Economic Fluctuations during Pregnancy and Smoking Onset among Adolescents in Brazil: Evidence from the Pesquisa Nacional de Saúde do Escolar (PeNSE)

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Abstract

In this paper, we aim to investigate the potential link between smoking initiation among 9^{th} grade Brazilian students and economic fluctuations during their life in *utero*. Using data about smoking behavior from the Pesquisa Nacional de Saúde do Escolar 2012 and the unemployment rate as a proxy for economic fluctuations, we estimate an interval censoring model. We link unemployment cycles to the trimesters of gestation based on the students birth date. The results suggest that a deviation of 0.1 log units in the unemployment rate from its long-term trend in the first trimester of pregnancy increases the risk of smoking onset in 4.35%. Maternal stress due to economic downturns is probably the main channel behind this effect, once epidemiological evidence has linked the excess of stress hormones during pregnancy to offspring's nicotine dependence in adult life. Moreover, we find evidence of selection associated to economic fluctuations in which the proportion of high-SES student is greater than low-SES students during recession periods. In particular, high-SES students are the group of adolescents more sensible to economic fluctuations, probably because their mother faced high opportunity costs during periods of economic contractions.

Keywords. Economic Fluctuations, Smoking Onset, Adolescents, Duration Analysis, Brazil.

Resumo

Neste artigo, nós estamos interessados em investigar a potencial associação entre a iniciação ao hábito de fumar entre estudantes brasileiros do 9^o ano e as flutuações econômicas durante a vida no útero. Usando dados sobre tabagismo a partir da Pesquisa Nacional de Saúde do Escolar 2012 e a taxa de desemprego como proxy para as flutuações econômicas, nós estimamos um modelo de risco proporcional com intervalos censurados. Nós associamos o ciclo do desemprego ao trimestre de gestação como base na data de nascimento. Os resultados sugerem que um desvio de 0.1 log da taxa de desemprego em relação a sua tendência de longo prazo aumenta o risco de início ao hábito de fumar em 4.35%. O estresse materno devido às flutuações econômicas é provavelmente o principal mecanismo por trás do efeito obtido, uma vez que evidências epidemiológicas têm relacionado o excesso de hormônios do estresse durante a gravidez à dependência de nicotina por parte dos filhos na vida adulta. Além disso, nós encontramos evidência de seleção associada às flutuações econômicas em que a proporção de elevado *status* socieconômico é maior do que os estudantes de baixo *status* socieconômico durante períodos de recessão. Em particular, os alunos de elevado *status* forma o grupo de adolescentes mais sensíveis às flutuações econômicas, provavelmente porque sua mãe enfrentaram altos custos de oportunidade durante os períodos de contrações da economia.

Palavras-chave. Flutuações Econômicas, Iniciação ao Fumo, Adolescentes, Análise de Duração, Brasil.

JEL Classification. I12, E32.

Área 12 - Economia Social e Demografia Econômica

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1 Introduction

The first experience of teenagers with cigarette or tobacco products is an important event that may trigger individual's smoking behavior (Azagba et al. 2015). Many experimenters may never become addicted to nicotine, but, for some, the first few cigarettes are enough to make them more vulnerable to addiction (Pomerleau 1995; Pomerleau et al. 1999).

The medical literature has shown that individuals who start smoking early in life are more likely to smoke intensively, to be addicted to nicotine and, consequently, to have difficulties of quitting during adulthood (Everett et al. 1999; Fernandez et al. 1999; Hu et al. 2006; Wilkinson et al. 2007; Reidpath et al. 2013; Reidpath et al. 2014; Hwang and Park 2014). Moreover, they are more willing to consume alcohol and hard drugs, prompting them to be associated to a variety of behavioral problems including: low academic performance, delinquency and violence, early pregnancy and parenthood (Ellickson et al. 2001). All these evidences support that adolescents are a critical demographic group for preventive policies, in addition to the fact that most adults smokers started smoking before age of 18 (Khuder et al. 1999; Wilkinson et al. 2007).

The economic analyses have also been interested in studying smoking onset, especially issues surrounding the determination of policy variables that may contribute to reduce cigarette demand among adolescents.[1] Several empirical studies have been devoted to analyse the impact of cigarette taxes or prices on aggregate cigarette consumption or individual cigarette demand among teenagers (DeCicca et al. 2002; Carpenter and Cook 2008; DeCicca et al. 2008; Nonnemaker and Farrelly 2011; Lillard et al. 2013). The idea is that increases in the health or direct money costs of smoking lead to declines in smoking propensities (Heckman et al. 2008).[2] Parental influence, risk preference, peer influences and access are also important predictors of smoking behavior that attracted attention from economists (Chaloupka 1991;Becker et al. 1994).

Nevertheless, it is possible that smoking initiation be linked to economic downturns during pregnancy. In this paper, we investigate whether economic fluctuations proxied by the unemployment rate during the gestational period affect the risk of smoking initiation among Brazilian adolescents. The literature shows that unemployment produces negative consequences for individual's health and mental health, where an unemployed person is more likely to exhibit mixed symptoms of distress, depression, anxiety, psychosomatic symptoms, subjective well-being, and self esteem (Paul and Moser 2009).[3]

Bozzoli and Quintana-Domeque (2014) show that pregnant women and her fetus form a demographic group highly vulnerable to economic shocks. The study provides evidence that the 2001 Argentinian economic crisis affected negatively child health at birth through maternal stress and nutritional deprivation. Children exposed to the crisis in the first and third trimesters presented low birth weight, but the effects were heterogeneous. While children of high-SES mothers were only affected in the first trimester with lower effects, children of low-SES mothers were affected in both first and third trimester with larger coefficients. Other studies have explored the stress channel as the main (biological) mechanism of the

[1] Smoking generates social costs such as direct medical costs due to spending on prevention, diagnosis, and treatment of smoking-related diseases, and indirect morbidity and mortality costs associated to lost (future) earnings due to a low work capacity of smokers or due to premature smoking-related deaths (Chaloupka and Warner 2000).

[2] However, younger adolescents may not be price sensitive because, in early stages of smoking, they are more likely to obtain cigarettes from other sources (e.g. from friends) rather than purchasing them (Emery et al., 2001).

[3] Moreover, unemployment may cause mental health problem not only to individual who lose the job, but also it affects the mental health of the spouse (Marcus 2013;Mendolia 2014). In the recent Greek economic crises, women were more negatively affected by unemployment in relation to their health and mental health statuses than men (Drydakis 2015).

effect of external shocks (e.g terrorism, civil conflicts and natural disasters) on birth outcomes (Camacho 2008;Torche 2011; Mansour and Rees 2012).

Our study shows that a deviation of 0.1 log units in the unemployment rate from its long-term trend in the first trimester of pregnancy increases the risk of smoking onset in 4.35%. This result is robust to classmate's peer effects, parental influence, parental education and household characteristics. A biological mechanism seems to support this evidence, since the excess of Glucocorticoids (stress hormones) during pregnancy is associated with offspring nicotine dependence later in life (Stroud et al. 2014).

Stress experienced by mothers can activate maternal HPA axis during pregnancy, leading to an increase in the circulation levels of cortisol which stimulates the production of Placental Corticotrophin-releasing Hormone - CRH (Seckl and Meaney 2004). Cortisol is secreted by the adrenal gland under regulation of the HPA axis in response to both physiological and psychological stress. Elevated CRH levels at 33 weeks' gestation (third trimester) were significantly associated to the risk of spontaneous preterm birth and fetal growth restriction (Wadhwa et al. 2001). Glucocorticoids (e.g. cortisol and cortisone) are essential for life, influencing virtually every tissue and affecting a wide range of physiological functions from metabolism, blood pressure, the immune system, regulation of fluid and electrolyte homeostasis and increasing energy demands in response to stress. The excess of such hormones is also associated to long term adverse programmed outcomes including metabolic and brain sequelae (Reynolds 2013).

Nonetheless, we find evidence on selection, probably due to fertility decision making during economic downturns in light of Dehejia and Lleras-Muney (2004). High unemployment rate during pregnancy seems to be connected with an increase in the proportion of high socioeconomic status adolescents in the cohorts of birth. When checking the existence of heterogeneous effect due to socioeconomic status (SES), we find that only high-SES adolescents were sensitive to unemployment cycles, driving the impact on smoking onset. A potential explanation is that high-SES mothers were more likely to face high labor market opportunity costs during economic downturns when they were pregnant and, consequently, they might experience more problems related to mental health than low-SES mothers.

We contribute to the very scarce literature of the determinants of smoking onset in Brazil by showing that individual's smoking behavior may have its origins in the prenatal period. The Foetal Origins Hypothesis of David Baker links some chronic diseases in adulthood such as cardiovascular disease, type 2 diabetes and some types of cancer to prenatal environmental conditions. Health economists have shown several external shock have consequence to the life in utero, not only in the short-run but also in the long-run (Almond and Currie 2011). For instance, poor health conditions at birth is associated to low education outcomes, low adult socioeconomic status, small QI and low labor market outcomes (Behrman and Rosenzweig 2004; Black et al. 2007; Currie and Moretti 2007). Nutritional shock during pregnancy increases learning disabilities in early childhood (Almond and Mazumder 2011), in addition to reduce longevity (Lindeboom et al. 2010). Moreover, individuals exposed in utero to the 1918 influenza pandemic exhibited low education attainment, physical disability, lower income, and low socioeconomic status (Almond 2006). In Brazil, the exposure to the 1918 influenza pandemic during pregnancy affected negatively education and labor market outcomes (Nelson 2010).

The rest of the paper proceeds as follows. Section 2 describes the data sources. Section 3 presents the econometric approach. Section 4 brings the estimated result. Section 5 concludes the paper.

2 Exploratory Analysis

2.1 Data

The data used in this study comes from the Pesquisa Nacional de Saúde do Escolar - PeNSE (National Survey of Student's Health) carried out by the Instituto Brasileiro de Geografia e Estatística - IBGE (Brazilian Institute of Geography and Statistics) in 2012. The PeNSE is a national representative survey, providing information about 109,104 students in the 9^{th} grade of the fundamental level from public and private schools. The PeNSE collected data about biological, cognitive, emotional and social changes experienced by students during the adolescence. This data source also provides information about parental behavior and characteristics, school and household characteristics.[4]

The crucial questions in the survey for our study is the following: "Que idade você tinha quando experimentou fumar cigarro pela primeira vez?" (What was your age when you first experienced a cigar?). Table 1 displays the distribution of observations by reported age of the first smoking experience and by year of the survey.

Table 1: Definitions for Interval Censored Smoke Initiation Durations

Age of the	Age Interval		Boys		Girls		All	
1^{st} Experience	Survey	Model	N	(%)	N	(%)	N	(%)
Never smoked	$[Age^{\star}, \infty)$	$[Age^{\star}, \infty)$	40,428	77.7	45,773	80.2	86,201	79.0
$\leq$ 9 years	(0,10)	[9,10)	1,644	3.2	1,499	2.6	3,143	2.9
10 years	[10,11)	[10,11)	966	1.9	846	1.5	1,812	1.7
11 years	[11,12)	[11,12)	1,140	2.2	1,061	1.9	2,201	2.0
12 years	[12,13)	[12,13)	1,882	3.6	2,020	3.5	3,902	3.6
13 years	[13,14)	[13,14)	2,386	4.6	2,803	4.9	5,189	4.8
14 years	[14,15)	[14,15)	1,937	3.7	1,955	3.4	3,892	3.6
15 years	[15,16)	[15,16)	969	1.9	682	1.2	1,651	1.5
16 years	[16,17)	[16,17)	353	0.7	223	0.4	576	0.5
$\geq$ 17 years	[17,∞)	[17,19)	143	0.3	98	0.2	241	0.2
# Missing data			167	0.3	129	0.2	296	0.3
# $1^{st} Experience$			11,420	22.0	11,187	19.6	22,607	20.7
# Observations			52,015	100	57,089	100	109,104	100

Source: Produced by the authors using data from the 2012 PeNSE.

The first column informs the age reported by students to the survey. The 2012 survey brings two age categories, $[0, 7]$ and $[8, 9]$, different from the 2009 survey, $[0, 9]$. In order to eliminate this difference, we aggregate those two age categories 2012 survey in only one, i.e., nine years or less. Besides, the second column of Table (1) shows the original survey age intervals. There should be an adaptation as to the boundary of *Seventeen or more* interval, since the age at interview from students is restricted: substitute $[17, 19)$ for $[17, Age^{\star})$, where $Age^{\star}$ refers to the age at the interview. However, we maintain two assumptions, i.e., everybody will end up smoking at infinity[5], $[Age^{\star}, \infty)$, and the risk of smoking onset starts at age 9. These changes appear on the third column where the actual intervals applied to the estimation process appear.

In Table 1, we observe that students who reported never have smoked a cigarette were about 79%, i.e., the number right censored observations is more than two-third of the total sample. The prevalence

[4]This study did not include data from the PeNSE 2009 for two reasons. The first reason has to do with the better representativeness of the 2012 survey compared to 2009 survey. The second reason relates to the expansion of the questionnaire in order to obtain comparability with international surveys conducted by the World Health Organization - WHO and the Center for Disease Control and Prevention such as the Global School-based Student Health Survey - GSHS and the Youth Risk Behavior Surveillance System - YRBSS.

[5]Otherwise, we should use "split population" models.

of the first smoking experience is 20.7%, and only 0.3% of the sample corresponds to missing information about the age of the first smoking experience. Notice that the mode of the distribution of the age of the first smoking experience is very similar between boys and girls for which the mode of the distribution is the age of thirteen. Nonetheless, the prevalence of the first experience is higher for boys than for girls, respectively 22% and 19.6%.

Table 2 displays the age distribution at the interview for boys and girls. The proportion of girls younger than 14 years of age are greater than proportion of boys. On the other hand, the proportion of boys with age greater than 14 is higher than the proportion of girls. So, girls are younger than boys in the 9^{th} grade of the primary level.

Table 2: Distribution of the Age at the Interview

	Boys		Girls		All	
Age at the interview	N	(%)	N	(%)	N	(%)
$\leq$ 11 years	18	0.03	13	0.02	31	0.03
12 years	336	0.65	492	0.86	828	0.76
13 years	8,794	16.91	12,790	22.40	21,584	19.78
14 years	23,240	44.68	27,660	48.45	50,900	46.65
15 years	11,231	21.59	9,874	17.30	21,105	19.34
16 years	5,449	10.48	3,946	6.91	9,395	8.61
17 years	2,036	3.91	1,460	2.56	3,496	3.20
18 years	589	1.13	467	0.82	1,056	0.97
$\geq$ 19 years	322	0.62	387	0.68	709	0.65
Total	52,015	100	57,089	100	109,104	100

Source: Produced by the authors using data from the 2012 PeNSE.

Some descriptive statistics are available in Table (3). First of all, the size of the sample reduces 7.2% (to 101,287 observations) due to missing information in some control variables

An important factor in the determination of smoking initiation during adolescence is the influence of peers. Several studies associate positively peers' behavior with smoking initiation during adolescence (Simons-Morton and Farhat 2010), and persisting during adult life (Ali and Dwyer 2009). In this study, we analyse the influence of classmates by computing the proportion of them who already have had their first experience with cigarette. In the sample, on average, about 21% of classmates have experienced cigarettes. There is no substantial differences between boys and girls regarding to the prevalence of smoking behavior among classmates.

However, girls report parental smoking more than boys. Parental influence is another predictor of smoking initiation that have been investigated by the literature. The evidence suggests a positive association between parental smoking habit and the likelihood of smoking initiation of their offspring (Gilman et al. 2009). Table 3 shows that 13.8% of students reported that their father smokes, while 8.7% reported that their mother smokes. A small fraction of the sample, 4.6%, reported that both parents smokes cigarette. Moreover, students' perception about the potential reaction of their parents relative to his/her smoking habit is included in the analysis. About 95.7% of the sample reported that parents would disapprove strongly their potential smoking habit.

The sample is composed by 78.6% of students from public schools. There are more girls than boys, respectively 52.4%. Moreover, the share of brown (or pardo) students is about 44%, whereas white students represents 35% and black students are 13%, Asiatic and native students account for 7.8%. Besides, a large fraction of students live with the mother, 89.5%, and 64.2% live with the father. The interaction between these two variables suggests that the proportion of students who live with both parents is about 59.7%.

In addition, Table 3 shows that 28.2% of the students reported that their mothers have no education

or incomplete primary education. About 14% have complete primary, 26.6% have complete secondary, and 14% inform that mothers have superior education. A limitation of this variable is the fact that the questions is not answered by the mother, but by her child. In this case, the fraction of students who did not know the schooling level of their mothers or did not want to report the information is 16.6%. So, in order to have no exclusion of the fraction of the sample, we include a dummy in the models relative to the missing information about mother's education.

Parental education is another variable reported by students. Table 3 shows that about 30% of students reported that their mothers have no education or did not conclude the primary level, and 31.7% informed that the father has low education. Moreover, 14.7% reported that mothers did attain the primary level, and 13% of their fathers. About 27% of the mothers attained the secondary level, and 21% of the fathers. Mothers with superior degree represent 12% of the sample, and 11% of fathers. Missing information about mother's education is smaller than for fathers, respectively 16.5% and 22.5%.

In the analysis, we also include variables relative to some household characteristics in order to capture a wealth effect. For instance, 50% of students have telephone in their residences, 87% have a cellphone,

Table 3: Descriptive Statistics

	Boys		**Girls**		**All**	
Covariates	Mean	SD	Mean	SD	Mean	SD
Classmate's peer effect	21.078	(12.536)	20.564	(12.388)	20.809	(12.461)
= 1 if smoking father	0.133	(0.340)	0.142	(0.349)	0.138	(0.345)
= 1 if smoking mother	0.081	(0.272)	0.093	(0.290)	0.087	(0.282)
= 1 if smoking parents	0.043	(0.203)	0.048	(0.213)	0.046	(0.208)
= 1 if strong parental reaction	0.952	(0.213)	0.960	(0.195)	0.957	(0.204)
= 1 if public school	0.779	(0.415)	0.792	(0.406)	0.786	(0.410)
= 1 if girl	-	-	-	-	0.524	(0.499)
Age at the interview	14.410	(1.137)	14.182	(1.064)	14.291	(1.105)
= 1 if white	0.366	(0.482)	0.336	(0.472)	0.350	(0.477)
= 1 if brown (pardo)	0.406	(0.491)	0.473	(0.499)	0.441	(0.497)
= 1 if black	0.154	(0.361)	0.111	(0.314)	0.131	(0.337)
= 1 if asiatic	0.039	(0.194)	0.048	(0.214)	0.044	(0.205)
= 1 if native	0.036	(0.185)	0.033	(0.177)	0.034	(0.181)
= 1 if living with mother	0.893	(0.309)	0.897	(0.304)	0.895	(0.307)
= 1 if living with father	0.668	(0.471)	0.618	(0.486)	0.642	(0.479)
= 1 if living with parents	0.615	(0.487)	0.581	(0.493)	0.597	(0.490)
= 1 if illiterate mother or no primary	0.279	(0.449)	0.318	(0.466)	0.300	(0.458)
= 1 if mother has primary education	0.147	(0.354)	0.147	(0.355)	0.147	(0.354)
= 1 if mother has secondary education	0.269	(0.444)	0.260	(0.438)	0.264	(0.441)
= 1 if mother has superior degree	0.134	(0.341)	0.114	(0.318)	0.124	(0.329)
= 1 if missing mother's education	0.171	(0.376)	0.161	(0.367)	0.165	(0.372)
= 1 if illiterate father or no primary	0.305	(0.461)	0.328	(0.470)	0.317	(0.465)
= 1 if father has primary education	0.135	(0.342)	0.125	(0.331)	0.130	(0.336)
= 1 if father has secondary education	0.220	(0.414)	0.205	(0.404)	0.212	(0.409)
= 1 if father has superior degree	0.126	(0.332)	0.105	(0.307)	0.115	(0.319)
= 1 if missing father's education	0.213	(0.410)	0.236	(0.424)	0.225	(0.418)
= 1 if telephone	0.536	(0.499)	0.474	(0.499)	0.503	(0.500)
= 1 if cellphone	0.845	(0.362)	0.890	(0.312)	0.869	(0.338)
= 1 if computer	0.716	(0.451)	0.674	(0.469)	0.694	(0.461)
= 1 if internet	0.666	(0.472)	0.630	(0.483)	0.647	(0.478)
= 1 if car	0.549	(0.498)	0.503	(0.500)	0.525	(0.499)
= 1 if motocicle	0.333	(0.471)	0.310	(0.462)	0.321	(0.467)
#Bathrooms	1.541	(0.868)	1.450	(0.836)	1.493	(0.853)
= 1 if household servant	0.141	(0.348)	0.111	(0.314)	0.125	(0.331)
= 1 if North	0.200	(0.400)	0.210	(0.407)	0.205	(0.404)
= 1 if Northeast	0.278	(0.448)	0.297	(0.457)	0.288	(0.453)
= 1 if Southeast	0.188	(0.390)	0.177	(0.382)	0.182	(0.386)
= 1 if South	0.143	(0.350)	0.134	(0.341)	0.139	(0.346)
= 1 if Center-west	0.191	(0.393)	0.182	(0.386)	0.186	(0.389)
Observations	48,206		53,081		101,287	

Source: Produced by the authors using data from the 2012 PeNSE.

69% have computer, and 64% have access to the internet. Besides, near 53% of students reported that a family member has a car, and 32% have a motorcycle. The average number of bathrooms is also included as a measure of the house size. Students inform 1.5 bathrooms, on average, in the houses. Moreover, 12.5% of students reported to have at least a servant in their homes.

Finally, the distribution of the sample regarding to the geographical regions of Brazil indicates 20.5% of students from the North region, 28.8% from the Northeast region, 18.2% from the Southeast region, 13.9% from the South region, and 18.6% from the Center-west region.

2.2 Economic Fluctuations

Our proxy for economic fluctuations is the unemployment rate obtained from the Pesquisa Mensal de Empregos - PME (Monthly Employment Survey) carried out by the IBGE between 1980 and 2002 (see Figure (1)). However, we are interested in only the cycle of the variable instead of the long term trend, since we want to single out only exogenous shocks during pregnancy. Therefore, we use the standard Hodrick-Prescott filter with smooth parameter equal to 129,600 (see Figure (2)).

Figure 1: Log Monthly Unemployment Rate

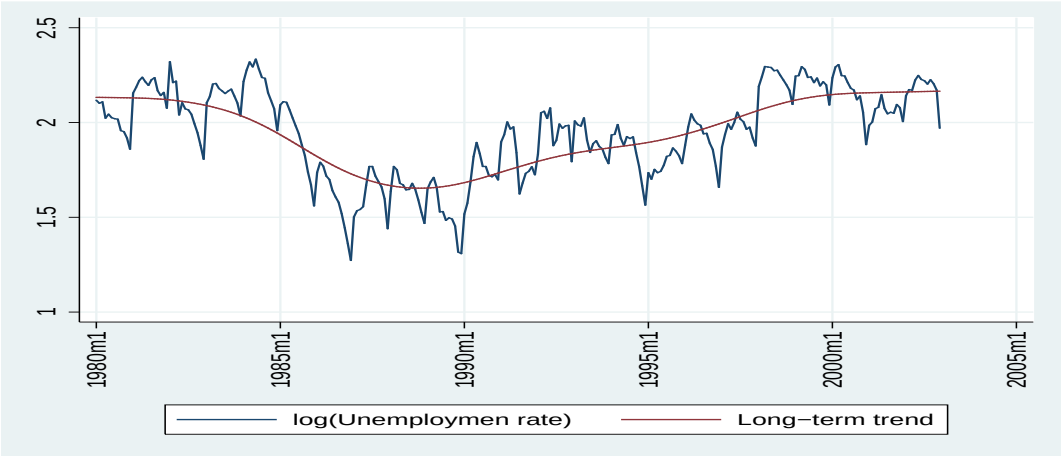
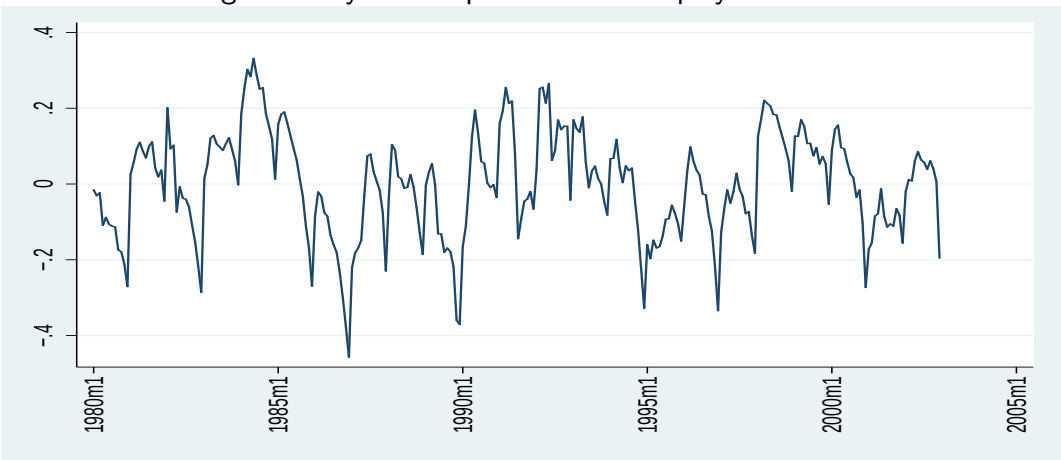


Figure 2: Cycle Component of Unemployment Rate



We match the average cycle of unemployment rate respectively with the trimester of pregnancy based on date of birth. Therefore, we have to assume 9 months of pregnancy for all observations in the sample. For instance, for a student born in December of a given year, the cycle of unemployment rate in the 3^{rd} trimester of gestation is an average of the indicator in October, November and December. In the 2^{nd} trimester of gestation, the cycle of unemployment rate takes into account the months July, August and September. Whereas in the 1^{st} trimester of gestation, the average in computed using information in the April, May and June of a given year.

Bozzoli and Quintana-Domeque (2014) use the cycle of the log index of economic activity in Argentina to measure the impact of the 2001 crises on the birth weight. Unfortunately, the index of economic activity started to be computed in Brazil from 2003 and, therefore, it does not cover the years of birth reported by students (1990-2001). The industrial production index could be another proxy of economic cycles, but it might reflect fluctuations only for manufacturing sector instead for the economy as a whole.

Table (4) presents the descriptives of the cycle of unemployment rate considering the moving average for 3 months. The mean of moving averages for the 3^{rd} and 2^{nd} trimester are positive, and negative for the 1^{st} trimester. Since a large fraction of the sample was born between 1995 and 1998, they are more likely to have experienced negative deviations of the unemployment rate from its long-term trend. However, the seasonality of the unemployment rate within the year its very important for our analysis, and we take it into account using dummies for month of birth and year of birth.

Table 4: Cycle of Unemployment Rate

	N	Mean	SD	Min.	Max.
Moving average - 3 months					
Unemp. Cycle - 3^{rd} Trim.	276	0.00040	(0.127)	-0.377	0.306
Unemp. Cycle - 2^{nd} Trim.	273	0.00028	(0.128)	-0.377	0.306
Unemp. Cycle - 1^{st} Trim.	270	-0.00036	(0.128)	-0.377	0.306
Average per year					
1980	12	-0.119	(0.078)	-0.271	-0.015
1981	12	0.059	(0.046)	-0.045	0.111
1982	12	-0.049	(0.137)	-0.286	0.201
1983	12	0.082	(0.042)	-0.002	0.128
1984	12	0.218	(0.091)	0.013	0.332
1985	12	0.034	(0.151)	-0.270	0.190
1986	12	-0.178	(0.138)	-0.457	-0.021
1987	12	-0.073	(0.113)	-0.230	0.079
1988	12	-0.015	(0.082)	-0.186	0.104
1989	12	-0.138	(0.140)	-0.371	0.054
1990	12	0.020	(0.102)	-0.166	0.195
1991	12	0.059	(0.142)	-0.144	0.255
1992	12	0.146	(0.096)	-0.042	0.265
1993	12	0.054	(0.086)	-0.082	0.177
1994	12	-0.024	(0.134)	-0.328	0.118
1995	12	-0.129	(0.043)	-0.197	-0.056
1996	12	-0.052	(0.125)	-0.334	0.098
1997	12	-0.064	(0.060)	-0.183	0.028
1998	12	0.142	(0.071)	-0.019	0.221
1999	12	0.090	(0.058)	-0.053	0.170
2000	12	0.021	(0.119)	-0.273	0.155
2001	12	-0.102	(0.044)	-0.172	-0.012
2002	12	0.018	(0.074)	-0.195	0.085

Source: Produced by the authors using data from the PME/IBGE 1980-2002.

3 Econometric Approach

The structure of the dependent variable presented in the Subsection 2.1 suggests the use of survival analysis for interval censored data. Since the range of the observed age of the first smoking experience is from 10 to 17 years, we use the *case k interval censoring* model in which $k = 9$, once we do not know the exact date of the event.

We follow Huang and Wellner (1997) in order to illustrate our econometric model. The observed age of the first smoking experience can be represented by the vector $(T_1, T_2, ..., T_k)$ with some distribution, where $0 < T_1 < T_2 < ... < T_k < \infty$. Since we do not know the exact date of the event, Z is the unobserved failure time with some distribution. We observe n $i.i.d$ copies of $(T_1, ..., T_k, \Delta_1, ..., \Delta_{k+1}) \equiv (\mathbf{T}, \mathbf{\Delta})$, where

$$\begin{aligned}
\mathbf{\Delta_1} &= 1\{Z \leq T_1\} \\
\mathbf{\Delta_2} &= 1\{T_1 < Z \leq T_2\} \\
&\vdots \\
\mathbf{\Delta_k} &= 1\{T_{k-1} < Z \leq T_k\} \\
\mathbf{\Delta_{k+1}} &= 1\{Z > T_k\}
\end{aligned}$$

The objective is to estimate the distribution function $F(z) = P(Z \leq z)$, that is, the risk of the first smoking experience. In this context, Z is the age at the first experience with cigarettes in the interval $(T_i, T_j]$ for all $i < j$. Formally, let $(z, t_1, ..., t_k, \delta_1, ..., \delta_k)$ be a realization of $(Z, T_1, ..., T_k, \Delta_1, ..., \Delta_k)$ for a student. When a student reports the first experience at age of 14, for example, indeed he/she is indicating that the event occurred in the interval from 14 to incomplete 15 years of age, or $(t_1, ..., t_9, \delta_1 = 0, ..., \delta_6 = 1, ..., \delta_{10} = 0)$. In this case, we know that $z \in (t_5, t_6]$, although we do not know the exactly date of the event.

The conditional log-likelihood function can be defined as follows:

$$l_n(F) = \sum_{i=1}^{n} \{\delta_{1i} \log F(t_{1i}|X_i) + \delta_{2i} \log[F(t_{2i}|X_i) - F(t_{1i}|X_i)] + ... + \delta_{ki+1} \log[1 - F(t_{ki}|X_i)]\} \tag{1}$$

where $\sum_{l=1}^{k+1} \delta_l = 1$, and X is the vector of covariates.

The regression analysis of the equation (1) can be done using the famous proportional hazard model proposed by Cox (1972), where the cumulative hazard function is written as

$$\Lambda(t_i|X_i) = \Lambda(t_i)e^{X_i\beta} \tag{2}$$

where Λ is the unknown baseline cumulative hazard function, and β is the vector of parameters to be estimated. In this case, the proportional hazard model considering interval-censored for the regression with vector β and the baseline cumulative hazard function Λ is

$$\begin{aligned}
l_n(\beta, \Lambda) = \sum_{i=1}^{n} &\{\delta_{1i} \log[1 - exp(-\Lambda(t_{1i})e^{X_i\beta})] \\
&+ \delta_{2i} \log[exp(-\Lambda(t_{1i})e^{X_i\beta}) - exp(-\Lambda(t_{2i})e^{X_i\beta})] + ... - \delta_{ki+1} exp(-\Lambda(t_{ki})e^{X_i\beta})\}
\end{aligned} \tag{3}$$

Our results comes from such maximum likelihood function that estimates $(\hat{\beta}, \hat{\Lambda})$ under the constraint that $\hat{\Lambda}_n$ is a nonnegative and nondecreasing function. The vector $X_i\beta$ includes $U_{\tau,m,y}$ which is the average

cycle of unemployment rate in the τ^{th} trimester of pregnancy for an individual i born in month m in the year y. Hence, we assume that all students experienced nine months of pregnancy. Besides, we include dummies for month of birth I_m, for year of birth I_y and for Brazilian geographic regions I_r. The vector $X_i^\star$ include other covariates such as classmates' peer effect, parental smoking behavior, demographic and household characteristics.

4 Results

Table 5 shows the estimates of the interval-censored model specifying the cumulative function $F(\cdot)$ as a Weibull distribution. The coefficients capture de impact of the respective variable on the risk of the first smoking experience. Before presenting the estimates, we observe that the estimate of Weibull parameter is positive and greater than 1 which indicates a positive duration dependence of the risk of smoking onset relative to the age.

Columns (1) to (5) present the estimates based on variations of the equation (4) relative to the inclusion of regional and time dummies, and interactions. The results show that the positive deviations of the unemployment rate from its long-term trend in the first trimester of pregnancy increases the risk of the first experience with cigarettes in adolescence. In column (1) and (2), the average cycle of unemployment in the first and third trimesters of pregnancy are important in the determination of smoking onset in the adolescence. However, after controlling for month and year of birth, only the first trimester remains significant.

The impact of the average unemployment cycle during the first trimester of pregnancy on smoking initiation varies from 0.425 to 0.454. To understand the magnitude of the impact, note that a (positive) deviation of 0.1 log units (about 10.5%) from the long-term trend in the unemployment during the third trimester of pregnancy would explain an increase in the risk of adolescent's smoking onset of about 4.35% (0.1 x 0.435) in the specification (5).[6] In column (3), we include region dummies and account for the month and year of birth. The same variation in the unemployment cycle increases the risk of smoking initiation in 4.27%. In addition to region dummies and birth month and birth year, we control for potential differences in the birth seasonality per geographic regions, including interactions between months of birth and regions. In this specifications the impact is about 4.25% (see column (4)). The last specification accounts for region specific trend and we find a very close estimate, 4.35% of increase in the risk (see column (5)). Therefore, adolescents exposed to economic downturns during the last trimester of the life in utero are more likely to experiment cigarette than their counterparts.

Our results agree with the recent literature that have predicted the high vulnerability of the first trimester of pregnancy to external shocks, although birth weight and gestational length have been the main outcomes of interest. Bozzoli and Quintana-Domeque (2014) found that birth weight of Argentinean children who experienced the 2001 economic crisis was smaller than their counterparts, specially those exposed in the first and third trimester of pregnancy. Whereas maternal stress was the driven factor of the recession in the first trimester effect, nutritional deprivations was the main channel that might explain

[6]The log transformation of the unemployment rate (u)can be observe in terms of differences $z - z' = log(u) - log(u') = log(1 + \frac{u-u'}{u})$. So, the percentage variation in the cycle of the unemployment rate can be written as:

$$\frac{u - u'}{u'} \cdot 100\% = \{\exp(z - z') - 1\} \cdot 100\%.$$

In this case a variation of 0.1 log units in the transformed variable is equivalent to 10.5% in the unemployment rate.

Table 5: Results from the Interval Censored Survival Model - Weibull

	Specifications				
	(1)	(2)	(3)	(4)	(5)
Economic Fluctuations					
Unemp. Cycle - 3^{rd} Trim.	0.439***	0.454***	-0.276	-0.277	-0.230
	(0.083)	(0.084)	(0.182)	(0.183)	(0.182)
Unemp. Cycle - 2^{nd} Trim.	-0.064	-0.070	-0.381	-0.382	-0.384
	(0.102)	(0.102)	(0.286)	(0.286)	(0.286)
Unemp. Cycle - 1^{st} Trim.	0.433***	0.454***	0.427**	0.425**	0.435**
	(0.093)	(0.093)	(0.173)	(0.173)	(0.173)
Parental Smoking Behavior and Peer Effect					
= 1 if smoking father	0.377***	0.370***	0.368***	0.368***	0.368***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
= 1 if smoking mother	0.389***	0.378***	0.374***	0.374***	0.374***
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
= 1 if smoking parents	0.539***	0.518***	0.514***	0.514***	0.517***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
= 1 if strong parental reaction	-0.708***	-0.705***	-0.707***	-0.707***	-0.707***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
Classmate's peer effect	0.040***	0.039***	0.039***	0.039***	0.039***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Other Controls					
= 1 if public school	-0.074***	-0.088***	-0.095***	-0.095***	-0.098***
	(0.017)	(0.018)	(0.018)	(0.018)	(0.018)
= 1 if girl	-0.077***	-0.074***	-0.067***	-0.067***	-0.068***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
= 1 if white	-0.066***	-0.098***	-0.096***	-0.096***	-0.096***
	(0.016)	(0.017)	(0.017)	(0.017)	(0.017)
= 1 if black	0.006	-0.005	-0.006	-0.006	-0.007
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
= 1 if asiatic	-0.015	-0.021	-0.022	-0.022	-0.022
	(0.037)	(0.037)	(0.036)	(0.036)	(0.036)
= 1 if native	0.079**	0.072*	0.069*	0.069*	0.070*
	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
= 1 if low-educated mother	-0.043**	-0.049***	-0.051***	-0.051***	-0.051***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
= 1 if low-educated father	0.045**	0.044**	0.042**	0.042**	0.043**
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
= 1 if missing mother's education	-0.078***	-0.085***	-0.087***	-0.087***	-0.086***
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
= 1 if missing father's education	0.013	0.011	0.008	0.008	0.009
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
= 1 if living with mother	-0.110***	-0.119***	-0.127***	-0.127***	-0.127***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
= 1 if living with father	-0.063	-0.068*	-0.079**	-0.080**	-0.080**
	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
= 1 if living with parents	-0.219***	-0.214***	-0.199***	-0.199***	-0.198***
	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)
Base line parameter	1.910	1.911	1.910	1.910	1.910
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Dummies for Region and Time					
Region		X	X	X	X
Trend					X
Birth Month			X	X	X
Birth Year			X	X	X
Region x Trend					X
Region x Birth Month				X	
Log-Likelihood	-75640.445	-75601.462	-75535.957	-75535.771	-75525.804
Wald test	6849.377	7011.930	7026.054	7038.786	7334.871
#Clusters	4,091	4,091	4,091	4,091	4,091
Observations	101,224	101,224	101,224	101,224	101,224

Note: All specifications include a constant term, and the following controls: student's age, 6 dummy variables for household assets (telephone, cellphone, computer, internet, car, and motorcycle), a variable for the size of the home (# bathrooms) and a dummy variable for the presence of a servant in the home. Robust standard errors clustered at classroom level. Significance levels: *** 1%; ** 5% and * 1%.

the impact of economic fluctuations in the third trimester. Torche (2011) shows that children exposed to the 2005 Tarapaca Earthquake in Chile had also low birth weight, especially those exposed in the first trimester of pregnancy. The author argues that the production of Placental Corticotrophin-releasing Hormone - CRH, which is a glucocorticoid, in response to the maternal stress was the biological factor that explains low birth weight of children exposed to the natural disaster in Chile. Camacho (2008) finds that the intensity of random landmine explosions during a woman's first trimester of pregnancy has a significant negative impact on child birth weight. Mansour and Rees (2012) show that intrauterine exposure in the first trimester of pregnancy to armed conflict of al-Aqsa Intifada reduces birth weight.

Notice that our results in Table 5 includes covariates that capture parental smoking behavior. The risk of an adolescent start smoking increases about 37% if father is a smoker. A similar effect is found if mother is a smoker, but the risk of smoking onset increases 51.4% if both parents are smokers. Moreover, the risk of smoking onset among adolescents decreases if they believe that their parents will strongly react to their smoking habit. We also find evidence of positive influence of peers. In this case, increasing the proportion of classmates who have experienced cigarettes in 1% raises the risk of individual's smoking initiation in 3.9%.

Students from public schools are less risky to start smoking than students from private schools. In column (5), the effect of studying in a public school is a reduction of 9.8% in the risk of smoking onset. Besides, the risk of smoking initiation during adolescence is 6.8% smaller for girls in comparison to boys, and 9.6% smaller for white students in comparison to brown (pardos) students. Natives exhibit a risk 7% greater than brown students, but the estimate is significant only at 10%.

Living with parents is also an important factor that inhibit the smoking initiation of adolescents. The risk decreases 12.7% if the adolescent lives with the mother, and 8% if he/she lives with the father. However, if the adolescents live with both parents, the risk drops even more, 19.8%.

Parental education seems to have different impacts over smoking initiation of the offspring. Whereas low-educated mother (illiterate or incomplete primary education) contributes to reduce the risk of the smoking onset, low-educated father contributes positively to smoking initiation (illiterate or incomplete primary education). However, we should be cautious in interpreting these estimated coefficients, once the missing information about parental education is substantial as shown in Table 3. Variables relative to durable goods and household characteristics that may capture wealth are included in the model (see footnote of Table 5), and the estimates can be accessed under request.

4.1 Different Baseline Functions

We also check whether the effect of unemployment fluctuations in the first trimester of pregnancy is significant for different specifications of the baseline function. We estimate a model including all covariates and region fixed effect, region specific time trend, dummy variables for month and year of birth. The first column brings the results of the unemployment cycles corresponding to the column (5) in Table 5.

Although knowing which model better fits the data is important to any survival analysis, what matters for us in Table 6 is to see whether the impact of economic fluctuations in the first trimester of pregnancy still significantly affects the risk of smoking onset. As we can see on Table 6, the effect remains robust for the exposure to the first trimester of pregnancy, but no effect is found for exposure in the second and third trimester. The estimate varies from 0.432 to 0.564 which means that 0.1 log deviation of the unemployment rate from its long-term trend in the first trimester of pregnancy increases the risk of smoking initiation from 4.3% to 5.6%.

Table 6: Results from Different Baseline Specifications

	Weibull	Exponential	Log-logistic	Gompertz
Unemp. Cycle - 3^{rd} Trim.	-0.230	-0.091	-0.301	-0.179
	(0.182)	(0.159)	(0.212)	(0.184)
Unemp. Cycle - 2^{nd} Trim.	-0.384	-0.270	-0.505	-0.340
	(0.286)	(0.246)	(0.333)	(0.290)
Unemp. Cycle - 1^{st} Trim.	0.435**	0.564***	0.432**	0.541***
	(0.173)	(0.150)	(0.205)	(0.175)
Log-Likelihood	-75525.804	-94874.038	-75846.046	-75192.415
Wald test	7334.871	8110.009	7056.867	9421.119
Observations	101,224	101,224	101,224	101,224

The estimated model corresponds to the specification (5) in the Table 5 which includes covariates and region fixed effects, region specific trends, and dummy variables for month and year of birth. Robust standard errors clustered at classroom level. Significance levels: *** 1%; ** 5% and * 1%.

4.2 Selection on Observables

However, our results seem to be accompanied by selection on observable characteristics. Table 7 reports OLS results for the effect of the cycle of unemployment rate during 9 months of pregnancy on some characteristics reported by students. The model includes region fixed effects, and dummy variables for month and year of birth, in addition to adolescent's gender and age. The objective is to observe the existence of changes in the composition of cohorts due to economic fluctuations.

In Table 7, gender is not sensitive to the economic fluctuations during pregnancy. On the other hand, the proportion of white adolescents is positively correlated to an increase in unemployment rate during pregnancy. White individuals is often associated to better socioeconomic status in Brazil.[7]

Table 7: Selection on Observables

Dependent Variable	Coefficient	SE	R^2	F-test	N
= 1 if Girls	0.055	(0.045)	44.8	0.014	101,224
= 1 if White	0.084**	(0.042)	116.9	0.075	101,224
= 1 if Non-smoking parents	0.074*	(0.041)	41.8	0.015	101,224
= 1 if Public school	-0.247***	(0.041)	35.0	0.065	101,224
= 1 if Low-educated mother	-0.086**	(0.042)	113.3	0.048	101,224
= 1 if Low-educated father	-0.170***	(0.042)	72.5	0.037	101,224
Wealth index	0.569***	(0.151)	91.0	0.084	101,224

All estimated models include region fixed effects, dummy variables for month and year of birth. Robust standard errors clustered at classroom level. Significance levels: *** 1%; ** 5% and * 1%.

We also observe that positive cycles of unemployment rate during pregnancy is correlated with high proportion of non-smoking parents. However, the estimate is significant only at 10%. Besides, we observe that the cycle unemployment rate is associated to less students from public schools, less low-educated mother and low-educated father, and positively correlated with the wealth index.[8]

These results suggests the presence of selection that may have its origins in the fertility decision. Fertility decision depends on whether individuals perceive changes in the unemployment rate as permanent or transitory. In this case, quantity-quality decision is adjusted by women during recession periods. The permanent changes in wages leads to a substitution and income effect on fertility, but transitory changes in labor market will only affect the timing of fertility. The imperfections of the credit markets lead low-skilled

[7]In Brazil, white individuals have better nutrition during childhood (Reis 2012), better school performance (Flores and da Silva Scorzafave 2014), better access to college (Francis and Tannuri-Pianto 2012), and better wages (Garcia et al. 2009) than non-white individuals.

[8]The wealth index is generated using principal components approach. We include possession of cellphone, computer, internet, car, motorcycle, the number of bathrooms in the house, and the presence of servants.

women to increase fertility if she is not credit constrained during recessions, or postpone fertility if she is (Becker 1965; Dehejia and Lleras-Muney 2004).

The results in Table 7 seem to associate positively high socio-economic status (high-SES) adolescents with high rates of unemployment rate during pregnancy period. Hence, we are tempted to think that low-SES mothers chose to postpone fertility in times of high unemployment rate.

4.3 Differences due to Socioeconomic Status

In this subsection we verify the existence of heterogeneous effect of unemployment fluctuations on the risk of smoking onset relative to adolescent's socioeconomic status. We assume that adolescents are low-SES if the wealth index (as presented in Table 7) is equal to the median value or smaller.

We also use mother's eduction as alternative measure to socioeconomic status. Indeed, we derive two measures of mothers education. One measure is the same variable used in Table 7 in which low-educated mother consider illiteracy and incomplete primary level (Education 1). The second measure consider missing information in addition to illiteracy and incomplete primary level (Education 2).

Table 8 shows that the impact of unemployment fluctuations on the risk of smoking onset is driven by high-SES adolescents. Based on the wealth index, a deviation of 0.1 log units of the unemployment rate from its long-term trend increases the risk of smoking onset of about 8% among high-SES adolescents. The same variation rises the risk of smoking onset in 7.7% for high-SES adolescents based on mother's education (Education 1), and 6.9% based on the second measure of mother's education (Education 2).

Table 8: Differences due to Socio-economic Status

	Wealth		Education 1		Education 2	
	Low-SES	High-SES	Low-SES	High-SES	Low-SES	High-SES
Unemp. Cycle - 3^{rd} Trim.	-0.203	-0.351	-0.010	-0.379	-0.082	-0.428
	(0.236)	(0.287)	(0.292)	(0.237)	(0.244)	(0.277)
Unemp. Cycle - 2^{nd} Trim.	-0.199	-0.609	-0.261	-0.444	-0.346	-0.351
	(0.361)	(0.470)	(0.445)	(0.372)	(0.383)	(0.432)
Unemp. Cycle - 1^{st} Trim.	0.144	0.813***	-0.144	0.774***	0.145	0.686***
	(0.226)	(0.269)	(0.272)	(0.224)	(0.234)	(0.250)
Log-Likelihood	-40621.8	-34773.6	-25175.4	-50248.8	-37388.8	-38015.6
Wald test	4505.4	3415.2	3239.6	4685.7	4350.7	3733.4
Observations	51,462	49,762	30,333	70,891	47,074	54,150

All estimated models include region fixed effects, dummy variables for month and year of birth. Robust standard errors clustered at classroom level. Significance levels: *** 1%; ** 5% and * 1%.

We argue that such effects are mainly driven by maternal stress caused by economic contractions during pregnancy. Some economic studies have claimed that health improves during economic downturns, arguing that people change their health behaviors (Ruhm 2000;Ruhm and Black 2002;Ruhm 2003;Dehejia and Lleras-Muney 2004;Ruhm 2005). If it is the case, pregnant women would adopt healthy attitudes during economic contraction, for instance, reducing smoking and drinking behavior. However, the 2012 PeNSE did not collect data about mother's smoking behavior during pregnancy.

On the other hand, unemployment may be associated with poor health outcomes due to mental health problems coming from job losses or reductions in income and wealth. The literature also shows that individual's health can deteriorate during bad times (Dee 2001;Eliason and Storrie 2009a;Eliason and Storrie 2009b; Sullivan and von Wachter 2009;Browning and Heinesen 2012). Tekin et al. find that better educated individuals appear to experience more mental health problems because they face higher labor market opportunity cost. This may explain why high-SES adolescents are more sensitive to the unemployment fluctuations than low-SES adolescents.

5 Final Considerations

In this study we were interested in investigating whether smoking onset among adolescents in Brazil may be influenced by economic fluctuations during pregnancy. We use the Pesquisa Nacional de Saúde do Escolar - PeNSE (National Survey of Student's Health) carried out by the Instituto Brasileiro de Geografia e Estatística - IBGE (Brazilian Institute of Geography and Statistics) in 2012. In order to do that we link the cycle of unemployment rate to the trimesters of pregnancy based on the date of birth.

The results suggest that the smoking onset is positively associated to the economic downturns in the first trimester of pregnancy. A deviation of 0.1 log units of the unemployment rate from its long-term trend explain 4.35% of an increase in the smoking initiation of adolescents from the 9^{th} grade of the primary schools. This result is robust to inclusion of several covariates such as parental and classmates' peer influences, and region fixed effects, region specific time trend, and fixed effects due to month and year of birth.

However, our results is accompanied by selection on observables, indicating that the composition of cohorts of birth changed due to economic cycles. We find that high-SES adolescents is more prevalent in period of high unemployment rates during pregnancy. This happens because low-SES mothers might postpone fertility when they face transitory shock in the economy. In this case, we check the existence of heterogeneous effects due to socio-economic status. Using a wealth index and mother's education as measures of socio-economic status, we find that high-SES adolescents were more sensible to economic shocks during pregnancy than their counterparts.

We argue that a biological mechanism mediates the effect of unemployment fluctuations on the adolescents' smoking onset. The excess of glucocorticoids, or stress hormones, during pregnancy is associated to a individual's nicotine dependence later in life (Stroud et al. 2014). Besides, our results is in line of the recent literature that have found maternal stress as a biological mechanism to a variety of types of external shocks affecting the life in utero (Camacho 2008; Torche 2011; Bozzoli and Quintana-Domeque 2014).

Our study suggests that the period in utero is very important to public policy because economic shocks may produce later-life consequences to exposed an individual. However, because of the limitations of the data source, we can not test other potential channels related (e.g mother's health behavior) to the prenatal period. Nonetheless, we contribute to the literature by suggesting that the origins of smoking onset may be linked to the environmental conditions during the prenatal period.

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