacco prices on smoking onset and quitting in Argentina. To this end, we perform duration analysis on Argentinean data obtained from the Global Adult Tobacco Survey (2012), using a continuous-time split population model. Results suggest that an increment in cigarettes' prices is positively associated with the starting age of smoking and negatively related to the quitting age. In particular, at the mean starting age of 15 years an increase of 20% in real cigarettes' prices is expected to delay smoking onset by 3 years. On the other hand, the same policy is less effective to reduce the duration of the habit because, while negative, the relationship between the duration of the smoking habit and the real price of cigarettes is not statistically relevant for the majority of our specifications. Evidence therefore suggests that increasing cigarettes' prices, using taxes, has a larger effect on the starting age of smoking than on the quitting age, something to be taken into account when considering policy strategies to provide incentives to quit smoking. In addition, we estimate the price elasticity of consumption of cigarettes using a two-part model and find that, while negative as expected, it is larger in absolute terms for people with a shorter history of addiction than for those that exhibit a longer duration of the habit. All these results are consistent with the fact that cigarettes generate addiction and a larger battery of policies is required to encourage people to quit the pervasive habit of smoking.

The rest of the paper is organized as follows. In the next section, we introduce the data and present a descriptive analysis of the prevalence, duration and hazard of incurring in the smoking addiction within both the total surveyed population, and disaggregated by gender and socioeconomic indicators. We then describe the methodology employed and present the results of the estimations. Finally, we conclude and provide some policy recommendations. Appendix A contains a detailed explanation of the Principal Components Analysis approach used to study the relationship between socioeconomic status and smoking. Appendix B describes the two-part model employed to compute participation and consumption elasticities with respect to price.

2. Data and Descriptive Analysis

The Global Adult Tobacco Survey (GATS) is a nationally representative household survey of adults 15 years of age or older. The survey systematically monitors adult tobacco use and tracks key tobacco control indicators. In Argentina it was implemented by the National Institute of Statistics and Censuses (INDEC) in 2012 using a multistage stratified cluster sample design in urban areas. The sample size is 9,790 selected households with 6,645 completed individual interviews.

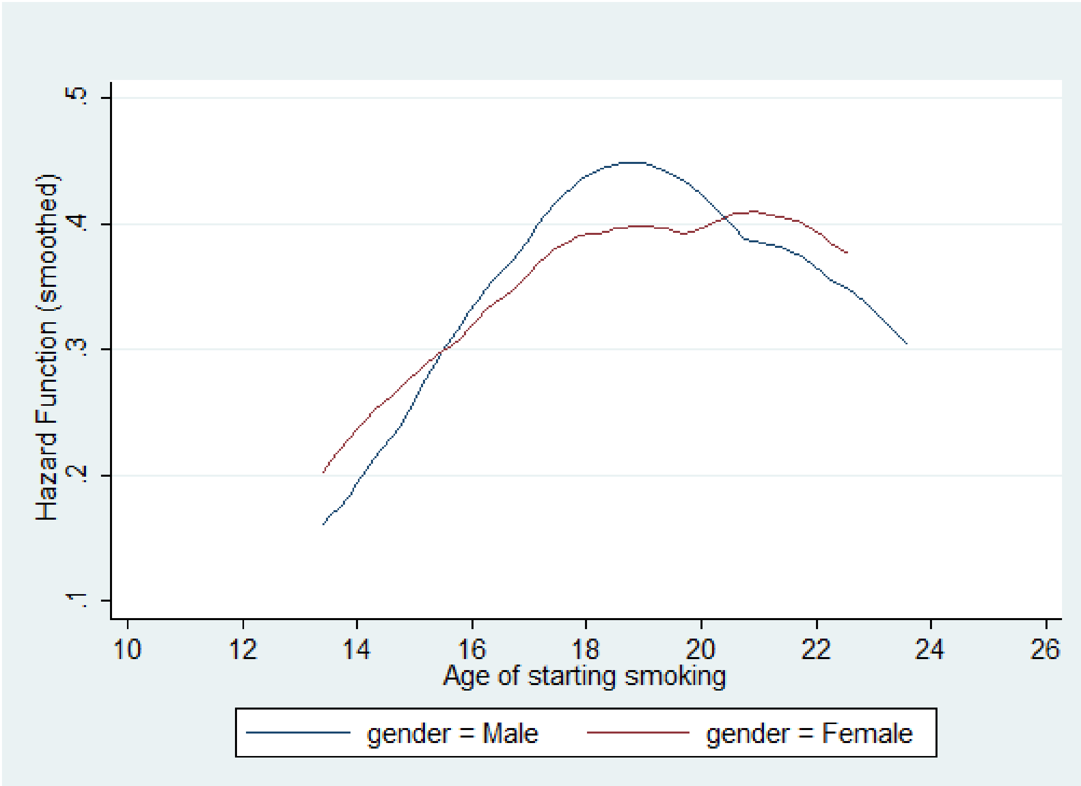
We define a smoker as a person that currently smokes daily or occasionally. A former smoker is a person who has smoked at least 100 cigarettes in his life, but currently does not smoke. Current and former smokers are classified as *ever smoke*. We assume individuals are first exposed to the risk of starting to smoke at age 11, a reasonable assumption based on evidence provided by the Ministry of Health in Argentina that suggests that smoking onset among high school students is common at age 12 or 13, and even earlier, at 11 (almost half the students interviewed in the Global Youth Tobacco Survey, of 2012, started smoking at age 12 or 13, and 21.6% at 11 or earlier). Since we have data on the price of cigarettes starting on January 1996, we trimmed our sample by excluding all individuals older than 27 in 2012, the date of the survey. That is, we exclude from the sample all individuals older than 11 in 1996. It should be noted then that the individuals considered are relatively young, particularly with respect to the risk age of smoking onset, which reduces the possibility of recall bias, a usual critique against the use of retrospective data.

Based on the individual's response, two things can happen: he can either have a complete spell (i.e., started smoking before 2012) or an incomplete spell (in which case he can either begin to smoke after 2012 or never start smoking). This final sample includes 1,674 individuals representing (using the sample weights) a population of 8,114,714 persons. For the analysis of the effect of increasing prices over the quitting age we only consider individuals who began smoking after January 1996, the first date for which we have cigarette prices. Two things can happen: they quitted smoking before the date of the GATS survey or they didn't. For those who quit smoking we observe the complete spell while for those individuals that did not quit we only observe an incomplete spell, in which case they can either quit smoking sometime after the date of the survey or never quit. This final sample includes 762 smokers representing (using the sample weights) a population of 2,799,920 individuals.

The prevalence of individuals who ever smoked is around 30%. The prevalence for those who currently smoke is around 23%, so the sample includes a 7% of former smokers. The probability of being a smoker, current or former is larger for men, 33%, than for women, 27%. In Argentina 45% of the population with primary education is either a former or current smoker and this figure is 42% for those with university education. The prevalence of ever smoked has a negative relationship with socioeconomic status (SES). To see this we construct a SES index using a Principal Components Analysis (PCA).[1] We then classify individuals in the survey according to quartiles of this SES index. The prevalence of smoking for those located in the first quartile of SES (highest SES) is around 20% while for those in the fourth quartile of SES (lowest SES) is about 44%. The mean starting age of smoking is 15 years old. It is a little bit larger for men, almost 16 years old, than for women, 15 years old. Figure 1 shows the hazard of initiating in the habit. Male teenagers around the age of 19 have the highest risk of picking up a smoking habit while for female teenagers the highest risk is around 21 years old. The hazard of initiating in the addiction increases sharply around the age of 13 for both men and women and falls after the age of 19 for men and 21 for women. This increment in the hazard function is steeper for men than women such that after the age of 15 and until the age of 20 the hazard rate is higher for men than for women. Before the age of 15 and after the age of 20 the hazard rate is higher for women.

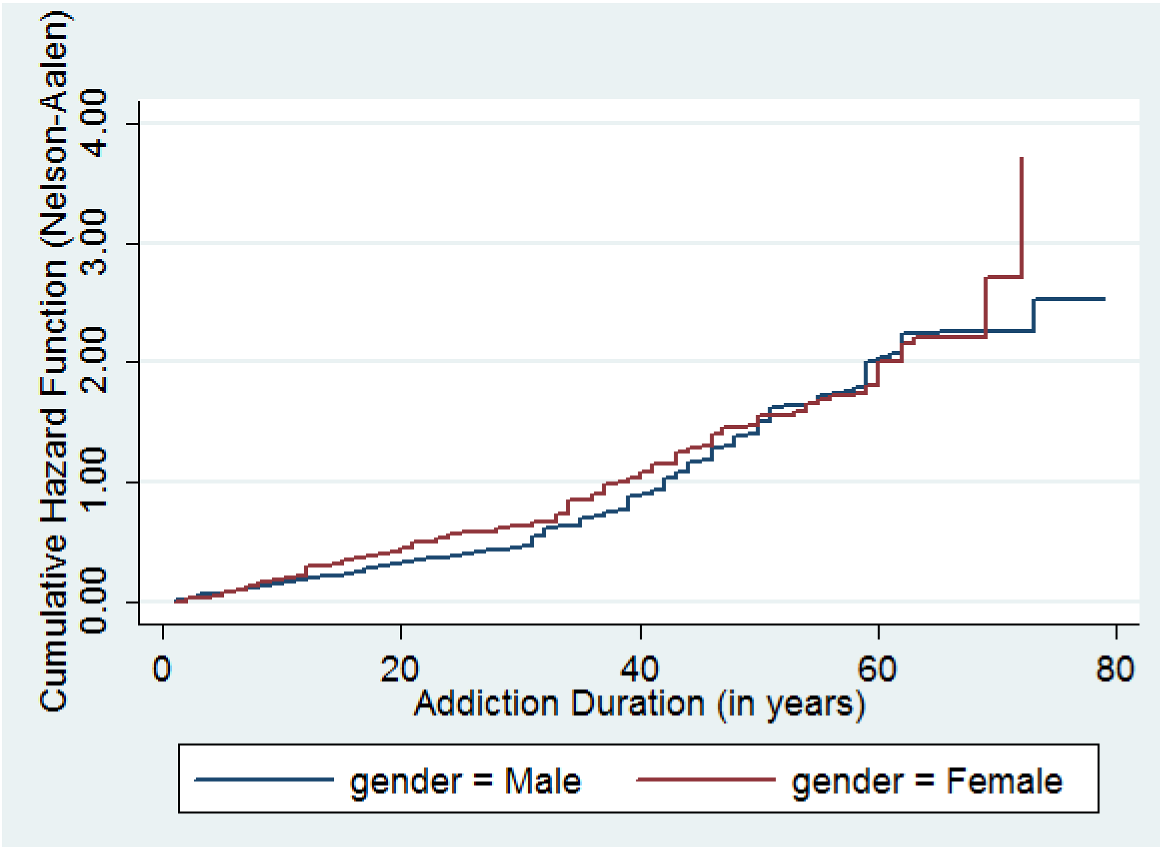
[1] See Appendix A for a complete description of the procedure.

Figure 1. Hazard of Initiating in the Tobacco Addiction



Once the individual initiates in the smoking habit the average duration of the addiction, defined as the difference between the age at the time of the survey and the staring age of smoking, is around 26 years. Average duration of the habit is higher for men, 28 years, than for women, 24 years. Figure 2 shows the cumulative hazard function of quitting the habit by gender. As reported already in the literature (see Forster and Jones, 2001) the figure suggests the hazard function of quitting smoking shows positive duration dependence for both men and women.

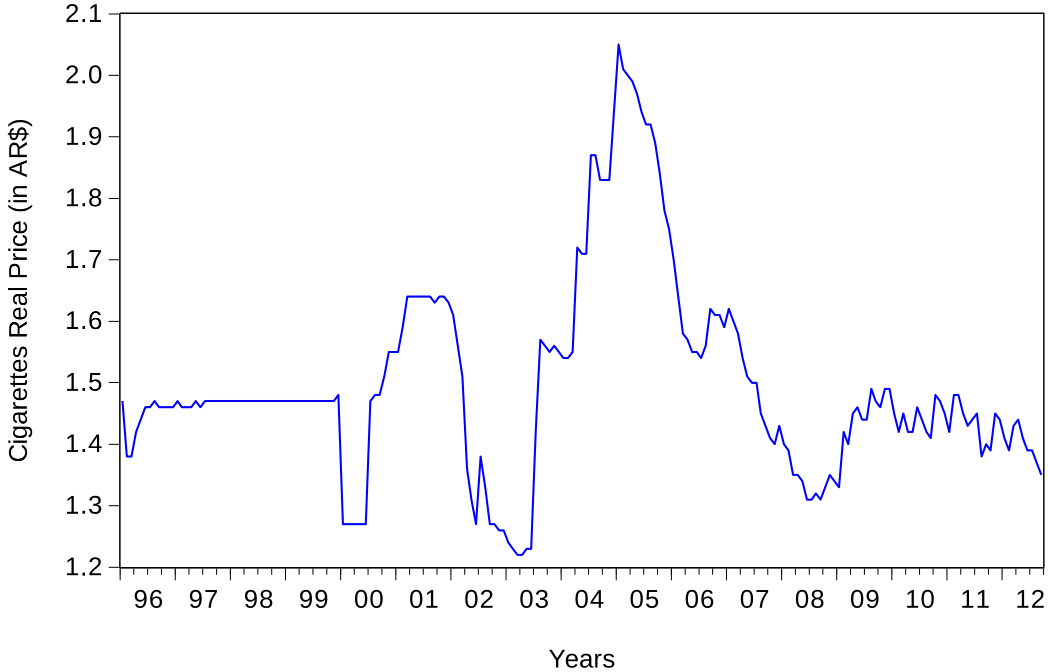
Figure 2. Cummulative Hazard of Quitting the Tobacco Addiction



We find an inverse relationship between the consumption price elasticity and the duration of the habit. Using a two-part model (Jones, 1989, Cragg, 1971) in which we interact the price variable with the addiction variable described above, we estimate the price elasticity of participation and consumption.[2] The price variable is a weighted average of the retail price of a 20 cigarettes pack reported by the National Ministry of Agriculture (MINAGRI). The weights are based on brand market share in Argentina. This price variable was transformed into real terms by deflating it by the Consumer Price Index (CPI) of Argentina. Figure 3 depicts the time evolution of cigarettes' real price from January 1996 to September 2012, the date of the GATS survey. The average real price of a 20 cigarettes pack in the sample is AR$ 1.50. The maximum price in the period analyzed was AR$ 2.05 while the minimum real price was AR$ 1.22. The figure shows no upward or downward trend for real price over the sample analyzed here.

[2] See Appendix B for a complete description of the procedure.

Figure 3. Real price of a pack of 20 cigarettes



We compute the total price elasticity of consumption by quartiles of addiction. For the people located in the lowest quartile of addiction (those with less than 7 years in the habit) the total price elasticity is around -0.51 while for those located in the highest quartile of addiction (more than 48 years in the habit) total price elasticity is only -0.19. This means that a 10% increase in cigarette prices, via taxes, reduces the consumption of those in the early stages of the addiction by 5% while this figure is only 1.9% for those with a longer history of addiction.

This empirical evidence suggests that increasing tobacco taxes is a public policy that seems to be more effective for those people that are somewhere between the onset of smoking and the development of the addiction. On the other hand, for those in more advanced stages of the smoking habit, increasing taxes would be a less effective policy as a means to reduce the use of tobacco. Therefore for people with a developed addiction a combination of increased taxes and other public health policies, like cessation therapies, might prove more effective.

In the next section we describe the methodology we use to analyze the effect of increasing prices over the onset of smoking and the duration of the addiction.

3. Methodology

To estimate the impact that a rise in prices can have on the age of starting and quitting smoking, we use a split population model similar to that first employed by Schmidt and Witte (1989) in a study of criminal recidivism. There are two parts to this model: the modeling of duration and the modeling of participation.

We have a single record per individual of their starting and/or quitting age, referred to in the literature as single failure data. Naturally, when dealing with smoking onset, the failure event is to start smoking; when addressing quitting, it is to quit smoking. Based on their reported ages of initiation and quitting, each individual has a duration spell. If we are interested in estimating the effect on smoking onset, duration refers to the time that elapses between the risk age of smoking onset and the age of starting. Therefore, a spell begins at the risk age (which we assume to be 11), and either ends on the period the individual reported to have started smoking, or at the survey year if they never started. When it is quitting we aim to analyze, we consider the period of time that runs from the moment the individual starts smoking up to the moment they quit. Individuals with a complete spell are those that started smoking (or quitted smoking) some time before the survey took place; for the rest, the spell is right-censored. Time is treated as a continuous variable. To model duration we use a log-Logistic distribution for smoking onset and a generalized Gamma distribution for quitting (we consider the parameterization specified in the manual of Stata 13 see www.stata.com/manuals13/st.pdf). This last distribution can result in a Weibull, Exponential, Gamma or log Normal distribution depending on the value of the parameters. As outlined in the previous section, data indicate that the cumulative hazard function increases over time; therefore we would expect to reject the Exponential and Weibull specifications when running tests on the parameters of the generalized Gamma distribution. We include the logarithm of price as a covariate, as well as the region of residence, the year of birth and the length of the spell. Estimates can he interpreted as the effect of the explanatory variable on the age of starting (quitting); the coefficient on price can be interpreted as an elasticity. We also estimate separately for women and men.

Participation refers to whether the individual eventually engages in the failure event. It is modeled by means of a Probit, the dependent variable being a dummy that indicates whether the individual "fails" (i.e., starts smoking or quits) or not; and the explanatory variables, a set of covariates including region of residence, gender, year of birth and the length of the spell.

The main idea behind the use of a split population model is to account for the fact that not all individuals that have an incomplete spell will eventually "fail" (i.e., start smoking or quit smoking), as opposed to the traditional and restrictive assumption of standard duration models that they all will. The duration process applies then only to those individuals who are predicted to eventually "fail". The likelihood of each observation is weighted with the probability that the individual will ever start (quit) smoking. Formally expressed, the log-likelihood function to be maximized is:

$$\ln(L) = \sum c_i \ln\left[F(\alpha' z_i) f(t / s = 1, x_i(t)\right] +$$

$$(1 - c_i)\ln[1 - F(\alpha' z_i) + F(\alpha' z_i) S(t/s=1, x_i(t)]$$

where *c* is a dummy variable equal to 1 if the individual ever smoked (quit) and 0 otherwise, s is another dummy equal 1 if the individual will eventually start smoking (will eventually quit) and 0 if they never do, *F* is the probability of starting (quitting) which we model using a Probit specification as mentioned earlier, *z* are time-invariant covariates, *f* refers to the chosen conditional density function to model duration and *S* is the respective survival function. We treat the price of cigarettes as a time-varying covariate (the length of the time series for the price of cigarettes is 16 years, from 1996 to 2012). All time-invariant covariates are used both in the specification for duration and participation. In this respect, it should be noted that we choose not to introduce variables whose values are reported for the time of the survey when in fact it is the values at the time of smoking onset or quitting that are relevant. Notice as well that we are not treating the probability of ever smoking or quitting as an additional parameter to be estimated, but instead consider a Probit model, allowing for the introduction of explanatory variables; something which, to the best of our knowledge, has not been done in previous studies using data from Argentina. Estimation of the Probit model is done using the sampling weights of the GATS survey; we do not consider weights when estimating the model for duration, a limitation that we hope to address in a future version of this study.

A note of caution: in continuous-time split population models, duration models are presented in accelerated failure time format and can be interpreted as regression equations for the logarithm of time until failure. Therefore, a positive coefficient indicates that higher values of an explanatory variable delays smoking onset or quitting. This means that, in the analysis of smoking onset, we expect to find significant positive estimations for the coefficient on the price of tobacco, indicating that higher prices are associated with a delay in the age an individual starts smoking. On the contrary, when analyzing quitting, we expect to get negative estimated coefficients, indicating that higher prices of tobacco are related to an accelerated time of quitting.

To proceed with this model, it is necessary to set up the data appropriately. Following Jenkins (2005), we reorganize it so that, for each individual, there are as many rows as there are months of risk of the event occurring for each person. We proceed by first expanding the sample by years and then by months. It should be noted that information in the survey is provided in annual terms, therefore we randomly assign the month at which the individual starts (or quits) smoking in the reported year of smoking onset (quitting). This way we convert the simple data set that contains one row for each individual, into another data set in which there are T_i rows for each person, T_i being the number of months that person *i* was at risk of the event. We thus obtain an unbalanced panel data set. We also create a unique identifier variable for each individual, and a spell period identifier variable.

4. Results

Table 1 shows the results of estimating a split population duration model for the risk of starting smoking. Columns under the header of participation report parameter estimation of the prevalence component of the model. Columns under the header of duration report parameter estimation of the duration component of the split-population model. As it can be seen from the table, the coefficient on the log of price variable is positive in all specifications suggesting a direct effect of prices on the age of starting smoking. In particular the last two specifications have coefficients on cigarette prices statistically significant. Using the last duration specification estimation we find that the mean expected survival time in the onset of smoking is around 115 months or about nine and a half years. The implied elasticity of the mean survival time with respect to cigarettes price is 1.58. This evidence suggests that at the mean starting age of 15 years an increase of 20% in prices is expected to delay smoking onset by 3 years. This is an important result from the public policy perspective since it highlights that increasing prices via taxes will delay the initiation in the smoking habit.

Table 1. Split-Population Estimations for the Onset of Smoking

	Duration	Participation	Duration	Participation	Duration	Participation
Ln(cigarette price)	0.120		0.143*		0.338***	
	(0.225)		(0.076)		(0.076)	
Gender (female=1)	0.144**	-0.199	-0.023	-0.149	-0.031*	-0.395**
	(0.059)	(0.183)	(0.018)	(0.178)	(0.016)	(0.189)
Region						
Cuyo	0.362***	-0.137	0.080***	-0.084	0.052**	-0.122
	(0.093)	(0.135)	(0.027)	(0.146)	(0.026)	(0.185)
NEA	0.282***	-0.192	0.029	-0.203	0.017	-0.112
	(0.092)	(0.129)	(0.028)	(0.137)	(0.025)	(0.186)
NOA	0.414***	-0.097	0.056**	0.039	0.027	0.170
	(0.084)	(0.127)	(0.025)	(0.138)	(0.023)	(0.179)
The Pampas	0.259***	-0.055	0.053**	-0.093	0.040	-0.049
	(0.089)	(0.165)	(0.026)	(0.166)	(0.025)	(0.201)
Birth year					0.017***	-0.690***
					(0.002)	(0.065)
Spell length			0.012***	-0.013***	0.012***	-0.056***
			(0.000)	(0.002)	(0.000)	(0.006)
Intercept	4.045***	-0.349***	3.269***	0.822***	-30.284***	1379.570***
	(0.090)	(0.122)	(0.035)	(0.202)	(4.964)	(129.044)
Rho (shape parameter)	0.394***		0.125***		0.117***	
	(0.014)		(0.005)		(0.004)	

Source: authors estimations.
*Note: asymptotic standard errors in parentheses. Statistical significance * 10%, ** 5% and *** 1%*

We included in the estimations several control variables that could affect the age of starting smoking, gender, region of residence, year of birth and the spell length. Region of residence is codified as northeastern (NEA); northwestern (NOA); west-center (Cuyo); the pampas; and the south region which is the base category in the tables. The year of birth variable would capture the fact that those born earlier could have less information about the tobacco epidemic and therefore start smoking earlier. The spell length is included to capture the effect of other covariates at the age of starting smoking that are not observed at the time of the survey (i.e. income/wealth, smoking behavior of parents etc.).

The table reports a positive and statistically significant coefficient, on the year of birth variable, in the duration component of the last split population model supporting the interpretation mentioned above. This variable has a negative and statistically significant coefficient in the participation equation implying that those born more recently have less probability of smoke. Region of residence does not seem to affect smoking onset or prevalence of smoking and women have less probability of being smokers than men.

Results for the split population model for men and women are presented in Table 2. For both groups the coefficient on the price variable is positive and statistically significant suggesting that an increase in prices will delay smoking onset. For males, an increment of 10% in cigarette's price induces a delay in the smoking onset of about 3.5% while this figure is 3% for women.

Table 2. Split-Population Estimations for the Onset of Smoking by Gender

	Males		Females	
	Duration	Participation	Duration	Participation
Ln(cigarette price)	0.349***		0.305***	
	(0.101)		(0.117)	
Region				
Cuyo	0.055	0.082	0.045	-0.343
	(0.034)	(0.258)	(0.040)	(0.269)
NEA	0.003	0.060	0.038	-0.264
	(0.033)	(0.270)	(0.038)	(0.247)
NOA	0.018	0.223	0.040	0.131
	(0.032)	(0.253)	(0.034)	(0.248)
The Pampas	0.030	0.171	0.048	-0.296
	(0.035)	(0.289)	(0.034)	(0.267)
Birth year	0.019***	-0.636***	0.013***	-0.772***
	(0.003)	(0.097)	(0.004)	(0.077)
Spell length	0.013***	-0.053***	0.012***	-0.061***
	(0.000)	(0.008)	(0.000)	(0.007)
Intercept	-34.50***	1270.62***	-22.65***	1542.19***
	(6.698)	(193.68)	(7.636)	(154.69)
Rho (shape parameter)	0.117***		0.115***	
	(0.006)		(0.006)	

Source: authors estimations.
*Note: asymptotic standard errors in parentheses. Statistical significance * 10%, ** 5% and *** 1%*

Now, we analyze the duration of the habit. As explained in the methodology section individuals that currently smoke could be interpreted as incomplete spells and defined as censored observations in our duration estimation. This is analogous to the analysis of smoking onset. Duration models assume that all individuals with incomplete spells will eventually fail. Since it is possible that some individuals do not quit and we do not have information about that, we estimate a split population model. We use a generalized Gamma function for the duration of the epidemic in order to take into account the positive duration dependence of the hazard of quitting the habit. Table 3 reports the results of our estimations. The first column in each model presents the estimated coefficients of the duration equation while the second column reports the estimation of the probability of quitting.

Table 3. Split-Population Estimations for the Duration of the Habit

	Duration	Quitting Prob.	Duration	Quitting Prob.	Duration	Quitting Prob.
Ln(cigarette price)	-1.754**		-0.091		-0.075	
	(0.722)		(0.214)		(0.214)	
Gender (female=1)	0.003	0.257	-0.014	0.268	-0.011	0.241
	(0.106)	(0.254)	(0.032)	(0.254)	(0.032)	(0.266)
Region						
Cuyo	0.136	-0.082	-0.029	-0.082	-0.027	-0.093
	(0.188)	(0.293)	(0.056)	(0.289)	(0.056)	(0.289)
NEA	-0.267	-0.234	-0.103**	-0.273	-0.098*	-0.261
	(0.171)	(0.254)	(0.052)	(0.256)	(0.052)	(0.246)
NOA	-0.065	-0.190	-0.060	-0.213	-0.051	-0.260
	(0.152)	(0.215)	(0.046)	(0.220)	(0.046)	(0.221)
The Pampas	0.109	0.184	-0.092**	0.179	-0.088**	0.183
	(0.137)	(0.217)	(0.042)	(0.216)	(0.042)	(0.223)
Educational categories						
Secondary education		-0.715*		-0.755**		-0.781**
		(0.377)		(0.375)		(0.386)
University education		-0.248		-0.289		-0.302
		(0.397)		(0.398)		(0.414)
Birth year					0.002	-0.041*
					(0.002)	(0.023)
Spell length			0.013***	-0.002	0.013***	-0.005*
			(0.000)	(0.002)	(0.000)	(0.003)
Intercept	4.843***	-0.675**	3.299***	-0.413	-1.504	80.834*
	(0.214)	(0.335)	(0.074)	(0.419)	(4.666)	(46.495)
Kappa (shape parameter)	8.724***		6.651***		6.631***	
	(1.436)		(0.738)		(0.738)	
p (shape parameter)	0.556***		2.112***		2.123***	
	(0.059)		(0.198)		(0.199)	

Source: authors estimations.

*Note: asymptotic standard errors in parentheses. Statistical significance * 10%, ** 5% and *** 1%*

The coefficient on the cigarette's price variable is negative in all specification suggesting an inverse relationship between prices and duration of the addiction. However, this coefficient is only statistically significant in the less complete model, the first one. When adding additional explanatory variables the statistical significance disappears. In the first specification, the price elasticity of the duration of the habit is about -1.75. This figure implies that an increment of 10% in the price of the cigarettes would reduce the duration of the habit in 17.5%. Considering an average duration of the addiction of 63 months the evidence here suggests that the average duration will fall by almost one year. This means that on average the reduction of the age of quitting is almost one year.

We included as a control variables gender, year of birth, region of residence and educational categories. The coefficient associated with the year of birth is negative and statistically significant in the quitting probability equation suggesting younger people have less chances of quit. Those with secondary education have less probability of quitting when compared to those with primary education. Finally, gender does not seem to affect neither the duration of the addiction nor the probability of quit smoking.

The test of κ (kappa)=1 rejects the null hypothesis of a Weibull distribution; testing κ=0 also rejects the null of a log-Normal distribution. The test for the κ=p=1 rejects the null eliminating the Exponential distribution. The test for the null p=0 rejects the Gamma distribution.

As in the case of the smoking onset, Table 4 reports the estimations of the more complete split population model for the duration of the habit by gender. The coefficient on the price variable is negative but is not statistically significant suggesting a mild relationship between prices and the reduction of the duration of the epidemic.

Table 4. Split-Population Estimations for the Duration of the Habit by Gender

	Males		Females	
	Duration	Quitting Prob.	Duration	Quitting Prob.
Ln(cigarette price)	-0.055		-0.174	
	(0.282)		(0.309)	
Region				
Cuyo	-0.050	-0.164	-0.018	-0.046
	(0.080)	(0.377)	(0.074)	(0.445)
NEA	-0.152**	-0.027	-0.074	-0.145
	(0.076)	(0.340)	(0.067)	(0.377)
NOA	-0.021	-0.608	-0.060	-0.437
	(0.075)	(0.404)	(0.058)	(0.333)
The Pampas	-0.041	0.280	-0.126**	-0.037
	(0.059)	(0.305)	(0.055)	(0.300)
Educational categories				
Secondary education		0.184		-1.148**
		(0.432)		(0.516)
University education		0.282		-0.375
		(0.477)		(0.532)
Birth year	0.009**	-0.182***	-0.001	-0.013
	(0.004)	(0.028)	(0.003)	(0.016)
Spell length	0.012***	-0.014***	0.013***	-0.006*
	(0.001)	(0.004)	(0.001)	(0.003)
Intercept	-15.055**	361.141***	4.275	25.814
	(7.229)	(55.881)	(5.884)	(32.455)
Kappa (shape parameter)	6.456***		7.026***	
	(0.944)		(1.249)	
p (shape parameter)	2.317***		2.065***	
	(0.332)		(0.269)	

Source: authors estimations.
*Note: asymptotic standard errors in parentheses. Statistical significance * 10%, ** 5% and *** 1%*

5. Conclusion and Policy Recommendations

In this paper we study the role of tobacco prices on smoking onset and quitting in Argentina. To this end, we perform duration analysis on data obtained from the Global Adult Tobacco Survey (2012), using a continuous-time split population model. We analyze the effect of increasing cigarettes prices on the starting age and the quitting age of smoking. We find a direct relationship between prices and the age of smoking onset. The empirical evidence in this paper suggests that at the mean starting age of 15 years an increase of 20% in real cigarettes prices is expected to delay smoking onset by 3 years. When analyzing the hazard of starting smoking across gender we find that for males, an increment of 10% in the real price of cigarettes induces a delay in the smoking onset of about 3.5% while this figure is 3% for women. We find an inverse relationship between the duration of the smoking habit and the real price of cigarettes.

In this case, the evidence is weaker relative to that found with respect to the smoking onset, suggesting a mild effect of raising cigarettes prices on the quitting age of smoking. In the only specification where the coefficient on the cigarettes' price variable is statistically significant the price elasticity of the duration of the habit is about -1.75. This suggests that increasing prices by 10% would reduce the duration of the smoking habit by 17.5%.

The findings in this paper suggest that increasing cigarettes' prices, using taxes, has a larger effect on the starting age of smoking than on the quitting age. How such an increase of cigarettes' prices could be achieved through a raise of taxes is not as straightforward as one would imagine: Argentina has a very complex tax structure on tobacco products which combines as series of ad valorem and lump sum taxes that overlap one another (see Gonzalez-Rozada and Rodriguez Iglesias, 2014). A gradual transition towards a single uniform tax would be ideal, but given the intricate tax structure combined with the existence of public agreements between the government and the tobacco industry that impose restrictions to increase taxes, such an approach would only be conceivable in the long run. In the short run, a plausible successful policy to increase prices must rely on increments of actual taxes. What is clear, as evidence highlights, is the fact that in Argentina the policy of increasing taxes on the consumption of cigarettes seems to be more effective to delay smoking onset. On the other hand, the same policy is less effective to reduce the duration of the habit. A policy recommendation that emerges from this evidence is that for people with a developed addiction a combination of increasing taxes and other public health policies, like cessation therapies, could prove more effective.

6. References

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Appendix A. Principal Components Analysis

In this appendix we describe the principal components analysis used to generate the weights for the construction of a SES index.

We use an orthogonal transformation to compute the first principal component, the one with the largest possible variance in order to define the weights of the wealth index. The variables included in the principal components analysis are binary and reflect not only dwelling but also head of the household characteristics. Among them are: electricity, flush toilet, fixed telephone, TV, black and white TV, refrigerator, car, washing machine, tank-style water heater, cable TV subscription, VCR, DVD player, microwave oven, air conditioner, laptop or PC, internet connection and educational categories for the head of the household. All these variables adopt the unit value if the household has electricity, flush toilet etc. To compute the SES index we use the eigenvector associated with the eigenvalue of the first principal component. We compute a linear combination of the variables with weights given by the ratio of the corresponding element of the eigenvector and the standard deviation of the variable.

Appendix B. Two-part model

In this appendix we describe the two-part model used to estimate the price elasticities of cigarette consumption, taking into account the individual's duration in the smoking habit. The first part is a model of smoking participation, and the second part analyzes consumption conditional upon participation.

In a first stage, we estimate a Probit model for the probability of smoking, for which we consider a binary indicator that equals one if the individual smokes and zero otherwise. The first equation we estimate is:

$$Pr_i = \Phi(\beta_0 + \beta_1 cp_i + X_i\beta_3)$$

Where Pr_i is the predicted probability of smoking cigarettes for individual i and cp_i is the natural logarithm of the cigarette price paid by individual i. For individuals that do not smoke, prices are imputed using a random regression imputation. X_i is a vector of other control variables including gender, dummies for age categories, for being out of the labor force, for being a housekeeper, and for the level of education attained by the individual.

Participation price elasticity is computed using the formula:

$$\varepsilon_i = \frac{\partial Pr_i}{\partial cp_i} \times \frac{1}{Pr_i}$$

We compute this elasticity at the quartiles of the duration of the addiction and at the sample mean of price and the other control variables.

In a second stage, we consider only the sample of those who smoke and estimate by OLS the regression of consumption (the logarithm of the number of cigarettes smoked by individual i) against the logarithm of price, the duration, the interaction of duration and price (in order to allow for different price elasticities at different stages of the duration of the habit), and the other control variables specified earlier. The second equation we estimate is then:

$$C_i = \beta_0 + \beta_1 cp_i + \beta_2 cp_i \times d_i + X_i\beta_3 + u_i$$

Where d_i is a variable measuring the duration of the habit (computed as the difference between the age at the time of the survey and the staring age of smoking).

The price elasticity of consumption is computed using the formula:

$$\eta_i^{cp} = \beta_1 + \beta_2 d_i$$

Both participation and consumption equations are estimated using the sampling weights of the GATS survey.