# ECONOMIC FLUCTUATIONS DURING PREGNANCY AND SMOKING ONSET AMONG ADOLESCENTS IN BRAZIL: EVIDENCE FROM THE 2012 NATIONAL SURVEY OF SCHOOL HEALTH[1]

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In this paper, we aim to investigate the potential relationship between smoking onset among nine-grade Brazilian students and economic fluctuations during their life in utero. Using data about smoking behavior from the 2012 National Survey of School Health and the unemployment rate as a proxy for economic fluctuations, we estimate an interval censoring model for the risk of early smoking onset in adolescence. The results suggest that students who experienced economic downturn during the third trimester of pregnancy are less likely to have the first experience of smoking earlier in adolescence than their counterparts. This association is basically driven by students of low-SES mothers who are less prevalent in the sample and potentially more susceptible to have their fertility decision influenced by economic cycles.

**Keywords**: economic fluctuations; smoking onset; adolescents; Brazil.

## FLUTUAÇÕES ECONÔMICAS DURANTE A GRAVIDEZ E INICIAÇÃO AO TABAGISMO ENTRE ADOLESCENTES NO BRASIL: EVIDÊNCIAS A PARTIR DA PESQUISA NACIONAL DE SAÚDE DO ESCOLAR 2012

Neste artigo, investigou-se a relação potencial entre o início do tabagismo entre estudantes brasileiros do 9º ano do ensino fundamental e as flutuações econômicas durante a vida intrauterina. Usando dados sobre o comportamento em relação ao hábito de fumar entre adolescentes da Pesquisa Nacional de Saúde Escolar em 2012 e a taxa de desemprego como *proxy* para as flutuações econômicas, estimou-se um modelo de risco para o início precoce do tabagismo na adolescência. Os resultados sugerem que as estudantes que experimentaram desaceleração econômica durante o último trimestre de gestação são menos propensas a experimentarem cigarro mais cedo na adolescência. Esta associação é basicamente observada para estudantes cujas mães possuem baixo *status* socioeconômico, as quais são menos prevalentes na amostra e mais suscetíveis à influência dos ciclos econômicos sobre a decisão de fertilidade.

**Palavras-chave**: flutuações econômicas; iniciação ao tabagismo; adolescentes; Brasil.

JEL: I12; E32.

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## 1 INTRODUCTION

The first experience of teenagers with cigarette or tobacco products is an important event that may trigger an individual's smoking behavior (Azagba, Baskerville and Minaker, 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; Hu, Davies and Kandal, 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, Tucker and Klein, 2001). All this evidence support the view that adolescents are a critical demographic group for preventive policies, in addition to the fact that most adult smokers started smoking before age of 18 (Khuder, Dayal and Mutgi, 1999; Wilkinson *et al.*, 2007).

The economic analyses have been interested in studying smoking onset, especially issues surrounding the determination of policy variables that may contribute to reduce cigarette demand among adolescents.[5] Several empirical studies have been devoted to investigate the impact of cigarette taxes and prices on aggregate cigarette consumption or individual cigarette demand among teenagers (DeCicca, Kenkel and Mathios, 2002; 2008; Carpenter and Cook, 2008; Nonnemaker and Farrelly, 2011; Lillard, Molloy and Sfekas, 2013).[6] The idea is that increases in the health or in the direct monetary costs of smoking lead to declines in smoking propensities (Heckman, Flyer and Loughlin, 2008).[7] Parental influence, risk preference, peer influences and access are also important predictors of smoking behavior that attracted attention from economists (Chaloupka, 1991; Becker, Grossman and Murphy, 1994).

Nevertheless, it is possible that smoking initiation may be linked to the economic environment during pregnancy. It may depend on whether mothers react negatively or positively to economic downturns. While Dehejia and Lleras-Muney (2004)

5. 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).

6. Particularly, there are no studies investigating the effects of tax police and price variation of tobacco products on smoking onset in Brazil, even though Lampreia *et al.* (2015) have recently shown that the policy of increasing cigarette price can effectively inhibit the demand for cigarettes in the country.

7. However, younger adolescents may not be price sensitive because, in early stages of smoking, they are more likely to obtain cigarettes from other sources (for example, from friends) rather than purchasing them (Emery, White and Pierce, 2001).

suggest that mother may adopt healthy attitudes in order to protect the life in utero, Currie, Duque and Garfinkel (2015) find evidence that mothers may badly react to economic contractions, for instance, by smoking and drinking more often.

Recent studies in the medical literature has suggest that maternal stress and smoking during pregnancy can alter fetal programing and increase offspring nicotine dependence later in life (Stroud *et al.*, 2014). On the other hand, other studies have argued that prenatal environment is an important confounding factor in the association between maternal smoking during pregnancy and offspring smoking onset (Rydell *et al.*, 2012; 2014; Taylor *et al.*, 2014).

In this perspective, economic shocks during pregnancy could influence offspring smoking behavior not only through behavioral channel, but also through biological channel. This view is in line with the recent literature of human capital formation (Heckman, 2007; Cunha and Heckman, 2007; Cunha, Heckman and Schennach, 2010), which predicts that parents may compensate (or even reinforce) early life shocks on child health either by a biological channel operating directly through the production function of human capital, or by intra-household resource allocation (Yi *et al.*, 2015).

Therefore, this paper aims to investigate whether the risk of early smoking initiation among Brazilian adolescents is associated to economic fluctuations, proxied by the unemployment rate, during the gestational period. In order to perform the analysis, we use the 2012 National Survey of School Health to estimate an interval-censored survival model for the first smoking experience. Our results show that students who experienced economic downturn during pregnancy are less likely to have the first experience of smoking earlier in adolescence than their counterparts. A deviation of 0.1 log units in the unemployment rate from its long-term trend in the third trimester of pregnancy reduces the risk of early smoking initiation of about 6%. This result is robust to pre- and post-pregnancy unemployment cycles, classmate's peer effects, parental influence, parental education and household characteristics, and different specification forms.

We also find evidence of selection on observable characteristics, probably due to fertility response to economic downturns. High unemployment rate during pregnancy is positively correlated with the prevalence of adolescents of high socioeconomic status mothers in the sample, which may reflect the decision of low-SES mothers in postponing fertility during recessions. Besides, the prevalence of smoking mothers tends to be small if a positive deviation of the unemployment rate from its long-term trend is large, especially among low-SES mothers. When we check the existence of heterogeneous effect, we find that only adolescents of low-SES mothers were sensitive to unemployment cycles, driving the result. If they are credit constrained during economic downturns, they may not only

postpone fertility, but also adopt health attitudes (for example, smoking less, or attend prenatal care more often) in order to protect the life in utero in case of pregnancy (Dehejia and Lleras-Muney, 2004). In addition, we find that only boys are sensitive to the economic fluctuations during pregnancy, which suggests a potential gender bias due to parental preference.

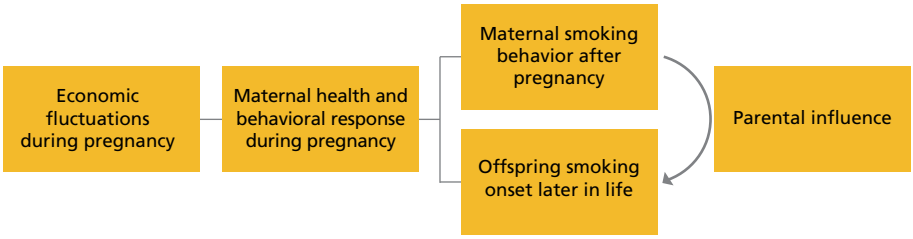
This study is probably the first attempt in the national literature that seeks to understand how the economic environment during pregnancy can influence individual's smoking behavior later in life. Moreover, there is a considerable gap in the economic literature in Brazil about evidence of the causes and consequences of the smoking behavior during the adolescence. A recent study is Almeida and Araújo Jr. (2016) who show that smoking behavior is one of the health risk factors positively associated with school delay among Brazilian students in the nine-grade of fundamental education. The epidemiological literature is predominant in the topic, but mostly presenting results from small-sample size studies.

The rest of the paper proceeds as follows. Section 2 presents the potential underlying mechanism. Section 3 describes the data sources. Section 4 presents the econometric approach. Section 5 brings the results. Section 6 concludes the study.

## 2 EARLY LIFE ENVIRONMENT AND SMOKING BEHAVIOR LATER IN LIFE

This section aims to describe a potential mechanism of analysis that links economic fluctuations during pregnancy and smoking behavior among adolescents. Figure 1 illustrates the main links we want to analyze in this paper.

FIGURE 1
**Mechanism description**




Authors' elaboration.

The first important link is whether maternal health and behavior are cyclical or countercyclical. Empirical evidence in health economics shows both patterns. Part of the studies demonstrates that unemployment produces negative consequences for individuals' health and mental health. For instance, 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).

Not only jobless individuals may have their mental health threatened by economic downturns, but also their spouses (Marcus, 2013; Mendolia, 2014; Drydakis, 2015).

Bad times also induce individual's health risk behavior. Latif (2014) finds that economic contractions from 1994 to 2009, proxied by the provincial unemployment rate, significantly increased alcohol and cigarettes consumption among Canadians. Nonetheless, the authors did not find significant effects on smoking initiation. Currie, Duque and Garfinkel (2015) found that the great recession between 2007 and 2010 in the United States deteriorated mothers' health, decreasing self-reported health status and increasing smoking and drug use, especially among the most disadvantaged mothers.

However, another part of the literature has shown that individuals' health may improve during hard times, because people may change their health behavior (Ruhm, 2000; 2003; Dehejia and Lleras-Muney, 2004). Ruhm and Black (2002) and Ruhm (2005) suggest that on average individuals are more likely to cut down on unhealthy behaviors during recessions such as smoking and drinking behavior, generating a countercyclical pattern in health.

A common line of reasoning is provided by Dehejia and Lleras-Muney (2004) who argue that negative income shocks (resulting from either lower own-wages or lower wages of family members) would lead to a lower consumption of all (normal) goods, including health-related goods such as health club memberships and nutritious diets, but also could reduce the consumption of health-damaging goods such as cigarettes and alcohol. The authors found improved birth outcomes (for example, low prevalence of low birth weight babies, fewer congenital malformations, and lower post-neonatal mortality) in times of high unemployment in the United States, and attribute such results to fertility selection and to improvements of mother's health behavior during recessions.

During pregnancy, economic downturns may increase maternal stress, inducing maternal smoking behavior and other bad health attitudes (Currie, Duque and Garfinkel, 2015). On the other hand, mothers may compensate the stress caused by the economic fluctuation if they adopt healthy attitudes during pregnancy such as reducing smoking habit and attending prenatal care service more often (Dehejia and Lleras-Muney, 2004). Which of these two mechanisms is prevailing among Brazilian mothers is still an open question in the national literature.

The second important link is how pregnant women could influence offspring smoking behavior later in life. Recently, the medical literature has provided evidence of a potential biological channel. Stroud *et al.* (2014) show two independent and additive prenatal pathways leading to increased risk of offspring (daughters) nicotine dependence later in life: excess of prenatal glucocorticoids

(stress hormones)[8] and the excess of cotinine.[9] The exposure of the fetus to glucocorticoids can naturally increase with maternal stress, while the exposure to cotinine increases with maternal smoking during pregnancy. For mothers who badly react to recessions by increasing smoking during pregnancy, it is possible that their children will be more exposed to excess of glucocorticoids and cotinine, increasing the likelihood of being nicotine dependent later in life.

Although fetal programming is a latent pathway in the relationship between offspring smoking behavior and maternal smoking during pregnancy, some epidemiological studies have suggested that the environmental factors are important mediators of such relationship. For instance, Rydell *et al.* (2012), using data on twins from Sweden, find that girls prenatally exposed to maternal tobacco use had a two to threefold increased odds of experiencing a high number of withdrawal symptoms, craving for tobacco, and heavy tobacco use (five or more cigarettes or *snus* dips per day). However, the authors suggest that associations between prenatal tobacco exposure and onset of regular tobacco use in both genders appeared to be mostly explained by parental socioeconomic status and postnatal smoking behavior. Taylor *et al.* (2014), using longitudinal data set from the United Kingdom, find that parental smoking behavior during pregnancy is more important for determination of offspring smoking onset than genetic factors. Rydell *et al.* (2014) suggest that the environmental factors are important confounders of the relationship between maternal smoking during pregnancy and offspring smoking initiation.

If environment during pregnancy is important in the long-term determination of offspring smoking behavior, positive health behavior of mothers could offset the biological mechanism. For instance, mothers could reduce smoking during pregnancy and attending prenatal care more often, which could help to reduce the levels of cotinine and stress hormones. Thus, it is expected that economic fluctuations during pregnancy exert influence over offspring smoking behavior later in life, once economic environment is a source of exogenous shock to the health and behavior of the pregnant woman.

Another important mechanism is the contemporaneous influence of parental smoking behavior on smoking initiation of their children during adolescence

8. Stress experienced by mothers can activate their hypothalamic-pituitary-adrenal (HPA) axes 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. Glucocorticoids (for example, 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).

9. Stroud *et al.* (2014) find that maternal cotinine, a nicotine metabolite, predicts offspring nicotine dependence in adulthood. The authors argue that a potential explanation for this relationship is that maternal cotinine cause alterations in fetal neuroteratogenesis increasing propensity to nicotine dependence in adulthood.

(Gilman *et al.*, 2009). The current smoking status of the mother may reflect her past decision about smoking behavior, potentially being influenced by the economic environment during pregnancy. In that way, it is important to account for contemporaneous parental influence on the children's smoking behavior if the objective is to analyze the association between economic downturns during pregnancy and child's smoking behavior later in life.

Therefore, we estimate the association between the risk of early smoking onset among adolescents and the fluctuations of the unemployment rate during pregnancy, accounting for contemporaneous parental influence. In this case, it can be thought as a reduced form analysis, if we assume that economic downturns can influence offspring smoking behavior only through maternal health and/or behavioral response during pregnancy. In order to shed light on this relationship, we analyze the potential changes in the composition of cohorts of birth due to economic fluctuation during pregnancy, and the potential existence of heterogeneous associations. The next section provides details about the data source and sample description.

## 3 EXPLORATORY ANALYSIS

### 3.1 Data

The data used in this study comes from the 2012 National Survey of School Health (Pesquisa Nacional de Saúde do Escolar – Pense) carried out by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística – IBGE). Pense is a national representative survey, providing information about 109,104 students in the nine-grade of the fundamental level from public and private schools. Pense collects data concerning biological, cognitive, emotional and social changes experienced by students during adolescence. This data source also provides information about parental behavior and characteristics, school and household characteristics. Students who did not report information about smoking behavior, parental and household characteristics were excluded from the sample (6.83%). We also exclude students who born in 1993 (0.99%) and 2000 or after (0.12%).

The crucial question in the survey for our study is the following: "*que idade você tinha quando experimentou fumar cigarro pela primeira vez*?".[10]

Table 1 presents the age distribution of the first smoking experience. The first column informs the age of the first smoking experience reported by students, whereas the second and the third columns show the corresponding age intervals. The age interval is important for the model specification, presented in the section 3 of this study. Students who have never smoked before are about 80% of the sample.

10. In english: how old were you when you first tried smoking cigarettes?

The prevalence of the first smoking experience is 20.9%. Notice that the mode of age distribution for the first smoking experience is 13 for boys and girls. Besides, the prevalence of the first experience is slightly higher for boys than for girls, respectively 21.3% and 19%. Conditioning to adolescents' age, differences in the prevalence of the first experience between boys and girls are very small, suggesting no gender differences in smoking behavior.

TABLE 1
**Definitions for interval-censored smoking initiation**

| Age of the 1st experience | Age interval | | Boys | | Girls | | All | |
|---|---|---|---|---|---|---|---|---|
| | Survey | Adaptation | N | (%) | N | (%) | N | (%) |
| Never smoked | [Age*, ∞) | [Age*, ∞) | 37,506 | 78.70 | 42,586 | 80.99 | 80,092 | 79.91 |
| ≤ 9 years | (0,10) | [9,10) | 1,436 | 3.01 | 1,323 | 2.52 | 2,759 | 2.75 |
| 10 years | [10,11) | [10,11) | 866 | 1.82 | 763 | 1.45 | 1,629 | 1.63 |
| 11 years | [11,12) | [11,12) | 1,044 | 2.19 | 954 | 1.81 | 1,998 | 1.99 |
| 12 years | [12,13) | [12,13) | 1,701 | 3.57 | 1,832 | 3.48 | 3,533 | 3.52 |
| 13 years | [13,14) | [13,14) | 2,182 | 4.58 | 2,556 | 4.86 | 4,738 | 4.73 |
| 14 years | [14,15) | [14,15) | 1,724 | 3.62 | 1,741 | 3.31 | 3,465 | 3.46 |
| 15 years | [15,16) | [15,16) | 825 | 1.73 | 605 | 1.15 | 1,430 | 1.43 |
| 16 years | [16,17) | [16,17) | 295 | 0.62 | 179 | 0.34 | 474 | 0.47 |
| ≥ 17 years | [17,∞) | [17,19) | 75 | 0.16 | 40 | 0.08 | 115 | 0.11 |
| 1st experience | | | 10,148 | 21.30 | 9,993 | 19.00 | 20,141 | 20.10 |
| Observations | | | 47,654 | 100.00 | 52,579 | 100.00 | 100,233 | 100.00 |

Source: Pense 2012.
Authors' elaboration.
* Age refers to the student's age at the interview date.

Table 2 displays age distribution at the date of the interview for boys and girls. About 67% of the sample corresponds to students aged 14 to 15, who are those with appropriate age to the nine-grade of fundamental education. Moreover, 13% of students should be enrolled in high school, *i.e.*, they exhibit age-grade distortions.

Table 3 presents the descriptive statistics for the vector of explanatory variables from Pense 2012. An important factor in the determination of smoking initiation during adolescence is the influence of peers. Several studies positively associate peers' behavior with smoking initiation during adolescence (Simons-Morton and Farhat, 2010), and persistence during adult life (Ali and Dwyer, 2009). In this study, we analyze the influence of classmates by computing the proportion of students from a classroom who have already had the first experience with cigarettes. In the sample, on average, about 21% of classmates have experienced cigarettes. There are no substantial differences between boys and girls regarding the prevalence of smoking behavior among classmates.

TABLE 2
**Age distribution at the interview**

| Age at the interview | Boys | | Girls | | All | |
|---|---|---|---|---|---|---|
| | N | (%) | N | (%) | N | (%) |
| ≤11 years | 4 | 0.01 | 2 | 0.00 | 6 | 0.01 |
| 12 years | 287 | 0.60 | 437 | 0.83 | 724 | 0.72 |
| 13 years | 8,329 | 17.48 | 12,164 | 23.13 | 20,493 | 20.45 |
| 14 years | 21,789 | 45.72 | 25,914 | 49.29 | 47,703 | 47.59 |
| 15 years | 10,194 | 21.39 | 8,998 | 17.11 | 19,192 | 19.15 |
| 16 years | 4,911 | 10.31 | 3,524 | 6.70 | 8,435 | 8.42 |
| 17 years | 1,780 | 3.74 | 1,246 | 2.37 | 3,026 | 3.02 |
| 18 years | 323 | 0.68 | 264 | 0.50 | 587 | 0.59 |
| ≥19 years | 37 | 0.08 | 30 | 0.06 | 67 | 0.07 |
| Observations | 47,654 | 100.00 | 52,579 | 100.00 | 100,233 | 100.00 |

Source: Pense 2012.
Authors' elaboration.

However, girls report parental smoking more than boys. Parental influence is another predictor of smoking initiation that has 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 13.7% of students reported that their fathers smoke, while 8.7% reported that their mothers smoke. A small fraction of the sample, 4.5%, reported that both parents smoke cigarettes. Besides, students' perception about the potential reaction of their parents regarding their smoking habit is included in the analysis. About 95.7% of the sample reported that parents would strongly disapprove their potential smoking habit.

The sample is composed by 78.4% of students from public schools. There are more girls than boys, respectively 52.5%. Moreover, the share of brown (or *pardo*) students is about 44%, whereas white students represent 35% and black students correspond to 13%, and Asiatic and native students account for 7.7%. Besides, a large fraction of students live with their mother, totaling 89.6%, and 64.3% live with their fathers. The interaction between these two variables suggests that the proportion of students who live with both parents is about 59.8%.

Parental education is another variable reported by students. In particular, a limitation of the survey is the fact that questions about parental and household characteristics are answered by children instead of their parents or tutors. Table 3 shows that about 30% of students reported that their mothers have no education or did not conclude the primary level, and 31.5% informed that their fathers have low education.

TABLE 3
**Discriptive statistics**

| Covariates | Boys | | Girls | | All | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Smoking behavior | | | | | | |
| Classmate's peer effect | 21.065 | 12.520 | 20.545 | 12.383 | 20.792 | 12.451 |
| = 1 if strong reaction | 0.953 | 0.211 | 0.961 | 0.193 | 0.957 | 0.202 |
| = 1 if smoking father | 0.133 | 0.339 | 0.141 | 0.348 | 0.137 | 0.344 |
| = 1 if smoking mother | 0.080 | 0.272 | 0.093 | 0.290 | 0.087 | 0.282 |
| = 1 if smoking parents | 0.043 | 0.202 | 0.047 | 0.212 | 0.045 | 0.208 |
| Adolescents' characteristics | | | | | | |
| = 1 if public school | 0.777 | 0.416 | 0.790 | 0.407 | 0.784 | 0.411 |
| = 1 if girl | 0.000 | 0.000 | 1.000 | 0.000 | 0.525 | 0.499 |
| Age at the interview | 14.376 | 1.072 | 14.151 | 0.995 | 14.258 | 1.038 |
| = 1 if white | 0.367 | 0.482 | 0.336 | 0.472 | 0.351 | 0.477 |
| = 1 if brown (pardo) | 0.405 | 0.491 | 0.473 | 0.499 | 0.441 | 0.496 |
| = 1 if black | 0.153 | 0.360 | 0.110 | 0.313 | 0.131 | 0.337 |
| = 1 if Asiatic | 0.039 | 0.194 | 0.048 | 0.214 | 0.044 | 0.205 |
| = 1 if native | 0.035 | 0.185 | 0.033 | 0.177 | 0.034 | 0.181 |
| = 1 if living with mother | 0.894 | 0.308 | 0.899 | 0.302 | 0.896 | 0.305 |
| = 1 if living with father | 0.669 | 0.471 | 0.619 | 0.486 | 0.643 | 0.479 |
| = 1 if living with parents | 0.615 | 0.487 | 0.582 | 0.493 | 0.598 | 0.490 |
| Parental education | | | | | | |
| = 1 if illiterate mother or no primary education | 0.276 | 0.447 | 0.315 | 0.465 | 0.297 | 0.457 |
| = 1 if mother has primary education | 0.147 | 0.354 | 0.148 | 0.355 | 0.147 | 0.354 |
| = 1 if mother has secondary education | 0.271 | 0.444 | 0.261 | 0.439 | 0.265 | 0.442 |
| = 1 if mother has higher education | 0.135 | 0.342 | 0.115 | 0.319 | 0.124 | 0.330 |
| = 1 if missing mother's education | 0.171 | 0.377 | 0.161 | 0.368 | 0.166 | 0.372 |
| = 1 if illiterate father or no primary education | 0.303 | 0.459 | 0.326 | 0.469 | 0.315 | 0.464 |
| = 1 if father has primary education | 0.135 | 0.342 | 0.126 | 0.332 | 0.130 | 0.337 |
| = 1 if father has secondary education | 0.221 | 0.415 | 0.207 | 0.405 | 0.213 | 0.410 |
| = 1 if father has higher education | 0.127 | 0.333 | 0.106 | 0.307 | 0.116 | 0.320 |
| = 1 if missing father's education | 0.214 | 0.410 | 0.237 | 0.425 | 0.226 | 0.418 |
| Household characteristics | | | | | | |
| = 1 if telephone | 0.538 | 0.499 | 0.475 | 0.499 | 0.505 | 0.500 |
| = 1 if cellphone | 0.846 | 0.361 | 0.891 | 0.312 | 0.869 | 0.337 |
| = 1 if computer | 0.720 | 0.449 | 0.676 | 0.468 | 0.697 | 0.460 |
| = 1 if internet | 0.669 | 0.471 | 0.632 | 0.482 | 0.650 | 0.477 |
| = 1 if car | 0.552 | 0.497 | 0.505 | 0.500 | 0.527 | 0.499 |
| = 1 if motorcycle | 0.332 | 0.471 | 0.309 | 0.462 | 0.320 | 0.467 |
| #Bathrooms | 1.545 | 0.868 | 1.453 | 0.835 | 1.497 | 0.852 |
| = 1 if household servant | 0.141 | 0.348 | 0.111 | 0.315 | 0.126 | 0.331 |
| Observations | 47,654 | - | 52,579 | - | 100,233 | - |

Source: Pense 2012.
Authors' elaboration.

In addition, 14.7% reported that their mothers attained the primary level, and 13% informed the same about their fathers. About 27% of the mothers attained the secondary level, and 21% reported the same about their fathers. Mothers with college or high education represent 12.4% of the sample, and father account for 11.6%. Missing information about mother's education is smaller than for fathers, respectively 16.6% and 22.6%. Because of the high fraction of missing information about parental education, we include a dummy variable for missing information in the estimations.

In the analysis, we also include variables relative to household characteristics in order to capture a wealth effect. For instance, 50.5% of students have telephone in their residences, 87% have a cellphone, 70% have a computer, and 65% have access to the internet. Nearly 53% of students reported that a household 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, 12.6% of the students reported to have at least a servant in their homes. These variables are used to create a wealth index (see appendix A).

### 3.2 Economic fluctuations

Our proxy for economic fluctuations is the unemployment rate obtained from the Monthly Employment Survey (Pesquisa Mensal de Empregos – PME) carried out by IBGE between 1980 and 2002 – see figure 2A.

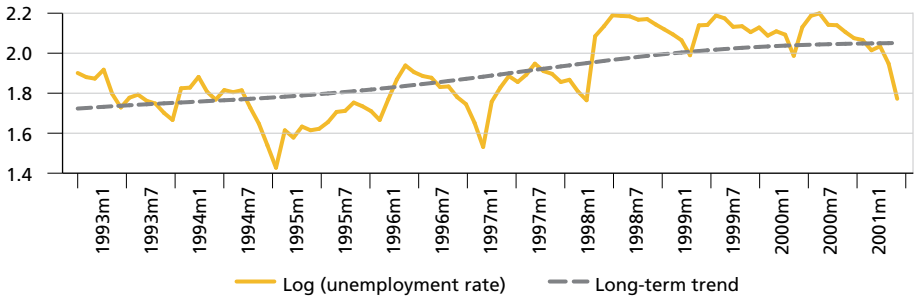
However, we are interested in the cycle component of such variable, since we intend to single out only exogenous shocks during pregnancy. Figure 2B exhibits the cycle of unemployment rate using three different decomposition methods that are: Hodrick-Prescott, Christiano-Fitzgerald and Butterworth filter. We observe similar patterns of the cycle of unemployment rate using those filters. So, we use the standard Hodrick-Prescott filter with a smooth parameter equal to 129,600 to decompose the monthly log of unemployment rate.[11]

We match the average unemployment rate cycle with the trimester of pregnancy based on adolescents' date of birth. Therefore, we have to assume nine months of pregnancy for all observations in the sample. For a given date of birth, we compute the average of the unemployment rate cycle, for instance, in the third trimester using the unemployment rate of the current month of birth and the 1st and 2nd lagged value of the variable. For the second trimester, the average value

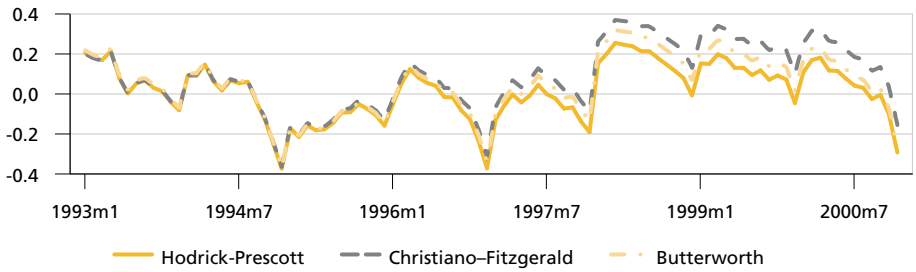
11. We follow Bozzoli and Quintana-Domeque (2014) who uses the standard Hodrick-Prescott filter with a smooth parameter equal to 129,600 to decompose the monthly log seasonally adjusted economic activity index for Argentina from January 1993 to December 2006 in order to measure the impact of the 2001 crisis on birth weight. Unfortunately, the index of economic activity started to be computed in Brazil from 2003 on and, therefore, it does not cover the years of birth reported by students (1993-2000).

is computed using the 3rd, 4th and 5th lagged value of the unemployment rate's cycle component. Finally, for the first trimester, we consider the 6th, 7th and 8th lagged value of the cycle component based on the date of birth.

FIGURE 2
**Monthly unemployment rate and cyclical component (1993-2000)**
2A – Natural log of monthly unemployment rate




2B – Cycle component of unemployment rate




Source: PME/IBGE.
Authors' elaboration.

For instance, for a student born in December of a given year, the cycle of unemployment rate in the 3rd trimester of gestation is an average of the indicator in October, November and December. In the 2nd trimester of gestation, the unemployment rate cycle takes the months of July, August and September into account. Whereas in the 1st trimester of gestation, the average in computed using information from April, May and June of a given year.

Table 4 presents the descriptive statistics of the cycle component of the natural log of the unemployment rate considering the moving average of three months and annual averages. We also add the sample size for each year of birth. The moving averages of the natural log of unemployment rate in trimesters are negative between 1994 and 1999. For a better understanding, a negative (positive) value means that natural log of unemployment rate is below (above) its long-term trend, *i.e.*, the period is characterized by a low (high) unemployment rate.

Moreover, about two-thirds of the sample were born between 1997 and 1998, when the economy moves from a period of low monthly unemployment rates (or below its long-term trend), 1994-1997, to a period of high monthly unemployment rates (or above its long-term trend), 1998-1999.

TABLE 4
**Unemployment rate and sample distribution by year of birth (1994-1999)**

| | Descriptives | | | | | Sample by |
|---|---|---|---|---|---|---|
| | N | Mean | Standard deviation | Minimum | Maximum | year of birth (%) |
| Moving average – three months | | | | | | |
| Unemployment cycle – 3rd trimester | 72 | -0.008 | 0.137 | -0.285 | 0.242 | - |
| Unemployment cycle – 2nd trimester | 72 | -0.011 | 0.136 | -0.285 | 0.242 | - |
| Unemployment cycle – 1st trimester | 72 | -0.014 | 0.135 | -0.285 | 0.242 | - |
| Average per year | | | | | | |
| 1994 | 12 | -0.029 | 0.161 | -0.398 | 0.139 | 1.85 |
| 1995 | 12 | -0.152 | 0.052 | -0.234 | -0.064 | 5.30 |
| 1996 | 12 | -0.059 | 0.147 | -0.396 | 0.116 | 12.54 |
| 1997 | 12 | -0.072 | 0.070 | -0.210 | 0.035 | 31.62 |
| 1998 | 12 | 0.163 | 0.080 | -0.020 | 0.251 | 44.47 |
| 1999 | 12 | 0.103 | 0.066 | -0.059 | 0.192 | 4.22 |

Source: PME/IBGE.
Authors' elaboration.

## 4 ECONOMETRIC APPROACH

The structure of the dependent variable presented in the subsection 3.1 suggests the use of survival analysis for interval-censored data. Although we know the age of the first smoking experience, we do not know the exact date when it happened. We just know a potential age interval when it would have happened, which corresponds to the second column of table 1. Besides, in table 1, more than two-thirds of the sample reported to have never smoked until the date of the interview, suggesting that the prevalence of the first smoking experience is right-censored. Therefore, survival analysis for interval-censored data looks like the most appropriate model to analyze the influence of the economic fluctuations on the risk of the first smoking experience.

Nevertheless, in order to estimate such model, there should be an adaptation in the boundary of seventeen or more interval, since students' age at the interview is restricted: substitute $[17, \infty)$ for $[17, 19)$. We maintain two assumptions, *i.e.*,

everybody will end up smoking at infinity[12] [Age*, ∞), where Age* refers to the adolescents' age at the interview, and the risk of smoking onset starts at age 9. These changes appear on the third column of the table 1.

We follow Huang and Wellner (1997) in order to illustrate our econometric model. The observed age for the first smoking experience can be represented by the vector $(T_1, T_2, \ldots, T_k)$ with some distribution, where $0 < T_1 < T_2 < \ldots < T_k < \infty$. 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 $(T_1, \ldots, T_k, \Delta_1, \ldots, \Delta_{k+1}) \equiv (T, \Delta)$, where $\Delta_1 = 1\{Z \leq T_1\}$, $\Delta_2 = 1\{T_1 < Z \leq T_2\}$, $\ldots$, $\Delta_k = 1\{T_{k-1} < Z \leq T_k\}$ and $\Delta_{k+1} = 1\{Z > T_k\}$.

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 $(z, t_1, \ldots t_k, \delta_1, \ldots \delta_k)$ be a realization of $(Z, T_1, \ldots T_k, \Delta_1, \ldots \Delta_k)$ for a student. When a student reports the first experience at the 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. In this case, we know that $z \in (t_5, t_6]$, although we do not know the exact date of the event.

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

$$\begin{aligned} \ln(F) = \sum_{i=1}^{n} \{ & \delta_{1i} \log F(t_{1i} \mid X_i) + \delta_{2i} \log [F(t_{2i} \mid X_i) - F(t_{1i} \mid X_i)] + \ldots \\ & + \delta_{ki+1} \log [1 - F(t_{ki} \mid X_i)]\}, \end{aligned} \tag{1}$$

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

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

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

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

12. Otherwise, we should use split population models.

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

Our results come from such maximum likelihood function that estimates $(\hat{\beta}, \hat{\Lambda})$ under the constraint that $\hat{\Lambda}_n$ is a nonnegative and nondecreasing function. Vector $X_i \beta$ includes the average unemployment rate cycle in the $T^{tn}$ trimester of pregnancy for an individual $i$ born in month $m$ in the year $t$. Hence, we include dummy variables for month of birth $\theta_m$, and for year of birth $\theta_t$. Besides, we include dummies for Brazilian federal unities $\theta_s$, and interactions of these dummies with a trend variable in order to capture different paths of the unemployment rate by states. Vector $X_i^*$ includes other covariates such as classmates' peer effect, parental smoking behavior, demographic and household characteristics (see table 3).

## 5 RESULTS

### 5.1 Baseline results

Table 5 shows the estimates of the interval-censored model specifying the cumulative function $F$ as a Weibull distribution. The coefficients capture the 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 on the risk of smoking onset relative to adolescents' age. Columns (1) to (4) present the baseline estimates based on variations of equation (3) regarding the inclusion of regional and time dummy variables, some interactions, beyond the unemployment cycles (twelve months) before and after pregnancy.

The baseline results show that positive deviations of the unemployment rate from its long-term trend in the third trimester of pregnancy is associated to a low risk of the first experience with cigarettes earlier in adolescence. In columns (1), the average cycle of unemployment in the first and third trimesters of pregnancy are important in the determination of smoking onset, but only the third trimester remains significant after controlling for month and year of birth, and state fixed effect in column (2).

The impact of the average unemployment cycle during the third trimester of pregnancy on smoking initiation is -0.54 in column (2). To understand the magnitude of the estimate, note that a deviation of 0.1 log units (about 10.5%)

from the long-term trend in unemployment during the third trimester of pregnancy is associated with a drop in the risk of smoking onset earlier in adolescence of about 5.4% (0.1 x (-0.54)).[13]

In addition to birth month and birth year fixed effects, we control potential differences in the birth seasonality for federal unities, including interactions between months of birth and state dummies. The estimate in column (3) is very close to the estimate in column (2), respectively a reduction of 5.4% in the risk. In column (4), which accounts for specific time-trend (month-year birth) for federal unities, the estimate shows that the same variation in the log of the cycle of unemployment rate is associated to a drop of 6.1%.

TABLE 5
**Results from the interval-censored survival model – Weibull**

| | Baseline estimations | | | | Pre- and post-pregnancy unemployment cycles | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Unemployment cycles | | | | | | | |
| Post-pregnancy (12 months) | - | - | - | - | -0.560** | -0.544** | -0.520* |
| | | | | | (0.269) | (0.270) | (0.266) |
| 3rd trimester | -0.421*** | -0.540** | -0.541** | -0.613** | -0.503* | -0.501* | -0.598** |
| | (0.062) | (0.260) | (0.260) | (0.259) | (0.265) | (0.265) | (0.265) |
| 2nd trimester | 0.004 | 0.103 | 0.102 | 0.112 | 0.056 | 0.056 | 0.055 |
| | (0.072) | (0.224) | (0.224) | (0.224) | (0.228) | (0.228) | (0.228) |
| 1st Trimester | -0.220*** | 0.071 | 0.072 | -0.013 | -0.122 | -0.116 | -0.165 |
| | (0.068) | (0.189) | (0.189) | (0.189) | (0.216) | (0.217) | (0.216) |
| Pre-pregnancy (12 months) | - | - | - | - | 0.021 | 0.037 | -0.111 |
| | | | | | (0.310) | (0.312) | (0.311) |
| Smoking behavior | | | | | | | |
| = 1 if smoking father | 0.380*** | 0.378*** | 0.378*** | 0.379*** | 0.378*** | 0.378*** | 0.379*** |
| | (0.019) | (0.019) | (0.019) | (0.019) | (0.019) | (0.019) | (0.019) |
| = 1 if smoking mother | 0.386*** | 0.383*** | 0.384*** | 0.381*** | 0.383*** | 0.383*** | 0.380*** |
| | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) |
| = 1 if smoking parents | 0.536*** | 0.529*** | 0.530*** | 0.533*** | 0.529*** | 0.530*** | 0.533*** |
| | (0.028) | (0.028) | (0.028) | (0.028) | (0.028) | (0.028) | (0.028) |

(Continua)

13. The *log* transformation of the unemployment rate ($u$) can be observed in terms of differences, *i.e.*, $z - z' = log(u) - log(u') = log\left(1 + \frac{u - u'}{u}\right)$. So, the percentage variation in the unemployment rate cycle 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.

(Continuação)

| | Baseline estimations | | | | Pre- and post-pregnancy unemployment cycles | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| = 1 if strong reaction | -0.701*** | -0.701*** | -0.701*** | -0.702*** | -0.701*** | -0.701*** | -0.702*** |
| | (0.025) | (0.025) | (0.025) | (0.025) | (0.025) | (0.025) | (0.025) |
| Classmates' peer effect | 0.040*** | 0.040*** | 0.040*** | 0.040*** | 0.040*** | 0.040*** | 0.040*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Base-line parameter in *log* | 1.921*** | 1.921*** | 1.921*** | 1.921*** | 1.921*** | 1.921*** | 1.921*** |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) |
| Fixed effects and time-trend | | | | | | | |
| State | - | X | X | X | X | X | X |
| Time-trend | - | - | - | X | - | - | X |
| Birth month | - | X | X | X | X | X | X |
| Birth year | - | X | X | X | X | X | X |
| State x time trend | - | - | - | X | - | - | X |
| State x birth month | - | - | X | - | - | X | - |
| Additional controls | X | X | X | X | X | X | X |
| *Log*-likelihood | -74,615 | -74,545 | -74,534 | -74,505 | -74,542 | -74,532 | -74,503 |
| Wald test | 6,443 | 7,082 | 7,163 | 7,313 | 7,086 | 7,171 | 7,314 |
| #Clusters | 4,091 | 4,091 | 4,091 | 4,091 | 4,091 | 4,091 | 4,091 |
| Observations | 100,233 | 100,233 | 100,233 | 100,233 | 100,233 | 100,233 | 100,233 |

Authors' elaboration.

Notes: 1. The vector of additional controls includes: a dummy for students from public schools, a dummy for girls, student's age, four dummies for ethnicity (white, black, Asiatic, and native), four dummies for parental (mother's low-education, mother's missing education, father's low-education, and father's missing education), six binary 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.

2. Standard errors in parentheses are robust and clustered at classroom level.

3. Significance levels: ***, ** and * = 1%, 5% and 10%.

However, we need to check whether these results remain robust after accounting for potential unemployment cycles pre- and post-pregnancy. Estimations in columns (5) to (7) replicates the specifications (2) to (4), but including the average value of unemployment cycle for a period of twelve months before and after pregnancy. The unemployment cycles before pregnancy may capture the influence of mothers' anticipative behavior regarding the economic downturns, whereas unemployment cycles after pregnancy capture the influence of the economic downturns in the first year of child's life.

The estimates show that unemployment cycles twelve months before pregnancy do not exhibit significant associations with the risk of early smoking onset. On the other hand, the unemployment cycles twelve months after pregnancy exhibit a significant and negative association with smoking onset in columns (5)

and (6), but marginally significant when specific time-trends for federal units are accounted for – see column (7).

The estimate of the unemployment cycles in the third trimester of pregnancy is robust to inclusion of specific time-trends for federal units. A deviation of 0.1 log units (about 10.5%) from the long-term trend in unemployment during the third trimester of pregnancy is associated with a drop in the risk of early smoking onset of about 6%. This magnitude is very close to the estimate in column (4).

Last but not least, table 5 shows that parental and peer smoking behavior may influence smoking onset among adolescents. For instance, in column (7), the risk of an adolescent starts smoking increases about 0.38% if the father is a smoker. A similar effect is found if the mother is a smoker (0.38%), but the risk of smoking onset increases 0.53% if both parents are smokers. Moreover, the same risk decreases in 0.7% if adolescents believe that their parents will strongly react to their smoking habit. We also find evidence of peers' positive influence. In this case, increasing the proportion of classmates who have experienced cigarettes in 1% raises the risk of individual's smoking initiation in approximately 0.04%.

Notice that the estimates in table 5 include not only peer effects from parents and classmates, but also parental education level, dummy variable for public schools, and several variables about household characteristics. These variables should account for potential differences in socioeconomic environment and monetary costs of cigarette experienced by adolescents at the time of which the interview was carried out. Besides, specification (7) is estimated using the cycle of unemployment rate obtained from Christiano-Fitzgerald and Butterworth filter, and results still remain robust (see appendix B).

### 5.2 Different baseline functions

We also verify, in table 6, whether the estimates are robust to different specifications of the baseline hazard function. We re-estimate the specification (7) of table 5, and the result for the third trimester remains robust for three out of four specifications with coefficients varying from -0.512 to -0.659. In these specifications, a positive variation of 0.1 log deviation of the unemployment rate from its long-term trend in the third trimester of pregnancy is associated to a reduction in the risk of early smoking initiation from 5.1% to 6.6%. For the inverse Gaussian baseline hazard function, we still observe a negative sign of the coefficient, but statistically significant only at the level of 10%.

Notice also that the unemployment cycle twelve months after pregnancy appears to be significant in two out of four specifications, being less robust than

the unemployment cycle in the third trimester. The unemployment cycles twelve months before pregnancy remain insignificant in all estimations.

TABLE 6
**Results from different baseline specifications**

| | Exponential | *Log*-logistic | Gompertz | Inverse Gaussian |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | Unemployment cycles | | | |
| Post-pregnancy (12 months) | -0.722*** | -0.404 | -0.620** | -0.075 |
| | (0.228) | (0.315) | (0.269) | (0.057) |
| 3rd trimester | -0.512** | -0.667** | -0.659** | -0.107* |
| | (0.231) | (0.311) | (0.268) | (0.057) |
| 2nd trimester | -0.212 | 0.237 | -0.055 | 0.030 |
| | (0.199) | (0.264) | (0.230) | (0.048) |
| 1st trimester | -0.243 | -0.083 | -0.224 | -0.010 |
| | (0.188) | (0.252) | (0.218) | (0.046) |
| Pre-pregnancy (12 months) | -0.419 | 0.009 | -0.320 | 0.008 |
| | (0.268) | (0.368) | (0.314) | (0.067) |
| *Log*-likelihood | -93,817 | -74,822 | -74,119 | -75,686 |
| Wald test | 8,919 | 7,066 | 9,823 | 5,518 |
| #Clusters | 4,091 | 4,091 | 4,091 | 4,091 |
| Observations | 100,233 | 100,233 | 100,233 | 100,233 |

Authors' elaboration.
Notes: 1. The estimated model corresponds to the specification (7) in table 5 which includes covariates and state fixed effects, state specific trends, and dummy variables for month and year of birth. The list of additional controls can be found in the footnote of table 5.
2. Robust standard errors clustered at classroom level.
3. Significance levels: ***, ** and * = 1%, 5% and 10%.

In addition, the negative association between the first smoking experience and recessions is also estimated using discrete choice models, Probit and Logit (see appendix C). The dependent variable assumes valor 1 to students who have their first smoking experience, and 0 for those who ever have smoked. The results support the evidence of table 5. Again, the third trimester of pregnancy is the most sensitive in utero period to economic downturns, reducing students' chance of having their first smoking experience during adolescence.

### 5.3 Selection on observables and maternal smoking behavior

The objective of this subsection is to test the existence of changes in the composition of cohorts due to economic fluctuations during pregnancy, and potential heterogeneous associations regarding maternal smoking behavior. The regression model is given by the following expression:

$$y_{ismt} = \beta_0 + \beta_1 C_{mt}^{Post} + \beta_1 C_{mt} + \beta_1 C_{mt}^{Pre} + \beta_2 Girls_{ismt} + \theta_m + \theta_t + \theta_s + \lambda trend + \delta(\theta_s * trend) + \varepsilon_{ismt}, \quad (4)$$

where $y_{ismt}$ if the dependent variable for individuals $i$ in the state $s$ and born in the month $m$ in the year $t$. The variable of interest is $C_{mt}$, which is the cycle of unemployment rate during nine months of pregnancy for an individual born in the month $m$ in the year $t$. We also include the average of the unemployment cycles (twelve months) before and after pregnancy. The inclusion of the unemployment cycle before pregnancy ($C_{mt}^{Pre}$) aims to account for potential anticipative behavior of mothers regarding future economic fluctuations, which may be reflected in some observables characteristics, while the unemployment cycle after pregnancy ($C_{mt}^{Post}$) may suggest potential response of mothers to economic downturns in the first year of child's life.

The model also includes a dummy variable for student gender, fixed effects for month and year of birth ($\theta_m$ and $\theta_t$), and state fixed effects ($\theta_s$).[14] The variable *trend* is the month-year of birth time-trend, and ($\theta_s * trend$) is the interaction between time trend and state fixed effects.

Table 7 presents estimates for different dependent variables based on demographic characteristics of students (gender and race), household wealth, mother's education and current smoking status. An important result from table 7 is that the unemployment cycles twelve months before pregnancy are not significantly correlated with any selected characteristic. It reinforces the hypothesis that mothers were not able to anticipate economic downturns before pregnancy.

However, the results suggest that prevalence of girls is positively associated to unemployment cycles during pregnancy.[15] The positive association is also verified for unemployment cycles twelve months after pregnancy, reflecting the changes in the composition of cohorts.

Similar results are observed for prevalence of white students. It is positively associated to unemployment cycles during pregnancy, and twelve months after. White individuals are often associated with better socioeconomic status in Brazil. For instance, white individuals have better nutrition during childhood (Reis, 2012), better school performance (Flores and Scorzafave, 2014), better access to college (Francis and Tannuri-Pianto, 2012), and better wages (Garcia, Nopo and Salardi, 2009) than non-white individuals. Thus, this result may indicate a higher prevalence of high socioeconomic status children during economic downturns. In order

14. For the regression that the girl's dummy variable is assumed as the dependent variable, it is automatically excluded from the vector of covariates.

15. Studies on reproductive health have found that maternal stress (measured by salivary cortisol), before conception and, during pregnancy is positively associated with female excess of live births (Chason *et al.*, 2011; Chason *et al.*, 2012).

to provide support for such evidence, we also check the correlation of unemployment cycle during pregnancy with other measures of socioeconomic status, which are: household wealth and mother's education.

TABLE 7
**Selection on observable characteristics**

| | Girls | White | Wealth index | Low-educated mother | Smoking mother |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| | Unemployment cycles | | | | |
| Post-pregnancy (12 months) | 0.222*** | 0.124** | 1.778*** | -0.268*** | -0.129*** |
| | (0.060) | (0.053) | (0.188) | (0.040) | (0.042) |
| Pregnancy (9 months) | 0.188*** | 0.261*** | 1.389*** | -0.238*** | -0.083** |
| | (0.056) | (0.050) | (0.171) | (0.040) | (0.039) |
| Pre-pregnancy (12 months) | -0.069 | -0.102* | -0.132 | -0.018 | 0.054 |
| | (0.067) | (0.059) | (0.199) | (0.044) | (0.048) |
| *F*-test (global significance) | 17.59*** | 50.75*** | 50.52*** | 17.05*** | 19.25*** |
| $R^2$ | 0.01 | 0.06 | 0.13 | 0.06 | 0.02 |
| Adjusted $R^2$ | 0.01 | 0.06 | 0.13 | 0.06 | 0.02 |
| Observations | 100,233 | 100,233 | 100,233 | 83,588 | 100,233 |

Authors' elaboration.
Notes: 1. Robust standard errors clustered at classroom level.
2. Significance levels: ***, ** and * = 1%, 5% and 10%.

Household wealth was defined as an index of durable goods (cellphone, computer, car, motorcycle, and the number of bathrooms) and the presence of some household services (internet and household servants) generated by principal components (see appendix A). Mother's education is represented by a binary variable, which indicates 1 for mothers with complete primary education or less and 0 for mothers with complete secondary or superior education. In this study, mothers with complete primary education or less are assumed to be low socioeconomic status, whereas mothers with complete secondary or superior education are assumed to be high socioeconomic status.

Table 7 shows that the index of household wealth is positively correlated to unemployment cycles during pregnancy, and the prevalence of low-educated mothers is negatively correlated with. So, the prevalence of high socioeconomic status adolescent at the time of the interview is positively associated with recessions during the life in utero.

Fertility decision is probably the mechanism behind this particular evidence, once it 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 lead to a

substitution and income effect on fertility, but transitory changes in the labor market will only affect the timing of fertility. However, the imperfections of the credit markets lead low-SES women to increase fertility if they are not credit constrained during recessions, or postpone fertility if they are (Becker, 1965; Dehejia and Lleras-Muney, 2004). Thus, the prevalence of high-SES characteristics during economic downturns in table 7 may actually reflect the decision of low-SES women in postponing fertility during contraction periods of the economy.

Another important hypothesis to be tested is whether the prevalence of maternal smoking at the time of the survey is correlated with the economic fluctuations during pregnancy. As exposed in section 2, if the current smoking status of mothers does not share any unobserved relationship with economic environment during pregnancy, we would expect insignificant coefficients. Nonetheless, the last column of table 7 shows that a positive deviation of the unemployment rate from its long-term trend during pregnancy is negatively associated with the current prevalence of smoking mothers. Notice also that the prevalence of smoking mothers is low when the post-pregnancy unemployment cycle increases, suggesting that mothers may have adopted healthy behavior during the first year of child's life as well.

### 5.4 Differences due to mother's education

In order to better understand the relationship between the current maternal smoking behavior and the economic fluctuations during pregnancy, we estimate the specification (5) of table 7 by mother's education attainment. The first column of table 8 presents the estimates for mothers with primary education or lower schooling level (incomplete primary or no schooling), which is the low socioeconomic status group of mothers. Column (4) shows the estimates for mothers with secondary or superior education, which corresponds to the high socioeconomic status group. The last column provides the estimated coefficients considering the group of mothers without any information about their education attainment.

Table 8 clearly shows that the negative relationship between the current maternal smoking behavior and unemployment cycles during pregnancy is basically driven by low-SES mothers. None of the estimations for high-SES mothers were statistically significant, as well as the estimation for group of missing information about mother's education.

TABLE 8
**Heterogeneous effect on maternal smoking behavior by socioeconomic status**

| | Low-SES | High-SES | | | Missing information |
|---|---|---|---|---|---|
| | Primary education or less | Secondary education | Superior education | Secondary and superior | |
| | (1) | (2) | (3) | (4) | (5) |
| | Unemployment cycles | | | | |
| Post-pregnancy (12 months) | -0.155*** | -0.076 | -0.122 | -0.107 | 0.115 |
| | (0.060) | (0.081) | (0.144) | (0.070) | (0.114) |
| Pregnancy (9 months) | -0.113** | -0.016 | -0.071 | -0.044 | 0.103 |
| | (0.058) | (0.072) | (0.116) | (0.060) | (0.107) |
| Pre-pregnancy (12 months) | 0.025 | 0.069 | 0.061 | 0.058 | 0.167 |
| | (0.070) | (0.087) | (0.149) | (0.075) | (0.123) |
| *F*-test (global significance) | 8.12*** | 4.97*** | 3.66*** | 6.14*** | 5.31*** |
| $R^2$ | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 |
| Adjusted $R^2$ | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 |
| Observations | 44,512 | 26,604 | 12,472 | 39,076 | 16,460 |

Authors' elaboration.
Notes: 1. Robust standard errors clustered at classroom level.
2. Significance levels: ***, ** and * = 1%, 5% and 10%.

This is an important result in light of Dehejia and Lleras-Muney (2004). If low-SES mothers are credit constrained, they may not only postpone fertility in periods of economic contractions, but also they may adopt healthy behavior if they get pregnant during hard times. Thus, an immediate question that arises from this result is whether the association between the risk of early smoking onset and unemployment cycles during pregnancy in table 5 is driven by adolescents of low-SES mothers.

In table 9, we re-estimate the specification (7) of table 5 based on mother's education attainment. The results show that a deviation of 0.1 log unity of the unemployment rate from its long-term trend in the third trimester of pregnancy reduces their risk of early smoking onset in 8.3%. Estimations for high-SES students did not show any significant coefficients. For students who did not report the education level of their mothers, only the coefficient for the unemployment cycle twelve months after pregnancy is statistically significant.

TABLE 9
**Heterogeneous effect on the risk of smoking onset due to socio-economic status**

| | Low-SES | High-SES | | | Missing information |
|---|---|---|---|---|---|
| | Primary education or less | Secondary education | Superior education | Secondary and superior | |
| | (1) | (2) | (3) | (4) | (5) |
| | Unemployment cycle | | | | |
| Post-pregnancy (12 months) | -0.051 | -0.609 | -0.552 | -0.660 | -1.395** |
| | (0.359) | (0.560) | (1.129) | (0.505) | (0.663) |
| 3rd trimester | -0.829** | -0.204 | -0.555 | -0.273 | 0.155 |
| | (0.366) | (0.531) | (0.987) | (0.478) | (0.683) |
| 2nd trimester | 0.203 | -0.473 | 0.492 | -0.301 | 0.024 |
| | (0.317) | (0.458) | (0.793) | (0.399) | (0.598) |
| 1st trimester | -0.054 | 0.081 | 0.135 | 0.095 | -0.556 |
| | (0.298) | (0.426) | (0.756) | (0.370) | (0.552) |
| Pre-pregnancy (12 months) | -0.289 | 0.132 | -0.468 | -0.088 | 0.479 |
| | (0.435) | (0.651) | (1.255) | (0.581) | (0.757) |
| *Log*-likelihood | -35,787 | -19,180 | -7,205 | -26,442 | -11,935 |
| Wald test | 4,351 | 2,102 | 764 | 2,493 | 1,532 |
| #Clusters | 4,023 | 3,975 | 2,834 | 4,016 | 3,897 |
| Observations | 44,512 | 26,604 | 12,472 | 39,076 | 16,493 |

Authors' elaboration.
Notes: 1. The estimated models correspond to the specification (7) in table 5, which includes covariates and state fixed effects, state specific trends, and dummy variables for month and year of birth. The list of additional controls can be found in the footnote of table 5.
2. Robust standard errors clustered at classroom level.
3. Significance levels: ***, ** and * = 1%, 5% and 10%.

Therefore, the impact of unemployment fluctuations on the risk of smoking onset earlier in adolescence is basically driven by students of low-SES mothers. In bad times, low-SES mothers could have attended prenatal care more often in order to monitor the fetal growth. It is worth noting that the access to health care service is public in Brazil. Moreover, low-SES mothers tend to be highly dependent of such public service, and might effectively increase the demand during recession periods. These health attitudes might have attenuated maternal stress and led to reductions in the prevalence of maternal smoking during pregnancy, reducing the risk of offspring smoking onset earlier in adolescence.[16]

16. In Brazil, the Seguro Desemprego (*i.e.*, unemployment insurance) and the Fundo de Garantia por Tempo de Serviço (FGTS) are two social security mechanisms that can improve the capacity of workers in smoothing consumption during transitory shocks in the economy. However, the 1990s were marked by a growth in the degree of informality of the Brazilian labor market, reaching almost half of the employees by the end of the decade. In addition, the majority of informal workers had lower schooling levels at that time (Ulyssea, 2006). Therefore, it is expected that the access of the less educated mothers (or their respective husbands) to these two social benefits was low during the 1990s, which could reinforce their necessity of adopting healthy behavior as a compensatory strategy.

### 5.5 Differences due to gender

We also investigate whether economic fluctuations during pregnancy exhibit heterogeneous associations regarding to adolescents' gender. Table 10 replicates the specification (7) in table 5, but splitting the sample for boys and girls. The estimates show that boys are the demographic group sensitive to economic downturns. A deviation of 0.1 log units from the long-term trend in the unemployment during the third trimester of pregnancy is associated with a drop in the risk of early smoking onset among boys of about 7.8%. Girls did not exhibit any significant estimates, although the coefficient for the third trimester is negative.

Early life investment will be more effective in mitigating early life shocks to child health depending on how parents weight their time preference in an underlying health production function (Heckman, 2007; Almond and Currie, 2011). In this case, parental preference concerning child gender may play an important role. If they prefer boys rather than girls, early investment in boy's health may mitigate later life consequences of economic shocks.

TABLE 10
**Heterogeneous effect due to gender**

| | Girls | Boys |
|---|---|---|
| | (1) | (2) |
| | Unemployment cycles | |
| Post-pregnancy (12 months) | -0.336 | -0.615* |
| | (0.402) | (0.355) |
| 3rd trimester | -0.250 | -0.781** |
| | (0.394) | (0.357) |
| 2nd trimester | 0.219 | -0.162 |
| | (0.323) | (0.318) |
| 1st trimester | -0.168 | -0.069 |
| | (0.316) | (0.296) |
| Pre-pregnancy (12 months) | 0.301 | -0.541 |
| | (0.463) | (0.428) |
| *Log*-likelihood | -36,762 | -37,559 |
| Wald test | 4,350 | 3,153 |
| #Clusters | 4,086 | 4,089 |
| Observations | 52,579 | 47,654 |

Authors' elaboration.
Notes: 1. The estimated model corresponds to the specification (7) in table 5, which includes covariates and state fixed effects, state specific trends, and dummy variables for month and year of birth. The list of additional controls can be found in the footnote of table 5.
2. Robust standard errors clustered at classroom level.
3. Significance levels: ***, ** and * = 1%, 5% and 10%.

Therefore, the results in table 10 suggest the existence of parental preference for boys, even though the literature about gender bias in Brazil has shown that mothers tend to allocate more resource to girls, whereas fathers exhibit preferences for boys (Thomas, 1994; Emerson and Souza, 2007).

## 6 CONCLUSION

In this study, we were interested in investigating whether smoking onset among adolescents in Brazil is correlated to economic fluctuations during pregnancy. We use the 2012 National Survey of School Health (Pense) carried out by the Brazilian Institute of Geography and Statistics (IBGE). In order to perform the analysis, we link the unemployment rate cycle to the trimesters of pregnancy based on the adolescents' date of birth.

The results suggest that the risk smoking onset earlier in adolescence decreases with economic downturns in the third trimester of pregnancy. A deviation of 0.1 log units of the unemployment rate from its long-term trend is associated to a drop 6% in the risk of early smoking initiation among students from the nine-grade of primary school, especially among boys. This result is robust even after including several additional controls and cohort fixed-effects, and different specifications of baseline hazard functions. This result is basically driven by adolescents of low-SES mothers, who are less prevalent than adolescents of high-SES mothers when pregnancy takes place in bad times.

A potential explanation for such results is that low-SES mothers might have adopted healthy behavior when they faced economic downturns during pregnancy, because they are more likely to be credit constrained in recession periods. Moreover, our evidence shows that the prevalence of smoking among low-SES mothers at the time of the interview is low if they experienced economic contractions during pregnancy, which suggests that their past decision of smoking may be linked to economic environment during pregnancy.

Although recent evidence in the economic literature has shown that mothers tend to exhibit deteriorated health during economic downturns (Currie, Duque and Garfinkel, 2015), our results is in line of the literature that found individuals' health improvements during bad times (Ruhm and Black, 2002; Ruhm, 2005), including health at birth (Dehejia and Lleras-Muney, 2004). Moreover, the recent literature of human capital formation suggests that parents may reallocate resources in order to compensate unexpected shocks to child health early in life (Heckman, 2007; Cunha and Heckman, 2007; Cunha, Heckman and Schennach, 2010; Yi *et al.*, 2015), opening a window for future research.

Therefore, if pregnant women are more health risky during bad economic periods they might increase demand for public health care, specially prenatal and

maternal care. Intensifying policies focused on reducing maternal addiction to smoking and improving mental health care during economic contractions would also be important to prevent smoking behavior among adolescents in Brazil. However, these policy recommendations would be much better addressed if we would able to properly test the biological and behavioral channels behind the associations presented in the current study.

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APPENDIX A

## WEALTH INDEX

The wealth index is generated by principal components approach. We include binary variables about possession of cellphone, computer, internet, car, motorcycle, the number of bathrooms in the house, and the presence of servants. Descriptive statistics are presented in table 3.

Table A.1 shows the eigenvalues and eigenvectors from principal components approach. We use the component with the largest eigenvalue to create the wealth index. The last column of table A.1 shows correlation between each variable the wealth index. The coefficients show that the wealth index is mainly correlated to possession of computer, internet, car and number of bathrooms of the house. Large values of the index are associated to possession of durable goods and with the size of the house. Therefore, adolescents with wealth index bigger than the median value (0.0176) are considered high socioeconomic status, and their counterparts are adolescents with wealth index smaller or equal than the median value.

TABLE A.1
**Eigenvalues and eigenvector**

| Components | C1 | C2 | C3 | C4 | C5 | C6 | C7 | Correlation coefficeint |
|---|---|---|---|---|---|---|---|---|
| Eigenvalue | 2.50 | 1.06 | 0.99 | 0.93 | 0.70 | 0.56 | 0.26 | Wealth Index |
| = 1 if cellphone | 0.20 | -0.18 | 0.25 | 0.93 | -0.02 | 0.02 | 0.02 | 0.310 |
| = 1 if computer | 0.51 | -0.36 | 0.11 | -0.21 | 0.23 | 0.03 | 0.71 | 0.800 |
| = 1 if internet | 0.51 | -0.36 | 0.10 | -0.19 | 0.27 | 0.02 | -0.70 | 0.801 |
| = 1 if car | 0.42 | 0.13 | 0.02 | -0.10 | -0.80 | 0.40 | -0.03 | 0.663 |
| = 1 if motorcycle | 0.00 | 0.40 | 0.90 | -0.16 | 0.09 | -0.03 | 0.00 | -0.006 |
| #Bathrooms | 0.43 | 0.38 | -0.18 | 0.05 | -0.12 | -0.79 | 0.01 | 0.673 |
| = 1if servant | 0.30 | 0.62 | -0.28 | 0.13 | 0.47 | 0.45 | 0.02 | 0.475 |

Authors' elaboration.

APPENDIX B

## RESULTS USING DIFFERENT FILTERING METHODS FOR UNEMPLOYMENT RATE

Table B.1 present the estimations using different detrended unemployment rates. The first column is the estimates for cycle component obtained by the Rodrick-Prescott filter as presented in table 5, whereas column (2) and (3) show the results for the cycle of unemployment rate obtained through Christiano-Fitzgerald and Butterworth filter.

TABLE B.1
**Results using different filtering methods for unemployment rate**

| | Hodrick-Prescott | Christiano-Fitzgerald | Butterworth |
|---|---|---|---|
| | (1) | (2) | (3) |
| | Unemployment cycle | | |
| Post-pregnancy (12 months) | -0.520* | -0.415* | -0.415* |
| | (0.266) | (0.243) | (0.245) |
| 3rd trimester | -0.598** | -0.603** | -0.604** |
| | (0.265) | (0.262) | (0.264) |
| 2nd trimester | 0.055 | 0.077 | 0.070 |
| | (0.228) | (0.228) | (0.228) |
| 1st trimester | -0.165 | -0.134 | -0.135 |
| | (0.216) | (0.212) | (0.212) |
| Pre-pregnancy (12 months) | -0.111 | -0.113 | -0.123 |
| | (0.311) | (0.290) | (0.295) |
| *Log*-likelihood | -75,253 | -75,253 | -75,253 |
| Wald test | 7,804 | 7,803 | 7,804 |
| #Clusters | 4,091 | 4,091 | 4,091 |
| Observations | 100,233 | 100,233 | 100,233 |

Authors' elaboration.
Notes: 1. The estimated model corresponds to the specification (7) in table 5, which includes covariates and state fixed effects, state specific trends, and dummy variables for month and year of birth. The list of additional controls can be found in the footnote of table 5.
2. Robust standard errors clustered at classroom level.
3. Significance levels: ***, ** and * = 1%, 5% and 10%.

The estimates in table B.1 are very similar. The estimated parameter for the cycle of unemployment rate using Hodrick-Prescott filter is slightly smaller in comparison with the other two filtering methods. A positive deviation of 0.1 log units (about 10.5%) from the long-term trend in unemployment during the third trimester of pregnancy is associated with a drop in the risk of early smoking onset in adolescence of about 6%, respectively using Christiano-Fitzgerald and Butterworth filter. Besides, the estimates of for unemployment cycles twelve months after pregnancy remain statistically insignificant using different filtering methods for the unemployment rate.

APPENDIX C

## DISCRETE CHOICE MODELS

In this subsection of the appendix, we present the estimates for the probability of a student has his/her first smoking experience. The estimates are obtained for two binary specifications: Probit and Logit.

The results suggest that a positive deviation of the natural *log* unemployment rate from its long-term trend in the third trimester of gestation is associated to a drop in the probability of a student has had his/her first smoking experience, in which the estimate is significant at the level of 5% of significance. Moreover, the unemployment cycle twelve months after pregnancy also reduces the probability of the first smoking experience. The results also confirm that students' smoking behavior is positively correlated to the parental smoking behavior and to the influence of their classmates as well. In summary, the results in table 5 are supported by those two binary choice models.

TABLE C.1
**Results from discrete choice models**

| | Specifications | |
|---|---|---|
| | Probit | Logit |
| Unemployment cycle | | |
| Post-pregnancy (12 months) | -0.414** | -0.702** |
| | (0.187) | (0.325) |
| 3rd trimester | -0.408** | -0.715** |
| | (0.182) | (0.321) |
| 2nd trimester | 0.025 | -0.032 |
| | (0.156) | (0.275) |
| 1st trimester | -0.128 | -0.221 |
| | (0.150) | (0.264) |
| Pre-pregnancy (12 months) | -0.116 | -0.251 |
| | (0.218) | (0.381) |
| Parental and peer smoking | | |
| = 1 if smoking father | 0.032*** | 0.055*** |
| | (0.000) | (0.001) |
| = 1 if smoking mother | -0.585*** | -0.993*** |
| | (0.021) | (0.035) |
| = 1 if smoking parentes | 0.270*** | 0.475*** |
| | (0.014) | (0.024) |

(Continua)

(Continuação)

| | Specifications | |
|---|---|---|
| | Probit | Logit |
| = 1 if strong parental reaction | 0.288*** | 0.504*** |
| | (0.016) | (0.028) |
| Classmates' peer effect | 0.422*** | 0.731*** |
| | (0.021) | (0.037) |
| Fixed effects and time trend | | |
| State | X | X |
| Time-trend | X | X |
| Birth month | X | X |
| Birth year | X | X |
| State x time-trend | X | X |
| Additional controls | X | X |
| *Log*-likelihood | -43,642 | -43,720 |
| Wald test | 18,013 | 15,514 |
| #Clusters | 4,091 | 4,091 |
| Observations | 100,233 | 100,233 |

Authors' elaboration.
Notes: 1. The list of additional controls can be found in the footnote of table 5. Robust standard errors clustered at classroom level.
2. Significance levels: ***, ** and * = 1%, 5% and 10%.