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ISABELA BRANDÃO FURTADO

ESSAYS ON HEALTH AT BIRTH, FINANCIAL LITERACY AND EDUCATIONAL OUTCOMES

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Tese apresentada à Escola de Economia de São Paulo da Fundação Getulio Vargas como requisito para a obtenção do título de Doutor em Economia

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Orientador: Enlinson Henrique Carvalho de Mattos

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ABSTRACT

This thesis consists of three essays related to microeconomics applied to health and education. The first chapter analyses a large-scale experimental impact evaluation of a financial education pilot program for students from public primary schools in two Brazilian cities. The second chapter estimates effects of birth weight on health and educational outcomes using a twin fixed effect approach for Brazil, using a matching of administrative records of birth and school enrollment. The third chapter explores the effects of prenatal exposure to a violent environment on birth weight and investigates whether the *in-utero* and early life violence shocks can have further impacts, particularly on schooling accumulation.

Key-words:financial literacy; birth weight, education.

RESUMO

Essa tese é composta por três ensaios relacionados aos temas de microeconomia aplicada à saúde e educação. O primeiro capítulo é uma avalição de impacto de um programa piloto de educação financeira aplicado a estudantes do ensino fundamental de escolas públicas em duas cidades brasileiras. O segundo capítulo apresenta estimativas dos efeitos do peso ao nascer sobre futuros resultados educacionais e de saúde no Brasil por meio de efeitos fixos de gêmeos, obtidos a partir da junção de registros de nascimento escolar. O terceiro capítulo investiga os efeitos da exposição pré-natal a um ambiente de violência sobre o peso ao nascer e se os choques de violência quando *in-utero* ou nos primeiros meses de vida podem ter impactos futuros sobre o recém-nascido, especialmente acúmulos educacionais.

Palavras-chave:alfabetização financeira; peso ao nascer; educação.

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Introduction

Over the past decades, economic growth has generated improvements regarding poverty reduction, access to basic sanitation systems and broader access to education. However, it has also led to a rise in social inequality. Public policies play a primordial role in mitigating these issues, as they aim to assure human dignity and improve the quality of human life.

Research in economics should thus continue to provide evidence on how to deal with these social challenges. Despite the growing focus on poor and developing countries, there is a lack of studies concerning several economic and social issues in these nations. Microeconomics applied to health and education gives support to the design and evaluation of public policies, helping foster economic development at local and national level. This thesis presents empirical studies on education and health using data from Brazil, contributing to the current debate on these issues.

The first chapter analyses a large-scale experimental evaluation of a financial education pilot program for students from public primary schools in two Brazilian cities. The program's goal was to increase students' financial proficiency and change attitudinal and behavioral outcomes regarding consumption and savings. The results suggest that the program had positive average effects on knowledge, mostly for middle school students. Moreover, the evidence indicates that the program had larger average effects among students with more educated mothers, but curiously it might have been slightly more effective among the poor.

The second chapter shows estimations of effects of birth weight on health and educational outcomes using a twin fixed effect for Brazil, from an innovative match of administrative records of birth and school attendance. The main finding for Brazil is that birth weight does matter, affecting infants' health and educational outcomes. Furthermore, most of the overall effects found came from the group of low birth weight, lower access to basic health care services, lower maternal education and from the ones that have attended schools with lower socioeconomic status.

The third chapter investigates the effects of prenatal exposure to a victimization environment on birth weight and whether the *in-utero* and early life violence shocks can have further impacts, particularly on schooling accumulation. The estimation shows that violence leads to a small reduction on birth weight, mainly through its effects on the second trimester of gestation. Moreover, the results for the human capital accumulation show that there is a weak association between exposure to violence during the first semester of life and the probability of completing elementary and high school. The effect, even if small, is more significant for children with low-educated mothers.

Thus, this thesis contributes to the related literature, providing additional empirical evidence of effects influencing outcomes related to health, education and financial literacy in Brazil.

Chapter I
How Early Should Financial Education Be Taught?
Evidence from a Large-Scale Experiment

1 How Early Should Financial Education Be Taught? Evidence from a Large-Scale Experiment*

Abstract

This paper presents the findings of a large-scale experimental evaluation of a financial education pilot program for primary school students in Brazil. The pilot was carried out during the school year of 2015 and included students in four different grades (3^{rd}, 5^{th}, 7^{th} and 9^{th}) in 101 municipal schools of Manaus and Joinville. The program's objective was to increase students' financial proficiency and, consequently, change attitudinal and behavioral outcomes regarding consumption and saving. This is the second randomized controlled trial of a financial education program targeting primary school students in a developing country, and the first to report gains in financial proficiency and changes in attitudinal outcomes. The results suggest that the program increased financial literacy by 0.07 SD for the overall sample and by 0.1 SD for middle school students. We also found positive results on attitudes towards consumption and saving of 0.09 and 0.05 SD respectively. Heterogeneous analyses were carried out seeking to understand: (1) for which subgroup the pilot had the largest effect, and (2) the extent to which the pilot's implementation influenced the program's efficacy. In fact, the program had positive average effects on knowledge only for middle school students. We found that the program had larger average effects among students with more educated mothers, but there is suggestive evidence that the program might have been slightly more effective among the poor. Finally, we explored information on the effectuation of the program and found positive and statistically significant effects only when at least 60 percent of the syllabus was covered in classroom. These results indicate that (i) knowledge is not a sufficient condition to change attitudes and behavior, (ii) the program might have larger effects if better targeted, and (iii) the quality of program's implementation plays a key role in program's effectiveness.

Keywords: randomized impact evaluation, financial literacy, financial behavior.

1.1 Introduction

Although economists disagree on several topics, there is a virtual consensus in economics that education is a key for long-term growth and development. In particular, evidence strongly suggests that educational quality plays is the decisive factor affecting economic development (HANUSHEK; WOESSMANN, 2010). Unfortunately, there does not seem to be an easy way to improve school quality. How to ensure that students develop their reading, writing and math skills since the very first days in school? This is a challenge that has led many countries worldwide to test interventions aimed at fostering school quality. Hundreds of different interventions have been tried and rigorously tested, but it seems that we are still far from having a good understanding of which policies in fact improve school quality (EVANS; POPOVA, 2015).

McEwan (2015) compared the effect of different programs that aimed to improve learning of elementary school students in developing countries. The comparison took into account the results obtained from assessment of the impacts of several public policies for education, such as

* This chapter is co-authored with Caio Piza (DIME/World Bank).

the use of computers, teachers' training, and better school supervision and management. The study concludes that it is difficult to improve students' knowledge. In general, the programs seem to have a quite limited effect, and many of them would fail a cost-effectiveness analysis. In brief, even today, with all investments made in education programs over the years, and in several countries, one does not know precisely what to do to improve the quality of education and, consequently, students' learning[1].

In any case, this debate is of paramount importance because it is directly associated to the individuals' cognitive skills in the short run and to the quality of the economy's stock of human capital in the long-term. This paper in particular focuses on a financial education program that is part of the Brazilian initiative to expose students to financial education since the early grades of elementary school.

Currently, there has been a growing interest in including financial education syllabuses in schools. A greater attention has been paid to high school education, although the question about how early students should have contact with financial education is in debate among academics and policymakers in developing and developed countries such as Ghana, Peru, Chile, Brazil and the U.S.

This is a legitimate concern, as many decisions made in everyday life can be seen as financial ones. For instance, the magnitude of an investment in knowledge accumulation should made today – and, therefore, the amount of leisure to be sacrificed – depends on the expected returns on education. Sacrificing consumption today (saving) to consume more in the future is a similar financial decision that may affect an individual's welfare in the long term. Better health tomorrow means some sacrifice today – good eating habits and physical exercise. All choices that require some sacrifice (cost) in the present aimed at having something better in the future (benefit) are investment decisions and, therefore, decisions associated with financial education. However, one has to remember that these financial education programs take both the school quality and the institutional environment as given. This is important since (i) some have argued that reading and numeracy skills might be two important moderator factors underpinning the effectiveness of financial literacy programs (LUSARDI, 2012), and (ii) the institutional settings define the 'rules of the game' and hence the incentives underlying individuals' decisions.

This debate reveals the challenge faced by governments and international institutions committed to financially include millions of illiterate individuals in a world with increasingly complex financial products and services (LUSARDI; MITCHELL, 2014).

To mention one of the contexts in which financial education proves relevant, international evidence suggests that several individuals and entrepreneurs fail to maximize the returns of an investment due to bad financial decisions. Part of the problem is related to behavioral issues (biases), such as lack of self-control (not being able to save, for example) and procrastination (e.g., not making a financial plan or a spending spreadsheet because it is time-consuming) (XU; ZIA, 2015; DREXLER; FISCHER; SCHOAR, 2014; ALAN; ERTAC, 2015; CARPENA et al., 2015). Another part is related to lack of information, which eventually leads to the underestimation of potential returns (JENSEN, 2010). Finally, lack of formal knowledge (training) is the third relevant factor (LUSARDI; MITCHELL; CURTO, 2010; LUSARDI; MITCHELL, 2011; LUSARDI;

[1] It should be highlighted that low-quality education has direct implications for the economy in the long run as it will affect labor productivity and will long-term growth. Hanushek e Woessmann (2012) argues that low-quality education is one of the factors that could explain the poor economic growth in Latin America as a whole, especially when compared with the growth experienced by Asian countries between 1960 and 2000.

MITCHELL, 2014; FERNANDES; LYNCH; NETEMEYER, 2014).

Hence, learning how to deal with these trade-offs inherent to intertemporal choice, and learning how to read financial texts (e.g., a light bill or a contract) and to master formal concepts presented in these texts (e.g., interest rates), is certainly important The question is whether a well-organized financial education program properly applied during early school years could contribute to reducing behavioral biases and enabling children to make better investment decisions – such as how much they should study and their career choice. Even though the literature has revealed that knowledge is easier to change than behavior, an experiment carried out in Brazil with approximately 20,000 high school students between 2010 and 2011 indicated remarkable effects on the increase of financial literacy and changes in attitudes and behavior (BRUHN et al., 2016). But would the introduction of financial education in elementary school also produce remarkable outcomes?

To investigate some of these issues, we conducted an experiment in 201 local schools in the Brazilian cities of Manaus and Joinville in 2015, involving around 18,000 students. The pilot study focused exclusively on elementary school students. The first assessment of the impact of a financial education program for elementary school students dates to 2006 and was conducted at U.S. public schools (MANDELL, 2009). Ever since, the number of impact evaluations of programs targeted at children has increased, but basically all that is known comes from quasi-experimental assessments performed at U.S. public schools. While the results of these assessments could tell us something about the impact of such programs, they cannot be easily generalized to other contexts. Rigorous assessments in developing countries are virtually nonexistent. To our knowledge, the only study and that bears some resemblance to the Brazilian case is the one undertaken by Berry, Karlan e Pradhan (2015) in Ghana. This experiment was conducted in 2010 and 2011 with 5,200 students from 165 schools. It measured the impact of a program on financial knowledge, financial decisions, preferences, trust, and academic performance. The authors did not find any effects on the outcome variables, except for the intention to save.

As a matter of fact, Kaiser e Menkhoff (2016) verified that the impact of financial education programs is, by and large, context-specific. By comparing several programs conducted in developed and developing countries, the authors noted that the effects tend to be stronger in the former group of countries. Consistent with the result, they also noted that programs tend to be less efficient among poorer students. These findings suggest that these programs are very heterogeneous and that, therefore, the average treatment effect, the most widely used parameter in impact evaluations, could reveal very little about the complexity of the programs.

In this respect, our study contributes to the literature in varied ways. First, this is the first experimental study focusing on students aged between 6 to 15 in a developing country, which found positive effects on financial knowledge and attitudes. Second, the experimental design allows measuring effects per elementary school cycle (first and second) and for each of the four grades included in the pilot study, something nonexistent hitherto. Third, the scope of the pilot study allows us to perform several heterogeneity analyses that help elucidate the program's outcome chain. Finally, unlike the previous pilot study conducted in Brazil with high school students, this new pilot study was applied in a format that is easily reproducible and extendable, as the intervention was much less intense and the teachers were trained by supervisors qualified as multipliers.

The main results indicate an increase in financial literacy (knowledge) and a change in attitudes. The impact on knowledge, in particular, was positive throughout the knowledge distri-

bution, with a displacement of the whole distribution to the right.

Analyses conducted with subgroups reveal heterogeneous effects of the program and shed some light upon the mechanisms that underlie the average effect observed. For instance, the impact of the program was found to be greater on students in the second elementary school cycle, especially in Manaus. It is important to stress that the results above do not suggest that the program should be expanded just in Manaus since we do not know precisely which factor(s) led to such an outcome. A more in-depth analysis of these determinants could be particularly useful for understanding the observed result but, unfortunately, the available data are not adequate for such an exercise.

Even though there is no statistically significant difference between the effects observed for boys and girls – which is consistent with international evidence (KAISER; MENKHOFF, 2016) –, maternal education could play an important role in the efficiency of the program, as the effect appears to be stronger among students whose mothers finished at least high school. While maternal education is correlated with numerous characteristics such as income, occupation, wage, and human capital investment in children and could hence be seen as a good proxy for the socioeconomic status of families, it is not possible to claim that the program should be expanded only among students with better-educated mothers. The results only allow us to affirm that the effect of the program was larger among students with better-educated mothers. Although we propose an explanation for this fact, we do not know exactly the reasons why that happened.

We also looked at the quality of implementation of the program and at the outcomes of interest. In fact, our results show that the quality of implementation is a key factor. For example, we observed a null effect in both cycles when up to 60% of the syllabus was covered, which occurred in one-third of the schools. On the other hand, the average effect was around 0.14 standard deviation (SD) in the second cycle when more than 60% of the syllabus was dealt with in the classroom. This finding is, to some extent, in line with the international evidence that the intensity of the program's fulfillment is a determinant of the magnitude of the effect observed (KAISER; MENKHOFF, 2016).

Apart from this introduction, this paper is organized into seven sections. Section 1.2 describes the pilot study in detail. Section 1.3 explains the design of the impact evaluation, the selection of treatment and control groups, and the identification strategy used. Section 1.4 describes the data collection, presents the questionnaires used, and the descriptive statistics that characterize the implementation of the project, as well as the students and teachers who participated in the pilot study. Section 1.5 shows the effects estimated for financial literacy as well as consumption and saving attitudes. Section 1.6 discusses the heterogeneous effects of financial literacy, consumption, and saving according to student's gender, maternal education, municipality, and quality of implementation of the study. Finally, Section 1.7 presents the final remarks.

1.2 The pilot study

The National Strategy for Financial Education (*Estratégia Nacional de Educação Financeira – ENEF*) was developed in 2010 by the Brazilian Federal Government with the aim of disseminating financial education and empowering the population to make more autonomous financial decisions. Between August 2010 and December 2011, ENEF devised a financial education program for public high schools in six states (São Paulo, Rio de Janeiro, Ceará, Tocantins, Minas Gerais, and Distrito Federal). The impact evaluation included 891 schools and approximately

20,000 students and resulted in significant improvement in aspects such as financial knowledge, intention to save, and financial autonomy, as well as larger participation of students in household finances (BRUHN et al., 2016).

As a way to strengthen the ENEF and because of the good results of the program for high schools, the financial education program for elementary schools was developed in 2014. The program consists of four different teaching approaches: for students in the 1st to 4th elementary school grades, for students in the 5th and 6th grades, for students in the 7th and 8th grades, and finally, specifically for students attending the 9th grade. These modules make up a teaching material designed to be cross-sectionally introduced into the syllabus currently taught in each grade. The modules have different approaches targeted particularly at students in each age group and grade, but they complement each other over time by focusing on the same set of competences to be developed and explored.

The teaching material takes for granted that financial education is associated with students' everyday life and thus develops financial concepts based on spatial and temporal dimensions. The spatial dimension is built upon notions at individual, local, regional, national and global levels and upon the effects of individual actions on the social context. The temporal dimension, however, deals with the notions of past, present, and future, i.e., with the intertemporal nature of decisions. In this context, the present is a consequence of decisions made in the past, but also the moment at which decisions that can affect the future are made.

In order for the teaching material and the method of implementation of the program to be assessed, the pilot study was implemented during 2015 in 101 schools, 36 in Joinville and 75 in Manaus, only in the 3rd, 5th,7th, and 9th grades so that all teaching approaches could be tested[2].

The selected schools were provided with training using the teaching material as part of the intervention. In Joinville, the training was held in February 2015 for teaching supervisors of each school. In Manaus, supervisors of regional education boards were trained at the end of March of the same year. In both cases, the trained supervisors worked as multipliers, being in charge of training the teachers.

1.3 Design of impact evaluation and identification strategy

1.3.1 Sample selection

To evaluate the impact of the financial education pilot study on elementary education, 201 schools were selected, 72 in Joinville and 129 in Manaus, half of them (101) received the intervention and the other half (100) served as control. The selection of participating schools was based on stratification per municipality and type of elementary education cycle offered by the school (only initial grades, only final grades, or all elementary school grades).

Of 72 local schools in Joinville, 20 offered only initial grades, only two offered only final grades, and 50 offered all grades. The local education network in Manaus consisted of 367 schools, of which 53 are located in riverside communities. Due to the difficult access to some of these areas, and following the guidelines of the local Department of Education, these schools did not participate in the pilot study. Of the 314 remaining schools, 302 offered some of the grades targeted by the

[2] The impact evaluation of the pilot study included a total of 201 schools, 100 of which served as control, i.e., they did not receive any intervention.

pilot study (3rd, 5th,7th, or 9th), distributed as follows: 202 offered only initial grades, 35 offered only final grades, and 65 offered all grades. The 65 schools that offered all elementary school grades were randomly assigned between treatment and control so that the final sample could have a considerable number of schools that offered the 7th and 9th grades. Among those schools that offered only the final grades, 28 were sampled according to the quartiles of IDEB (Basic Education Development Index) distribution for the 9th grade for year 2013 and later randomly assigned to treatment and control groups. Of those schools that offered only the initial grades, 36 were sampled according to the IDEB quartiles for the 5th grade for year 2013 and later randomly assigned to treatment and control groups. Table 1.1 summarizes how the impact evaluation sample was selected.

Table 1.1 – Sample selected for the pilot study

	Joinville			Manaus				Total		
School type	Total	T	C	Total	Sampled to pilot	T	C	T	C	Total
Only initial grades	20	10	10	202	36	18	18	28	28	56
Only final grades	2	1	1	35	28	14	14	15	15	30
All elementary school grades	50	25	25	65	65	33	32	58	57	115
Total	72	36	36	302	129	65	64	101	100	201

Note: T =treatment; C = control.

Since the evaluation was based on random selection and there were some budget constraints, baseline data were not collected. However, the availability of administrative educational data allowed for a pretreatment balance analysis within schools – at the randomization unit. Table 1.12 in the Appendix 1.A presents the results for the balance analysis considering only the schools in Joinville, only the schools in Manaus, and the overall sample.

Table 1.12 shows the coefficients of binary variable that identify whether the selected schools belong to the treatment or control group. These coefficients were obtained from the regression of a set of covariates on the treatment dummy, the dummies for strata (cycles available at the school in each municipality), and a constant.

Note that the groups of schools are, on average, statistically very similar. In the case of Joinville, the null hypothesis of equal means was rejected in only one case, for the age-grade distortion in the 5th grade. Some rejection is actually expected since, by definition, a test with a 5% significance level with 20 variables will necessarily reject the null hypothesis once.

In the case of Manaus, the null hypothesis was rejected in three cases, in two of them – promotion rate for the 9th grade in year 2009 and test score in Portuguese in the 9th grade in year 2011 –, the statistically significant difference is not persistent over time. Considering the whole sample, there is some statistically significant difference in the promotion rate for the 9th grade in 2009 and 2011 that does not produce significant differences in test score and IDEB, indicators that are quite probably more strongly correlated with the outcome variables of the pilot study. Moreover, there are differences in the age-grade distortion rate and in the rate of teachers with tertiary education.

These results demonstrate that the schools assigned to the treatment and control groups share common characteristics (see Table 1.12). While no baseline data on students were collected, the follow-up study contains information about students' socioeconomic characteristics that are not sensitive to intervention and hence can be used to check balance at student level. The analysis confirms that the groups of students from treated and control schools are, on average, very similar

(see Table 1.13 in the Appendix 1.A). This is an important finding for the interpretation of results since randomization was done at school level but the unit of analysis is the student.

1.3.2 Identification strategy

To assess the impact of the program on the outcome variables, we used the following regression model:

$$Y_{iksm} = \alpha + \delta T + Z_{ksm} + \epsilon_{iksm} \tag{1.1}$$

where Y is the outcome variable (financial literacy or attitude) of student i in grade k at school s in municipality m, T is a binary variable that is equal to 1 if the student belongs to the treatment group and 0 otherwise, Z is a vector of dummy variables that identifies the randomization strata and ϵ is a random disturbance with zero mean.

The parameter of interest δ measures the average intention-to-treat (ITT) effect, i.e., the average effect on students randomly selected to receive treatment. As the students from the same class-school may be similar, the standard error is estimated by correcting for dependence at the class-school level. It is worth noting that this regression does not distinguish the effect between grades. To assess the training effect in different cycles or grades, Equation 1.1 can be re-estimated only for the students in each cycle or grade tested separately.

Finally, to measure the distributive effect of the program on financial literacy, we will estimate the quantile intention-to-treat (QITT) effects. Unlike the average effect, quantile effect allows to check whether the impact of the pilot study was different at distinct points (quantiles) along the outcome distribution. In other words, if the program had a positive effect only on one distribution interval, the effect in that quantile might be positive even when the average effect was zero. Intuitively, the QITT effect and the average effect can be interpreted similarly. In fact, the former corresponds to the (horizontal) difference between accumulated (or marginal) distributions of treated and control students for a given quantile. For example, the effect on the median is given by QITT(0.5) = $Q_{0.5}(Y_T)$ - $Q_{0.5}(Y_C)$, where Y_T is the value of the outcome variable (e.g., financial literacy test score) in the distribution median of the treated group and Y_C is the value of the outcome variable (e.g., financial literacy) in the distribution median of the control group[3].

1.4 Data collection

1.4.1 Questionnaires

A primary data collection was carried out in December 2015 by a firm specialized in this sort of service. In each municipality, Joinville and Manaus, the data were collected in 2 days – the 3rd and 5th grades on the first day, and the 7th and 9th grades on the second day. Three different instruments were used for the collection: a test on financial knowledge, a questionnaire on financial attitudes and habits, and a socioeconomic questionnaire. These instruments contained multiple choice questions and had some differences between the grades in order to suit the specificity of each grade. The questionnaires were applied by external examiners. Teachers in charge of the class

[3] We estimated the unconditional QITT in two steps. We first ran a regression of Y on a constant and stratum dummies and saved the residuals. We then used the residuals as a dependent variable to estimate the QITT.

(in the case of control schools) or those who were in charge of the teaching material (in the case of treatment schools) answered a specific questionnaire. Students were given 2 hours to answer the three instruments.

The test on financial knowledge consisted of questions related to the topics related to financial education taught by means of the teaching material. The questions were created based on descriptors referring to the skills to be developed by the teaching material. Not all skills are dealt with in all grades. Table 1.2 shows the descriptors and skills associated with each grade. Based on the answers to the financial knowledge items, a financial literacy score is calculated using the item response theory (IRT).

Table 1.2 – Descriptors and skills on the financial knowledge test

		Grade			
Descriptor	Skill	3rd	5th	7th	9th
D01	Being able to identify the subject of texts whose topic explores socially responsible attitudes towards the environment	yes	yes	yes	yes
D02	Being able to find information in texts about consumption – light, water, telephone bills, among others	yes	yes	no	no
D03	Being able to identify the purpose of texts and text formats that include expenses, consumption, spending	yes	yes	no	no
D04	Being able to recognize the purpose of text genres related to finances – receipts, checks, invoices	no	yes	yes	yes
D05	Being able to recognize situations in which concepts related to finances are present: savings, expenses, consumption, spending, waste, risk, return, financial planning, investment, among others.	no	no	yes	yes
D06	Being able to identify situations related to financially responsible attitudes	no	yes	yes	yes
D07	Being able to find information in graphs and tables that contain data related to finances (purchases, sales, spending)	yes	no	no	no
D08	Being able to find information in texts that circulate in the financial world: classified ads, news features, among others	yes	yes	yes	yes
D09	Being able to estimate values and/or procedures necessary for financial projects	yes	yes	yes	yes
D10	Being able to distinguish remunerated from non-remunerated work.	yes	yes	no	no
D11	Being able to identify the origin and destination of varied products and/or those that can be recycled.	yes	no	no	no
D12	Being able to recognize socially responsible situations related to public and private spaces.	no	no	no	yes
D13	Being able to identify advantages, disadvantages, and risks of cash and credit sales.	no	yes	no	yes
D14	Being able to find implicit information in media texts that are relevant for decision making in finances.	no	yes	yes	yes

The test on financial knowledge for students in the 3rd grade consisted of 26 questions that were answered with the help from the enumerator, who read out the questionnaire. Since these students were still in the process of acquiring their reading and writing abilities, this strategy was intended to make the test easier to all students, regardless of their reading and writing skills. The questionnaire on financial attitudes and habits and the socioeconomic questionnaire for students in the 3rd grade were sent to legal guardians and should be returned on the following day. Because of this particularity in the application of these questionnaires, they contained questions that differed from those applied to older students. Questions about contact with financial issues referred to the legal guardian and those about attitudes required the legal guardian to state how he/she believed his/her child would behave in a given situation. Schools made previous contact with legal guardians by sending them a note prior to the test day, informing that the questionnaire would be sent home and stressing the importance of filling it in and sending it back on the

following day.

For 5th graders, the test on financial knowledge consisted of 30 questions. The socioeconomic questionnaire contained 24 questions, whereas the questionnaire on financial attitudes and habits comprised 35 questions. Seventh graders answered 32 financial knowledge questions, a socioeconomic questionnaire identical to the one applied to 5th graders, and a questionnaire on financial attitudes and habits that contained the same 35 questions applied to 5th graders, in addition to six additional questions on attitudes, totaling 41 questions. The socioeconomic questionnaire and the one on financial attitudes and habits for 9th graders were the same as the ones applied to 7th graders, and the financial knowledge test was based on 36 questions. The questionnaire on financial attitudes and habits for 5th to 9th graders also included six questions on the use of the teaching material in the classroom and their opinion about the material.

The questionnaire for teachers included questions related to socioeconomic background and to the use of the teaching material that should be answered only by the teachers who participated in the project.

1.4.2 Participation rates

In both municipalities where the pilot study was carried out, the data were collected on the last school days. This period was the most appropriate according to school calendars, although there could be a smaller participation of students as some might have already gone away on vacation or dropped out[4]. However, Figure 1.1 shows that the participation rate was quite close to the average observed on a regular school day (around 80%).

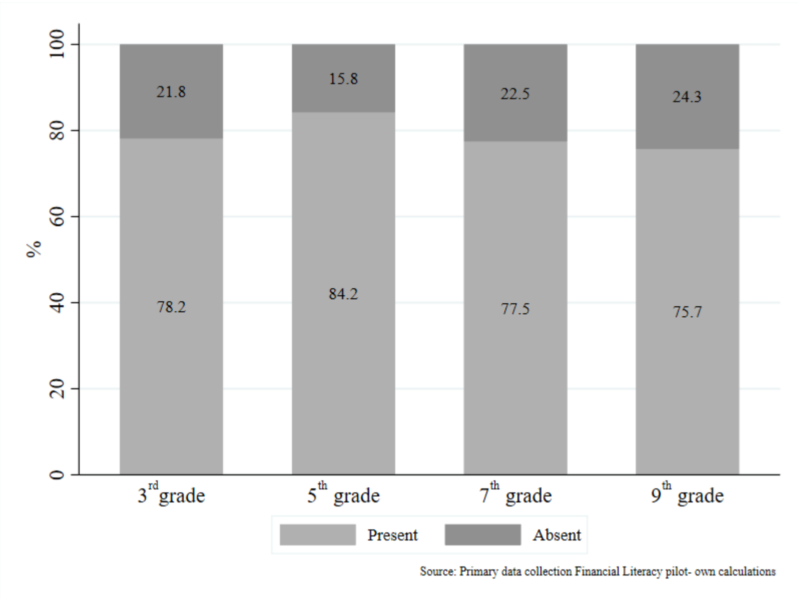


Figure 1.1 – Students' participation rate

The participation rates displayed in Figure 1.1 refer to the financial literacy test. In the case of 5th, 7th, and 9th graders, a student who completed the literacy test might not have answered the socioeconomic questionnaire and the questionnaire on financial attitudes and habits either due

[4] It is not clear if the absent student are the best ones, who had already succeeded in being promoted to the next grade even without final tests, or the worse students that had already failed the grade and dropped out of school.

to lack of time or to lack of interest. Among 3rd graders, whose questionnaires were sent home to be filled in by their legal guardians, failure to return the questionnaire on the following day was a possible risk. Figure 1.2 shows that the percentage of 5th, 7th, and 9th graders who answered the questionnaires was very high. However, the rate of questionnaires returned by the parents was 64.2%.

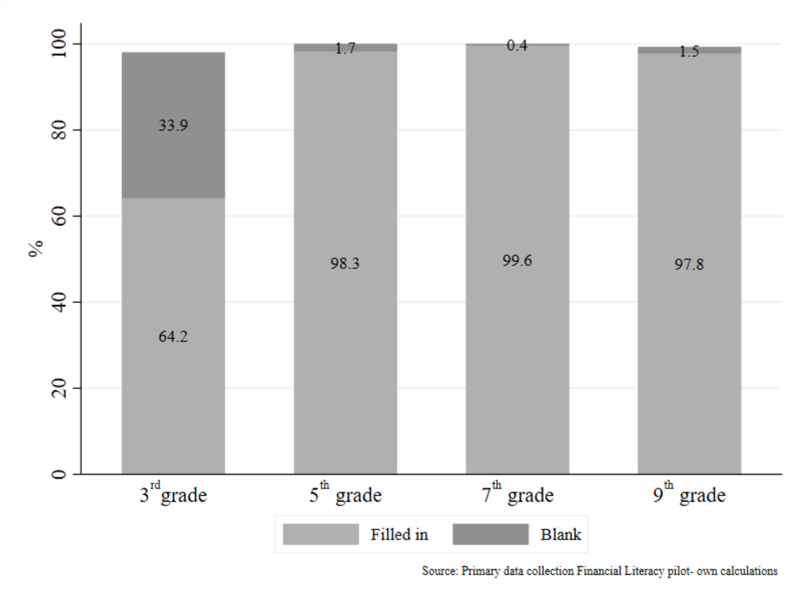


Figure 1.2 – Response rate of socioeconomic and attitudinal questionnaires

The participation rate in the financial literacy test and in the socioeconomic questionnaire and questionnaire on financial attitudes and habits did not differ between the treatment and control groups, as demonstrated in panel A of Table 1.13 in Appendix 1.A. This finding corroborates the success of the random selection as it indicates that the attendance of students on test days is very similar between the two groups of schools.

1.4.3 Implementation

The project was implemented in a way that allowed schools in the treatment group to use the teaching material freely and according to their calendars. At the beginning of the school year, supervisors from each participating school in Joinville and supervisors from the regional boards of education in Manaus underwent training. These supervisors acted as multipliers of knowledge, being in charge of training the teachers who would use the teaching material in their classrooms.

During the school year, questionnaires for monitoring of the implementation of the study were sent to the supervisors. The questionnaires were intended to keep track of the implementation of the project at schools and get some insight into some of the major challenges concerning the use of the teaching material. In the first semester, two questionnaires were sent to supervisors, which allowed to identify inadequate use of the teaching material at the beginning of the academic year.

In order to encourage the use of the material by the teachers, the project team organized a meeting with the teachers in charge of the project implementation at the beginning of the second semester in each of the participating municipalities. The meeting sought to stimulate the use of the teaching material, introducing it and encouraging teachers who were already using it to share their experience and questions with those who had had little contact with the material so far.

Actually, when the teachers were asked about which semester they to started using the material, 27.2% of 3rd grade teachers answered they used only in the second semester. This rate increased with grade, reaching 55.3% among 9th grade teachers. On the other hand, 48.1% and 37.5% of 3rd and 5th grade teachers, respectively, said they used the teaching material all year round. Among 7th and 9th grade teachers, this rate was 24.5% and 19.1% respectively. These data concur with the diagnosis made throughout the implementation that the material was more intensively used in the second semester, especially in the 7th and 9th grades (Figure 1.3).

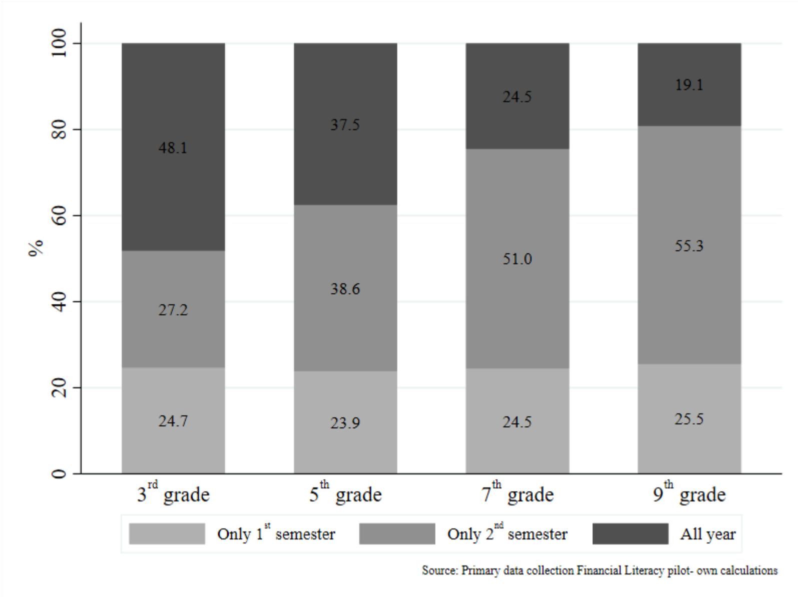


Figure 1.3 – Semester in which teachers used the teaching material

When asked about how many financial education lessons were taught during the school year, 65.4% of 3rd grade teachers mentioned seven or more lessons. This rate gradually decreased in more advanced grades, corresponding to 61.1% for the 5th grade, 48.5% for the 7th grade, and 46.3% for the 9th grade. Figure 1.4 displays these rates for all grades and shows that most groups had more than five lessons on the topic. The fact that students in more advanced grades had, on average, fewer lessons may be related to the later usage of the teaching material, as illustrated in Figure 1.3.

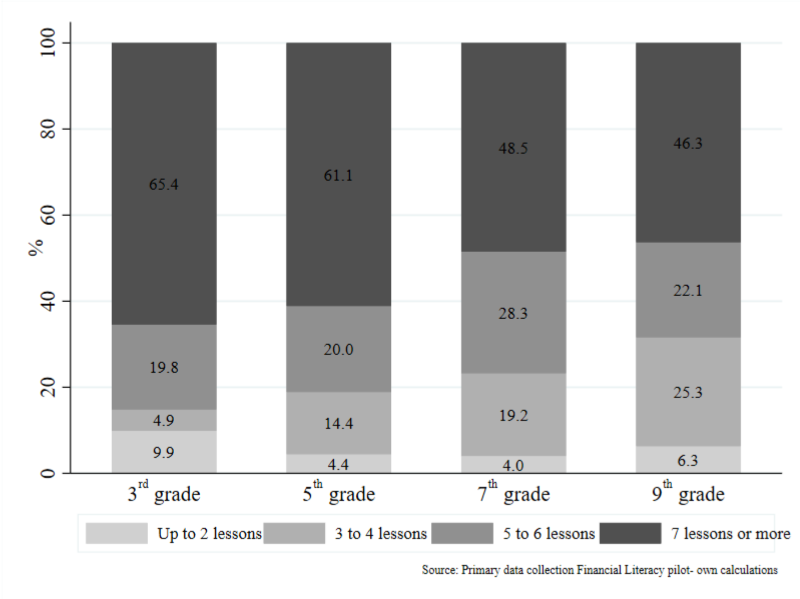


Figure 1.4 – Number of financial education lessons taught

Regarding the percentage of the syllabus covered by the teachers, Figure 1.5 shows that 32.9% of 3rd graders, 26.4% of 5th graders, 42.4% of 7th graders, and 42.1% of 9th graders were taught less than 60% of the syllabus. Conversely, 26.8% of 3rd graders were taught more than 80% of the syllabus, whereas 36.3%, 20.2%, and 22.1% of 5th, 7th, and 9th graders had most the teaching material covered. The percentage of the syllabus taught is presented in Figure 1.5 and reveals that more than half of the teachers covered 60% or more of the syllabus.

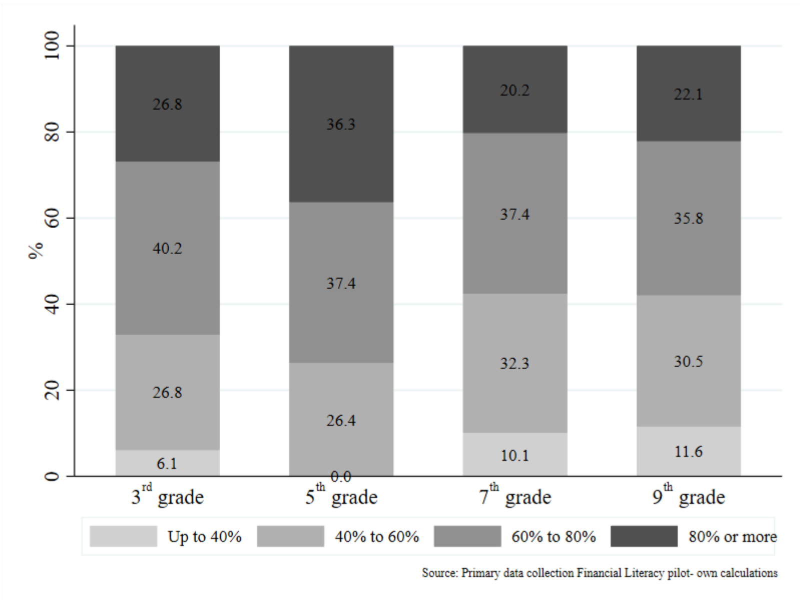


Figure 1.5 – Percentage of syllabus covered

From the students' standpoint, Figure 1.6 shows that more than half of 5th, 7th, and 9th graders had received the teaching material in the middle of the school year. Some students claimed they had received the material at the end of the year, which accounted for 18% among 9th graders. Some students claimed they had not received the material – a rate that corresponded to

9.7% among 7th graders. However, considering all treatment classes, there was no class in which most students stated they had not received the material, which indicates that the percentage of students who reported not having received the material might be due to students who were transferred and were admitted at the school after the books had been delivered, or to incorrect answers. Figure 1.6, which considers the use of the teaching material from the perspective of students, corroborates the information obtained from the questionnaire applied to teachers that the project was implemented, or at least fostered, from the middle of the year onwards.

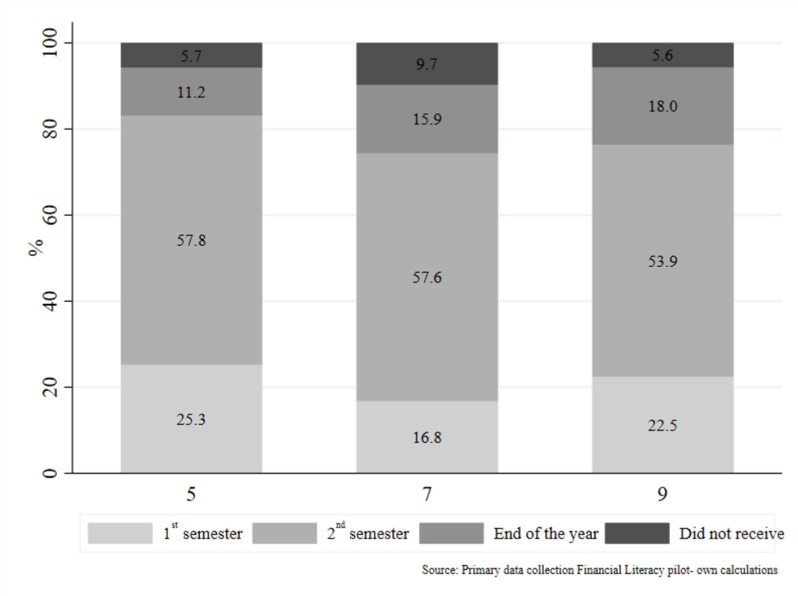


Figure 1.6 – Deliver of the teaching material, according to students

In summary, the information on implementation obtained from the questionnaires applied to teachers and students indicates that the financial education program was developed at the schools more intensively in the second semester and that not all of the syllabus was covered in most classes. These findings reveal difficulty in implementation, which is relatively common in experimental studies, but could have an impact on the outcomes. Collecting information about the pilot study is important as it helps distinguish, to some extent, the effect of the program from the effect of its implementation.

1.4.4 Students' characteristics

This section describes the main characteristics of the students who participated in the program in Manaus and Joinville[5].

According to Table 1.3, approximately 70% of the students lived on paved streets, a rate that rose to 86% when only 3rd graders were accounted for. Virtually all students lived in households with access to electricity supply – 99.4% of 3rd graders, 95.9% of 5th graders, and around 97% of 5th and 7th graders. Access to piped water was also present in most households (around 96%) and that does not vary considerably among students. Garbage collection was available in nearly 90% of the households of 3rd and 9th graders and in approximately 85% of the households of 5th

[5] As the socioeconomic questionnaire applied to 3rd graders differed from the ones used in other grades (it was filled in at home by legal guardians), some questions are not available for all grades.

Table 1.3 – Students' characteristics

Variables	3rd grade Obs.	3rd grade Mean	5th grade Obs.	5th grade Mean	7th grade Obs.	7th grade Mean	9th grade Obs.	9th grade Mean
Household characteristics								
Access to paved street	2115	67.80%	3897	67.50%	3606	70.40%	3278	74.40%
Access to electric power	2046	99.40%	3894	95.90%	3603	97.60%	3289	97.40%
Access to piped water	2083	96.50%	3913	96.10%	3614	96.60%	3285	97.10%
Access to garbage collection	2052	92.40%	3868	85.00%	3590	87.00%	3277	90.70%
Participant in the Brazilian Bolsa Familia	2141	36.20%	3863	45.10%	3578	41.90%	3252	37.10%
Students characteristics								
Age appropriate to the grade	2035	86.30%	3854	78.00%	3562	77.00%	3238	76.50%
Gender: male			3869	50.70%	3597	48.00%	3274	49.50%
Skin color: white			3833	38.90%	3558	35.70%	3219	36.20%
Mother's education: incomplete elementary school			2605	25.70%	2664	26.00%	2699	23.50%
Mother education: incomplete high school			2605	18.40%	2664	20.30%	2699	19.40%
Mother education: at least high school degree			2605	55.90%	2664	53.70%	2699	57.10%
Legal guardian characteristics (only 3rd graders)								
Age: less than 20 years	2030	2.20%						
Age: 21 to 59 years	2030	96.30%						
Age: more than 60 years	2030	1.50%						
Education: incomplete elementary school	2131	27.10%						
Education: incomplete high school	2131	20.90%						
Education: at least high school degree	2131	52.00%						
Occupation: formal labor market	2083	36.10%						
Occupation: informal labor market	2083	29.50%						
Occupation: unemployed	2083	18.60%						

and 7th graders. Over one-third of the households were beneficiaries of the Brazilian conditional cash transfer program Bolsa Família, but the rate approaches 45% among 5th graders.

The percentage of students attending the right grade for their age decreases gradually though monotonically as students get older. Around one-third of students are white. With respect to parents' education, approximately 25% of mothers did not complete elementary school and about 20% of them did not hold a high school degree. The percentage of mothers who finished at least high school was 55% among 5th graders and 57% among 9th graders.

Most legal guardians of 3rd graders were aged 21 to 59. Around 27% of them did not finish elementary school, 20% did not complete high school, and 52% held at least a high school degree. Finally, 36% of legal guardians worked in the formal labor market, whereas 29% held informal jobs, and 18% were either unpaid workers or unemployed.

1.4.5 Teachers' characteristics

Concerning the profile of the teachers involved in the project (Table 1.4), most were women. However, the more advanced is the grade, the higher the ratio of male teachers, with rates ranging from 8.5% in the 3rd grade to 42.1% in the 9th grade. More than one-third of the

teachers involved in the study were older than 35 years and nearly 40% self-identified as white. Regarding classroom experience, approximately 15% had been working for less than 5 years as teachers and 41.3% had been teaching for more than 16 years. Most teachers earned up to five minimum wages[6].

Table 1.4 – Teachers' characteristics

	3rd grade		5th grade		7th grade		9th grade	
Variables	Obs.	Mean	Obs.	Mean	Obs.	Mean	Obs.	Mean
Teacher gender: male	164	8.50%	171	15.80%	173	39.30%	171	42.10%
Teacher age: less than 35 years	165	27.30%	172	28.50%	174	34.50%	172	29.70%
Teacher age: 36 to 50 years	165	55.20%	172	56.40%	174	50.60%	172	51.70%
Teacher gender: older than 51 years	165	17.60%	172	15.10%	174	13.80%	172	18.00%
Teacher race: white	165	44.20%	172	43.00%	174	38.50%	172	41.90%
Teacher experience: up to 5 years	165	18.20%	172	15.70%	174	16.10%	172	14.50%
Teacher experience: 6 to 15 years	165	43.60%	172	41.90%	174	50.60%	172	48.30%
Teacher experience: more than 16 years	165	38.20%	172	41.30%	174	32.80%	172	37.20%
Teacher wage: 3 to 4 minimum wages	165	24.80%	172	26.70%	174	20.70%	172	20.90%
Teacher wage: 4 to 5 minimum wages	165	28.50%	172	36.00%	174	25.30%	172	25.60%
Teacher wage: 5 to 6 minimum wages	165	10.90%	172	16.30%	174	21.80%	172	27.90%
Teacher wage: more than 6 minimum wages	165	6.70%	172	8.10%	174	13.20%	172	9.90%

1.5 Results

1.5.1 Financial literacy

The literature on financial education suggests a theory of change in which formal knowledge is an intermediate outcome and changes in attitudes and behavior are the final outcome. Accordingly, the discussion of the results begins with the effect of the program on knowledge, here referred to as financial literacy.

Financial literacy was calculated based on students' answers to the corresponding questionnaire, using the IRT (Item Response Theory). According to this theory, proficiency is a latent trait and a set of questions (items) is the instrument used to measure proficiency. Each question is accounted for based on the level of difficulty, creating an invariant measurement scale of the latent trait that is comparable among the grades and over time. The results were estimated by taking into consideration the standardized literacy rate and, therefore, the treatment effect was presented as standard deviation (SD). The use of the standardized rate prevents the analysis from being scale-sensitive and thus comparable between grades and with other studies.

Table 1.5 shows the intent-to-treat (ITT) effects for all students and separately by cycles and grades. The pooled effect suggests that the program had an effect on eligible students of 0.07 of a SD and the point estimate is statistically significant at 5%. When the program effect is

[6] The minimum wage in 2015 was R$ 788, corresponding to approximately US$ 422 (using 2015 Purchasing Power Parities- PPP, World Bank, International Comparison Program database). Five minimum wages corresponded to approximately US$ 2,111.

estimated by cycle, one can see that the pooled effect is driven by the effect on the second cycle (middle school students). The coefficient is 0.1 of a SD and statistically significant at 5%, while the estimated effect for the first cycle is smaller and statistically insignificant.

Columns 4 to 7 show the ITT for each grade. The results confirm that the positive effect of the program was limited to 7th and 9th graders, especially among the latter.

Table 1.5 – Financial literacy intent-to-treat effect

Variables	Pooled (1)	1st cycle (2)	2nd cycle (3)	3rd grade (4)	5th grade (5)	7th grade (6)	9th grade (7)
Treatment	0.0724**	0.0455	0.0965**	0.0492	0.0406	0.0900*	0.107*
	(0.0354)	(0.0421)	(0.0409)	(0.0719)	(0.0433)	(0.0477)	(0.0558)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	14,655	7,641	7,014	3,635	4,006	3,640	3,374
R-squared	0.154	0.149	0.182	0.127	0.173	0.208	0.168

Note: Clustered standard errors at school level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 1.7 shows the pooled intent to treatment effect as well as the effect at 20 different points along the financial literacy distribution. The solid black horizontal line stands for an ITT of 0.07 SD. Each point represents the effect in a given quantile. The graph shows the effect estimated between the 5th and 95th percentiles of knowledge distribution. It is worth noting that the point estimates were slightly larger than the ITT in a large part of the distribution, although the difference is not statistically significant in any case.

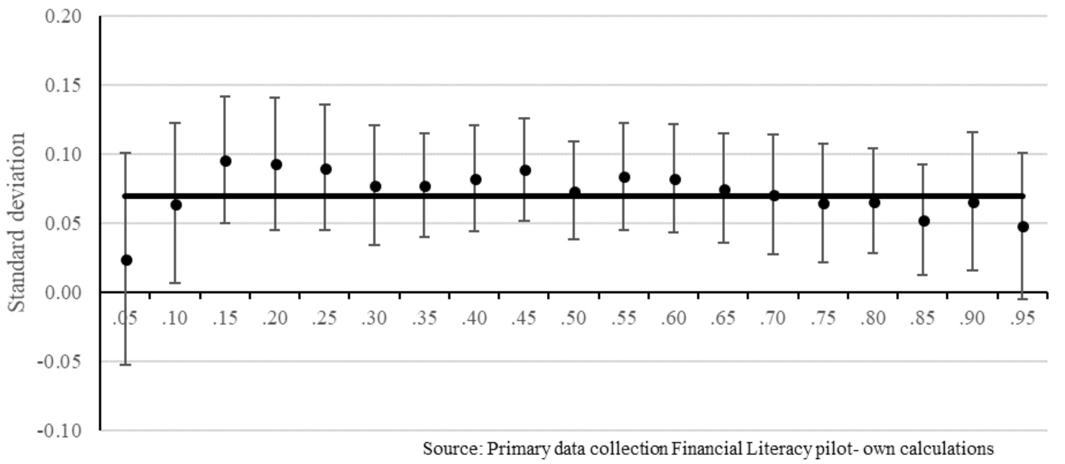


Figure 1.7 – Financial literacy- intent-to-treat effect and quantile intent-to-treat effect, pooled– 95%CI

Figure 1.8 displays the effect of the pilot study on the first cycle (3rd and 5th grades). While ITT is statistically equal to zero (the solid black horizontal line is on the x axis as ITT was not statistically different from zero), the quantile effects are positive and significant between the 45th and the 95th percentiles, being close to 0.13 of a SD at the top of the distribution. In other words, the program had a positive effect only in the upper tail of the knowledge distribution.

This result should be viewed with caution. It only shows that knowledge distribution among treated students was higher than that of control students in the upper tail only. That does not mean, however, that the program affected only the best students in the 3rd and 5th grades, nor

does it mean that the program benefited more the 50% top students. That said, it is interesting to note that the figure reveals that the program did affect some elementary school students

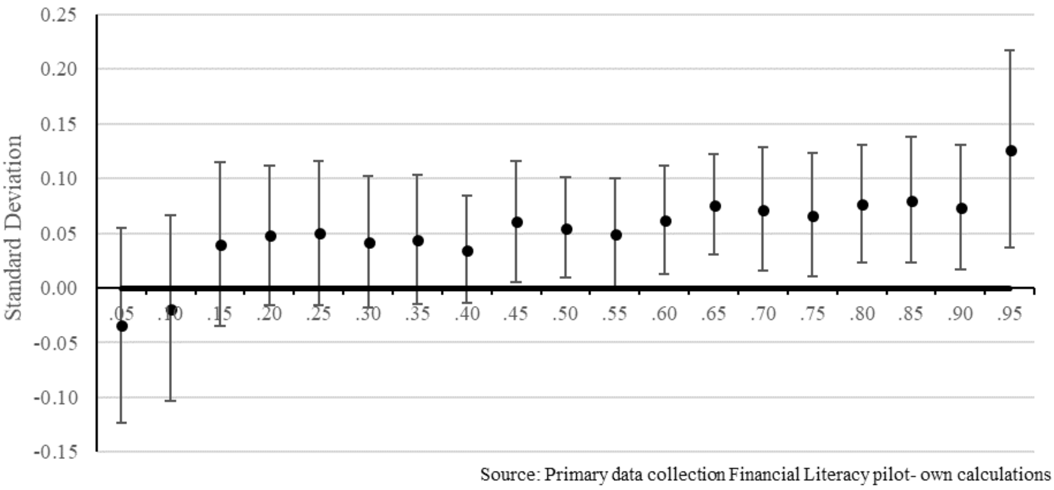


Figure 1.8 – Financial literacy- intent-to-treat effect and quantile intent-to-treat effect, first cycle – 95%CI

The effect on the second cycle is illustrated in Figure 1.9. As a matter of fact, the program seems to have been more effective in the second cycle of elementary school. This may be due to a maturity effect, but also to the way the program was implemented in the different cycles. It should also be noted that, although the quantile effects were not statistically different from ITT, the estimated points were higher than the average effect in the lower tail of the knowledge distribution. In the first decile of the distribution, for instance, the effect corresponded to 0.17 of a SD. The figures suggest that the program had a very heterogeneous effect along the knowledge distribution.

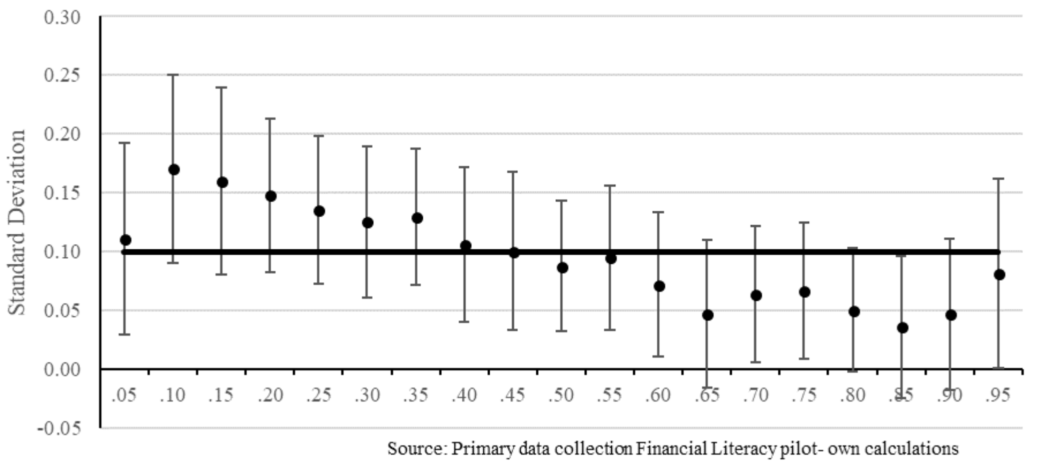


Figure 1.9 – Financial literacy- intent-to-treat effect and quantile intent-to-treat effect, second cycle – 95%CI

1.5.2 Consumption and saving attitudes

This subsection describes the effect of the pilot study on attitudes associated with consumption and saving decisions. An attitudinal index was developed for consumption and another one for savings. Both indices were computed based on the answers given by students to some of the questions in the questionnaire on financial attitudes and habits.

The development of consumption and saving indices relied on hypothetical decisions based on the students' choice of an answer among four options (I totally agree, I agree, I disagree, I totally disagree). The answers were classified on a scale from 1 to 4, where 4 represented the most responsible financial behavior. Table 1.15 in Appendix 1.A shows the questions used to assess consumption and saving and how the answer options were classified in each case. For each student, the answers about consumption or saving were synthesized using the principal component analysis. This method summarizes, in orthogonal indices, information (variables) that is highly correlated and that helps explain the same phenomenon.

1.5.2.1 Consumption attitudinal index

Table 1.6 shows the results for consumption attitudes taking into consideration all grades together, first and second cycles and the grades separately[7]. Results show that students have what is regarded as 'better attitudes' toward consumption in both cycles. The estimated increase in consumption attitude was 0.09 of a SD for all grades combined, 0.12 of a SD for the first cycle and 0.08 of a SD for the second cycle, indicating that students reported more conscious and sensible consumption attitudes. The estimates for each grade separately are showed in columns 5 to 6. The ITT for 5th graders was identical to that of the first cycle (0.12) since consumption attitude was not computed for the 3rd grade. The ITT for 7th and 9th graders were 0.08 and 0.09 of a SD respectively, indicating that students in all grades reported better consumption attitudes.

Table 1.6 – Consumption index intent-to-treat effect

	Pooled	1st cycle	2nd cycle	5th grade	7th grade	9th grade
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.0940***	0.122***	0.0823***	0.122***	0.0796*	0.0840**
	(0.026)	(0.0417)	(0.0305)	(0.0417)	(0.041)	(0.0372)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	10,220	3,648	6,572	3,648	3,409	3,163
R-squared	0.089	0.119	0.076	0.119	0.1	0.055

Note: Clustered standard errors at school level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

1.5.2.2 Saving index

The results for the saving index are displayed in Table 1.7. In general, it seems that the program is less likely to affect saving behaviors. The overall average effect of the pilot study on saving behavior was 0.05 of a SD and is statistically significant at 10%. However, when the analysis was broken down into elementary school cycles, only the ITT effect on the first cycle was statistically significant. While ITT was positive in the second cycle, it was not statistically different from zero. The analysis per grade reveals that the lack of effect on the second cycle.

[7] Owing to the characteristics of the research instruments for the 3rd grade, the variables used to construct the index are not available for this grade. Thus, the first cycle corresponds to the 5th grade only.

Table 1.7 – Saving index intent-to-treat effect

Variables	Pooled (1)	1^{st} cycle (2)	2^{nd} cycle (3)	5^{th} grade (4)	7^{th} grade (5)	9^{th} grade (6)
Treatment	0.0545**	0.0869**	0.044	0.0869**	0.0656	0.0177
	(0.0249)	(0.0412)	(0.0279)	(0.0412)	(0.0398)	(0.0383)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	10,022	3,549	6,473	3,549	3,368	3,105
R-squared	0.046	0.096	0.025	0.096	0.032	0.019

Note: Clustered standard errors at school level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

1.6 Heterogeneous effects on financial literacy and consumption and saving behaviors

This section assesses the effect of the pilot study on subgroups in order to shed some light upon the focus of the program – which groups benefited most from the pilot study – and upon its implementation. Thus, the purpose is to have a better idea about the mechanisms behind the estimation of the causal effects of the program. Even though the sample is balanced by gender and maternal education and coefficients can thus be read as average causal effect of the program, the results concerning program targeting and possible scale-up should be viewed with caution.

First, the analysis should determine whether the impact of the pilot study differed among boys and girls in general and in each elementary school cycle separately. Thereafter, we verify whether the average effect of the pilot study differed according to the level of education (schooling) of students' mothers. Third, the effects were estimated for poverty status (proxied by participation in the Brazilian CCT). Finally, the information about the quality of implementation of the program in schools – the percentage of the syllabus covered in the classroom – was used to check whether the effects on learning and attitudes could have been influenced by the quality of the program's implementation.

Girls vs Boys

To determine whether the effect of the program differed among boys and girls, we estimated the regression model for each group separately. The estimates of the effect of financial literacy, consumption and saving index are in Table 1.8.

The first panel in Table 1.8 shows the ITT for financial literacy of girls and boys separately. For the pooled estimation, it seems that boys benefited more from the program than girls. However, when cycles are considered, girls apparently benefited most from the pilot study in elementary school cycle, while boys did so in middle school. It should be highlighted that the difference between the point estimates for boys and girls is not statistically significant. This finding is consistent with the available evidence worldwide.

Regarding financial literacy proficiency, it is important to check whether the average effect of consumption and savings is heterogeneous. In fact, the program seemed to improve the self-reported consumption attitudes for girls and boys, since the impact was positive and significant in both groups (0.12 of a SD for girls and 0.06 of a SD for boys). Table 1.8 suggests that only boys seem to have benefited in the first cycle. In the second cycle, the effect of the program seems to have been positive for both girls and boys. As for financial literacy, the difference between the

Table 1.8 – Intent-to-treat effect in general and per cycle - per gender

	Pooled		1st cycle		2nd cycle	
	Girls	Boys	Girls	Boys	Girls	Boys
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Financial Literacy						
Treatment	0.0602	0.0855**	0.0519	0.0254	0.0761*	0.120**
	(0.0384)	(0.042)	(0.0487)	(0.0535)	(0.0438)	(0.0491)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	5.427	5.306	1,906	1,960	3,521	3,346
R-squared	0.182	0.163	0.202	0.156	0.193	0.186
Consumption Index						
Treatment	0.0603**	0.121***	0.0562	0.174***	0.0696*	0.0914**
	(0.0293)	(0.0349)	(0.0478)	(0.0531)	(0.0354)	(0.0436)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	5,140	4,971	1,794	1,796	3,346	3,175
R-squared	0.087	0.096	0.122	0.123	0.071	0.086
Saving Index						
Treatment	0.0743**	0.0289	0.113**	0.0577	0.0631*	0.0189
	(0.0295)	(0.0343)	(.0486)	(0.057)	(0.0337)	(0.0408)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	5,045	4,877	1,743	1,758	3,302	3,119
R-squared	0.047	0.048	0.099	0.098	0.026	0.025

Note: Clustered standard errors at school level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

effects for boys and girls was not statistically significant.

The positive results obtained for savings appear to be influenced by the effect observed among girls. Table 1.8 demonstrates that the result obtained for girls was positive and statistically different from zero, whereas for boys, the result was not statistically different from zero. The effect observed for girls in the total sample (0.07 of a SD) was influenced by the result obtained for the first cycle.

Unfortunately, there is no information available in the database that allows to check if this could be related, for example, to a higher participation of girls in household financial decisions. Data from the 2014 Brazilian National Household Survey (PNAD) show that the rate of girls aged less than 16 years engaged in domestic chores is way higher than that of boys, who tend to work outside the home earlier. Some of the domestic chores possibly involve decisions about the allocation of financial resources, such as purchases at supermarkets, bakeries, among others, and that might perhaps raise girls' awareness of good consumption and saving decisions.

Maternal education

The maternal level of education or schooling is a variable with large explanatory power in human capital empirical models. This variable helps elucidate parents' decisions about investments in the education of their children and, consequently, about the long-term outcomes these children will have in school and in the labor market (BEHRMAN, 1997; HECKMAN; CARNEIRO, 2003; CURRIE; MORETTI, 2003).

Maternal education can have a direct and indirect effect on children. Better-educated mothers may have greater clarity on the importance of human capital investments in children

since infancy and possess more accurate information about the returns on this investment. We refer to this direct effect as inductive effect. On the other hand, mothers can have an indirect and unintentional effect on children. If they are well informed and used to reading and studying in the presence of their children, this may prompt children to mirror their parents' behavior. This indirect effect is designated as demonstration effect.

For the sake of analysis, we split maternal education into three groups: incomplete elementary education, complete elementary education, and at least complete high school education. Table 1.9 shows ITT of financial literacy of children from mothers with different levels of education.

The result is quite revealing and suggests that the effect of the program was stronger among children with better-educated mothers. The ITT was approximately 0.09 SD among students with mothers who finished at least high school education.

According to the results above, the program appears to have been more effective in the second cycle, especially among students with better-educated mothers. The average effect on the first cycle was virtually zero. However, the average effect on the first cycle concealed a lot of heterogeneity along the financial literacy distribution, as elucidated by both the quantile treatment effect and the analysis of heterogeneity.

The pattern observed in the results for the consumption attitudinal index was quite similar (Table 1.9). The positive effects prevailed among students with better-educated mothers. The average effect of 0.2 SD in the first cycle for students whose mothers had poor schooling was noteworthy.

Table 1.9 – Intent-to-treat effect in general and per cycle-maternal education

Variables	Pooled			1st cycle			2nd cycle		
	Less than element. school	Element school	High school	Less than element. school	Element school	High school	Less than element. school	Element school	High school
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Financial Literacy									
Treatment	0.0647	0.0387	0.0877**	0.117	-0.11	0.101*	0.026	0.136*	0.0898**
	(0.0551)	(0.0629)	(0.0389)	(0.0762)	(0.0857)	(0.053)	(0.0608)	(0.0701)	(0.0436)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1,996	1,543	4,423	669	479	1,454	1,327	1,064	2,969
R-squared	0.159	0.16	0.181	0.18	0.159	0.193	0.157	0.173	0.195
Consumption Index									
Treatment	0.0825	0.0875	0.0918***	0.198**	0.128	0.107*	0.0266	0.0811	0.0866**
	(0.0518)	(0.0599)	(0.0334)	(0.0798)	(0.118)	(0.0575)	(0.0627)	(0.0645)	(0.0389)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1,854	1,440	4,193	604	432	1,365	1,250	1,008	2,828
R-squared	0.095	0.092	0.09	0.152	0.129	0.123	0.073	0.066	0.079
Saving Index									
Treatment	0.118**	-0.00877	0.0392	0.192**	0.0777	0.0778	0.0883	-0.036	0.021
	(0.0493)	(0.0513)	(0.0334)	(0.0887)	(0.0949)	(0.0596)	(0.057)	(0.0576)	(0.0387)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1,805	1,440	4,107	589	421	1,314	1,216	1,019	2,793
R-squared	0.039	0.038	0.057	0.073	0.087	0.117	0.024	0.021	0.032

Note: Clustered standard errors at school level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Saving attitudes present a totally different picture. Positive and statistically significant results were observed exclusively among students with poorly educated mothers. This may be due to the fact that such families are relatively more economically disadvantaged and, consequently, have to make ends meet on a daily basis. Unfortunately, we cannot conclude from the collected data whether such attitudes cause consistent changes in behavior, but available evidence suggests that, owing to the mental stress of having to allocate meager resources to various activities, more economically underprivileged individuals can even have good intentions, but they eventually move away from optimal investment decisions (MANI et al., 2013).

Bolsa Família

Table 1.10 shows results for poor and non-poor students, i.e., beneficiaries and non-beneficiaries of Bolsa Família. The pooled ITT estimate on financial literacy is significant only for the poor. In middle school, the ITT is positive for both groups though larger for beneficiaries. The ITT estimates on the consumption attitudinal index are systematically larger for the poor, although the coefficients are not statistically different between the two groups. It is interesting to note that the ITT on saving attitudinal index is statistically significant only for poor students attending middle school.

Table 1.10 – Intent-to-treat effect in general and per cycle - Bolsa Família

Variables	Pooled		1st cycle		2nd cycle	
	Non-beneficiary	Beneficiary	Non-beneficiary	Beneficiary	Non-beneficiary	Beneficiary
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Literacy						
Treatment	0.0625	0.0921**	0.0514	0.057	0.0776*	0.129***
	(0.0379)	(0.0414)	(0.0423)	(0.0568)	(0.0437)	(0.0492)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	7,596	5,214	3,475	2,509	4,121	2,705
R-squared	0.156	0.037	0.146	0.07	0.191	0.032
Consumption Index						
Treatment	0.0776***	0.108***	0.110**	0.123**	0.0661**	0.102**
	(0.0281)	(0.0373)	(0.0479)	(0.0591)	(0.0332)	(0.0458)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	5,911	4,155	1,983	1,602	3,928	2,553
R-squared	0.093	0.027	0.129	0.043	0.081	0.019
Saving Index						
Treatment	0.0512*	0.0612*	0.106**	0.0607	0.0296	0.0732*
	(0.0298)	(0.0346)	(0.0524)	(0.055)	(0.0344)	(0.0395)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	5,796	4,076	1,938	1,551	3,858	2,525
R-squared	0.048	0.017	0.098	0.053	0.028	0.004

Note: Clustered standard errors at school level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Quality of implementation

The following analysis seeks to shed some light upon the mechanism that underlies the observed effects. The aim of this section is to test the theory of change and to check the importance of the quality of implementation of the program for the outcomes of interest. This exercise is very enlightening as it avoids hasty conclusions that a given intervention did not have the expected effect when, in fact, the program was not carried out as planned.

In order to explore the importance of the program's implementation to the outcomes of interest, we used a variable that informs the percentage of syllabus (use of the teaching material) covered during the school year. As discussed earlier, the material was delivered somewhat late at the treated schools, which eventually hindered the exposure to the program and, consequently, the intensity of treatment. Furthermore, approximately one-third of teachers claimed they had covered at most 60% of the syllabus.

Based on this information, the sample was organized into three groups: control, treatment with up to 60% of the syllabus covered, and treatment with more than 60% of the syllabus covered. Thus, we redefined the dummy treatment variable such that, in the first case, it assumed value 1 if up to 60% of the syllabus had been covered and zero otherwise (original control group). In the second case, the dummy treatment variable had value 1 if more than 60% of the syllabus had been covered and zero otherwise (control). It should be emphasized that, unlike the previous analyses, the effects reported in what follows are not subject to causal interpretation. The financial literacy results are shown in Table 1.11.

Table 1.11 – Intent-to-treat effect in general and per cycle-quality of implementation

	Pooled		1st cycle		2nd cycle	
	Up to 60%	>60%	Up to 60%	>60%	Up to 60%	>60%
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Financial Literacy						
Treatment	0.0383	0.0876**	-0.0205	0.0679	0.0283	0.135***
	(0.0516)	(0.039)	(0.0668)	(0.046)	(0.0564)	(0.0444)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	9,566	12,456	4,809	6,665	4,757	5,791
R-squared	0.16	0.153	0.162	0.149	0.18	0.188
Consumption Index						
Treatment	0.0995***	0.0916***	0.137**	0.119***	0.0755*	0.0868**
	(0.0361)	(0.0288)	(0.0631)	(0.0446)	(0.041)	(0.0346)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	6,699	8,640	2,235	3,225	4,464	5,415
R-squared	0.089	0.087	0.118	0.119	0.076	0.075
Saving Index						
Treatment	0.0524	0.0557**	0.0771	0.0900*	0.0492	0.0427
	(0.0375)	(0.0272)	(0.0498)	(0.0468)	(0.0422)	(0.03)
Strata F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	6,554	8,464	2,157	3,122	4,397	5,342
R-squared	0.044	0.047	0.106	0.095	0.023	0.025

Note: Clustered standard errors at school level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.11 indicates the importance of implementation. The effect for financial literacy was null and quite inaccurate (high variance) when syllabus coverage was less than 60%. While the difference between the coefficients associated with the syllabus coverage was not statistically significant, the effect was positive and statistically different from zero only when the teachers managed to cover more than 60% of the syllabus. Again, the ITT seemed to be stronger in the second cycle.

The figures show that the effect of an intervention depends essentially on the quality of implementation. In case this information had not been collected, one could conclude that the intervention was not effective when, in fact, it was more effective for some groups than for others and, seemingly, that the program was far more effective when well implemented.

The estimated average effect per quality of implementation for consumption was always positive and significant, even for those groups of students with syllabus coverage under 60%. Finally, Table 1.11 shows positive results for saving attitudes even for those groups of students with syllabus coverage below 60%. However, the results were significant only for the whole sample and for the first cycle in the cases in which more than 60% of the syllabus was covered. The overall effect for the groups of students with more than 60% of syllabus coverage was 0.05 SD, and 0.08 SD for the first cycle. Syllabus coverage appeared to be less relevant for saving outcomes in the second cycle since the results for students with high and low syllabus coverage were similar.

1.7 Conclusion

This study assessed the effect of the pilot project for financial education implemented among elementary school students. The pilot project involved around 18,000 students from 200 local schools in Manaus and Joinville. Results suggest that the program had a positive impact on financial knowledge and attitudes towards consumption and saving. The average effect was slightly lower than 0.1 SD for financial literacy, around 0.05 SD for consumption attitudes and 0.06 for saving attitudes. Although these figures suggest a relatively negligible effect, the magnitude obtained for financial literacy was similar to the one observed in other programs.

In addition, a high level of heterogeneity was found between the groups. The effect on students in the first cycle was stronger in the upper tail of the knowledge distribution. For instance, the effect of the program on financial literacy was considerably higher in the second elementary school cycle, especially when at least 60% of the syllabus was covered during the school year. Furthermore, it should be noted that maternal education was an important factor concerning the effects on financial literacy and consumption attitudes.

In summary, results suggest that (a) the efficiency of the program depends on more careful implementation and (b) the method for teaching financial education to younger students should perhaps be reconsidered. In this respect, taken together, the results have direct implications for the targeting of the program in an eventual extension thereof.

1.A Appendix A

Table 1.12 – Pretreatment balancing teste with administrative data at school level

	Joinville		Manaus		Overall Sample	
Variables	Beta	Obs.[1]	Beta	Obs.[1]	Beta	Obs.[1]
% teachers in 1^{st} to 5^{th} grade with tertiary education	0	70	0.864	100	0.508	170
% teachers in 6^{th} to 9^{th} grade with tertiary education	-1.101	51	-0.357	91	-0.624*	142
Age grade distortion- 3^{rd} grade (2013)	-2.335	66	-2.057**	100	-2.167***	166
Age grade distortion- 5^{th} grade (2013)	-1.865*	68	3.73	100	1.465	168
Age grade distortion- 7^{th} grade (2013)	-2.697	51	-0.92	90	-1.563*	141
Age grade distortion- 9^{th} grade (2013)	-2.532	50	3.312	89	1.21	139
Promotion rate 7^{th} grade (2009)	-1.307	45	2.502	70	1.009	115
Promotion rate 9^{th} grade (2009)	-0.811	45	-2.884**	70	-2.071**	115
Promotion rate 7^{th} grade (2011)	-0.534	51	-0.685	77	-0.625	128
Promotion rate 9^{th} grade (2011)	-0.473	51	-2.651	76	-1.776*	127
Promotion rate 7^{th} grade (2013)	-1.036	51	-0.677	86	-0.81	137
Promotion rate 9^{th} grade (2013)	-0.479	51	0.00465	86	-0.175	137
Promotion rate 3^{rd} grade (2009)	1.746	60	1.811	82	1.784	142
Promotion rate 5^{th} grade (2009)	0.535	60	-0.0412	82	0.203	142
Promotion rate 3^{rd} grade (2011)	0.652	61	-0.0204	88	0.254	149
Promotion rate 5^{th} grade (2011)	0.495	62	-2.247	88	-1.118	150
Promotion rate 3^{rd} grade (2013)	0.368	59	0.256	97	0.298	156
Promotion rate 5^{th} grade (2013)	0.928	60	-2.826	97	-1.396	157
Prova Brasil Math Test score 9^{th} grade (2009)	-7.531	45	-0.00191	69	-2.976	114
Prova Brasil Reading Test score 9^{th} grade (2009)	-2.115	45	1.401	69	0.0118	114
Prova Brasil Math Test score 9^{th} grade (2011)	-3.408	51	0.413	74	-1.146	125
Prova Brasil Reading Test score 9^{th} grade (2011)	-6.517	51	-2.004*	74	-3.846	125
Prova Brasil Math Test score 9^{th} grade (2013)	-4.268	51	-2.551	85	-3.195	136
Prova Brasil Reading Test score 9^{th} grade (2013)	-2.87	51	-0.708	85	-1.519	136
Prova Brasil Math Test score 5^{th} grade (2009)	-4.807	59	0.719	79	-1.645	138
Prova Brasil Reading Test score 5^{th} grade (2009)	-2.941	59	-0.043	79	-1.283	138
Prova Brasil Math Test score 5^{th} grade (2011)	-5.587	62	-0.477	86	-2.614	148
Prova Brasil Reading Test score 5^{th} grade (2011)	-3.85	62	1.195	86	-0.915	148
Prova Brasil Math Test score 5^{th} grade (2013)	-3.036	59	0.74	97	-0.683	156
Prova Brasil Reading Test score 5^{th} grade (2013)	-3.218	59	0.434	97	-0.943	156
IDEB 9^{th} grade (2009)	-0.18	45	0.059	69	-0.0353	114
IDEB 9^{th} grade (2011)	-0.204	51	-0.0153	74	-0.0925	125
IDEB 9^{th} grade (2013)	-0.159	51	-0.0272	85	-0.0768	136
IDEB 5^{th} grade (2009)	-0.0776	59	0.00637	79	-0.0296	138
IDEB 5^{th} grade (2011)	-0.138	62	0.0164	86	-0.0483	148
IDEB 5^{th} grade (2013)	-0.123	59	-0.0306	97	-0.0655	156

[1] Since the table uses administrative data, we do not always have information about all the selected schools.
Note: Clustered standard errors at school level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.13 – Balance test at student level - by cycle

Variables	Total Beta/ (s.d.)	Total Obs.	1st cycle Beta/ (s.d.)	1st cycle Obs.	2nd cycle Beta/ (s.d.)	2nd cycle Obs.
Test Participation						
Blank test score	-0.0061	18,557	-0.0142	9,405	0.00354	9,152
	(0.0117)		(0.0144)		(0.0186)	
Blank socioeconomic questionnaire	-0.00989	13,882			-0.00178	9,127
	(0.0144)				(0.0189)	
Household characteristics						
Student age is appropriate to the grade	-0.00684	12,689	-0.00829	5,889	-0.00543	6,800
	(0.0124)		(0.0149)		(0.0192)	
Student household is in a paved street	-0.00862	12,896	-0.0106	6,012	-0.00569	6,884
	(0.0150)		(0.0220)		(0.0203)	
Student household has electric power	-0.00282	12,832	-0.00092	5,940	-0.0043	6,892
	(0.0035)		(0.0056)		(0.0043)	
Student household has piped water	-0.000369	12,895	0.000287	5,996	-0.0007	6,899
	(0.0044)		(0.0067)		(0.0057)	
Student household has garbage collection	0.0117	12,787	-0.00166	5,920	0.0236*	6,867
	(0.0096)		(0.0128)		(0.0135)	
Student household is Bolsa Familia beneficiary	-0.00578	12,834	-0.00735	6,004	-0.004	6,830
	(0.0105)		(0.0150)		(0.0141)	
Students characteristics						
Student gender: male	-0.00318	10,740			0.0016	6,871
	(0.0104)				(0.0125)	
Student color: with	-0.0169	10,610			-0.0152	6,777
	(0.0113)				(0.0126)	
Mother education: did not finish elementary school	-0.00166	7,968			0.00321	5,363
	(0.0126)				(0.0153)	
Mother education: did not finish high school	-0.00578	7,968			-0.0116	5,363
	(0.0101)				(0.0126)	
Mother education: high school or attended college	0.00744	7,968			0.00844	5,363
	(0.0154)				(0.0190)	

Note: Clustered standard errors at school level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.14 – Balance test at student level- by grades

Variables	3rd grade Beta/ (s.d.)	3rd grade Obs.	5th grade Beta/ (s.d.)	5th grade Obs.	7th grade Beta/ (s.d.)	7th grade Obs.	9th grade Beta/ (s.d.)	9th grade Obs.
Test Participation								
Blank test score	-0.0151 (0.0219)	4,650	-0.0112 (0.0173)	4,755	-0.0153 (0.0256)	4,697	0.0229 (0.0269)	4,455
Blank socioeconomic questionnaire	- -	-	-0.0253 (0.0210)	4,755	-0.0149 (0.0254)	4,697	0.0117 (0.0279)	4,430
Did not return socioeconomic questionnaire	-0.0155 (0.0312)	4,579	- -	-	- -	-	- -	-
Household characteristics								
Student age is appropriate to the grade	-0.0191 (0.0205)	2,035	-0.00023 (0.0193)	3,854	-0.00501 (0.0277)	3,562	-0.00532 (0.0263)	3,238
Student household is in a paved street	-0.00837 (0.0345)	2,115	-0.00974 (0.0279)	3,897	-0.0162 (0.0293)	3,606	0.00664 (0.0280)	3,278
Student household has electric power	-0.00571 (0.0046)	2,046	0.00316 (0.0080)	3,894	-0.00015 (0.0062)	3,603	-0.00879 (0.0056)	3,289
Student household has piped water	-0.00751 (0.0118)	2,083	0.00395 (0.0081)	3,913	0.00246 (0.0081)	3,614	-0.00399 (0.0081)	3,285
Student household has garbage collection	0.0118 (0.0217)	2,052	-0.00669 (0.0148)	3,868	0.0341 (0.0212)	3,590	0.0125 (0.0155)	3,277
Student household is Bolsa Familia beneficiary	0.0136 (0.0241)	2,141	-0.0206 (0.0180)	3,863	0.0246 (0.0178)	3,578	-0.0348* (0.0207)	3,252

continue

Continuation - Balance test at student level - by grades

	3rd grade		5th grade		7th grade		9th grade	
Variables	Beta/ (s.d.)	Obs.	Beta/ (s.d.)	Obs.	Beta/ (s.d.)	Obs.	Beta/ (s.d.)	Obs.
Students characteristics								
Student gender: male	-	-	-0.0124	3,869	0.000151	3,597	0.00121	3,274
	-		(0.0183)		(0.0172)		(0.0175)	
Student color: with	-	-	-0.0215	3,833	-0.0217	3,558	-0.00796	3,219
	-		(0.0217)		(0.0166)		(0.0190)	
Mother education: did not finish elementary school	-	-	-0.0117	2,605	0.0175	2,664	-0.0126	2,699
	-		(0.0219)		(0.0220)		(0.0208)	
Mother education: did not finish high school	-	-	0.00642	2,605	-0.0381*	2,664	0.0147	2,699
	-		(0.0162)		(0.0195)		(0.0159)	
Mother education: high school or attended college	-	-	0.00533	2,605	0.0205	2,664	-0.00219	2,699
	-		(0.0254)		(0.0288)		(0.0246)	
Legal guardian age: less than 20 years	0.0149**	2,030	-	-	-	-	-	-
	(0.0069)		-		-		-	
Legal guardian age: 21 to 59 years	-0.0147*	2,030	-	-	-	-	-	-
	(0.0084)		-		-		-	
Legal guardian age: more than 60 years	-0.00019	2,030	-	-	-	-	-	-
	(0.0056)		-		-		-	
Legal guardian education: did not finish elementary school	0.0289	2,131	-	-	-	-	-	-
	(0.0259)		-		-		-	
Legal guardian education: did not finish high school	-0.0002	2,131	-	-	-	-	-	-
	(0.0200)		-		-		-	
Legal guardian education: high school or attended college	-0.0287	2,131	-	-	-	-	-	-
	(0.0317)		-		-		-	
Legal guardian occupation: formal labor market	-0.015	2,083	-	-	-	-	-	-
	(0.0220)		-		-		-	
Legal guardian occupation: informal labor market	-0.00793	2,083	-	-	-	-	-	-
	(0.0232)		-		-		-	
Legal guardian occupation: unemployed	-0.00849	2,083	-	-	-	-	-	-
	(0.0175)		-		-		-	

Note: Clustered standard errors at school level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.15 – Consumption and saving index

Statement	Answers' scale				Weight in index
	Totally agree	Agree	Disagree	Totally disagree	
Consumption questions					
I buy what I want, then I see how I can pay	1	2	3	4	0.45
I see no problem in owing money	1	2	3	4	0.44
If the brand is famous the product is of high quality	1	2	3	4	0.32
The best product is always the most expensive	1	2	3	4	0.33
I plan before spending my money.	4	3	2	1	0.1
It is worthless to plan because money comes by luck.	1	2	3	4	0.43
Buy what I want is more important than have planning	1	2	3	4	0.45
Saving questions					
I think that saving money is important to avoid problems in the future.	4	3	2	1	0.41
I feel safer when I can save some money.	4	3	2	1	0.39
Saving some money is important to avoid debt	4	3	2	1	0.42
Buying everything I want is more important than putting the money together.	1	2	3	4	0.24
Avoiding waste is also a way to save money.	4	3	2	1	0.38
I try to use the products for longer.	4	3	2	1	0.35
Whenever I can, I save money.	4	3	2	1	0.37
I would rather spend the change on something I want than save the money for later.	1	2	3	4	0.19

Chapter II
Health at Birth, short-run health effects and educational outcomes

2 Health at Birth, short-run health effects and educational outcomes

Abstract

This paper estimates the effects of birth weight on health and educational outcomes for Brazil using a twin fixed effect approach. The recent literature, mainly based on data from developed countries, has provided evidence that health at birth is a critical factor for outcomes related to health and to cognition. Using a matching of administrative records of birth and school enrollment we aim to provide this type of evidence for Brazil. The main finding is that birth weight matters. For instance, there is evidence that a 10% increase in weight is associated with a 0.6% increase in Apgar, a score for health at birth. In the educational dimension, the findings suggest that a 10% increase in birth weight is associated with a 6% increase in the chances of completing high school by the age of 17 and with a 3.6% decrease in the probability of repeating a grade. Furthermore, estimates provide evidence that parents tend to reinforce, rather than compensate, the negative effects of adverse initial health conditions. Larger effects are found for the infants with low birth weight, limited access to basic health care services, lower maternal education and enrolled at schools of lower socioeconomic status.

Keywords: health at birth, parental response, health effects, educational outcomes.

2.1 Introduction

Health at birth, mainly measured by birth weight, has been for a long time a primary concern in the literature on economic development, mainly because of the high prevalence of low birth weight infants in developing countries and the strong association between poor neonatal health and infant mortality (UNICEF; WHO, 2004; ALMOND; CHAY; LEE, 2005; OREOPOULOS et al., 2008). A growing body of economic and medical literature, however, has stressed that poor health at birth can have short-run and long-lasting effects on health, cognitive and non-cognitive development (BLACK; DEVEREUX; SALVANES, 2007; NILSSON, 2017; LARROQUE et al., 2001; SANZ-CORTES et al., 2014). Moreover, initial endowments and early life investments have been associated with the perpetuation of lower socioeconomic status (CURRIE, 2011; HECKMAN; MOSSO, 2014). Because of data availability, most of the studies assessing the enduring consequences of poor health at birth have provided evidence for developed countries. This paper contributes to the literature by presenting additional evidence of the effects of birth weight on health and educational outcomes for children in Brazil, a developing country.

The literature investigating the effects of birth weight on newborn health frequently uses the Apgar score, an index which, in order to evaluate health at birth, assesses five vital signs one and five minutes after birth, and survival in the first year of life. Several studies have confirmed the effects of birth weight on these outcomes (ALMOND; CHAY; LEE, 2005; BLACK; DEVEREUX; SALVANES, 2007; BHARADWAJ; LøKEN; NEILSON, 2013; CARRILLO; FERES, 2017). Particularly for Brazil, Carrillo e Feres (2017) estimate that a 1% increase in birth weight lead to a 1.6% reduction in infant mortality. The effect is much higher than the one estimated for developed

countries[1], suggesting that poor health at birth may have severer impacts in developing contexts. Likewise, the estimated effects of birth weight on Apgar scores presented in this paper is twice larger than the effects found by Black, Devereux e Salvanes (2007) for Norway. In addition to direct impacts on children's well-being, poor health at birth is also associated with higher hospital costs, which are incurred by society as a whole (ALMOND; CHAY; LEE, 2005).

Moreover, it is well documented that the impacts of bad health at birth can last throughout schooling and adult life. Exploring a discontinuity design that assigns special medical care to very low birth weight newborns (less than 1500g), Bharadwaj, Løken e Neilson (2013) and Breining et al. (2015) found that early life health interventions have positive impacts on test scores in elementary school. Furthermore, Figlio et al. (2014) and Bharadwaj, Eberhard e Neilson (2018) present evidence that the gap in academical achievement, explained by birth weight differences between twins, is persistent and does not fade in higher grades. Also using twins weight differences, Black, Devereux e Salvanes (2007) show that low birth weight infants present worse long-run outcomes, such as lower high school completion rate and worse labor market outcomes, including earnings. Nilsson (2017) indicates that newborns with compromised health because of *in-utero* exposition to alcohol are associated with lower cognitive and non-cognitive ability as well as with worse labor market outcomes.

Most of the estimation of the impacts of health at birth consists of seeking to separate the effect of birth weight itself from parental characteristics and investments made during life. After all, maternal background characteristics and even genetic factors associated with the birth weight may also play a critical role in determining a child's health and educational outcomes. In order to address this omitted variable bias issue, a twin fixed effect (TFE) identification strategy has been widely used instead of the Ordinary Least Square (OLS) estimations. The OLS estimator confounds the direct effects of health at birth with parental investments, whereas looking at the variation within twins - by using the TFE identification strategy - captures the effect that can be attributed only to the health shock. Bharadwaj, Eberhard e Neilson (2018) presents a theoretical model that supports the notion that the differences between OLS and TFE estimators can be attributed to the role of parental investment.

Parental investment can be positively or negatively correlated with a child's initial adverse shock - e.g. being born with low birth weight. If the response of parents is positively correlated with the shock, their behavior is considered as reinforcing the effect of the initial adverse situation. On the other hand, if the response is negatively correlated with the shock, it is seen as a compensating behavior. Within families, parents reinforce or compensate a child's initial shock according to their degree of aversion to inequality among children. If parents allocate more resources to the infant with better health, they reinforce the effect of the initial shock, increasing the outcome gaps between children. In contrast, more parental investments in the lower birth weight newborn reveal a response that counters the initial shock, by attempting to mitigate or reduce the dissimilarity among the infants (ALMOND; MAZUMDER, 2013; BHARADWAJ; EBERHARD; NEILSON, 2018).

This paper uses two rich administrative records for birth (System of Information on Live-Born Infants-SINASC) and school attendance (School Census) so as to produce evidence of the effects of birth weight through life for Brazil. Using the date of birth, municipality of birth, gender and municipality of residence as a child identifier, 17% of all births in Brazil from 1999 to 2006

[1] Almond, Chay e Lee (2005) found that for the USA the increase in 1% in birth-weight is associated with a 0.51% decrease in infant mortality, while Black, Devereux e Salvanes (2007) provide evidence that this elasticity is -0.83 in Norway

were successfully matched to the schooling records. Although the birth register data available is not restricted to the years between 1999 and 2006, these cohorts were chosen to ensure a minimal quality of birth records while observing children in at least half of the mandatory schooling years (6 years for the cohorts born in 2006). Regarding the variables of interest, the birth register provides information on birth weight and Apgar scores (measurement of newborn health) while repetition, dropout and age-grade distortion rates for ages 7 to 16 and high school completion are outcomes provided by school records.

The Apgar score is a measure of health at birth consolidated in the literature (ALMOND; CHAY; LEE, 2005; BLACK; DEVEREUX; SALVANES, 2007). It assesses five vital signs - heart rate, respiratory effort, reflex irritability, muscle tone and skin color - of a newborn and is a critical information, for example, in the decision to use resuscitation methods in certain circumstances (APGAR, 1953). Created in 1953, the Apgar measurement has been widely used in hospitals as part of neonatal care protocols (EHRENSTEIN, 2009). In the educational sphere, high school completion is an outcome frequently used in the literature as a measure of schooling accumulation (BLACK; DEVEREUX; SALVANES, 2007; NILSSON, 2017). Other educational outcomes, however, are not widely used, test score being the main educational outcome of interest in this literature. Despite the data availability of scores from large-scale assessment tests in Brazil, the data structure does not allow the linkage with birth records. Barros (2017) argues that in the absence of a measure of cognitive achievement, grade retention confounds the effect of low academic performance with lack of motivation and student engagement. On the other hand, there is no consensus in the literature about the impact of retention itself on academic and motivational results. While some have found evidence that repeating a grade improves future achievement (JACOB; LEFGREN, 2004; SCHWERDT; WEST; WINTERS, 2017), others argue that repetition is not associated with better achievement and may cause demotivation, increasing the chances of school dropout (EREN; DEPEW; BARNES, 2017; BARROS, 2017). Furthermore, these effects can be context-dependent: retention in a country or a region can have effects different from those identified in another one (IKEDA; GARCíA, 2014). Although providing a consolidated understanding of the positive or negative effects of repetition is beyond the scope of this paper, it is important to shed light on the relation between grade retention, dropout, and educational outcomes, especially for the Brazilian context.

According to PISA Key Findings Report (OECD, 2016), Brazil is the country with the second largest grade retention rate, only behind Colombia. Nevertheless, according to the 2017 School Census, 29.45%[2] of schools in Brazil organize the elementary school (1st to 9th grade) in cycles within which students have automatic grade promotion[3]. Concerning the profile of the students more vulnerable to repetition, PISA 2015 findings state that, across OECD countries, even after accounting for students' previous educational performance and self-reported motivation, socioeconomically disadvantaged students and males are more likely to have repeated a grade. Similarly, Soares et al. (2015) show that the following groups are more likely to drop out of school in Brazil: boys, students with a prior history of grade repetition, students with low academic

[2] Own calculations.The share does not vary significantly across years, it is 30.6% in 2014 and 25.60% in 2009.

[3] States, municipalities and private schools can have their own rules for student promotion/retention. Even so, it is known that the most common way of organizing cycles are: 1st to 3rd grade, 4th to 5th grade and 6th to 9th grade. A school that organizes the 1st to 9th grade in cycles does not necessarily follows the aforementioned classification, nor does the school need to organize all grades in cycles. Whatever the cycle composition is, in case of insufficient achievement, the retention occurs in the last grade of the cycle.

achievement and little engagement in school activities.

Using the richness of the administrative data for Brazil, the main contribution of this paper is threefold: (i) to estimate the effects of birth weight on Apgar score and educational outcomes using a twin fixed effect identification strategy; (ii) to compare the OLS and TFE estimations, providing evidence on parental reinforcing behavior; (iii) to show that birth weight impacts are different across socioeconomic groups.

Regarding the first contribution, we estimate the effects of birth weight on short-run health outcomes, the Apgar scores, and on educational outcomes - the repetition, dropout, and age-grade distortion rates -, using Ordinary Least Squares (OLS) and twin fixed effect (TFE) estimators. As these are probably the first estimates of this type for Brazil, this paper contributes to the literature by focusing on a developing country and by providing evidence on Brazil's need of public policies that mitigate the effects of initial inequalities that can last through adulthood.

Following the theoretical framework proposed by Bharadwaj, Eberhard e Neilson (2018), under the assumption that parents can not fully differentiate investments within twins, the second contribution consists of empirical evidence suggesting that parents act reinforcing the effect of low weight at birth, particularly with respect to educational outcomes. Parental behavior reinforcing initial endowments was also found by Adhvaryu e Nyshadham (2016) in Tanzania, whereas Bharadwaj, Eberhard e Neilson (2018) find evidence of parental compensating behavior in Chile.

The third contribution is to provide evidence of differential impact across socioeconomic groups. The impacts of birth weight on the Apgar score, the grade retention rate and the age-grade distortion are much less relevant for children of highly educated mothers and for the ones attending schools with better socioeconomic status. The effects are either zero or smaller than the ones observed for children with a disadvantaged background. These results contrast remarkably with the evidence of stability in the effects of birth weight on educational outcomes across demographic and socioeconomic groups found by Figlio et al. (2014), Black, Devereux e Salvanes (2005), Bharadwaj, Eberhard e Neilson (2018).

The remaining of the paper is organized as follows. In Section 2.2, the main causes of low birth weight are discussed, especially in the context of a twin pregnancy. The medical channels that may justify differences in future development following birth weight differences are presented, along with details on the Apgar score and its computation. Section 2.3 introduces the two datasets used and presents the matching algorithm and the matching rates; it also displays the main descriptive statistics. Section 2.4 describes the theoretical framework and the empirical approach used. Section 2.5 shows the results and discusses the heterogeneous effects. Section 2.6 presents the final remarks.

2.2 Background: Health at Birth, Weight and Apgar Score

Birth weight is a central measure of health at birth, and the occurrence of low birth weight is highly correlated with adverse neonatal outcomes. Low birth weight is defined by the World Health Organization (WHO) as weight below 2500g at birth (UNICEF; WHO, 2004). Medical literature lists two causes for a baby's low birth weight: premature birth and intrauterine growth restriction (IUGR). Premature birth occurs before 37 weeks of gestation. Since much of a baby's weight is gained during late pregnancy, an early birth means less time in the mother's uterus to grow and gain weight. IUGR refers to a fetal growth rate fetus below the limits considered normal for the population. There are three sources of IUGR: (i) placental dysfunctions that include

placental insufficiency and abnormal cord insertions, (ii) maternal health, including inadequate nutrition, smoking or drug use habits, (iii) fetal conditions such as anomalies and multiple pregnancy (UNICEF; WHO, 2004; KRAMER, 1987). Preterm birth and IUGR are situations that can occur together or separately, which means that not all babies born before 37 weeks is growth restricted and that a baby born at term (after 37 weeks) might present growth below its potential[4].

In a twin pregnancy, gestational length is the same for both babies, so that birth weight discordance [5] among twins arises solely due to differences in intrauterine growth. It is well established in medical literature that during gestation, twins have a growth curve different from singletons and that differences arise mainly in the third trimester of pregnancy (TOWNSEND; KHALIL, 2018; KIBEL et al., 2017). In addition to the differentiated growth curve, weight discordance and IUGR among twin siblings arise solely due to placental factors, since maternal health and fetal conditions (not considering situations of congenital anomalies) are held constant for twins (PAEPE et al., 2010; CAMBIASO et al., 2016; KIBEL et al., 2017).

Twin pregnancies are distinguished by whether the twins are identical (monozygotic) or fraternal (dizygotic) and by whether they share the same placenta (monochorionic) or have one placenta for each (dichorionic). Fraternal twins are always dichorionic (DC) meaning that each fetus has one placenta. According to Laventhal e Treadwell (2018), two-thirds of identical twins are monochorionic (MC). Chorionicity rather than zygosity is the key factor determining pregnancy characteristics and risks. MC pregnancies present a higher risk of stillbirth, growth restrictions and perinatal loss (TOWNSEND; KHALIL, 2018; LAVENTHAL; TREADWELL, 2018; DUBE; DODDS; ARMSON, 2002). For both types of twin pregnancies, the placental aberrant characteristics and type of cord insertion play an essential role in determining growth discordance among twins and also IUGR. Specifically for DC twins, Kibel et al. (2017) argues that the main cause of growth restriction is the non-central umbilical cord insertion rather than other placental pathologies.

Whatever may be the cause for a particular situation of low birthweight and IUGR, this condition is associated in medical literature with fetal and neonatal mortality, neonatal abnormal neurobehaviour, worse cognitive outcomes, and chronic diseases in later life (UNICEF; WHO, 2004; LARROQUE et al., 2001; SANZ-CORTES et al., 2014; CRUZ-MARTINEZ et al., 2009). The exact biological mechanisms explaining the worse short and long-term outcomes of growth-restricted babies are not yet clearly determined in medical literature. Nevertheless, there is evidence that the structure and the functions of the brain in IUGR babies are different from the ones observed in non-restricted babies. Notably, medical research has found differences in the frontal area of the brain -which is related with instinctual behaviour, attention and impulsiveness (CRUZ-MARTINEZ et al., 2009)-; in brain stem, which is important for motor and sensory systems; as well as in the cerebellum, which plays a central role in motor control and in the performance of tasks such as memory, attention and language (SANZ-CORTES et al., 2014)

This paper uses birth weight discordance among dichorionic (DC) twins to estimate the

[4] It is important to highlight that IUGR and "small for gestational age" (SGA), other definition frequently used in the medical literature, are different conditions. SGA is defined as a birth weight lower than the 10th centile. However, a SGA baby can be, in fact, genetically and constitutionally small, though well-nourished and healthy, presenting no growth restrictions. Considering an average growth curve, being either SGA or born with less than 2500g is considered a proxy for having IUGR.

[5] Discordant growth here does not necessarily refer to the selective fetus growth restriction (sFGR) but instead to any differences in birth weight among twins. sFGR is increasing risk factor in twins pregnancy, strongly correlated with the incidence of IUGR in a twin pregnancy. For a review of the definitions of selective growth restriction see Blickstein e Kalish (2003).

impacts of birth weight on health and educational outcomes. The matching algorithm used to link birth records to school register requires the twins to be of opposite gender, hence creating a sample exclusively with DC twins (we present more details on the matching in section 2.3). Following the available medical literature, we assume that among twins weight differences arise only due to placental factors, e.g., the type of umbilical cord insertion, which an exogenous factor, not related with any intrinsic characteristics of the babies. Moreover, material characteristics are held constant when looking at variations within twins.

Another important measure of newborn health is the Apgar score. It was created in 1953 by Dr. Virginia Apgar and rates five vital signs: heart rate, respiratory effort, reflex irritability, muscle tone and skin color, in 0, 1 or 2 whether these signs are absent or present, compounding a final index that varies from 0 to 10, where 10 stands for perfect newborn health. Several factors including uterus health, maternal health, fetus position, the delivery type (e.g. use of forceps), induction of labor and anesthesia can influence the Apgar score of a baby(APGAR, 1953). Worldwide, the Apgar score measured one minute after birth is used as a critical variable to decide on the use of resuscitation methods, while the five minutes score serves to evaluate the effectiveness of the resuscitation. Low Apgar score (≤ 7) is associated with neonatal mortality as well as with worse cognitive outcomes later in life (EHRENSTEIN, 2009). In our sample, 20% of the infants present one minute Apgar below this cut-off, and 4% present low five minute Apgar.

2.3 Data

This section describes the data and provides details on the merge algorithm used to link birth records to school administrative data. We also discuss the quality of birth and school records, as well as the quality of the merge and potential differences across the universe (the totality of births registered), the set of individuals that could be potentially be matched, and the final sample.

2.3.1 Birth administrative records: SINASC

The System of Information on Live-Born Infants (SINASC - *Sistema de Informações de Nascidos Vivos*) was created in 1990 by the Health Ministry of Brazil aiming to collect information on births in all municipalities, so as to support the design of health policies. Prior to the creation of SINASC, the Civil Registration instituted in 1939 was the only source of birth information. However, due to the relatively high cost of registering a child[6], the absence of a pattern for the registration, sub-registration and late registration, Civil Registration has not been considered a reliable source of information on vital events, particularly for public policy purposes. In this context, SINASC was gradually implemented by the municipalities using a unified form, the Declaration of Live Born (DNV- *Declaração de Nascido Vivo)* to collect information directly from hospitals and from Civil Registration Offices for births occurring outside a hospital (BORGES; SILVA, 2015). The microdata are publicly available at the website of the Health Ministry, starting in the year of 1994, but since 1996 it has a similar structure, which is the reason why the following analysis will focus on the period from 1996 onwards. Figure 2.1 shows the evolution over time of the total number of records (line and left-hand axis) in SINASC as well as an estimate of SINASC coverage (bar and right-hand axis)[7]. SINASC coverage increased between 1995 and 1999, reaching

6 Only on 1997 did law n°.9.534 ensure costless Civil Registration.

7 Coverage estimation from RIPSA- *Rede Interagencial de Informções para a Saúde*- available at http://tabnet.datasus.gov.br/cgi/idb2012/a17.htm.

a stable level of around 95% of coverage after 2003. The observable increase in the number of births until 1999 can be explained by the improvement in coverage, rather than by the increase in births itself. It is known that since the 1970's Brazil is experiencing a reduction in fertility rates, leading to a gradual reduction in the number of births over time (SIMõES, 2016). The reduction in the total number of births after 1999 - when coverage surpassed 90% - is a result of a reduction in fertility rates.

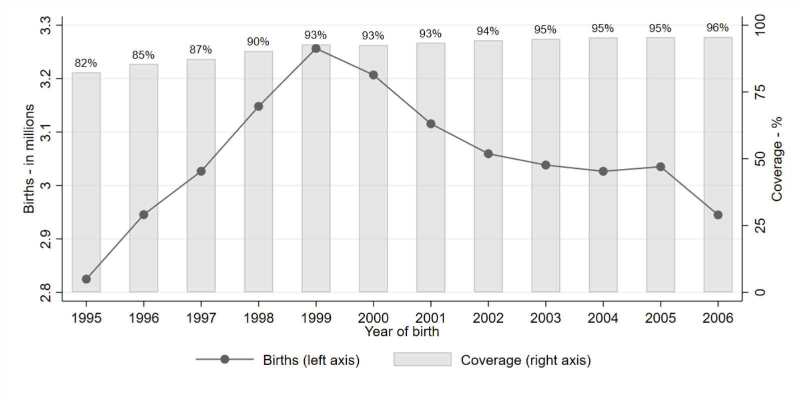


Figure 2.1 – SINASC estimated coverage and number of births registered 1996-2006

The information collected by the DNV changed over time with the inclusion of additional variables (e.g., mother's characteristics). Considering the most recent version of the form, the information collected includes mother's characteristics, gestation conditions and birth conditions. Mother's characteristics available in the public dataset are: age, education, marital status, number of previous births and municipality of residence. Gestation conditions include the number of prenatal visits, gestation length, and an indicator of the type of birth (single or multiple). Birth conditions include municipality and place of birth (home or hospital), date of birth, baby's gender and race, birth weight and Apgar score. Figure 2.2 depicts the share of missing information registered in a few key variables across years. Data quality improved significantly after 2000, as expressed by the reduction of missing values in these variables. Therefore, this paper will focus on the cohorts born between 1999 and 2006. Although the data quality is not so high for 1999, this cohort is of particular interest when linked with the educational record because students born in this year are eligible to complete high school in 2016, allowing the inclusion of high school completion as a relevant outcome.

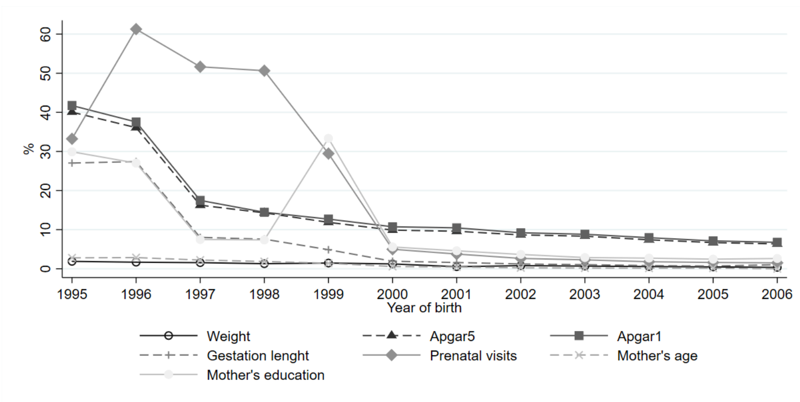


Figure 2.2 – Number of births registered in SINASC 1996-2006

In case of multiple births, SINASC data do not identify individuals who are the twins, neither provides information on the zygosity of the twins. However, in the dataset entries for twins are close to each other, displaying identical mother, gestational characteristics and date of birth. Using these facts, it is possible to create an algorithm that matches the twin siblings[8]. Out of all double pregnancies registered, 68% had both siblings identified using the algorithm.

In short, SINASC data provide information on health at birth - measured by birth weight and Apgar at 1 and 5 minutes -, in addition to prenatal, gestational and maternal characters. As discussed in Section 2.2 Apgar scores are a measure of health at birth that can be affected by birth weight as well as by birth circumstances. In order to explain how birth weight impacts on Apgar scores, the measurements at 1 and 5 minutes will be outcome variables. Yet these scores will also be treated as explanatory variables when educational outcomes are analyzed.

2.3.2 School enrollment records: School Census

The School Census is an administrative record created by INEP (Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira), a department of the Brazilian Ministry of Education. Prior to 2007, the data was collected at school level, aggregating information of students and teachers. Since 2007 it encompasses four interconnected datasets at school, class, student and teacher levels. Schools report the information to INEP every year, in the last week of May.

The School Census does not use the civil IDs/registers available in Brazil as identifiers, neither are these fields mandatory for students' registration. Instead, the Census uses a student code created by INEP for this purpose. Using the student code, it is possible to link each of the Census's cross sections creating a panel of students from 2007 to 2017. The panel contains information on school and grade of enrollment in each year, in addition to individual characteristics like gender, date and municipality of birth, municipality of residence, etc.

Despite the increasing quality of the registers of the School Census, inconsistencies[9] can happen when the student moves to a new school that does the registration under a new ID (student code). It is possible to clean these duplicates to some extent, by adding identifiers other than the student code, such as students' and parents' names. However, for confidentiality reasons, public datasets do not contain names, nor the non-mandatory IDs (when the school filled it in), making the process of cleaning the duplicates of individuals unfeasible without additional information. Section 2.3.3 discuss how SINASC information can be used to clean some of these duplicated registers.

[8] Unfortunately, the time of birth is available in SINASC only since 2006, so that this information was not used for matching the twin siblings. Births that occurred around midnight, for which the day of birth of each twin is different, were not captured by the algorithm. Expanding the algorithm to match lines with equal maternal and gestational characteristics within one day of difference in date of birth leads to few additional matched siblings, whereas most of them linked twins that already have a matched sibling born on the same day. In order to avoid matching wrong siblings, the most conservative algorithm was used, which means that neither the flexibilization of the day of birth, nor slight differences in maternal and gestational characteristics were allowed.

[9] Another kind of inconsistency is that there are students enrolled at different schools and even in different grades in regular education at the same Census' cross-section. This probably happens when a student changes schools and the previous school keeps reporting the student. Furthermore, the previous school could not have approved the student for the subsequent grade but the student changes to a new school that promotes the student. This fact explains how the same student code can be at different grades in a given year. For data cleaning purposes, if a student appears in a given year t of the School Census in a new school but also in the school he/she was enrolled in *t-1*, the information of the new school is considered as correct. That happens with less than 1% of students per year.

Figure 2.3 compares the estimated total number of students born in each year according to school register (dark grey line) with the amount of births in SINASC, correcting the observable number of births in Figure 2.1 by the estimated coverage also depicted in Figure 2.1 (light grey line). Considering that school coverage in Brazil is high[10] and that some mortality occurs, the number of registered students is expected to be smaller than the number of infants born in each year (schools registers include only Brazilian natives). However, as can be seen in Figure 2.3, the panel of students contains a higher number of students registered than births, confirming the existence of duplicates.

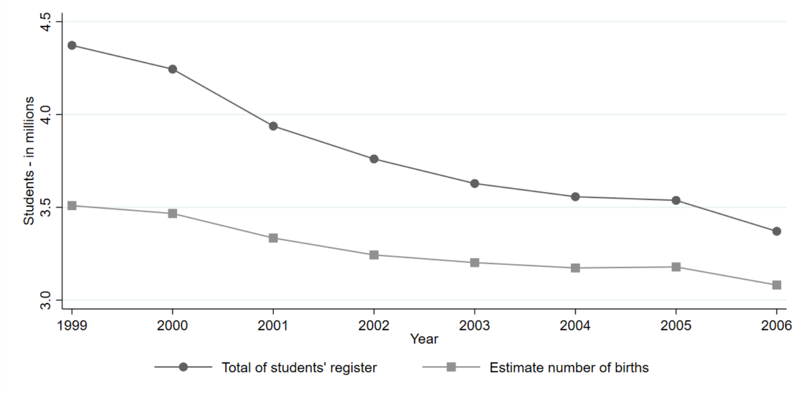


Figure 2.3 – Number of students registered in School Census from 2007 to 2017 according to year of birth- cohorts 1996-2006

Even taking into account these inconsistencies, the panel of students created using the School Census from 2007 to 2017 (using student code) is a reliable source of information of grade promotion, repetition, and age-grade distortion rates. To create promotion/repetition rates by year, it is sufficient to observe the student in two subsequent years. For age-grade distortion rates, only grade and age are needed, which are both mandatory and reliable information. In contrast, the panel does not provide a reasonable estimate for dropout rates. The aforementioned inconsistencies can lead to a misestimation of school dropout since the absence of a student code in a given year might mean either data inconsistency or dropout[11]. Therefore, the outcome variables obtained from the School Census panel are:

- *Repetition at a specific year/age*: grade repetition occurs at year t (age g) when a student is enrolled in year t (age g) at the same grade k of enrolment at year $t-1$ (age $g-1$). Also, a variable of grade repetition overall is considered: it assumes value 1 when at least one of the specific year/age repetition variables is 1, and zero otherwise.

- *Dropout at a specific year/age*: a dropout occurs at year t (age g) when the student does not appear in the School Census in year t (age g) and the last register occurred in year

[10] 97.7% of the population of 6 to 14 years old is at school and 84.3% of the population of 15 to 17 years old. See http://www.observatoriodopne.org.br/metas-pne/2-ensino-fundamental and http://www.observatoriodopne.org.br/metas-pne/3-ensino-medio for more details.

[11] It is important to notice that, in order to clean duplicates when computing official promotion, repetition and dropout rates, INEP uses the available additional confidential identifiers and a dataset sent by schools at the end of the academic year containing student's final situation. Both sets of information are not publicly available. For more information see: http://download.inep.gov.br/informacoes_estatisticas/indicadores_educacionais/2007_2016/nota_tecnica_taxas_transicao_2007_2016.pdf.

$t - i$ (age $g - i$), $i >= 1$, at grade k, $k < 12$ ($k = 12$ implies high school completion), and in the next register in year $t + n$ (age $g + n$), $n >= 1$, the student is enrolled in grade $k + 1$ (assuming grade promotion before dropping out) or k (assuming the student was not promoted before dropping out). A variable of overall dropout assumes value 1 when at least one of the specific year/age dropout variables is 1.

- *Age-grade distortion at specific year/age*: considering grade k and the adequate age d for that grade, age-grade distortion occurs when the student enrolled at year t (age g) at grade k is $d + 2$ years old or more. Adequate age for 1^{st} graders is 6 years, for 2^{nd} grades 7 years, and so on, until 17 years for the 12^{th} grade. Overall age-grade distortion assumes value 1 when the student is older than the adequate age at any grade. Age-grade distortion is an accumulative variable: once a student is older than expected in grade k, this will persist through the following grades.

- *Non-cumulative age-grade distortion at specific year/age*: the non-accumulative age-grade distortion assumes values 1 at year t (age g) if it is the first year(age) in which the student became older than the adequate for the current grade. This variable assumes value 1 at every new event (repetition or return to school after dropout) that creates an additional year of distortion.

- *High-school completion*: students born in 1999 and 2000 are able to complete high school in 2016 or 2017, since they will be 18 and 17 years old in 2017, respectively. For these two specific cohorts, high school completion assumes value 1, for students born in 1999, if the student is enrolled in grade 12 in 2016 or 2017 (17 or 18 years old); for those born in 2000, the variable takes value 1 if the student is enrolled in the 12^{th} grade in 2017 (17 years old). Due to the cohort composition, this variable has the smallest sample size.

Section 2.3.4 presents descriptive statistics of these outcomes for the overall population as well as to the final merged sample.

2.3.3 Merge algorithm

Data from SINASC and School Census are merged using the date of birth, municipality of birth, gender and municipality of residence, which are variables present in both administrative registers. The first three variables are more precise, since are mandatory information in the two datasets and are not affected by migration. Hence, the merge is implemented in two rounds, the first of which considers the date of birth, municipality of birth and gender as identifiers. The second round adds municipality of residence for the observations that were not matched. The municipality of residence is used as ID only when it is constant over time in the School Census, showing that the student has not moved to a new city of residence. SINASC data from 1999 to 2006 are merged with a panel of students created using the School Census from 2007 to 2017.

Assuming that SINASC can be under-reported and is less likely to have duplicated entries compared to the School Census, the merge algorithm searches in the panel of students only the uniquely identified births. Therefore, the algorithm has five steps. The first step selects the uniquely identified births in SINASC according to round 1 and round 2 criteria. Next, the second step performs a merge using round 1 criteria assuming that more than one student in the School Census is associated with each entry in SINASC, either because SINASC is under-reported (and so the entry is in truth not uniquely identified) or because the panel of students has duplicates.

The third step uses the successfully merged observations in round 1 to eliminate the duplicates of the panel of students. The SINASC identifiers are a source of additional information that allows to distinguish between two situations in the School Census. In the first kind of situation, two or more students' codes with consistent educational information are matched to the same individual in SINASC. Having consistent information over time means that each student code appears in several years of the School Census with a logical and consistent sequence of grades and schools. These cases can happen due to SINASC underreporting, so that it is assumed that the students are not uniquely identified and thus they are not considered in the final sample. The second kind of situation is the identification of duplicates in the panel of students. As in the first case, a unique individual from SINASC is linked to more than one student code. However, these codes seem to refer to the same individual, since the data are fragments that, put together, form a consistent educational history. Therefore, student codes that always appear in alternate years or that appear once simultaneously in a maximum of two schools in the same year are considered to refer to the same individual (i.e. student codes alternates in all years except for a specific year, in which the two codes are registered in a school)[12].

The fourth step performs a new merge using round 2 IDs for those observations in the panel of students that were not matched in round 1. The fifth and last step cleans the duplicates of round 2. Steps four and five use the same procedures and hypotheses of steps two and three. A combination of successfully merged observations in round 1 and round 2 generates the final merged dataset.

Table 2.1 shows the number of observations in SINASC from 1999 to 2006 and how many of them are uniquely identified by either of the criteria (round 1 or round 2). Almost 30% of all entries in SINASC[13] are births uniquely identified using the date of birth, municipality of birth, gender and municipality of residence. When merging the birth information with the panel of students using these IDs, 59% of the students uniquely identified are successfully matched, resulting in a sample of more than 4 million students[14]. The share of uniquely identified students matched is considered satisfactory compared to other studies[15]. Only 6.2% of matched twin siblings are uniquely identified because the identification of twins requires that siblings to be of opposite genders (one boy and one girl), so that they can be differentiated from each other in the School Census. Hence, out of the total of uniquely identified twin siblings matched, 39.9% are merged with the panel of students.

The second panel of Table 2.1 shows the merge results from the perspective of the School Census, including an estimate for the share of duplicated entries. In the first line, where the totals are displayed, one can see that out of more than 30 million registers, around 10 million were uniquely identified. A total of, 4,899,676 records were successfully matched to birth records (not necessarily are uniquely identified). However, part of these records (12%) were duplicated entries of the same individual. After the duplicate cleaning process, these matched records were reduced to 4,306,170 observations. Assuming that the share of duplicated registers (12%) can be applied to the totality of the Census, the second line of the panel "School Census" in Table 2.1 presents an

12 As for the case of a student code enrolled at different schools in the same year, only the new school is considered; if both schools are different from the previous, the higher grade is considered.

13 Out of those, 54,5% or 16.1% of total observations are uniquely identified according to round 1 criteria.

14 69.1% of students were matched using criteria from round 1 (the date of birth, municipality of birth, gender).

15 For instance, Figlio et al. (2014) use students' name, date of birth and social security number to match birth records with scholar records in Florida, U.S., and successfully match 79.6% of the registers.

Table 2.1 – SINASC and Scholle Census Total, Uniquely identified and matched registers total and by samples- 1999 to 2006

Sample	Total	Uniquely identified		Matched			
		Nbr.	% of total	Nbr.	% of total	% of uniquely id	% of matched
SINASC							
Total	24,682,893	7,274,976	29.5%	4,306,170	17.4%	59.2%	100.0%
Singleton	24,157,717	7,197,043	29.8%	4,268,643	17.7%	59.3%	99.1%
Twins	453,915	53,495	11.8%	29,114	6.4%	54.4%	0.7%
Twins siblings matched	293,634	18,280	6.2%	7,286	2.5%	39.9%	0.2%
Missing	71,261	24,438	34%	8,413	11.8%	34.4%	0.2%
School Census							
Total	30,407,578	10,108,545	-	4,899,676	-		
After duplicates corrections	26,724,257	8,884,080	33.2%	4,306,170	16.1%	48%	

estimate of the totals without duplicates. Correcting the duplicates, the totals in School Census and SINASC became much similar, not considering the estimations of underreporting in SINASC so far. Among all the matched records, most of them (99%) are from singletons (similar to the proportion of this group on the population, and 0.2% are twins with siblings matched. Although 0.2% percent is a smaller percentage of the total matched sample, it represents more than 7 thousand students, a considerably large sample.

Figure 2.4 and Figure 2.5 represent the geographical coverage of the matched sample. Figure 2.4 shows the percentage of births from 1999 to 2006 that are in the matched sample, according to the municipality of residence of the mother. In general, the municipalities located in the Brazilian regions known as Midwest and South have a greater share of birth of residents in the final sample. Administrative region North and a considerable part of the coast have more municipalities with a lower percentage of births in the final sample.

The place of of birth, however, might not coincide with the municipality of the school where the student is registered. Thus, Figure 2.5 presents the average of the percentage of students matched over the total number of students registered in schools in each municipality from 2007 to 2017. Two important facts can be seen in Figure 2.5. First, the percentages are, on average, lower than when considering the municipality of birth. This is because the numerator in the percentage is the number of registers matched after cleaning duplicates and the denominator is the total number of registers, regardless of duplicates. That said, one can see that the pattern of regions is very close to the geographical coverage of births: a bigger share of students in the Midwest and South regions are part of the sample, while a smaller share of students in the North and Coast is in the final sample.

2.3.4 Population versus Sample Characteristics

Table 2.2 presents the descriptive statistics of key variables from SINASC for the population and the matched sample overall and divided by birth weight below 3500g, twins and twins with sibling matched. The cut-off of 3500g was chosen to generate a sample with common support to the twin sample, as 95% of the twins in the sample weigh less than this threshold. The average birth weight is 3185 grams for the population and 3251 grams for the full matched sample, or

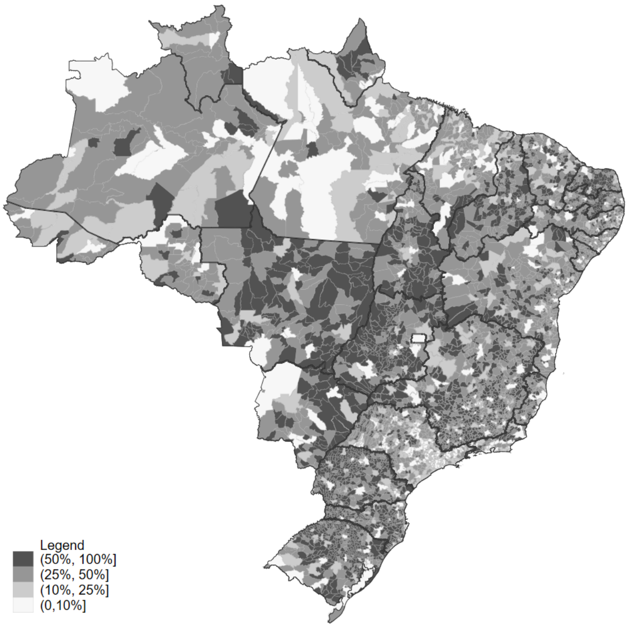


Figure 2.4 – Percentage of birth records for residents from 1999 to 2006 in the final sample

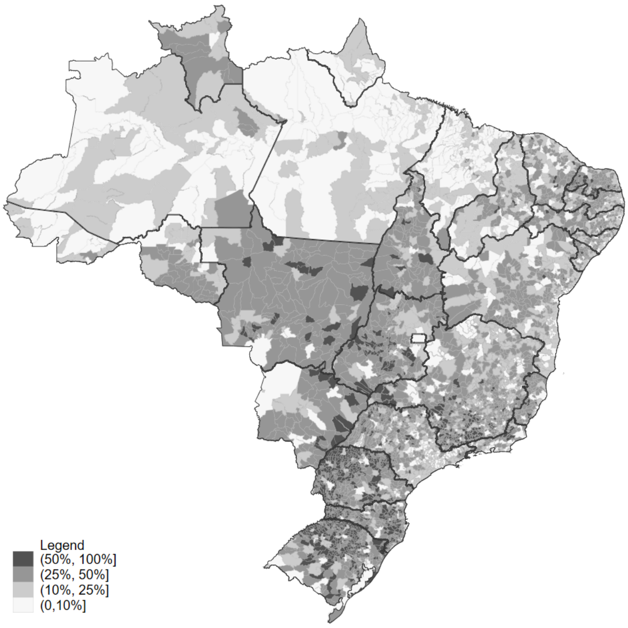


Figure 2.5 – Average percentage of students in the final sample (2007 to 2017)

2% higher than the population average. This difference, yet small, should be explained by two channels. The first is the smaller proportion of twins, which are lighter than singletons, in the matched sample compared to the population. The second and more important channel is related to neonatal and infant mortality. The lighter the baby, the higher are the chances of mortality during the first year of life, generating a sample of children that survived the first year of life, on average, heavier than the average of the totality of newborns (CARRILLO; FERES, 2017; OREOPOULOS et al., 2008; BLACK; DEVEREUX; SALVANES, 2007; UNICEF; WHO, 2004). Despite the small difference in means, Figure 2.6 shows that the distributions of birth-weight for the population, for the population of singletons, for the full matched sample and for matched singletons are quite similar.

It is known that twins are lighter than singletons (FIGLIO et al., 2014; ALMOND; CHAY; LEE, 2005; BLACK; DEVEREUX; SALVANES, 2007), which can be confirmed by the averages in Table 2.2 and by the left-shifted weight distribution for twins in Figure 2.6. Matched twins and twin siblings have a similar birth weight, with a difference of 75 grams. Looking at matched twin siblings, the main sample of interest, they are on average 678 grams (or 21%) lighter than the average of the population (and 744 grams or 23% lighter, relative to the full matched sample). The birth weight distribution of the sample with matched twin siblings is right-shifted compared to the distribution for all twin births (Figure 2.6). Again, neonatal and infant mortality partially justifies the differences in the birth weight distribution between the sample of twin siblings and the population of twins. However, other fact plays a more import role and justify the greater differences for twins compared to singletons. The sample of matched siblings has exclusively dichorionic twins, who have on average a higher birth weight than monochorionic twins, (TOWNSEND; KHALIL, 2018; PAEPE et al., 2010) who are part of the population.

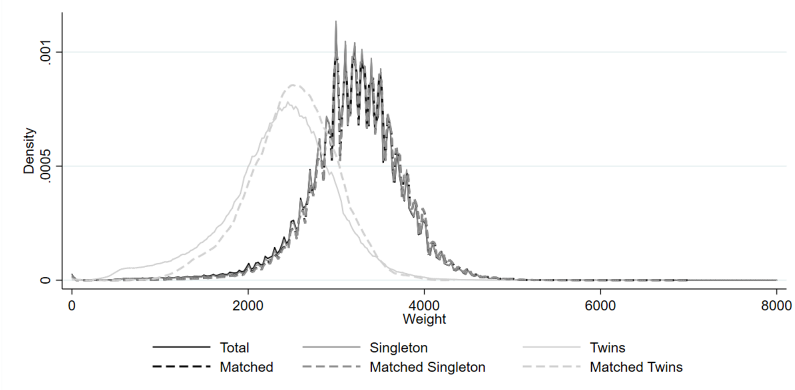


Figure 2.6 – SINASC weight distribution total observations and matched sample 1996-2006

Apgar scores display a pattern similar to birth weight: the full matched sample has slightly higher scores than the population and twins are the group with the lowest average Apgar score. All reasons that explain the differences in birth weight across groups are valid for the Apgar scores.

Almost the totality of registered births in Brazil occurred at hospitals (97%) and this percentage does not vary considerably across samples. Cesarean sections represent 40% of all births, reaching 65% in the sample of twins siblings matched. Although twin delivery represents an increased risk factor for mothers' and babies' lives (LAVENTHAL; TREADWELL, 2018), the rates of cesarean sections in both cases are high compared to an ideal rate of 10% to 15% that is being recommended by WHO since 1985 (WHO, 2015). On average, half the pregnant women have 7 or more prenatal visits, and one third have 4 to 6 visits, for the population and in the matched samples. These numbers are not high considering that the WHO recommendations until 2016 suggested a minimum number of 4 visits, while the current recommendation suggests 8 or more visits (WHO, 2016). Preterm birth (less than 37 weeks) occurs in 27% of the twin births and in 6% of births for the overall population. This fact is in accordance with the medical literature, since twin pregnancy increases the chances of preterm birth (LAVENTHAL; TREADWELL, 2018; TOWNSEND; KHALIL, 2018).

The educational characteristics indicate a sub-representation of highly-educated mothers in the matched sample, 35% of the matched babies have mothers with incomplete high school or

higher education whereas this proportion is of 45% on the population. The remaining socioeconomic characteristics show that the sample of twins with matched siblings is considerably different from the population and from the full matched sample. Mothers of twins are older on average (28 years old versus 25) for the population and in full sample, in conformity with other studies (LAVENTHAL; TREADWELL, 2018; FIGLIO et al., 2014) and a higher proportion of such mothers are married.

All these facts evidence that there are differences in the characteristics of the population, if compared to the full matched sample as well as to the twins samples. Notwithstanding, when reducing the analysis to the twin sample aiming to eliminate confounding factors of the effects of birth weight on future outcomes, one should have in mind that the gains in internal validity bring some loss of external validity, due to the particular characteristics of twins.

Table 2.2 – SINASC - Average values of variables for Total, Matched Sample, Matched Singletons and Matched Twins siblings (1999 to 2006)

Variables	Total			Full Matched Sample			Sample weight <=3500g			Matched Twins			Matched Twins siblings		
	Obs.	Mean	SD	Obs.	Mean	SD	Obs.	Mean	SD	Obs.	Mean	SD	Obs.	Mean	SD
Weight	24,490,950	3,185	553	4,261,319	3,251	511	3,065,297	3,024	388	22,729	2,582	600	7,237	2,507	489
Apgar 1 minute	22,547,534	8.09	1.41	3,836,756	8.10	1.35	2,752,662	8.10	1.36	20,127	7.73	1.61	6,672	7.81	1.47
Apgar 5 minute	22,392,457	9.18	1.15	3,798,692	9.25	1.16	2,727,878	9.24	1.16	19,872	8.93	1.36	6,645	9.03	1.14
Race															
White	21,473,712	0.53	0.50	4,007,322	0.54	0.50	2,859,171	0.55	0.50	20,969	0.53	0.50	6,730	0.58	0.49
Non white	21,473,712	0.47	0.50	4,007,322	0.46	0.50	2,859,171	0.45	0.50	20,969	0.47	0.50	6,730	0.42	0.49
Pregnancy type															
Singleton	24,611,632	0.98	0.13	4,294,681	0.99	0.08	3,060,506	0.99	0.09	22,962	0.00	0.00	7,286	0.00	0.00
Twins	24,611,632	0.02	0.13	4,294,681	0.01	0.08	3,060,506	0.01	0.09	22,962	1.00	0.00	7,286	1.00	0.00
Birth type															
Caesarean	24,577,814	0.40	0.49	4,289,745	0.35	0.48	3,058,421	0.34	0.47	22,839	0.56	0.50	7,280	0.65	0.48
Vaginal	24,577,814	0.60	0.49	4,289,745	0.65	0.48	3,058,421	0.66	0.47	22,839	0.44	0.50	7,280	0.35	0.48
Birth place															
Hospital	24,673,764	0.97	0.18	4,304,640	0.95	0.22	3,064,316	0.95	0.21	22,950	0.95	0.22	7,281	0.96	0.19
Home or other place	24,673,764	0.03	0.18	4,304,640	0.05	0.22	3,064,316	0.05	0.21	22,950	0.05	0.22	7,281	0.04	0.19
Prenatal visits															
None	23,147,428	0.04	0.19	4,073,301	0.04	0.19	2,907,700	0.04	0.19	21,555	0.04	0.21	6,950	0.03	0.17
1 to 3	23,147,428	0.10	0.30	4,073,301	0.11	0.31	2,907,700	0.11	0.32	21,555	0.11	0.32	6,950	0.09	0.29
4 to 6	23,147,428	0.34	0.47	4,073,301	0.38	0.49	2,907,700	0.38	0.49	21,555	0.37	0.48	6,950	0.36	0.48
7 or more	23,147,428	0.52	0.50	4,073,301	0.47	0.50	2,907,700	0.47	0.50	21,555	0.47	0.50	6,950	0.52	0.50
Pregnancy length															
Less than 36 weeks	24,265,933	0.06	0.24	4,245,678	0.05	0.21	3,027,637	0.06	0.24	22,324	0.26	0.44	7,156	0.27	0.44
37 to 41 weeks	24,265,933	0.92	0.28	4,245,678	0.92	0.27	3,027,637	0.91	0.28	22,324	0.71	0.45	7,156	0.72	0.45
42 or more weeks	24,265,933	0.02	0.15	4,245,678	0.03	0.17	3,027,637	0.03	0.16	22,324	0.03	0.16	7,156	0.01	0.12
Mother Age	24,580,093	24.9	6.35	4,284,685	24.6	6.38	3,051,662	24.3	6.39	22,815	27.3	6.48	7,276	28.0	6.33
Nbr. of live children	21,569,141	1.34	1.63	3,842,415	1.46	1.78	2,726,358	1.38	1.73	20,820	1.96	2.12	6,750	1.89	2.07
Mother education															
None	22,841,507	0.04	0.19	3,989,793	0.06	0.23	2,847,628	0.05	0.23	21,107	0.08	0.27	6,816	0.07	0.25
Incomplete elementary school	22,841,507	0.51	0.50	3,989,793	0.59	0.49	2,847,628	0.59	0.49	21,107	0.59	0.49	6,816	0.56	0.50
Incomplete high school	22,841,507	0.32	0.47	3,989,793	0.26	0.44	2,847,628	0.26	0.44	21,107	0.22	0.42	6,816	0.25	0.43
Complete high school or more	22,841,507	0.12	0.33	3,989,793	0.09	0.29	2,847,628	0.09	0.29	21,107	0.11	0.31	6,816	0.12	0.33
Mother marital status															
Single	22,095,956	0.46	0.50	3,898,636	0.44	0.50	2,781,608	0.44	0.50	20,710	0.39	0.49	6,672	0.35	0.48
Married	22,095,956	0.53	0.50	3,898,636	0.55	0.50	2,781,608	0.55	0.50	20,710	0.60	0.49	6,672	0.63	0.48
Divorced or Widow	22,095,956	0.01	0.10	3,898,636	0.01	0.10	2,781,608	0.01	0.10	20,710	0.01	0.12	6,672	0.02	0.12
Mother occupation															
Outside the household	16,099,207	0.32	0.47	2,931,605	0.37	0.48	2,102,741	0.36	0.48	15,074	0.41	0.49	4,996	0.42	0.49
Housewife	16,099,207	0.68	0.47	2,931,605	0.63	0.48	2,102,741	0.64	0.48	15,074	0.59	0.49	4,996	0.58	0.49

The last descriptive statistics presented come from the School Census. In fact, the existence of duplicated registers in this dataset complicates the computation of retention, dropout, age grade distortion and high school competition rates for all students. The panel of students, which ignores the existence of duplicated registers, does not generate reliable statistics. To overcome this issue, the rates are computed only for the merged sample (which accounts for duplicate cleaning) and official rates published by INEP are used to compare the population rates with the ones obtained in the sample.

Using INEP rates, published each year by grades, it is possible to recover the overall rate (repetition, dropout, and age-grade distortion) in each year. However, official rates consider all students' cohorts enrolled at a school in a given year, while the rates computed using the sample consider only students born from 1999 to 2006. Thus, looking at the School Census cross-section for example, in 2008, the oldest students present in the sample are enrolled in grade 4, or in lower grades[16]. For 2009, the sample comprises students at grade 5, or lower grades, and so on. Therefore, the overall official rates for each year were recovered taking into account the grades found in the sample. Even so, the official rate may be composed of older students and will be higher than the rates obtained using the sample. For more recent years, the sample cohorts comprise a greater part of the student population, so that the divergences between official and estimated rates tend to be smaller. Figure 2.7 confirms these facts. The divergence between official and estimates rates are expected, not actually a problem. Furthermore, they confirm that the rates computed using the sample are reliable, especially when presented by age (as in the estimations). Unfortunately, the official rates are not presented by age and the best comparison possible is the one carried out.

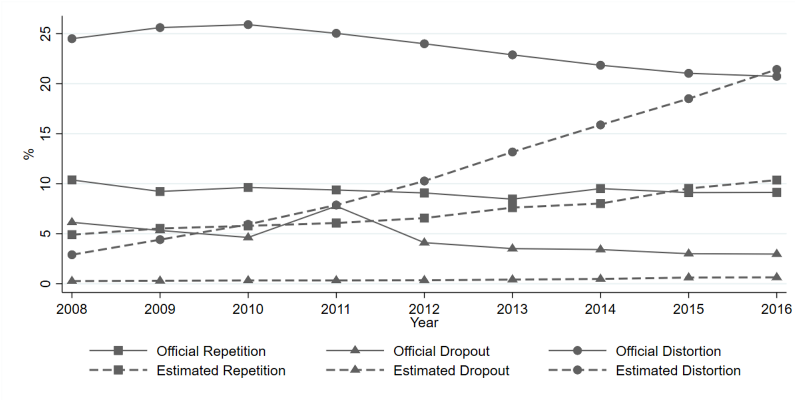


Figure 2.7 – Retention, dropout and age-grade distortion rates- using official and estimated rates- 2008-2016

Table 2.3 presents the mean rates in each sample considered. The twin sample presents some outcomes slightly higher than the other samples. For the full sample, for the sample with birth weight less than 3500g and for the one with twins with a matched sibling, 38% of the students have repeated a grade, whereas this figure is 43% in the sample of twins. The chances of repeating a grade and dropping out of school increase with age and around 40% of 16-17 year old students have completed high school.

16 They entered school at the age of 6 in 2005.

Table 2.3 – School Census - Average values of Retention, dropout age-grade distortion and high school completion rates overall and by age

	Full Matched Sample			Sample weight <=3500g			Twins Matched			Twins siblings Matched		
Variables	Obs.	Mean	SD	Obs.	Mean	SD	Obs.	Mean	SD	Obs.	Mean	SD
Repetition	4,306,170	0.38	0.49	3,065,297	0.38	0.48	26,038	0.43	0.49	7,286	0.37	0.48
At age 7	2,922,873	0.03	0.17	2,093,452	0.03	0.17	17,227	0.04	0.19	5,161	0.03	0.16
At age 8	3,660,725	0.07	0.25	2,613,115	0.07	0.25	21,828	0.08	0.28	6,340	0.07	0.26
At age 9	4,198,111	0.09	0.28	2,989,137	0.09	0.28	25,259	0.11	0.31	7,156	0.10	0.29
At age 10	4,233,455	0.09	0.29	3,013,882	0.09	0.29	25,515	0.11	0.32	7,199	0.10	0.30
At age 11	4,237,038	0.08	0.27	3,016,415	0.08	0.27	25,566	0.10	0.30	7,209	0.09	0.28
At age 12	3,678,977	0.09	0.28	2,618,076	0.08	0.28	22,614	0.10	0.30	6,096	0.09	0.28
At age 13	3,105,652	0.11	0.31	2,208,832	0.10	0.31	19,198	0.12	0.32	5,052	0.10	0.30
At age 14	2,529,068	0.12	0.33	1,793,974	0.12	0.33	15,927	0.13	0.34	4,084	0.11	0.31
At age 15	1,912,295	0.13	0.33	1,351,163	0.13	0.33	12,187	0.14	0.34	3,090	0.12	0.32
At age 16	1,289,661	0.13	0.34	907,990	0.13	0.33	8,226	0.14	0.35	2,116	0.13	0.33
Dropout	4,306,170	0.03	0.18	3,065,297	0.03	0.18	26,038	0.04	0.19	7,286	0.03	0.16
At age 7	3,215,996	0.00	0.05	2,304,046	0.00	0.05	18,958	0.00	0.05	5,599	0.00	0.04
At age 8	3,782,770	0.00	0.07	2,699,957	0.00	0.07	22,605	0.01	0.07	6,480	0.00	0.05
At age 9	4,278,069	0.00	0.07	3,045,595	0.00	0.07	25,839	0.01	0.07	7,258	0.00	0.05
At age 10	4,293,839	0.00	0.06	3,056,716	0.00	0.06	25,940	0.00	0.07	7,273	0.00	0.05
At age 11	3,738,686	0.00	0.06	2,660,391	0.00	0.06	23,046	0.00	0.07	6,186	0.00	0.05
At age 12	3,167,563	0.00	0.07	2,252,724	0.00	0.07	19,674	0.01	0.08	5,151	0.00	0.06
At age 13	2,604,368	0.01	0.07	1,847,140	0.01	0.07	16,436	0.01	0.08	4,193	0.01	0.08
At age 14	2,047,621	0.01	0.08	1,445,678	0.01	0.08	13,049	0.01	0.09	3,244	0.01	0.09
At age 15	1,477,733	0.01	0.09	1,039,496	0.01	0.09	9,462	0.01	0.09	2,349	0.01	0.08
At age 16	925,822	0.01	0.11	645,744	0.01	0.11	6,011	0.01	0.12	1,513	0.02	0.12
Age-grade distortion	4,306,170	0.29	0.45	3,065,297	0.29	0.45	26,038	0.34	0.47	7,286	0.29	0.45
At age 7	3,666,499	0.02	0.15	2,617,330	0.02	0.15	21,913	0.03	0.17	6,346	0.02	0.14
At age 8	4,177,148	0.03	0.16	2,974,593	0.03	0.16	25,165	0.03	0.18	7,133	0.03	0.16
At age 9	4,203,564	0.07	0.25	2,992,967	0.07	0.26	25,376	0.09	0.29	7,167	0.08	0.26
At age 10	4,215,511	0.12	0.33	3,001,594	0.13	0.33	25,430	0.16	0.37	7,188	0.14	0.35
At age 11	4,217,722	0.16	0.36	3,002,795	0.16	0.36	25,433	0.20	0.40	7,165	0.18	0.38
At age 12	3,662,548	0.18	0.39	2,606,303	0.19	0.39	22,516	0.23	0.42	6,060	0.21	0.40
At age 13	3,094,648	0.24	0.42	2,201,001	0.24	0.42	19,127	0.29	0.45	5,030	0.26	0.44
At age 14	2,521,942	0.27	0.45	1,788,881	0.27	0.45	15,908	0.32	0.47	4,075	0.29	0.45
At age 15	1,907,024	0.29	0.45	1,347,545	0.29	0.45	12,157	0.34	0.47	3,079	0.31	0.46
At age 16	1,287,720	0.27	0.44	906,749	0.27	0.45	8,216	0.32	0.47	2,112	0.29	0.46
Non-cumulative age grade distortion	4,306,170	0.29	0.45	3,065,297	0.29	0.45	26,038	0.34	0.47	7,286	0.29	0.45
At age 7	3,666,499	0.02	0.15	2,617,330	0.02	0.15	21,913	0.03	0.17	6,346	0.02	0.14
At age 8	4,164,643	0.02	0.15	2,965,468	0.02	0.15	25,073	0.03	0.17	7,109	0.02	0.15
At age 9	4,128,750	0.05	0.22	2,938,309	0.05	0.22	24,845	0.07	0.26	7,036	0.06	0.23
At age 10	4,006,440	0.08	0.27	2,850,001	0.08	0.27	23,824	0.10	0.31	6,798	0.09	0.29
At age 11	3,849,038	0.08	0.26	2,736,089	0.08	0.27	22,612	0.10	0.30	6,476	0.09	0.28
At age 12	3,233,686	0.08	0.27	2,297,083	0.08	0.27	19,234	0.10	0.30	5,258	0.09	0.28
At age 13	2,657,814	0.11	0.31	1,886,831	0.11	0.31	15,757	0.13	0.34	4,218	0.11	0.32
At age 14	2,521,942	0.27	0.45	1,788,881	0.27	0.45	15,908	0.32	0.47	4,075	0.29	0.45
At age 15	1,583,636	0.14	0.35	1,117,394	0.14	0.35	9,659	0.17	0.38	2,484	0.14	0.35
At age 16	1,071,126	0.12	0.33	752,809	0.12	0.33	6,559	0.15	0.36	1,722	0.13	0.34
High School completion	979,610	0.41	0.49	682,175	0.41	0.49	6,388	0.35	0.48	1,570	0.39	0.49

2.4 Conceptual Framework

This section describes the economic framework underlying the channels through which birthweight can affect short-run outcomes such as the Apgar score, as well as mid-run educational outcomes like grade retention, school dropout, and high school completion. The economic framework presents the sources of bias when using the Ordinary Least Square (OLS) estimates and shows how a twin fixed effect (TFE) estimator addresses these biases. The section dealing with the empirical framework presents the OLS and TFE models used.

2.4.1 Economic Framework

The economic framework presented next is an application of the model proposed by Bharadwaj, Eberhard e Neilson (2018). The model considers the following general production function for a child outcome (T_{ijg}), parental investments (X_{ijg}) and infant endowments (θ_{ijg}) for a child i born to mother j at age (g) who has a sibling denoted by i':

$$T_{ijg} = T(X_{ijg}, \theta_{ijg}) \tag{2.1}$$

$$X_{ijg} = f(\theta_{ijg}, \theta_{i'jg}) \tag{2.2}$$

$$\theta_{ijg} = f(\theta_{ij(g-1)}, X_{ij(g-1)}) \tag{2.3}$$

The child outcome (health or educational outcome) is a function of parental investments (X_ijg) and current endowment (θ_{ijg}). The intra-household allocation decision of parental investment depends on each child's endowments ($\theta_{ijg}, \theta_{i'jg}$) and has the characteristics of a public good, as it is subsequently discussed. Finally, children's endowments are a function of previous endowments ($\theta_{ij(g-1)}$) and of past investments ($X_{ij(g-1)}$).

An initial shock e_{ij0}, such as being born low birthweight, can only have a direct effect on the initial endowment and will affect future outcomes only through the effect it has on initial endowment. Therefore, the effects of the shock on the child and his or her sibling are:

$$\frac{dT_{ijg}}{de_{ij0}} = \frac{\partial T}{\partial X_{ijg}} \cdot \frac{\partial X_{ijg}}{\partial \theta_{ijg}} \cdot \frac{\partial \theta_{ijg}}{\partial \theta_{ij0}} \cdot \frac{\partial \theta_{ij0}}{\partial e_{ij0}} + \frac{\partial T}{\partial \theta_{ijg}} \cdot \frac{\partial \theta_{ijg}}{\partial \theta_{ij0}} \cdot \frac{\partial \theta_{ij0}}{\partial e_{ij0}} \tag{2.4}$$

$$\frac{dT_{i'jg}}{de_{ij0}} = \frac{\partial T}{\partial X_{i'jg}} \cdot \frac{\partial X_{i'jg}}{\partial \theta_{ijg}} \cdot \frac{\partial \theta_{ijg}}{\partial \theta_{ij0}} \cdot \frac{\partial \theta_{ij0}}{\partial e_{ij0}} \tag{2.5}$$

The first term in both Equation 2.4 and Equation 2.5 is the intra-household resource reallocation as a response to the initial shock. The second term is a biological effect of the shock e_{ij0} that affects only the child that suffered it through θ_{ij0}.

The biological effect is assumed to be negative. As discussed in Section 2.2, being born with a low birth weight is associated with changes in the brain structure that have a negative impact on short and long-run outcomes. The sign of the resource reallocation effect, however, depends on parental preferences and on the way parents react to the initial shock. If parents have a preference for equalizing children's outcomes by investing more in the child who suffered the negative shock, this *compensating behavior* will have a positive sign as it may reduce, or even

cancel out, the effects of the shock. On the other hand, parents can have preferences by investing more in the child with a higher return, so that this *reinforcing behavior* will have a negative sign, amplifying the effects of the initial shock.

In the absence of information that captures all the investment parents have made in each child, the coefficient associated with the initial shock (birthweight, for example) in an OLS estimation that captures the biological and resource allocation effects. Assuming that parents' investment has the features a public good, the TFE estimator nets-out the resource allocation effect, allowing to isolate the biological effects.

The idea behind the public good dimension of parental investment is that when children are close in age, and in the most extreme case twins, parental investments have a spillover effect. Hence, parents cannot fully differentiate in which child to invest. When parents can only partially differentiate, the reinforcing or compensating effect is attenuated and will thus take longer to have greater effects. When no differentiation is possible, the difference between siblings' outcomes will be considerably stable over time.

Assuming that parents cannot invest differently in each twin and that hence the TFE estimator nets-out the resource reallocation effects, the difference in magnitude between OLS and TFE coefficients can be interpreted as evidence of reinforcing or compensating parental behavior. For outcomes measuring positive achievements, e.g. high school completion, if OLS estimates are larger with respect to TFE, parents may be reinforcing the differences among children, whereas smaller OLS estimates can be seen to reveal a compensating behavior.

More details on the model are presented by Bharadwaj, Eberhard e Neilson (2018), who also demonstrate the public good dimension of parental investment and discuss the model's limitations more thoroughly. The main limitation important for this application is that parental investments are the only source of investment in children, ignoring, for instance, investments by medical services or by teachers, which can both differ across siblings. Despite these limitations, the model is useful to shed light on the channels through which birth weight can affect future outcomes and on the way TFE estimations address the biases present in OLS estimations.

2.4.2 Empirical Framework

Following Bharadwaj, Eberhard e Neilson (2018), the outcome (Equation 2.1) can be written in an alternative representation, as a function of past parental investment and endowments. Thus:

$$T_{ijg} = T(X_{ijg}, X_{ij(g-1)}, \cdots, X_{ij0}, \theta_{ij0}) \tag{2.6}$$

And a liner version for estimations purposes, Equation 2.6 is:

$$T_{ijg} = \lambda_g \theta_{ij0} + \beta_1 X_{ijg} + \beta_2 X_{ij(g-1)} + \cdots + \beta_t X_{ij0} + e_{ijg} \tag{2.7}$$

Where the outcome of infant i, born from mother g at age g (T_ijg) is explained by the initial endowment at birth θ_{ij0}, by the complete history of parental investments, the vector X, and by an error term e_{ijg}. Moreover, the parental investments vector includes choices made even

before birth such as the mother's decisions related to her health (smoking or drug use) and prenatal visits. Birth weight is the endowment at birth θ_{ij0} and θ_g is the parameter of interest.

In the absence of measurements for the complete history of parental investment $X = (X_{ijg}, X_{ij(g-1)}, \cdots, X_{ij0})$, parental characteristics can be used as controls, partially capturing the effects of investments. Hence, the outcome T_{ijg} is expressed as:

$$T_{ijg} = \lambda_g BW_{ij} + X'_{ij}\beta + e_{ijg} \tag{2.8}$$

Parental observable characteristics, such as mother's education, age, and marital status are thus considered as part of vector X. However, the parental investment itself is unobservable and will be in the error term e_{ijg}. According to the Equation 2.2, parents' inputs that directly affect the outcome are a response to children's current endowments that is itself dependent on initial endowment (Equation 2.3). In this particular case, these facts imply that parental investment choices are correlated with the birth weight (the initial endowment). Therefore, OLS estimations of Equation 2.8 generate biased estimates of λ_g, the parameter of interest. The bias is given by the relation between birth weight and X as follows:

$$\lambda_g^{OLS} = \lambda_g + \frac{Cov(BW_{ij}, X)}{Var(BW_{ij})} \tag{2.9}$$

The direction of the bias in the OLS estimates depends on whether parents act in order to equalize or reinforce differences between children. The twin fixed effect estimator used by Bharadwaj, Eberhard e Neilson (2018), Figlio et al. (2014), Black, Devereux e Salvanes (2007), Almond, Chay e Lee (2005) among others, can address this potential bias by using the variation in birth weight among twins and the fact that parental investment does not vary among twins. Taking the differences of Equation 2.8 with respect to the twin sibling $i\prime$ generates:

$$T_{ijg} - T_{i\prime jg} = \lambda_g(BW_{ij} - BW_{i\prime j}) + \underbrace{(X'_{ij} - X'_{i\prime j})\beta + (e_{ijg} - e_{i\prime jg})}_{\varepsilon_{ijg} - \varepsilon_{i\prime jg}} \tag{2.10}$$

The part of vector X that refers to the parental characteristics is necessarily the same for twins. Furthermore, as it is discussed in Section 2.2 the only source of variation in birth weight among twins is associated to placental characteristics, mainly the position of cord insertion that caused differences in nutritional intake (disregarding anomalies). Regarding to parental investments, the aforementioned model assumes that it has a public good dimension, so that parents cannot completely differentiate investment across twins. The weaker hypothesis needed for the estimation of an unbiased λ_g is that parental investment is necessarily the same (has perfect spillover) when parents wish to differentiate investment *based on birth weight*.

Equation 2.10 is estimated via TFE using the natural logarithm of birth weight and dummies for twins and controlling only by child gender (which is necessarily different between twins in the sample considered). In order to compare the TFE estimates with the OLS estimates, Equation 2.8 is also estimated using the natural logarithm of birth weight, gender, and race as child individual controls. Vector X includes: mother's age, education, marital status, occupation, number of prenatal visits, dummies for Brazilian macro-region and for birth cohorts. Except for the Apgar, all other outcomes are binary variables and thus the OLS estimations are in fact a Linear Probability Model (LMP).

Two concerns with the TFE approach should be emphasized. The first one regards the fact that both twins should be observed in school registers to be part of the sample. Biases can be raised if the reasons why one twin is not in school registers is correlated with birth weight. For instance, due to neonatal mortality of the lower birthweight child. This source of selection is more likely to happen with the lighter twin not being part of the sample. Supposing that the lightest twins are not in the sample, and so their respective twin pairs, this would lead to an underestimation of the coefficients λ_g. A similar effect can also happen to the OLS estimations. However, this bias is not of major concern if one considers that the sample of interest relies on babies that survived.

The second concern is the fact that because of the matching strategy the sample of twins has only fraternal and not identical twins. One can argue that the estimated effects can be the expression of genetic characteristics through birth weight rather than to birth weight itself. This argument is minimized firstly by referring to medical literature and secondly by considering similar papers that could test for zygotic characteristics. According to medical literature, the main cause for birth weight differences even between identical twins is the position of the umbilical cord. Boys are more likely to be heavier than girls and this is the reason why gender is an important variable to account for, but it is difficult to believe that other genetic characteristics that determine a baby's weight play an important role in determining future outcomes. Considering similar research, Black, Devereux e Salvanes (2007) has access to zygosity information and found no differences in the effects estimated using the full twin sample and the monozygotic sample for high school completion, the probability of full-time work and adult earnings. Figlio et al. (2014) do not have access to zygosity information but test differences in effects of birth weight in test scores considering a same-sex sample, which has a larger share of monozygotic twins. They found no differences in estimations using the full and gender-restricted samples. Because of all these facts, it is not likely that genetic differences are the main driver of the results.

2.5 Results

2.5.1 Main results

The OLS and TFE estimates of effects of birth weight on Apgar score, repetition rate, dropout, age-grade distortion and high school completion are shown as follows. The estimates are obtained using: (i) full matched sample, (ii) the sample with birth weight less than 3500 grams, (iii) the twins sample and (iv) sample with matched twin siblings. The TFE estimator is implemented only in the last sample (matched twin siblings), which is also used for the OLS estimations in order to make results comparable across samples. The OLS and TFE regressions include a set of control variables that are omitted from the tables presented. The results tables include an auxiliary estimate of the percentage change in the outcome of interest as a response to a 10% increase in birth weight, displaying the stars for the statistical significance of the coefficient.

Table 2.4 shows the results for the one and five minute Apgar scores and for high school completion. The OLS estimate using the full sample for Apgar at 1 minute of life indicates that a 10% increase in birth weight is associated with a Apgar increase of 0.067 (in a scale of 0 to 10). The average Apgar at 1 minute for the full sample is 8.10, implying the estimated 0.8% increase. The coefficient for birth weight increases by a factor of 2 using the sample with less than 3500g, and by a factor of 2.5 for the twin sample and for the sample of matched twins siblings. All the three alternative samples select babies with potentially poor health outcomes compared to the full

sample since the weight cut-off and twin pregnancy imply increased health vulnerability. Hence, the overall increase in the coefficient is justified by the selection of more vulnerable babies. The sample of matched twin siblings is a subsample of the matched twins sample, with potentially less confounding factors. Therefore, the OLS coefficient in the twin siblings sample is expected to be more similar, and more comparable, to the TFE estimate rather than the OLS coefficient in the twins sample.

The TFE estimated for the one minute Agpar implies that a 10% increase in birth weight raises the Apgar by 0.083, or by 1.1% over the average Agpar. The coefficient point estimate obtained by TFE is smaller than the OLS estimates, in line with what Black, Devereux e Salvanes (2007), Almond, Chay e Lee (2005) found for Apgar at 5 minutes.

The estimates for Apgar at 5 minute follow the same pattern observed for the results for Apgar at 1 minute, but are smaller in magnitude. The five minute Apgar measurement incorporates the newborn's response to the resuscitation methods, or to other interventions applied when needed, being less sensitive to weight only. Other birth conditions that include the hospital and even the medical team also play a crucial role in the determination of the five minute Apgar. The OLS and TFE coefficients estimated using the twins sample can be compared to the results found by Black, Devereux e Salvanes (2007) for Norway. The OLS point estimate for the twin sample in Norway is 1.46 (standard deviation 0.06) and the twin fixed effect point estimate is 0.35 (standard deviation 0.07)[17], while for Brazil these estimates are respectively 1.14 (or 1.15 for the whole twins sample) and 0.526.

According to the economic framework presented in Section 2.4 both estimates suggest that immediate neonatal care acts as a compensating component, equalizing health differences among twins. Especially for the most vulnerable and fragile babies, actions taken immediately after birth are essential to save the infant's life. Consequently, the compensating behavior in this context is not surprising given that it is a matter of saving a baby's life. Nevertheless, the TFE estimate for Brazil is higher than for Norway, while the OLS estimate for Brazil is smaller. The two OLS estimates use a different set of controls and the estimates for Brazil that use a set of controls as similar as possible to Black, Devereux e Salvanes (2007) generate a coefficient of 1.09 in the twin siblings sample[18]. Anyhow, the differences in socioeconomic context between Brazil and Norway play a more important role in explaining the differences in magnitude[19].

The probability of high school completion is the first educational outcome analyzed. Although, from the perspective of a life cycle sequence, it is the last educational outcome considered in this research, its results are displayed first because it is also comparable to Black, Devereux e Salvanes (2007). Birth weight is positively associated with the probability of high school completion at age 17 or 18, feasible and adequate ages to finish high school in Brazil. The OLS estimates are all close in magnitude implying that a 10% increase in birth weight is associated with a 0.8 to 1.3 percentage points increase in the probability of completing high school before 18 years old (similarly to Black, Devereux e Salvanes (2007)). Even though the effect on percentage point might seem small, it represents a rise in the chances of completing high school from 2% to 3.1%

[17] Black, Devereux e Salvanes (2007) have a larger sample with more than 20,000 twins.

[18] The controls used by Black, Devereux e Salvanes (2007) are: year and month of birth dummies, indicators for mother's education and age, sex of the child and birth order. Birth order is not available in Brazilian registers, but all other variables are a subset of the controls used in the OLS estimates. The OLS coefficient using the subset of controls for the twins sample is 1.11 (standard error 0.052) and 1.09 (standard error 0.071) for the matched twin siblings.

[19] For instance, while 88% of the mothers in Brazil have less than 12 years of education (incomplete high school or less) the average education of mothers in Norway is 11.25 years of schooling.

depending on the sample considered. The TFE estimate, by its turn, reveals that the magnitude of birth weigh impact is twice bigger, a 10% increase in birth weight raises the chances of finishing high school by 2.3 percentage points or 6%.

In contrast to the relation found for the Apgar scores (in which parents behave compensating the effect of low birth weight), the TFE coefficient for high school completion is greater in magnitude than the OLS, suggesting that parents act reinforcing the effect of low birth weight on educational outcomes. The educational outcomes presented next add evidence to this finding. Retention rates, school dropout, and age-grade distortion are variables negatively associated with birth weight, meaning that the higher the weight, the lower are the chances to have these adverse outcomes. The biological effect of the initial shock (being born low birthweight) has a positive sign, raising the chances of the adverse outcome. Therefore, if the module of TFE coefficient is greater than the module of the OLS, parents are reducing the positive effect of raising the birth weight and *reinforcing* the effect of the initial shock. Contrarily, if the module of the TFE is smaller than OLS, parents have a *compensating* behavior, mitigating the effect of the initial shock and reducing the chances of the adverse outcome as the birth weight increases.

Table 2.5 displays the results for the probability of repeating a grade at any time and by age. The first fact to be noted is that the OLS and TFE coefficients are negative, confirming the fact that the higher the birth weight, the lower the chances of repeating a grade at any age. The TFE coefficient suggests that a 10% increase in birth weight reduces the chances of repeating a grade in 1.3 percentage point or in 3.5% for an average repetition rate of 37% (one-third of students have repeated a grade at least once). The overall chance, however, hides differences across ages that can also be associated with the organization of grades in cycles and with policies of automatic promotion within a cycle. Unfortunately, the School Census does not inform the cycles' structures within schools. At ages of 7 and 8 students attend the 2nd and 3rd grade, respectively. The non-significative TFE effect for these grades are explained by the fact that repetition rates are lower in first grades (3% and 7%, respectively). At the age of 9, when students who have not repeated before are in grade 4, the repetition rate is 9.5%, and the effect of birth weight is to reduce the chances of grade retention in 10.4%. For students 11, 12 and 13 years old the effects are also considered to be high, reaching a reduction of -11.6% in the probability of repeating a grade as a response to a 10% increase in birth weight. For ages 14 to 16, when students with no previous repetitions are in the 9th grade or 1st and 2nd grade of high school the effects are statistically zero.

When the TFE coefficients of birth weight are statistically different from zero, they are always bigger in module in comparison to the OLS coefficient for all samples. The increase in birth weight has a smaller effect of reducing the chances of grade retention when parents' behavior is accounted for (OLS estimate). Parents seem to choose to invest in the child with the higher return.

The estimates for school dropout are presented in Table 2.6. It is worth to highlight that dropout rates are not as accurate as the other outcomes due to data limitations. Anyhow, this outcome shows important results. The OLS estimates for the full sample and for the sample with less than 3500g are negative and statistically significant. The effect for dropout at any age indicates a 2.8% decrease in the chances of dropping out of school in response to a 10% increase in birth weight. For the twins sample, either OLS or TFE estimates give small coefficients, which are statistically equal to zero. The twins sample contains a larger share of siblings than the full sample, while the sample of matched twin siblings necessarily contains only siblings. The composition of these samples can explain the differences in the results obtained since it is less likely to have parents allowing just one child to drop out of school. Repeating a grade is an event that occurs independently of parents approval, whereas it is less likely to believe that parents will allow just

one of the twin siblings to drop out of school. The absence of variation among twins explains the null results for the twins samples.

For the age-grade distortion, Table 2.7 and Table 2.8 show that the OLS coefficient indicates a 3.9% decrease in the probability of being older than the adequate for a grade, when birth weight increases by 10%. The overall effect, however, is non-significant when estimated using TFE. This fact is driven by the absence of effect in early life, since the TFE is significant and larger in magnitude than the OLS mainly after the age of 9. As for the retention grade, the coefficients evidence a reinforcing behavior on the part of parents.

Table 2.4 – OLS and TFE Estimates: Apgar 1 and 5 Minute

	(1)	(2)	(3)
Variables	Apgar 1 minute	Apgar 5 minute	High school completion
OLS-Full sample			
Ln weight	0.671***	0.577***	0.115***
	(0.00550)	(0.00470)	(0.00287)
Beta: % of the mean	0.8%***	0.6%***	2.8%***
Observations	3,811,466	3,774,567	948,081
R-squared	0.031	0.035	0.151
OLS-Sample weight <=3500g			
Ln weight	1.218***	0.966***	0.127***
	(0.00798)	(0.00689)	(0.00400)
Beta: % of the mean	1.5%***	1.0%***	3.1%***
Observations	2,742,273	2,718,066	673,258
R-squared	0.041	0.043	0.152
OLS-Twins sample			
Ln weight	1.615***	1.149***	0.0869***
	(0.0528)	(0.0521)	(0.0228)
Beta: % of the mean	2.1%***	1.3%***	2.5%***
Observations	22,221	21,870	6,132
R-squared	0.082	0.073	0.145
OLS-Twins siblings matched sample			
Ln weight	1.621***	1.146***	0.0778
	(0.0925)	(0.0704)	(0.0574)
Beta: % of the mean	2.1%***	1.3%***	2.0%
Observations	6,652	6,625	1,544
R-squared	0.064	0.066	0.174
TFE-Twins siblings matched sample			
Ln weight	0.831***	0.526***	0.233**
	(0.169)	(0.0980)	(0.0970)
Beta: % of the mean	1.1%***	0.6%***	6.0%**
Observations	6,638	6,612	1,544
R-squared	0.772	0.827	0.782

*** p<0.01, ** p<0.05, * p<0.1.The beta as % of the mean is computed using the mean of the outcome variable for the sample considered.

All OLS estimates include as controls: student gender and race, mother age, education, marital status and occupation, number of prenatal visits, dummies for Brazilian macro-region and for birth cohorts. Robust standard errors of the OLS estimates are in parentheses.

The TFE estimate includes as controls: student gender and fixed effect dummies for twins. Clustered standard errors at twins level of the TFE estimates are in parentheses.

Table 2.5 – OLS and TFE Estimates: Repetition rate- overall and by age

Variables	(1) Retention	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
OLS-Full sample											
Ln weight	-0.102***	-0.00619***	-0.0290***	-0.0450***	-0.0484***	-0.0422***	-0.0354***	-0.0261***	-0.0273***	-0.0286***	-0.0274***
	(0.00133)	(0.000625)	(0.000816)	(0.000862)	(0.000877)	(0.000831)	(0.000918)	(0.00109)	(0.00128)	(0.00149)	(0.00184)
Beta: % of the mean	-2.7%***	-2.1%***	-4.3%***	-5.2%***	-5.4%***	-5.3%***	-4.2%***	-2.5%***	-2.2%***	-2.3%***	-2.1%***
Observations	4,237,826	2,892,322	3,614,735	4,132,864	4,167,054	4,170,334	3,615,102	3,047,057	2,476,420	1,868,233	1,256,021
R-squared	0.165	0.015	0.034	0.038	0.042	0.043	0.042	0.043	0.043	0.040	0.027
OLS-Sample weight <=3500g											
Ln weight	-0.108***	-0.00613***	-0.0296***	-0.0469***	-0.0511***	-0.0446***	-0.0382***	-0.0277***	-0.0286***	-0.0293***	-0.0250***
	(0.00182)	(0.000850)	(0.00112)	(0.00119)	(0.00121)	(0.00114)	(0.00126)	(0.00148)	(0.00174)	(0.00204)	(0.00252)
Beta: % of the mean	-2.8%***	-2.0%***	-4.4%***	-5.4%***	-5.7%***	-5.6%***	-4.5%***	-2.6%***	-2.4%***	-2.3%***	-1.9%***
Observations	3,047,615	2,086,013	2,602,646	2,972,294	2,996,681	2,999,105	2,600,745	2,192,240	1,778,240	1,336,922	895,883
R-squared	0.166	0.015	0.035	0.038	0.042	0.044	0.043	0.044	0.044	0.040	0.027
OLS-Twins sample											
Ln weight	-0.0558***	0.00571	-0.0105	-0.0364***	-0.0477***	-0.0242***	-0.0364***	-0.00585	-0.00727	0.00327	-0.0296*
	(0.0116)	(0.00567)	(0.00758)	(0.00804)	(0.00794)	(0.00730)	(0.00830)	(0.00885)	(0.0104)	(0.0121)	(0.0157)
Beta: % of the mean	-1.3%***	1.5%	-1.3%	-3.3%***	-4.2%***	-2.5%***	-3.7%***	-0.5%	-0.6%	0.2%	-2.1%*
Observations	25,499	16,998	21,447	24,736	24,987	25,039	22,105	18,732	15,507	11,832	7,955
R-squared	0.178	0.020	0.044	0.049	0.052	0.053	0.052	0.048	0.050	0.045	0.036
OLS-Twins siblings matched sample											
Ln weight	-0.0939***	0.0111	-0.0164	-0.0386**	-0.0657***	-0.0659***	-0.00526	-0.0153	-0.0104	-0.0368	-0.0577
	(0.0262)	(0.0116)	(0.0167)	(0.0171)	(0.0181)	(0.0169)	(0.0169)	(0.0191)	(0.0232)	(0.0282)	(0.0373)
Beta: % of the mean	-2.5%***	4.2%	-2.3%	-4.0%**	-6.5%***	-7.5%***	-0.6%	-1.5%	-1.0%	-3.1%	-4.5%
Observations	7,223	5,125	6,286	7,093	7,136	7,146	6,036	4,999	4,036	3,051	2,083
R-squared	0.187	0.017	0.052	0.052	0.071	0.067	0.063	0.058	0.058	0.052	0.052
TFE-Twins siblings matched sample											
Ln weight	-0.130***	-0.0185	-0.0373	-0.0993***	-0.000817	-0.102***	-0.0994**	-0.101**	0.0525	0.0222	-0.107
	(0.0490)	(0.0173)	(0.0268)	(0.0345)	(0.0385)	(0.0382)	(0.0405)	(0.0484)	(0.0507)	(0.0597)	(0.0863)
Beta: % of the mean	-3.5%***	-6.9%	-5.3%	-10.4%***	-0.1%	-11.6%***	-11.6%**	-10.1%**	5.0%	1.9%	-8.4%
Observations	7,226	5,006	6,190	7,020	7,070	7,084	5,964	4,924	3,962	2,948	1,924
R-squared	0.766	0.864	0.794	0.728	0.665	0.675	0.622	0.627	0.617	0.643	0.607

*** p<0.01, ** p<0.05, * p<0.1. The beta as % of the mean is computed using the mean of the outcome variable for the sample considered.
All OLS estimates include as controls: student gender and race, mother age, education, marital status and occupation, number of prenatal visits, dummies for Brazilian macro-region and for birth cohorts.
Robust standard errors of OLS estimates are in parentheses
The TFE estimate includes as controls: student gender, and fixed effect dummies for twins. Clustered standard errors at twins level of the TFE estimates are in parentheses

Table 2.6 – OLS and TFE Estimates: Dropout rate- overall and by age

Variables	(1) Dropout	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
OLS-Full sample											
Ln weight	-0.00874***	-0.000658***	-0.00175***	-0.00221***	-0.00184***	-0.00169***	-0.000878***	-0.00103***	-0.00106***	-0.000993**	-0.000792
	(0.000530)	(0.000179)	(0.000219)	(0.000216)	(0.000201)	(0.000217)	(0.000240)	(0.000284)	(0.000348)	(0.000454)	(0.000704)
Beta: % of the mean	-2.8%***	-2.7%***	-3.9%***	-4.9%***	-4.6%***	-4.2%***	-2.0%***	-2.0%***	-1.7%***	-1.3%**	-0.7%
Observations	4,237,826	3,181,170	3,734,127	4,210,510	4,225,857	3,673,407	3,107,420	2,549,783	1,999,608	1,438,311	896,432
R-squared	0.021	0.001	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.002
OLS-Sample weight <=3500g											
Ln weight	-0.00955***	-0.000868***	-0.00166***	-0.00253***	-0.00189***	-0.00200***	-0.00102***	-0.00131***	-0.000360	-0.00108*	-0.000312
	(0.000723)	(0.000249)	(0.000303)	(0.000303)	(0.000280)	(0.000302)	(0.000325)	(0.000384)	(0.000480)	(0.000619)	(0.000969)
Beta: % of the mean	-3.0%***	-3.6%***	-3.7%***	-5.5%***	-4.7%***	-5.0%***	-2.3%***	-2.5%***	-0.6%	-1.4%*	-0.3%
Observations	3,047,615	2,295,742	2,688,920	3,028,129	3,039,134	2,642,763	2,235,808	1,830,934	1,430,299	1,025,434	637,409
R-squared	0.021	0.001	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.002
OLS-Twins sample											
Ln weight	0.00176	-0.000193	0.00123	-0.00172	-0.000224	-0.00106	0.00139	0.00281	0.00325	0.000138	0.00385
	(0.00486)	(0.00170)	(0.00212)	(0.00180)	(0.00181)	(0.00189)	(0.00243)	(0.00255)	(0.00258)	(0.00373)	(0.00613)
Beta: % of the mean	0.5%	-0.7%	2.4%	-3.4%	-0.4%	-2.3%	2.2%	4.0%	4.4%	0.2%	2.8%
Observations	25,499	18,690	22,198	25,307	25,405	22,523	19,191	15,997	12,661	9,135	5,772
R-squared	0.026	0.003	0.005	0.007	0.004	0.004	0.005	0.004	0.003	0.007	0.005
OLS-Twins siblings matched sample											
Ln weight	-0.0182**	-0.00602*	0.00222	-0.000796	-0.00209	-0.00239	-0.00361	-0.00412	0.00196	-0.00597	-0.0263
	(0.00899)	(0.00359)	(0.00249)	(0.00254)	(0.00281)	(0.00266)	(0.00381)	(0.00604)	(0.00747)	(0.0101)	(0.0193)
Beta: % of the mean	-7.3%**	-41.9%*	8.4%	-2.7%	-7.2%	-11.3%	-11.5%	-6.3%	2.5%	-8.2%	-17.9%
Observations	7,223	5,562	6,426	7,195	7,210	6,125	5,098	4,144	3,204	2,315	1,488
R-squared	0.029	0.007	0.008	0.014	0.003	0.007	0.011	0.011	0.007	0.024	0.018
TFE-Twins siblings matched sample											
Ln weight	-0.0148	-0.000723	-0.0142**	0.00126	-0.00377	-0.00413	-0.00595	0.00545	-0.000687	0.00979	-0.00628
	(0.0183)	(0.00466)	(0.00577)	(0.00448)	(0.00709)	(0.00675)	(0.00909)	(0.0126)	(0.0153)	(0.0210)	(0.0303)
Beta: % of the mean	-5.9%	-5.0%	-53.7%**	4.3%	-13.0%	-19.5%	-19.0%	8.4%	-0.9%	13.4%	-4.3%
Observations	7,226	5,502	6,400	7,172	7,200	6,122	5,100	4,142	3,204	2,292	1,454
R-squared	0.625	0.624	0.688	0.699	0.599	0.576	0.625	0.535	0.617	0.686	0.542

*** p<0.01, ** p<0.05, * p<0.1. The beta as % of the mean is computed using the mean of the outcome variable for the sample considered.

All OLS estimates include as controls: student gender and race, mother age, education, marital status and occupation, number of prenatal visits, dummies for Brazilian macro-region and for birth cohorts. Robust standard errors of OLS estimates are in parentheses

The TFE estimate includes as controls: student gender and fixed effect dummies for twins. Clustered standard errors at twins level of the TFE estimates are in parentheses

Table 2.7 – OLS and TFE Estimates: Age-grade distortion - overall and by age

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Variables	Grade distortion	At age 7	At age 8	At age 9	At age 10	At age 11	At age 12	At age 13	At age 14	At age 15	At age 16
OLS-Full sample											
Ln weight	-0.112***	-0.00893***	-0.0193***	-0.0518***	-0.0858***	-0.101***	-0.117***	-0.123***	-0.128***	-0.130***	-0.137***
	(0.00126)	(0.000480)	(0.000525)	(0.000796)	(0.00101)	(0.00110)	(0.00125)	(0.00146)	(0.00168)	(0.00197)	(0.00238)
Beta: % of the mean	-3.9%***	-4.0%***	-7.3%***	-7.6%***	-7.0%***	-6.5%***	-6.4%***	-5.3%***	-4.7%***	-4.5%***	-5.1%***
Observations	4,237,826	3,620,156	4,111,932	4,137,557	4,149,244	4,151,293	3,598,968	3,036,238	2,469,434	1,863,110	1,254,123
R-squared	0.161	0.031	0.013	0.042	0.070	0.088	0.104	0.125	0.130	0.127	0.113
OLS-Sample weight <=3500g											
Ln weight	-0.117***	-0.00851***	-0.0212***	-0.0545***	-0.0908***	-0.106***	-0.125***	-0.133***	-0.138***	-0.141***	-0.149***
	(0.00173)	(0.000656)	(0.000741)	(0.00111)	(0.00141)	(0.00152)	(0.00175)	(0.00203)	(0.00234)	(0.00275)	(0.00334)
Beta: % of the mean	-4.0%***	-3.8%***	-7.8%***	-7.8%***	-7.2%***	-6.7%***	-6.7%***	-5.7%***	-5.1%***	-4.9%***	-5.5%***
Observations	3,047,615	2,606,772	2,957,747	2,975,898	2,984,438	2,985,544	2,589,084	2,184,481	1,773,235	1,333,385	894,647
R-squared	0.162	0.032	0.014	0.043	0.071	0.089	0.106	0.126	0.131	0.128	0.115
OLS-Twins sample											
Ln weight	-0.0565***	-0.00732	-0.0132***	-0.0402***	-0.0771***	-0.0770***	-0.0938***	-0.0939***	-0.0913***	-0.0959***	-0.101***
	(0.0110)	(0.00490)	(0.00486)	(0.00745)	(0.00929)	(0.00989)	(0.0111)	(0.0126)	(0.0142)	(0.0164)	(0.0200)
Beta: % of the mean	-1.7%***	-2.6%	-4.2%***	-4.5%***	-4.8%***	-3.9%***	-4.1%***	-3.3%***	-2.9%***	-2.8%***	-3.1%***
Observations	25,499	21,532	24,646	24,858	24,901	24,912	22,016	18,668	15,491	11,803	7,944
R-squared	0.177	0.039	0.016	0.053	0.091	0.108	0.123	0.141	0.145	0.146	0.128
OLS-Twins siblings matched sample											
Ln weight	-0.0729***	0.00859	-0.0156	-0.0281*	-0.0774***	-0.0868***	-0.0786***	-0.0921***	-0.0983***	-0.122***	-0.127***
	(0.0239)	(0.00795)	(0.0100)	(0.0153)	(0.0202)	(0.0218)	(0.0249)	(0.0285)	(0.0328)	(0.0380)	(0.0475)
Beta: % of the mean	-2.6%***	4.4%	-5.8%	-3.8%*	-5.5%***	-4.9%***	-3.8%***	-3.6%***	-3.4%***	-4.0%***	-4.3%***
Observations	7,223	6,294	7,070	7,104	7,125	7,102	6,000	4,978	4,029	3,042	2,079
R-squared	0.191	0.054	0.029	0.074	0.107	0.130	0.143	0.161	0.165	0.167	0.154
TFE-Twins siblings matched sample											
Ln weight	-0.0621	-0.00343	-0.0160	-0.0922***	-0.0920**	-0.101**	-0.115**	-0.156***	-0.139**	-0.137*	-0.191**
	(0.0461)	(0.0105)	(0.0122)	(0.0273)	(0.0376)	(0.0420)	(0.0488)	(0.0565)	(0.0630)	(0.0743)	(0.0841)
Beta: % of the mean	-2.2%	-1.8%	-5.9%	-12.3%***	-6.6%**	-5.7%**	-5.6%**	-6.1%***	-4.9%**	-4.5%*	-6.5%**
Observations	7,226	6,200	6,986	7,030	7,058	7,018	5,906	4,892	3,944	2,932	1,906
R-squared	0.768	0.915	0.879	0.786	0.743	0.746	0.750	0.753	0.751	0.763	0.771

*** p<0.01, ** p<0.05, * p<0.1.The beta as % of the mean is computed using the mean of the outcome variable for the sample considered.
All OLS estimates include as controls: student gender and race, mother age, education, marital status and occupation, number of prenatal visits, dummies for Brazilian macro-region and for birth cohorts. Robust standard errors of OLS estimates are in parentheses
The TFE estimate includes as controls: student gender and fixed effect dummies for twins. Clustered standard errors at twins level of the TFE estimates are in parentheses

Table 2.8 – OLS and TFE Estimates: Non-Cumulative Age-grade distortion- overall and by age

Variables	(1) Grade distortion	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
OLS-Full sample											
Ln weight	-0.112***	-0.00893***	-0.0162***	-0.0397***	-0.0570***	-0.0550***	-0.0564***	-0.0552***	-0.0598***	-0.0645***	-0.0681***
	(0.00126)	(0.000480)	(0.000494)	(0.000703)	(0.000864)	(0.000864)	(0.000951)	(0.00120)	(0.00146)	(0.00173)	(0.00201)
Beta: % of the mean	-3.9%***	-4.0%***	-6.9%***	-7.7%***	-7.3%***	-7.3%***	-7.5%***	-5.1%***	-4.5%***	-4.5%***	-5.6%***
Observations	4,237,826	3,620,156	4,099,743	4,064,553	3,946,072	3,792,059	3,181,908	2,611,982	2,080,575	1,550,304	1,045,212
R-squared	0.161	0.031	0.012	0.037	0.051	0.062	0.070	0.084	0.091	0.089	0.075
OLS-Sample weight <=3500g											
Ln weight	-0.117***	-0.00851***	-0.0179***	-0.0411***	-0.0602***	-0.0572***	-0.0600***	-0.0575***	-0.0632***	-0.0659***	-0.0698***
	(0.00173)	(0.000656)	(0.000695)	(0.000979)	(0.00120)	(0.00120)	(0.00133)	(0.00166)	(0.00201)	(0.00240)	(0.00281)
Beta: % of the mean	-4.0%***	-3.8%***	-7.4%***	-7.8%***	-7.6%***	-7.5%***	-7.9%***	-5.3%***	-4.7%***	-4.6%***	-5.6%***
Observations	3,047,615	2,606,772	2,948,679	2,921,605	2,834,207	2,720,982	2,282,624	1,873,432	1,489,358	1,106,283	743,220
R-squared	0.162	0.032	0.012	0.038	0.052	0.063	0.071	0.086	0.092	0.090	0.077
OLS-Twins sample											
Ln weight	-0.0565***	-0.00732	-0.00761*	-0.0324***	-0.0610***	-0.0388***	-0.0572***	-0.0397***	-0.0437***	-0.0289*	-0.0601***
	(0.0110)	(0.00490)	(0.00443)	(0.00670)	(0.00804)	(0.00785)	(0.00873)	(0.0105)	(0.0126)	(0.0150)	(0.0180)
Beta: % of the mean	-1.7%***	-2.6%	-2.7%*	-4.6%***	-5.9%***	-4.0%***	-5.8%***	-3.0%***	-2.8%***	-1.7%*	-4.0%***
Observations	25,499	21,532	24,555	24,334	23,346	22,180	18,839	15,414	12,551	9,408	6,360
R-squared	0.177	0.039	0.015	0.051	0.073	0.078	0.090	0.101	0.112	0.113	0.096
OLS-Twins siblings matched sample											
Ln weight	-0.0729***	0.00859	-0.0117	-0.0174	-0.0655***	-0.0716***	-0.0140	-0.0358	-0.0328	-0.0665**	-0.0827**
	(0.0239)	(0.00795)	(0.00906)	(0.0134)	(0.0179)	(0.0178)	(0.0181)	(0.0223)	(0.0268)	(0.0332)	(0.0413)
Beta: % of the mean	-2.6%***	4.4%	-4.9%	-3.0%	-7.3%***	-8.1%***	-1.7%	-3.2%	-2.6%	-4.8%**	-6.2%**
Observations	7,223	6,294	7,046	6,973	6,739	6,418	5,204	4,177	3,297	2,454	1,695
R-squared	0.191	0.054	0.028	0.068	0.083	0.096	0.102	0.115	0.127	0.127	0.122
TFE-Twins siblings matched sample											
Ln weight	-0.0621	-0.00343	-0.0162	-0.0795***	-0.0524	-0.105***	-0.0662	-0.101*	-0.0436	-0.0991	-0.133
	(0.0461)	(0.0105)	(0.0116)	(0.0265)	(0.0356)	(0.0382)	(0.0407)	(0.0523)	(0.0541)	(0.0675)	(0.0807)
Beta: % of the mean	-2.2%	-1.8%	-6.9%	-13.8%***	-5.8%	-11.9%***	-7.8%	-8.9%*	-3.5%	-7.1%	-9.9%
Observations	7,226	6,200	6,954	6,856	6,492	5,954	4,696	3,712	2,866	2,076	1,402
R-squared	0.768	0.915	0.883	0.750	0.699	0.711	0.689	0.692	0.690	0.732	0.685

*** p<0.01, ** p<0.05, * p<0.1. The beta as % of the mean is computed using the mean of the outcome variable for the sample considered.
All OLS estimates include as controls: student gender and race, mother age, education, marital status and occupation, number of prenatal visits, dummies for Brazilian macro-region and for birth cohorts. Robust standard errors of OLS estimates are in parentheses
The TFE estimate includes as controls: student gender and fixed effect dummies for twins. Clustered standard errors at twins level of the TFE estimates are in parentheses

2.5.2 Heterogeneous effects

In order to understand whether the previous findings changes are in conformity with socioeconomic conditions and with the profile of access to health services, this section presents estimates of the TFE model by subsamples of interest. High school completion is the only educational outcome that is not part of this exercise due to the reduced sample size. For the Apgar score, only the heterogeneity related to birth weight, maternal characteristics and health conditions are presented. For all heterogeneous, the sample is broken into two groups, so as to keep subsamples with equal sizes, approximately half of the total of observations.

The first heterogeneity divides the sample according to low birth weight. There is evidence in the literature that the lower the weight, the higher the effects would be (FIGLIO et al., 2014; BLACK; DEVEREUX; SALVANES, 2007). To test for this, the sample is divided into two subgroups, one with birth weight lower or equal to 2500g and other with weight above 2500g.

Based on the importance of the access to health services to explain birth outcomes, the second kind of heterogeneity divides births according to a proxy for the quality of public health services in the mother's municipality of residence at the time of the birth. In the mid-1900s a community-based health program (Programa Saúde da Família) has been created in Brazil and since then has provided basic health care by means of community-based professional teams [20]. The health teams are responsible for a well-defined population of 3000 to 4500 people and are based in basic health care units, being also responsible for household visits. Among other information, the Brazilian Ministry of Health provides, since 1998, data on the number of children aged 1 year old or less registered by these teams, the number of babies aged 4 months or less registered, as well as the number of medical appointments for children 1 year old or less. These three variables are used to create a measure of the access to public health care in each municipality on a monthly basis.

Using SINASC records, for each municipality/month the number of live children aged 4 months or less and 1 year or less is computed as the sum of births in the 4 months or 12 months previous to a given month (each month is included as the last month of its sum). Then, these sums are assumed to be the total population of children aged 4 months and 1 year or less. Based on the data of the community-based health services, three variables are created for each municipality/month: the share of children aged 4 months or less registered, the share of children aged 1 year or less registered and the number of medical appointments by children. A child born in month t is exposed to the share of children aged 4 months or less registered of the months $t, t+1, t+2, t+3$ and to the variables for children aged 1 year or less of the months $t, t+1, ..., t+11$. Thus, for each municipality-month, the coverage variable associated with a month of birth is the mean of the months in which the child has been exposed to health coverage. Finally, for each variable of average coverage share, the municipality is evaluated as being above or below the median for Brazil in each month. If the municipality/month is below the median in two or more variables, it is considered to have low health coverage. If the municipality/month is above the median in two or more variables, it is considered to have high health coverage.

The third type of heterogeneity regards the socioeconomic level of schools. In 2014, INEP has launched a socioeconomic status index (SES index) for schools using the socioeconomic questionnaires from two large-scale tests[21]. The index scale provides seven levels of socioeconomic

[20] See Rocha e Soares (2010) for evidence of the positive impact of the program on reducing mortality especially at an early ages.

[21] The tests are Prova Brasil, taken by students of 5th and 9th grade and ENEM, an exam for the

status for students. The schools were classified into these same levels according to the average profile of students. In the sample of matched twin siblings, an average SES index is created considering the average SES of all schools a student has ever attended. A cut-off to separate the students into low and high school average SES has been selected considering the median of the average distribution and the original socioeconomic levels created by INEP. Hence, a school with low SES corresponds to INEP's levels I to III, meaning that the average student has parents with incomplete elementary education or (less schooling) and household income of to 1.5 minimum wages[22]. The high SES schools are those where the majority of students have parents with incomplete middle school or higher schooling and household income of more than 1.5 minimum wages.

The last two heterogeneities refer to mothers' characteristics. The students were divided into two groups of low and high maternal education using the information on educational level at the time of the birth. Mothers with incomplete elementary schooling (or less) are the low-education group, while mothers with at least incomplete high school or higher education are the group of high education. Finally, the last heterogeneity considers the number of live children the mother had already had at the time of the birth. Mothers are split in two groups: in one the twins are the first children, while in the other they have at least one older sibling.

The results for these heterogeneities are presented in a sequence of graphs where the left-hand line refers to the group associated to 'low' characteristics, while the right-hand represents the 'high' profile. For the Apgar score, the dots are the estimated coefficients and the ranges are the 95% confidence interval. For the educational variables, the connected line refers to the coefficient and the shaded area to the 95% confidence interval. Appendix 2.A show the complete regressions tables.

For the Apgar score, Figure 2.8(a) shows that the effect of birth weight at one minute is higher for those born with low weight than for the babies weighing more than 2500g. The coefficient for the lighter babies is 0.84, showing that this group is responsible for most of the effect found in the full sample. For the Apgar at 5 minutes, the coefficient is not different across the weight ranges, confirming the fact that the weight itself is less relevant to explain the Apgar at 5 minutes, when medical intervention plays an important role in newborn health. The variance is higher in the sample relative to a weight larger than 2500g due to the relatively small sample size.

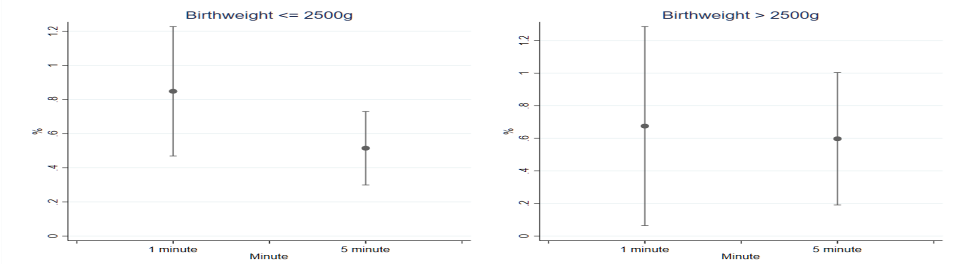
The health coverage variable is associated with the basic health care received at community level rather than to the hospital care received right after birth. The higher the measurement of health coverage, the higher are the chances that the mother had received adequate health care prior to birth, potentially including prenatal care. The effect of birth weight on 1 minute Apgar is 30% higher in regions with low basic health coverage compared to the regions with high coverage (Figure 2.8(b)). The possible differences in prenatal supply can explain the higher effect in municipalities with lower health coverage. The five minute Apgar, which is more sensitive to the immediate post-birth care, exhibits no relevant differences across health coverage situation.

There are no differences in the effect of birth weight o the five and one minute Apgar, according to maternal education groups (Figure 2.8(c)). The last heterogeneity is in line with the

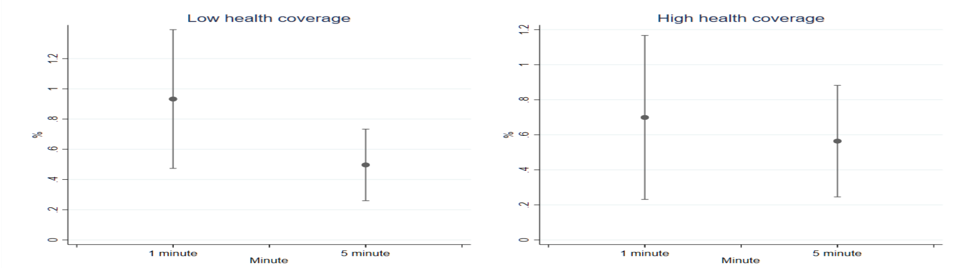
admission in higher education. The index combines students' answers through Item Response Theory using the questionnaires of 2011 and 2013. For more information see INEP (2014).

22 Between 2011 and 2013 the minimum wage augmented from R$545 to R$678. Considering the mean minimum wage in the period of R$615, this would correspond to a monthly income of US$175, approximately.

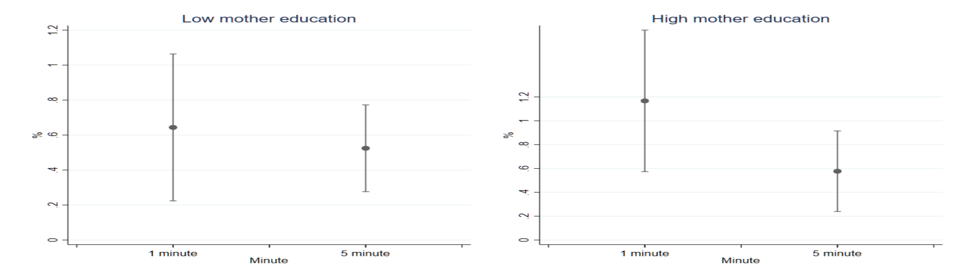
well-known fact in the medical literature that the first pregnancy is associated to a higher risk, so that the first child (or children in this particular case of twin pregnancy) exhibits worse neonatal outcomes. Effects of birth weight on Apgar score are higher for first children.



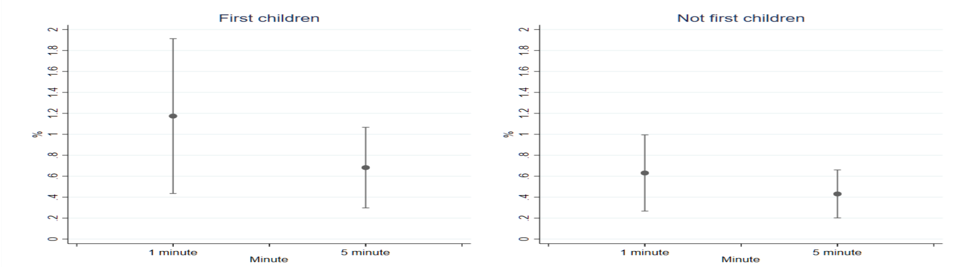
(a) Birth weight



(b) Quality of Health Services



(c) Mother's education



(d) Number of children

Figure 2.8 – TFE Heterogeneity for Apgar

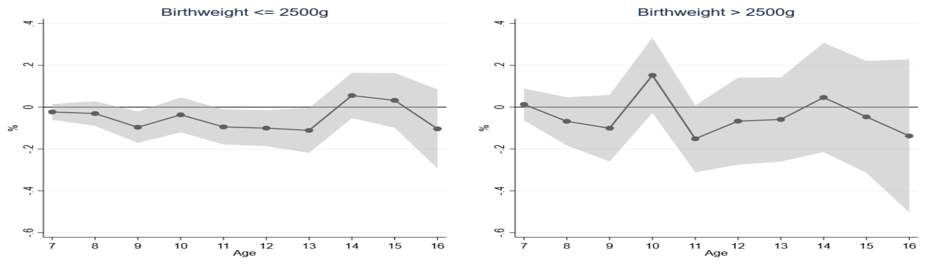
Except for the school dropout outcome - TFE coefficients are small and statistically zero with no differentiation of results across socioeconomic and health quality groups (see Figure 2.10) - all educational outcomes have similar effects overall and across groups.

Students born weighing less than 2500g are driving the overall effect of increasing birth weight on the probability of grade repetition or age-grade distortion. The point estimates for the non-low birthweight group are not only smaller in magnitude than the low birthweight group, but also non-significant. Indeed, at the age of 12 a 10% increase in birth weight reduces the chances of repeating a grade in 12.1% for the low birthweight group and in 7.3% (non-significant) for the non-low birthweight group (see Figure 2.9(a)). Bharadwaj, Eberhard e Neilson (2018) and Figlio et al. (2014) found similar results using test score as an outcome.

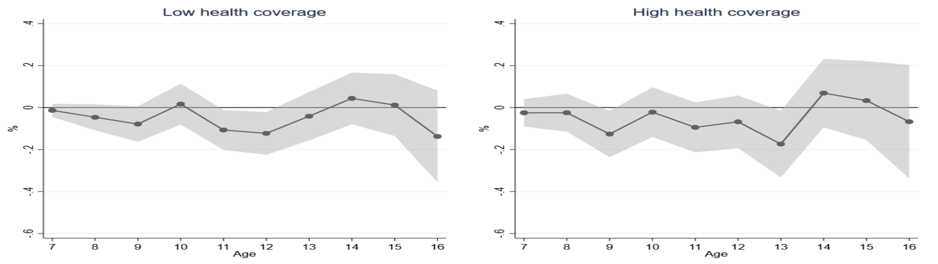
Primary health care coverage seems to be a relevant mechanism through which the impacts of being born low birthweight can be mitigated. For age-grade distortion, the coefficients associated to municipalities with low health coverage are higher in magnitude than the high coverage municipalities, as well as consistently different from zero. Particularly after the age of 12, the effects on age grade distortion in low health coverage areas are bigger (in module) than in high health coverage cities (see Figure 2.11(b)). Further investigation is needed to better understand the role of health services in these results. WHO e UNICEF (2009) suggest that home visits during the neonatal period are a strategy to increase children survival. The visits are important as they give parents orientation regarding early recognition of health problems, hygiene, breastfeeding and problems related to growth.

The SES level of a school can be associated with the educational environment the student has accessed or even with the student's own socioeconomic status. In both cases, attending a low SES school is indicative of being in a more vulnerable condition. Subgroups of low SES and low maternal education have similar trends, always displaying a greater sensitiveness to an increase in birth weight compared to the groups that have attended high SES schools or have more educated mothers. One can see in Figure 2.12(c) and 2.12(d) that the non-cumulative age-grade distortion is not statistically different from zero for the group with high SES and high mother education. On the other hand, the coefficient reaches a value of -0.208 at the age of 13 for the group of low mother's education, implying a reduction of 12.8% in the chances to have age-grade distortion when birth weight increases 10%. Further information and research are needed to understand the mechanisms underpinning the absence of effects in the student with a higher socioeconomic background. Even so, there is evidence that students with low socioeconomic background suffer stronger consequences of the initial adverse health conditions. This finding points to a peculiarity of the Brazilian scenario relative to the ones found by Bharadwaj, Eberhard e Neilson (2018) in Chile, by Figlio et al. (2014) in the USA, andby Black, Devereux e Salvanes (2007) in Norway, where the effects of birth weight on educational outcomes are quite stable across socioeconomic backgrounds.

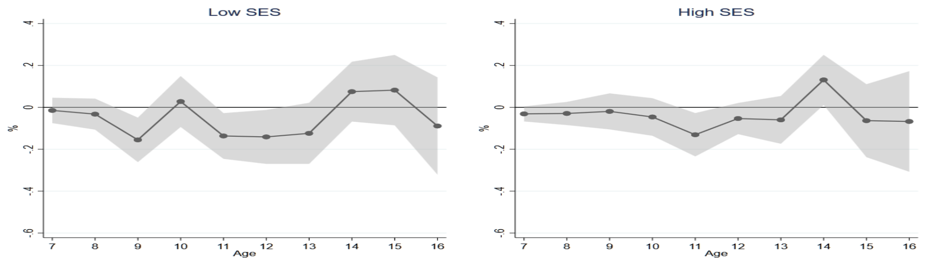
Regarding the fact of being the first child, the educational outcomes show evidence of a quality-quantity trade-off. Most of the effects obtained come from twins that are not the first to be born.



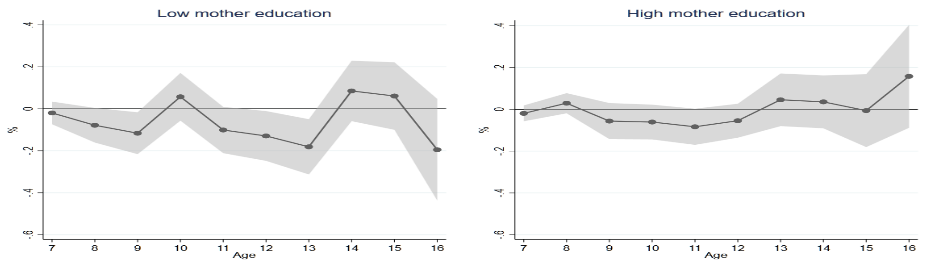
(a) Birth weight



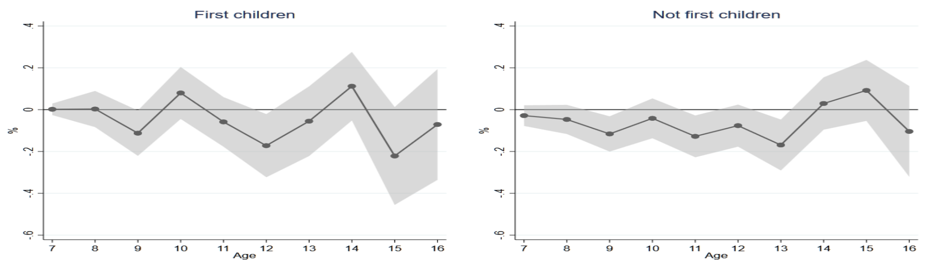
(b) Quality of Health Services



(c) Socioeconomic Status of School

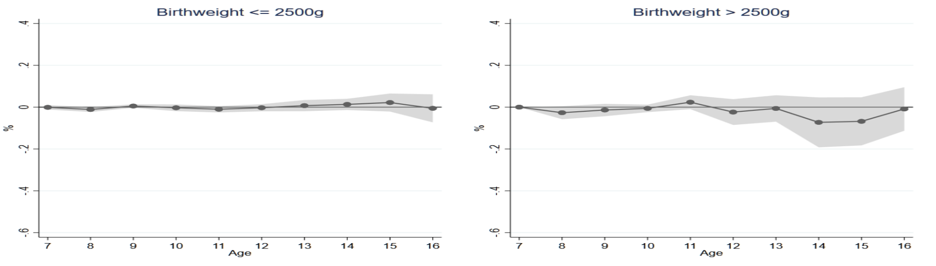


(d) Mother's education

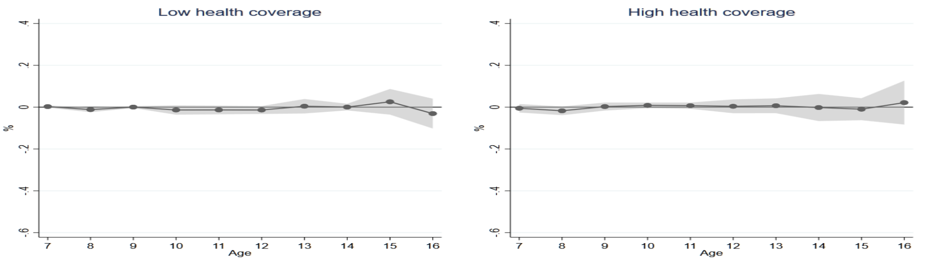


(e) Number of children

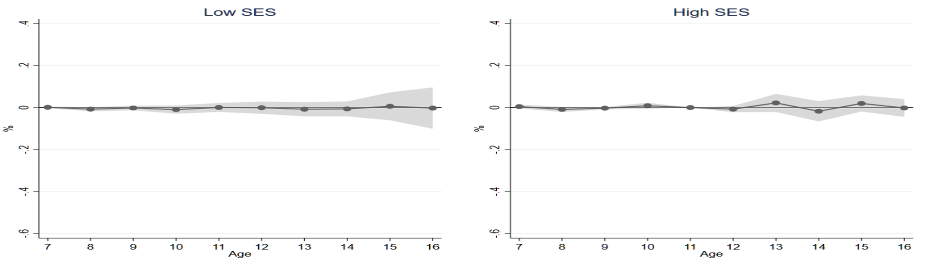
Figure 2.9 – TFE Heterogeneity for Retention Rates



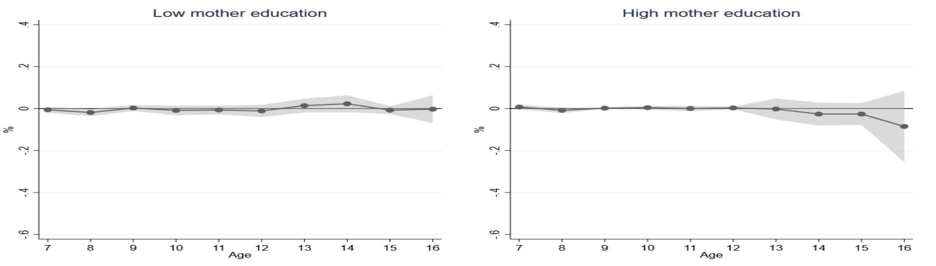
(a) Birth weight



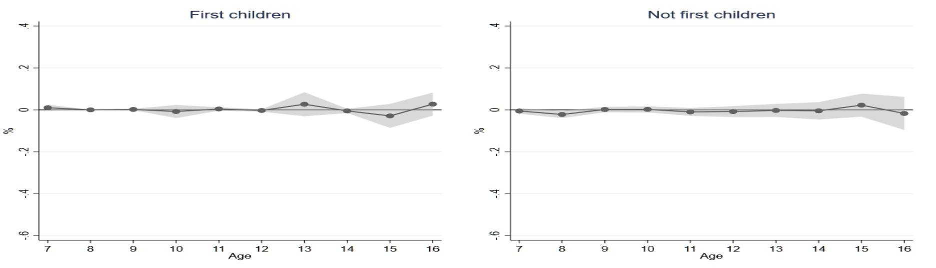
(b) Quality of Health Services



(c) Socioeconomic Status of School

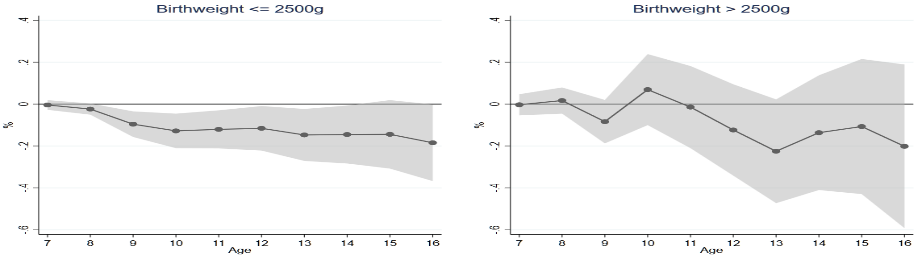


(d) Mother schooling

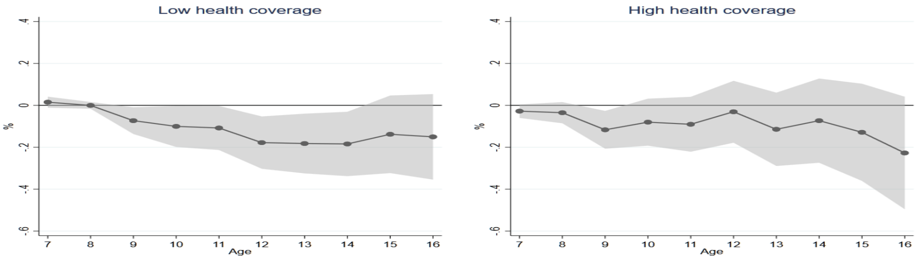


(e) Number of children

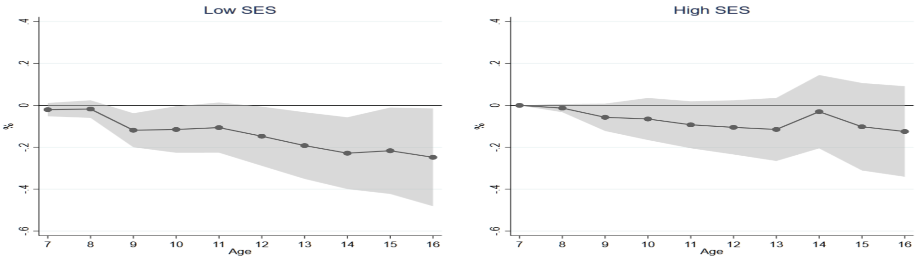
Figure 2.10 – TFE Heterogeneity for Dropout Rates



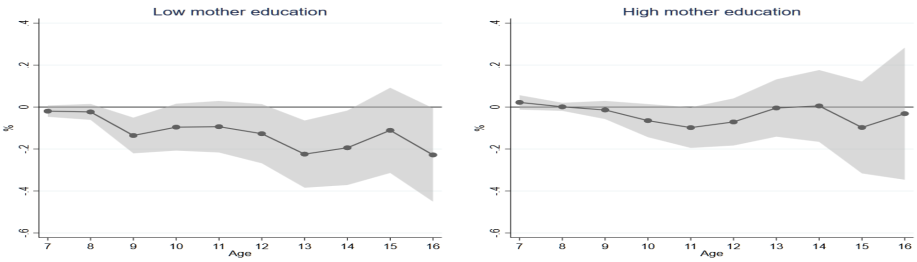
(a) Birth weight



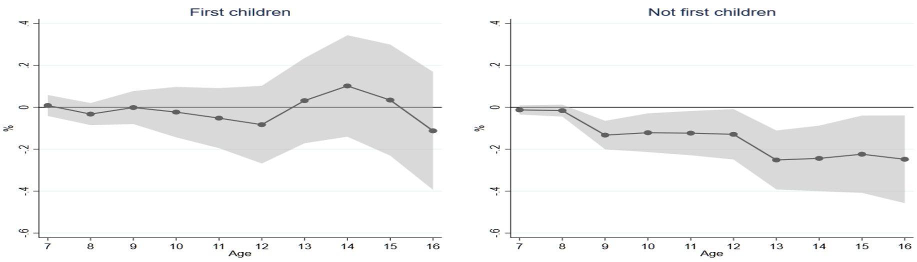
(b) Quality of Health Services



(c) Socioeconomic Status of School

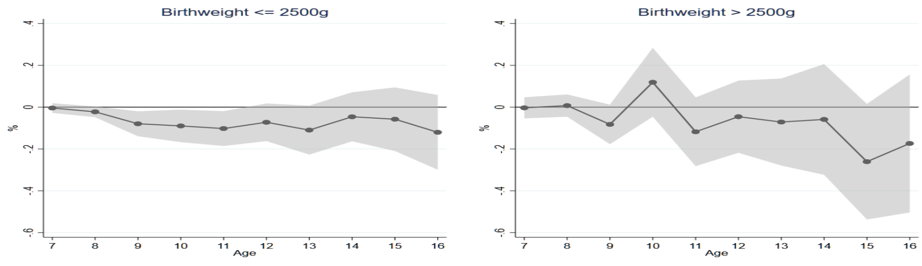


(d) Mother schooling

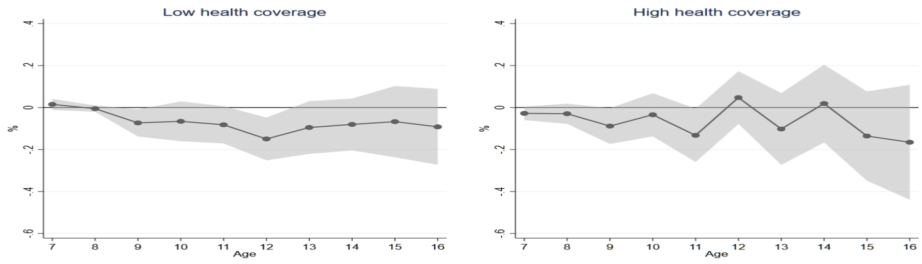


(e) Number of children

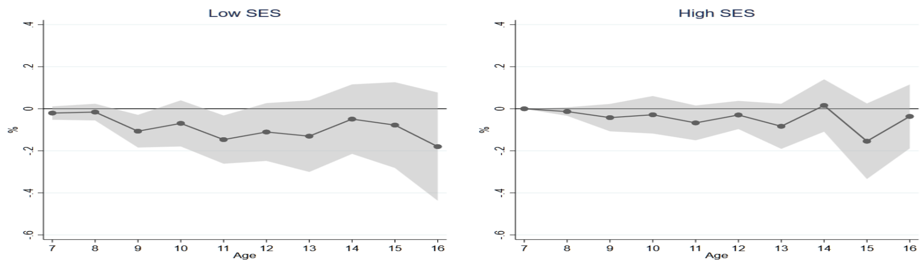
Figure 2.11 – TFE Heterogeneity for Age-Grade Distortion



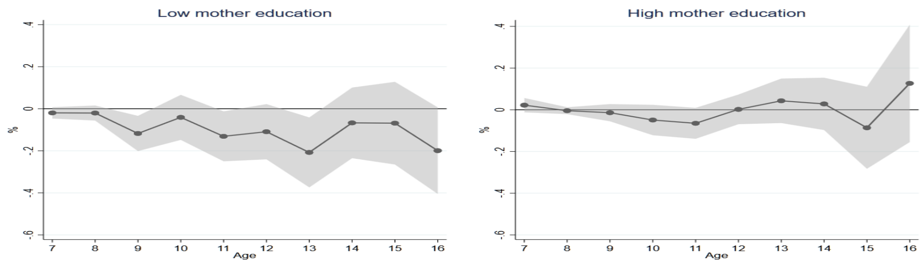
(a) Birth weight



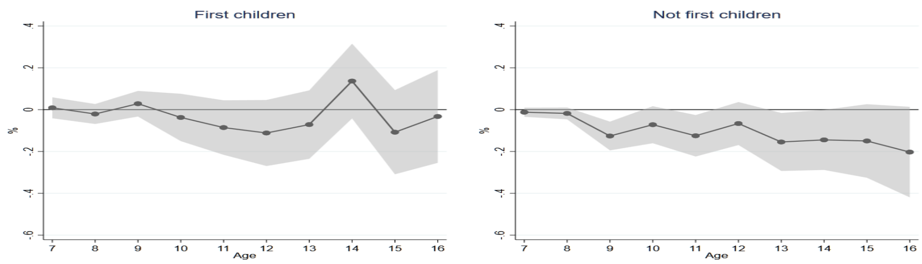
(b) Quality of Health Services



(c) Socioeconomic Status of School



(d) Mother schooling



(e) Number of children

Figure 2.12 – TFE Heterogeneity for Non-cumulative Age-Grade Distortion

2.6 Final Remarks

This paper presents the first estimations for Brazil of the effects of birth weight on health and educational outcomes, using a twin fixed effects approach. Administrative records related to birth and school enrollment were linked using the date of birth, municipality of birth, gender and municipality of residence. The main finding is that birth weight does matter: it has effects on infants' health and on educational outcomes. For the Apgar score, we found evidence that a 10% increase in weight is associated with a 0.6% increase in Apgar. While the percentage impact can be considered small, the coefficient is 1.5 times larger than the one found for Norway, meaning that a poor initial endowment may have stronger effects in Brazil.

For the educational outcomes, the findings suggest that a 10% increase in birth weight is associated with a 6% increase in the chances of completing high school by the age of 17 and with a 3.6% decrease in the probability of repeating a grade. We also found effects of birth weight in the reduction of the probability of being older than the expected for a grade after 9 years of age, but found no effects for school dropout. Furthermore, the differences in the magnitude of the OLS and TFE estimates reveal that parents act in a way that reinforces, rather than compensates, the negative effects of an adverse initial health condition. When heterogeneous effects are considered, we learn that most of the overall effects found are accentuated for those with low birth weight, less access to basic health care services, low educated mothers and education at schools of lower socioeconomic status.

The evidence that children born in municipalities with worse supply of a community-based health program and that children with lower socioeconomic background are more sensitive to birth weight justify the implementation of public policies, in the fields of health and education, targeting the most vulnerable groups. For instance, Duncan e Sojourner (2013) show that the Infant Health and Development Program (IHDP) has much larger impacts among low-income than high-income children[23].Similar public policies can be designed in Brazil, aimed at boosting early development of low-birthweight infants, especially those born of in a disadvantaged socioeconomic context.

The focus on maternal care, prenatal care and *in-utero* development can ensure more equal initial conditions for children, giving them fairer opportunities in life. After all, most of the parental background (education, wealth) closely associated with a child's development is not easily malleable by means of public policies. However, this does not seem to be the case of health at birth and immediate neonatal care, which are sensitive to health interventions and responsive to improvements in the environment to which the mother is exposed. Further research is needed to investigate the potential effects of interventions that seek to reduce pre-birth gaps in Brazil.

[23] The IHDP delivered a center-based curriculum targeting diverse groups of low birthweight children aged one to two years old.

2.A Appendix B

Table 2.9 – TFE Apgar - By birth weight

Variable	(1) Apgar 1st minute	(2) Apgar 5th minute
Low birthweight		
Ln weight	0.848***	0.514***
	(0.193)	(0.110)
Gender-Female	0.0158	0.0257
	(0.0335)	(0.0217)
Observations	4,204	4,198
R-squared	0.760	0.810
Without low birthweight		
Ln weight	0.675**	0.597***
	(0.311)	(0.207)
Gender-Female	0.0571	0.0239
	(0.0366)	(0.0252)
Observations	2,434	2,414
R-squared	0.790	0.851

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.10 – TFE Apgar - By Quality of Health Services

VARIABLES	(1) Apgar 1st minute	(2) Apgar 5th minute
Low health quality		
Ln weight	0.933***	0.496***
	(0.234)	(0.121)
Gender-Female	0.0518	0.0128
	(0.0329)	(0.0215)
Observations	3,742	3,750
R-squared	0.768	0.809
High health quality		
Ln weight	0.699***	0.564***
	(0.239)	(0.162)
Gender-Female	0.00691	0.0401
	(0.0386)	(0.0258)
Observations	2,896	2,862
R-squared	0.777	0.846

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.11 – TFE Apgar - By Mother schooling

Variables	(1) Apgar 1st minute	(2) Apgar 5th minute
Low mother education		
Ln weight	1.174***	0.524***
	(0.214)	(0.127)
Gender-Female	0.0305	0.0241
	(0.0332)	(0.0224)
Observations	3,904	3,886
R-squared	0.771	0.829
High mother education		
Ln weight	1.167***	0.577***
	(0.303)	(0.172)
Gender-Female	0.0535	0.0391
	(0.0423)	(0.0270)
Observations	2,372	2,366
R-squared	0.759	0.807

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.12 – TFE Apgar - Number of Children

Variables	(1) Apgar 1st minute	(2) Apgar 5th minute
First children		
Ln weight	1.174***	0.682***
	(0.377)	(0.196)
Gender-Female	0.0423	0.0277
	(0.0520)	(0.0308)
Observations	1,634	1,632
R-squared	0.774	0.844
Has other children		
Ln weight	0.631***	0.431***
	(0.186)	(0.117)
Gender-Female	0.0254	0.0209
	(0.0291)	(0.0208)
Observations	4,598	4,578
R-squared	0.776	0.820

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.13 – TFE Redo - By birth weight

Variable	(1) Retention	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Without low birthweight											
Ln weight	-1.04e-05	0.0130	-0.0678	-0.101	0.152*	-0.151*	-0.0669	-0.0588	0.0462	-0.0465	-0.138
	(0.119)	(0.0388)	(0.0587)	(0.0810)	(0.0918)	(0.0815)	(0.106)	(0.102)	(0.133)	(0.136)	(0.186)
Gender-Female	-0.140***	-0.00729	-0.0298***	-0.0480***	-0.0290***	-0.0525***	-0.0723***	-0.0589***	-0.0800***	-0.0640***	-0.0698***
	(0.0130)	(0.00459)	(0.00709)	(0.00836)	(0.00941)	(0.00873)	(0.0111)	(0.0115)	(0.0140)	(0.0167)	(0.0222)
Observations	2,622	1,836	2,280	2,548	2,570	2,574	2,182	1,812	1,456	1,080	714
R-squared	0.769	0.849	0.786	0.738	0.644	0.678	0.618	0.667	0.627	0.655	0.642
Low birthweight											
Ln weight	-0.150***	-0.0229	-0.0306	-0.0962**	-0.0366	-0.0945**	-0.100**	-0.111**	0.0557	0.0325	-0.104
	(0.0539)	(0.0193)	(0.0300)	(0.0383)	(0.0425)	(0.0427)	(0.0440)	(0.0547)	(0.0554)	(0.0667)	(0.0961)
Gender-Female	-0.130***	-0.00178	-0.0261***	-0.0371***	-0.0588***	-0.0559***	-0.0538***	-0.0666***	-0.0723***	-0.0744***	-0.0810***
	(0.0101)	(0.00313)	(0.00535)	(0.00705)	(0.00785)	(0.00727)	(0.00800)	(0.00994)	(0.0116)	(0.0134)	(0.0172)
Observations	4,604	3,170	3,910	4,472	4,500	4,510	3,782	3,112	2,506	1,868	1,210
R-squared	0.764	0.874	0.798	0.722	0.674	0.672	0.625	0.605	0.611	0.636	0.586

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.14 – TFE Redo - Quality of Health Service

Variable	(1) Retention	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low health quality											
Ln weight	-0.107	-0.0133	-0.0462	-0.0785*	0.0166	-0.107**	-0.123**	-0.0413	0.0438	0.0118	-0.138
	(0.0662)	(0.0159)	(0.0317)	(0.0431)	(0.0497)	(0.0485)	(0.0519)	(0.0587)	(0.0628)	(0.0748)	(0.111)
Gender-Female	-0.131***	0.000166	-0.0211***	-0.0388***	-0.0396***	-0.0440***	-0.0527***	-0.0532***	-0.0579***	-0.0748***	-0.0794***
	(0.0106)	(0.00264)	(0.00534)	(0.00695)	(0.00734)	(0.00664)	(0.00800)	(0.00906)	(0.0110)	(0.0127)	(0.0182)
Observations	3,984	2,782	3,456	3,902	3,920	3,912	3,298	2,728	2,208	1,646	1,094
R-squared	0.760	0.905	0.781	0.728	0.684	0.675	0.608	0.638	0.652	0.657	0.575
High health quality											
Ln weight	-0.159**	-0.0249	-0.0247	-0.126**	-0.0218	-0.0944	-0.0678	-0.174**	0.0691	0.0331	-0.0674
	(0.0729)	(0.0334)	(0.0461)	(0.0560)	(0.0604)	(0.0607)	(0.0639)	(0.0810)	(0.0831)	(0.0959)	(0.138)
Gender-Female	-0.137***	-0.00911*	-0.0354***	-0.0439***	-0.0586***	-0.0674***	-0.0709***	-0.0765***	-0.0968***	-0.0649***	-0.0740***
	(0.0121)	(0.00481)	(0.00693)	(0.00851)	(0.0100)	(0.00938)	(0.0107)	(0.0127)	(0.0147)	(0.0171)	(0.0206)
Observations	3,242	2,224	2,734	3,118	3,150	3,172	2,666	2,196	1,754	1,302	830
R-squared	0.766	0.829	0.804	0.727	0.646	0.671	0.629	0.615	0.584	0.627	0.640

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.15 – TFE Redo - Socioeconomic Status of School

Variable	(1) Retention	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low school socioeconomic level											
Ln weight	-0.108	-0.0146	-0.0324	-0.155***	0.0279	-0.137**	-0.141**	-0.124*	0.0750	0.0822	-0.0891
	(0.0706)	(0.0309)	(0.0377)	(0.0541)	(0.0619)	(0.0556)	(0.0657)	(0.0744)	(0.0727)	(0.0856)	(0.118)
Gender-Female	-0.152***	-0.00515	-0.0336***	-0.0490***	-0.0573***	-0.0693***	-0.0744***	-0.0756***	-0.0889***	-0.0709***	-0.0800***
	(0.0113)	(0.00434)	(0.00612)	(0.00818)	(0.00916)	(0.00811)	(0.00987)	(0.0111)	(0.0131)	(0.0147)	(0.0185)
Observations	3,892	2,658	3,294	3,758	3,800	3,808	3,268	2,748	2,226	1,626	1,038
R-squared	0.762	0.840	0.789	0.723	0.664	0.691	0.622	0.625	0.614	0.647	0.633
High school socioeconomic level											
Ln weight	-0.104	-0.0312*	-0.0293	-0.0192	-0.0459	-0.131**	-0.0534	-0.0597	0.131**	-0.0635	-0.0674
	(0.0718)	(0.0184)	(0.0281)	(0.0438)	(0.0457)	(0.0527)	(0.0379)	(0.0581)	(0.0610)	(0.0887)	(0.122)
Gender-Female	-0.103***	-0.00320	-0.0182***	-0.0248***	-0.0363***	-0.0261***	-0.0278***	-0.0370***	-0.0368***	-0.0614***	-0.0624***
	(0.0118)	(0.00279)	(0.00568)	(0.00703)	(0.00761)	(0.00714)	(0.00740)	(0.00944)	(0.0110)	(0.0140)	(0.0195)
Observations	2,690	1,914	2,352	2,658	2,670	2,670	2,262	1,858	1,510	1,166	806
R-squared	0.766	0.905	0.794	0.741	0.644	0.621	0.618	0.615	0.651	0.660	0.579

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.16 – TFE Redo - Mother Schooling

Variable	(1) Retention	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low mother education											
Ln weight	-0.155**	-0.0196	-0.0784*	-0.116**	0.0573	-0.101*	-0.129**	-0.181***	0.0852	0.0610	-0.195
	(0.0688)	(0.0275)	(0.0420)	(0.0508)	(0.0579)	(0.0562)	(0.0604)	(0.0670)	(0.0733)	(0.0820)	(0.123)
Gender-Female	-0.150***	-0.00712*	-0.0342***	-0.0498***	-0.0521***	-0.0694***	-0.0830***	-0.0847***	-0.0910***	-0.0900***	-0.0928***
	(0.0111)	(0.00396)	(0.00635)	(0.00796)	(0.00889)	(0.00837)	(0.00957)	(0.0107)	(0.0124)	(0.0150)	(0.0191)
Observations	4,256	2,874	3,708	4,112	4,138	4,160	3,598	3,010	2,416	1,798	1,094
R-squared	0.752	0.853	0.797	0.729	0.671	0.675	0.621	0.635	0.611	0.632	0.620
High mother education											
Ln weight	-0.0655	-0.0193	0.0292	-0.0564	-0.0609	-0.0836*	-0.0546	0.0456	0.0356	-0.00632	0.158
	(0.0734)	(0.0193)	(0.0245)	(0.0439)	(0.0424)	(0.0440)	(0.0414)	(0.0641)	(0.0643)	(0.0887)	(0.125)
Gender-Female	-0.0949***	0.000226	-0.0169***	-0.0242***	-0.0339***	-0.0260***	-0.0216***	-0.0337***	-0.0413***	-0.0470***	-0.0504**
	(0.0116)	(0.00322)	(0.00511)	(0.00677)	(0.00740)	(0.00619)	(0.00745)	(0.00998)	(0.0128)	(0.0141)	(0.0205)
Observations	2,516	2,006	2,318	2,464	2,482	2,472	1,952	1,520	1,172	814	532
R-squared	0.735	0.892	0.742	0.687	0.624	0.616	0.594	0.586	0.641	0.664	0.548

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.17 – TFE Redo - Number of Children

Variable	(1) Retention	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
First children											
Ln weight	-0.108	0.00171	0.00305	-0.113**	0.0797	-0.0585	-0.172**	-0.0551	0.112	-0.222*	-0.0710
	(0.0884)	(0.0140)	(0.0441)	(0.0552)	(0.0633)	(0.0604)	(0.0769)	(0.0848)	(0.0834)	(0.119)	(0.134)
Gender-Female	-0.111***	-0.00153	-0.0200***	-0.0292***	-0.0212**	-0.0415***	-0.0359***	-0.0399***	-0.0791***	-0.0836***	-0.0590**
	(0.0144)	(0.00431)	(0.00736)	(0.00879)	(0.00962)	(0.00857)	(0.0110)	(0.0135)	(0.0171)	(0.0189)	(0.0249)
Observations	1,696	1,260	1,492	1,662	1,670	1,672	1,366	1,114	884	644	422
R-squared	0.766	0.884	0.737	0.703	0.657	0.706	0.614	0.561	0.566	0.690	0.510
Has other children											
Ln weight	-0.166***	-0.0285	-0.0469	-0.116***	-0.0415	-0.128**	-0.0764	-0.169***	0.0294	0.0921	-0.104
	(0.0623)	(0.0252)	(0.0355)	(0.0429)	(0.0486)	(0.0509)	(0.0513)	(0.0620)	(0.0638)	(0.0742)	(0.110)
Gender-Female	-0.144***	-0.00541	-0.0321***	-0.0488***	-0.0566***	-0.0592***	-0.0675***	-0.0779***	-0.0793***	-0.0688***	-0.0746***
	(0.0101)	(0.00335)	(0.00556)	(0.00695)	(0.00776)	(0.00730)	(0.00830)	(0.00943)	(0.0110)	(0.0131)	(0.0169)
Observations	5,008	3,416	4,274	4,860	4,896	4,908	4,156	3,434	2,758	2,068	1,334
R-squared	0.756	0.859	0.801	0.734	0.664	0.666	0.619	0.634	0.620	0.618	0.632

Note: Clustered standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2.18 – TFE Dropout - By birth weight

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Variables	Dropout	At age 7	At age 8	At age 9	At age 10	At age 11	At age 12	At age 13	At age 14	At age 15	At age 16
Low birthweight											
Ln weight	0.00146	-0.000865	-0.0112*	0.00539	-0.00295	-0.0101	-0.00284	0.00728	0.0132	0.0221	-0.00559
	(0.0192)	(0.00537)	(0.00605)	(0.00422)	(0.00817)	(0.00774)	(0.00861)	(0.0137)	(0.0136)	(0.0219)	(0.0341)
Gender-Female	-0.0117***	-4.37e-05	-0.00157	0.000278	-0.000154	-0.00206	-0.00386**	-0.00575*	0.00163	-0.00450	-0.00672
	(0.00415)	(0.00129)	(0.00132)	(0.000974)	(0.00152)	(0.00189)	(0.00174)	(0.00323)	(0.00338)	(0.00298)	(0.00738)
Observations	4,604	3,490	4,052	4,566	4,586	3,894	3,230	2,624	2,038	1,446	930
R-squared	0.619	0.624	0.625	0.749	0.624	0.499	0.666	0.548	0.564	0.749	0.560
Without low birthweight											
Ln weight	-0.103**	0	-0.0265*	-0.0137	-0.00592	0.0236	-0.0235	-0.00618	-0.0727	-0.0678	-0.00873
	(0.0517)	(0)	(0.0159)	(0.0151)	(0.00906)	(0.0169)	(0.0314)	(0.0321)	(0.0607)	(0.0585)	(0.0529)
Gender-Female	-0.0139***	0	-0.00408**	-0.00493**	-0.00167	0.000596	-0.00275	-0.00410	0.00188	0.00359	-0.00784
	(0.00497)	(0)	(0.00205)	(0.00204)	(0.00168)	(0.00140)	(0.00272)	(0.00353)	(0.00386)	(0.00458)	(0.00898)
Observations	2,622	2,012	2,348	2,606	2,614	2,228	1,870	1,518	1,166	846	524
R-squared	0.641		0.751	0.626	0.500	0.750	0.500	0.499	0.700	0.502	0.496

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.19 – TFE Dropout - Quality of Health Service

Variables	(1) Dropout	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low health quality											
Ln weight	-0.0281	0.00275	-0.0118*	0.000222	-0.0135	-0.0134	-0.0136	0.00443	0.000314	0.0257	-0.0308
	(0.0219)	(0.00262)	(0.00621)	(0.00238)	(0.0114)	(0.0106)	(0.00961)	(0.0176)	(0.00804)	(0.0312)	(0.0363)
Gender-Female	-0.0108***	0.000767	-0.00275**	-0.000495	-0.00211*	-0.00236	-0.00273*	-0.00503	0.00227	-0.000461	-0.0114
	(0.00391)	(0.00111)	(0.00137)	(0.000775)	(0.00124)	(0.00177)	(0.00159)	(0.00355)	(0.00214)	(0.00392)	(0.00797)
Observations	3,984	3,066	3,558	3,964	3,968	3,376	2,818	2,302	1,774	1,282	806
R-squared	0.638	0.700	0.667	0.833	0.611	0.501	0.502	0.553	0.749	0.609	0.579
High health quality											
Ln weight	0.00245	-0.00528	-0.0174*	0.00286	0.00843	0.00705	0.00406	0.00676	-0.00174	-0.00979	0.0216
	(0.0310)	(0.0103)	(0.0106)	(0.00977)	(0.00684)	(0.00761)	(0.0168)	(0.0181)	(0.0330)	(0.0267)	(0.0533)
Gender-Female	-0.0141***	-0.00104	-0.00214	-0.00301	0.000949	0.000279	-0.00423	-0.00519*	0.00134	-0.00225	-0.00248
	(0.00521)	(0.00113)	(0.00181)	(0.00191)	(0.00200)	(0.00195)	(0.00258)	(0.00315)	(0.00510)	(0.00304)	(0.00849)
Observations	3,242	2,436	2,842	3,208	3,232	2,746	2,282	1,840	1,430	1,010	648
R-squared	0.614	0.500	0.700	0.590	0.590	0.624	0.653	0.499	0.554	0.784	0.493

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.20 – TFE Dropout - Socioeconomic Status of School

Variables	(1) Dropout	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low school socioeconomic level											
Ln weight	-0.00928	0.00120	-0.00758	-0.00202	-0.00975	0.000580	-0.000694	-0.00804	-0.00634	0.00602	-0.00248
	(0.0270)	(0.00206)	(0.00522)	(0.00562)	(0.00996)	(0.0109)	(0.0149)	(0.0172)	(0.0181)	(0.0338)	(0.0501)
Gender-Female	-0.0137***	0.000733	-0.00209	-0.00216	-0.000922	-0.000572	-0.00494**	-0.00545	0.00310	-0.00294	-0.00520
	(0.00476)	(0.00121)	(0.00150)	(0.00155)	(0.00168)	(0.00212)	(0.00227)	(0.00336)	(0.00392)	(0.00416)	(0.00814)
Observations	3,892	2,934	3,412	3,852	3,876	3,354	2,848	2,330	1,806	1,274	782
R-squared	0.646	0.500	0.772	0.714	0.653	0.590	0.591	0.553	0.563	0.711	0.564
High school socioeconomic level											
Ln weight	0.00405	0.00452	-0.00872	-0.00292	0.00862	0	-0.00758	0.0220	-0.0176	0.0196	-0.00196
	(0.0218)	(0.00454)	(0.00629)	(0.00293)	(0.00714)	(0)	(0.00759)	(0.0220)	(0.0246)	(0.0196)	(0.0214)
Gender-Female	-0.00653*	-0.000805	-0.00201	0.000631	-0.00263**	0	0.000732	-0.00422	-0.000833	-0.00144	-8.97e-05
	(0.00371)	(0.000805)	(0.00142)	(0.000631)	(0.00133)	(0)	(0.000732)	(0.00387)	(0.00264)	(0.00145)	(0.00697)
Observations	2,690	2,056	2,394	2,680	2,688	2,290	1,896	1,556	1,204	892	594
R-squared	0.530	0.501	0.501	0.500	0.501		0.501	0.499	0.665	0.503	0.497

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.21 – TFE Dropout - Mother Schooling

Variables	(1) Dropout	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low mother education											
Ln weight	-0.0210	-0.00579	-0.0187**	0.00269	-0.00880	-0.00688	-0.0112	0.0139	0.0228	-0.00750	-0.00280
	(0.0256)	(0.00706)	(0.00861)	(0.00730)	(0.0118)	(0.0107)	(0.0146)	(0.0165)	(0.0205)	(0.00935)	(0.0334)
Gender-Female	-0.0127***	0.000980	-0.00344**	-0.00273*	-0.000856	-0.000839	-0.00493**	-0.00339	0.00283	0.00118	-0.0124
	(0.00466)	(0.00114)	(0.00153)	(0.00153)	(0.00190)	(0.00203)	(0.00229)	(0.00323)	(0.00327)	(0.00331)	(0.00817)
Observations	4,256	3,246	3,856	4,220	4,240	3,710	3,140	2,542	1,986	1,384	812
R-squared	0.624	0.666	0.682	0.722	0.557	0.499	0.633	0.550	0.569	0.721	0.496
High mother education											
Ln weight	-0.0125	0.00740	-0.00823	0.00192	0.00428	0.000320	0.00306	-0.00223	-0.0261	-0.0262	-0.0854
	(0.0205)	(0.00539)	(0.00679)	(0.00193)	(0.00429)	(0.00658)	(0.00308)	(0.0256)	(0.0276)	(0.0263)	(0.0859)
Gender-Female	-0.0124***	-0.00159	-0.00117	-0.000722	-0.000625	-0.00200	-0.00115	-0.0116***	0.00116	-0.00444	0.00835
	(0.00385)	(0.00112)	(0.00170)	(0.000722)	(0.000625)	(0.00143)	(0.00115)	(0.00449)	(0.00368)	(0.00443)	(0.0118)
Observations	2,516	2,128	2,376	2,500	2,506	1,992	1,562	1,214	852	570	324
R-squared	0.602	0.501	0.700	0.500	0.833	0.501	0.500	0.503	0.699	0.503	0.501

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.22 – TFE Dropout - Number of Children

Variables	(1) Dropout	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
First children											
Ln weight	0.0125	0.0102	0	0.00184	-0.00779	0.00416	-0.00287	0.0268	-0.00501	-0.0289	0.0274
	(0.0247)	(0.00744)	(0)	(0.00186)	(0.0159)	(0.00419)	(0.00292)	(0.0292)	(0.00511)	(0.0290)	(0.0278)
Gender-Female	-0.00662	-0.00257	0	-0.00112	-0.00146	0.00160	-0.00187	-0.00552	0.00276	-0.00502	0.00790
	(0.00533)	(0.00182)	(0)	(0.00112)	(0.00243)	(0.00160)	(0.00187)	(0.00622)	(0.00276)	(0.00501)	(0.00791)
Observations	1,696	1,360	1,534	1,686	1,694	1,386	1,136	910	678	474	284
R-squared	0.610	0.750		0.500	0.642	0.501	0.501	0.498	0.833	0.504	0.503
Has other children											
Ln weight	-0.0349	-0.00537	-0.0220**	0.00156	0.00222	-0.00987	-0.00815	-0.00283	-0.00469	0.0225	-0.0171
	(0.0242)	(0.00652)	(0.00887)	(0.00670)	(0.00737)	(0.00975)	(0.0133)	(0.0159)	(0.0211)	(0.0280)	(0.0402)
Gender-Female	-0.0143***	0.00135	-0.00373**	-0.00154	-0.000702	-0.00184	-0.00428**	-0.00495*	0.00157	-0.000359	-0.0122
	(0.00414)	(0.000819)	(0.00165)	(0.00128)	(0.00143)	(0.00180)	(0.00201)	(0.00277)	(0.00335)	(0.00322)	(0.00765)
Observations	5,008	3,776	4,418	4,966	4,984	4,276	3,574	2,894	2,272	1,622	1,046
R-squared	0.625	0.501	0.643	0.721	0.582	0.590	0.633	0.498	0.597	0.698	0.543

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.23 – TFE Age grade distortion - By birth weight

Variables	(1) Grade distortion	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low birthweight											
Ln weight	-0.0646	-0.00413	-0.0238*	-0.0958***	-0.128***	-0.121***	-0.116**	-0.147**	-0.145**	-0.144*	-0.185**
	(0.0509)	(0.0118)	(0.0136)	(0.0311)	(0.0420)	(0.0463)	(0.0542)	(0.0632)	(0.0704)	(0.0833)	(0.0931)
Gender-Female	-0.126***	-0.00431**	-0.0107***	-0.0344***	-0.0726***	-0.0879***	-0.107***	-0.141***	-0.152***	-0.139***	-0.119***
	(0.00944)	(0.00200)	(0.00268)	(0.00572)	(0.00783)	(0.00845)	(0.00964)	(0.0113)	(0.0133)	(0.0153)	(0.0183)
Observations	4,604	3,910	4,446	4,476	4,488	4,478	3,746	3,100	2,500	1,872	1,208
R-squared	0.765	0.923	0.865	0.767	0.747	0.751	0.753	0.760	0.748	0.761	0.774
Without low birthweight											
Ln weight	-0.0595	-0.00322	0.0170	-0.0837	0.0692	-0.0143	-0.123	-0.225*	-0.136	-0.107	-0.202
	(0.111)	(0.0257)	(0.0318)	(0.0528)	(0.0864)	(0.0999)	(0.111)	(0.126)	(0.139)	(0.164)	(0.199)
Gender-Female	-0.119***	-0.00183	-0.00352	-0.0271***	-0.0474***	-0.0751***	-0.0985***	-0.123***	-0.128***	-0.134***	-0.136***
	(0.0120)	(0.00273)	(0.00243)	(0.00627)	(0.00944)	(0.0108)	(0.0125)	(0.0148)	(0.0165)	(0.0193)	(0.0237)
Observations	2,622	2,290	2,540	2,554	2,570	2,540	2,160	1,792	1,444	1,060	698
R-squared	0.773	0.905	0.903	0.819	0.736	0.735	0.744	0.742	0.757	0.767	0.765

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.24 – TFE Age grade distortion - Quality of Health Service

Variables	(1) Grade distortion	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low health quality											
Ln weight	-0.0640	0.0151	-0.000248	-0.0730**	-0.100**	-0.108**	-0.178***	-0.182**	-0.184**	-0.138	-0.150
	(0.0592)	(0.0135)	(0.00826)	(0.0326)	(0.0500)	(0.0536)	(0.0637)	(0.0727)	(0.0783)	(0.0943)	(0.104)
Gender-Female	-0.113***	6.63e-05	-0.00259	-0.0278***	-0.0577***	-0.0738***	-0.0918***	-0.114***	-0.120***	-0.123***	-0.110***
	(0.00956)	(0.00166)	(0.00178)	(0.00543)	(0.00778)	(0.00822)	(0.00949)	(0.0112)	(0.0128)	(0.0151)	(0.0185)
Observations	3,984	3,458	3,874	3,902	3,896	3,882	3,286	2,724	2,220	1,642	1,088
R-squared	0.765	0.933	0.912	0.783	0.749	0.756	0.756	0.755	0.767	0.772	0.764
High health quality											
Ln weight	-0.0574	-0.0277*	-0.0350	-0.117**	-0.0802	-0.0903	-0.0306	-0.114	-0.0730	-0.129	-0.227*
	(0.0729)	(0.0164)	(0.0258)	(0.0460)	(0.0572)	(0.0668)	(0.0753)	(0.0892)	(0.102)	(0.118)	(0.137)
Gender-Female	-0.136***	-0.00772**	-0.0148***	-0.0365***	-0.0708***	-0.0953***	-0.119***	-0.159***	-0.172***	-0.155***	-0.144***
	(0.0116)	(0.00303)	(0.00371)	(0.00686)	(0.00952)	(0.0108)	(0.0124)	(0.0146)	(0.0170)	(0.0192)	(0.0228)
Observations	3,242	2,742	3,112	3,128	3,162	3,136	2,620	2,168	1,724	1,290	818
R-squared	0.766	0.901	0.857	0.787	0.736	0.734	0.740	0.745	0.730	0.750	0.773

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.25 – TFE Age grade distortion - Socioeconomic Status of School

Variables	(1) Grade distortion	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low school socioeconomic level											
Ln weight	-0.0738	-0.0205	-0.0177	-0.119***	-0.115**	-0.106*	-0.147**	-0.192**	-0.228***	-0.217**	-0.248**
	(0.0662)	(0.0162)	(0.0214)	(0.0413)	(0.0566)	(0.0610)	(0.0720)	(0.0810)	(0.0873)	(0.105)	(0.119)
Gender-Female	-0.148***	-0.00696***	-0.0141***	-0.0390***	-0.0760***	-0.102***	-0.132***	-0.173***	-0.179***	-0.161***	-0.157***
	(0.0106)	(0.00262)	(0.00308)	(0.00657)	(0.00889)	(0.00968)	(0.0113)	(0.0132)	(0.0150)	(0.0174)	(0.0206)
Observations	3,892	3,294	3,734	3,768	3,790	3,774	3,220	2,720	2,206	1,620	1,030
R-squared	0.770	0.915	0.858	0.784	0.747	0.748	0.737	0.744	0.741	0.750	0.778

Variables	(1) Grade distortion	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
High school socioeconomic level											
Ln weight	-0.0226	-0.000103	-0.0130	-0.0571*	-0.0651	-0.0927	-0.105	-0.115	-0.0302	-0.102	-0.125
	(0.0661)	(0.000184)	(0.0101)	(0.0333)	(0.0512)	(0.0571)	(0.0659)	(0.0767)	(0.0891)	(0.106)	(0.110)
Gender-Female	-0.0894***	-0.000854	-0.00203	-0.0181***	-0.0415***	-0.0528***	-0.0594***	-0.0740***	-0.0792***	-0.0913***	-0.0755***
	(0.0105)	(0.000855)	(0.00186)	(0.00514)	(0.00816)	(0.00893)	(0.00966)	(0.0115)	(0.0134)	(0.0156)	(0.0184)
Observations	2,690	2,352	2,642	2,652	2,668	2,642	2,254	1,852	1,514	1,158	798
R-squared	0.759	0.978	0.916	0.779	0.706	0.717	0.757	0.762	0.759	0.776	0.773

Note: Clustered standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2.26 – TFE Age grade distortion - Mother Schooling

Variables	(1) Grade distortion	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low mother education											
Ln weight	-0.0698	-0.0195	-0.0232	-0.135***	-0.0958*	-0.0936	-0.127*	-0.224***	-0.194**	-0.111	-0.228**
	(0.0677)	(0.0138)	(0.0193)	(0.0434)	(0.0569)	(0.0627)	(0.0719)	(0.0816)	(0.0904)	(0.103)	(0.113)
Gender-Female	-0.145***	-0.00570**	-0.0103***	-0.0426***	-0.0766***	-0.103***	-0.129***	-0.171***	-0.172***	-0.156***	-0.148***
	(0.0105)	(0.00247)	(0.00295)	(0.00660)	(0.00896)	(0.00970)	(0.0110)	(0.0127)	(0.0143)	(0.0163)	(0.0197)
Observations	4,256	3,716	4,098	4,132	4,138	4,126	3,556	2,988	2,406	1,782	1,080
R-squared	0.762	0.909	0.874	0.785	0.745	0.747	0.745	0.744	0.743	0.758	0.784
High mother education											
Ln weight	-0.00797	0.0222	0.00119	-0.0139	-0.0646	-0.0980**	-0.0709	-0.00445	0.00535	-0.0972	-0.0315
	(0.0607)	(0.0175)	(0.00979)	(0.0221)	(0.0402)	(0.0493)	(0.0572)	(0.0695)	(0.0871)	(0.111)	(0.160)
Gender-Female	-0.0758***	4.51e-05	-0.00404*	-0.0152***	-0.0374***	-0.0481***	-0.0593***	-0.0661***	-0.0901***	-0.107***	-0.0694***
	(0.0102)	(0.00187)	(0.00212)	(0.00452)	(0.00735)	(0.00827)	(0.00952)	(0.0118)	(0.0149)	(0.0184)	(0.0230)
Observations	2,516	2,322	2,446	2,454	2,468	2,444	1,944	1,518	1,174	816	528
R-squared	0.705	0.921	0.886	0.747	0.665	0.663	0.699	0.720	0.725	0.727	0.719

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.27 – TFE Age grade distortion - Number of Children

Variables	(1) Grade distortion	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
First children											
Ln weight	0.0455	0.00884	-0.0321	-0.000953	-0.0227	-0.0514	-0.0826	0.0322	0.102	0.0348	-0.112
	(0.0835)	(0.0255)	(0.0268)	(0.0401)	(0.0614)	(0.0729)	(0.0944)	(0.103)	(0.123)	(0.135)	(0.143)
Gender-Female	-0.0986***	0.000316	-0.0132***	-0.0349***	-0.0452***	-0.0671***	-0.0851***	-0.101***	-0.127***	-0.128***	-0.109***
	(0.0130)	(0.00280)	(0.00425)	(0.00742)	(0.00971)	(0.0114)	(0.0135)	(0.0161)	(0.0205)	(0.0218)	(0.0253)
Observations	1,696	1,486	1,656	1,662	1,668	1,656	1,342	1,100	884	636	418
R-squared	0.752	0.944	0.807	0.712	0.725	0.727	0.743	0.740	0.725	0.778	0.787
Has other children											
Ln weight	-0.128**	-0.0122	-0.0156	-0.132***	-0.121**	-0.123**	-0.129**	-0.251***	-0.244***	-0.224**	-0.248**
	(0.0590)	(0.0111)	(0.0145)	(0.0347)	(0.0471)	(0.0539)	(0.0613)	(0.0718)	(0.0797)	(0.0940)	(0.107)
Gender-Female	-0.134***	-0.00337*	-0.00607***	-0.0318***	-0.0660***	-0.0889***	-0.111***	-0.149***	-0.152***	-0.148***	-0.132***
	(0.00946)	(0.00194)	(0.00220)	(0.00543)	(0.00778)	(0.00850)	(0.00975)	(0.0113)	(0.0129)	(0.0150)	(0.0185)
Observations	5,008	4,286	4,836	4,868	4,886	4,870	4,126	3,422	2,742	2,064	1,320
R-squared	0.763	0.919	0.900	0.799	0.744	0.748	0.744	0.750	0.747	0.750	0.758

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.28 – TFE Non-cumulative Age grade distortion - By birth weight

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Variables	Grade distortion	At age 7	At age 8	At age 9	At age 10	At age 11	At age 12	At age 13	At age 14	At age 15	At age 16
Low birthweight											
Ln weight	-0.0646	-0.00413	-0.0224*	-0.0794***	-0.0897**	-0.102**	-0.0723	-0.110*	-0.0461	-0.0576	-0.120
	(0.0509)	(0.0118)	(0.0131)	(0.0304)	(0.0396)	(0.0425)	(0.0459)	(0.0596)	(0.0597)	(0.0774)	(0.0909)
Gender-Female	-0.126***	-0.00431**	-0.00927***	-0.0261***	-0.0526***	-0.0519***	-0.0575***	-0.0831***	-0.0948***	-0.0794***	-0.0655***
	(0.00944)	(0.00200)	(0.00256)	(0.00543)	(0.00716)	(0.00699)	(0.00742)	(0.00988)	(0.0121)	(0.0139)	(0.0162)
Observations	4,604	3,910	4,432	4,368	4,126	3,780	2,930	2,324	1,790	1,304	872
R-squared	0.765	0.923	0.866	0.730	0.716	0.721	0.690	0.690	0.692	0.720	0.674
Without low birthweight											
Ln weight	-0.0595	-0.00322	0.00749	-0.0825*	0.119	-0.118	-0.0456	-0.0711	-0.0586	-0.261*	-0.174
	(0.111)	(0.0257)	(0.0272)	(0.0481)	(0.0839)	(0.0837)	(0.0879)	(0.106)	(0.135)	(0.141)	(0.168)
Gender-Female	-0.119***	-0.00183	-0.00220	-0.0245***	-0.0326***	-0.0543***	-0.0499***	-0.0739***	-0.0684***	-0.0935***	-0.0757***
	(0.0120)	(0.00273)	(0.00202)	(0.00603)	(0.00859)	(0.00866)	(0.00977)	(0.0126)	(0.0142)	(0.0164)	(0.0222)
Observations	2,622	2,290	2,522	2,488	2,366	2,174	1,766	1,388	1,076	772	530
R-squared	0.773	0.905	0.916	0.787	0.660	0.685	0.686	0.697	0.688	0.755	0.700

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.29 – TFE Non-cumulative Age grade distortion - Quality of Health Service

Variables	(1) Grade distortion	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low health quality											
Ln weight	-0.0640	0.0151	-0.00519	-0.0730**	-0.0657	-0.0821*	-0.150***	-0.0950	-0.0804	-0.0671	-0.0919
	(0.0592)	(0.0135)	(0.00761)	(0.0331)	(0.0483)	(0.0453)	(0.0519)	(0.0641)	(0.0629)	(0.0865)	(0.0919)
Gender-Female	-0.113***	6.63e-05	-0.00178	-0.0266***	-0.0403***	-0.0424***	-0.0462***	-0.0656***	-0.0667***	-0.0738***	-0.0551***
	(0.00956)	(0.00166)	(0.00169)	(0.00537)	(0.00703)	(0.00609)	(0.00704)	(0.00902)	(0.0104)	(0.0131)	(0.0155)
Observations	3,984	3,458	3,862	3,838	3,622	3,350	2,708	2,186	1,706	1,240	832
R-squared	0.765	0.933	0.914	0.740	0.709	0.719	0.666	0.678	0.727	0.731	0.643
High health quality											
Ln weight	-0.0574	-0.0277*	-0.0294	-0.0882**	-0.0344	-0.132**	0.0475	-0.102	0.0191	-0.136	-0.165
	(0.0729)	(0.0164)	(0.0245)	(0.0434)	(0.0524)	(0.0648)	(0.0639)	(0.0871)	(0.0944)	(0.108)	(0.139)
Gender-Female	-0.136***	-0.00772**	-0.0128***	-0.0241***	-0.0523***	-0.0657***	-0.0666***	-0.0995***	-0.111***	-0.0996***	-0.0880***
	(0.0116)	(0.00303)	(0.00342)	(0.00629)	(0.00880)	(0.00954)	(0.0102)	(0.0137)	(0.0169)	(0.0179)	(0.0222)
Observations	3,242	2,742	3,092	3,018	2,870	2,604	1,988	1,526	1,160	836	570
R-squared	0.766	0.901	0.862	0.759	0.688	0.702	0.702	0.700	0.655	0.732	0.713

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.30 – TFE Non-cumulative Age grade distortion - Socioeconomic Status of School

Variables	(1) Grade distortion	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low school socioeconomic level											
Ln weight	-0.0738	-0.0205	-0.0158	-0.107***	-0.0694	-0.147**	-0.111	-0.130	-0.0492	-0.0776	-0.180
	(0.0662)	(0.0162)	(0.0202)	(0.0396)	(0.0559)	(0.0585)	(0.0701)	(0.0867)	(0.0842)	(0.104)	(0.131)
Gender-Female	-0.148***	-0.00696***	-0.0114***	-0.0280***	-0.0562***	-0.0631***	-0.0680***	-0.115***	-0.110***	-0.0956***	-0.0857***
	(0.0106)	(0.00262)	(0.00283)	(0.00625)	(0.00822)	(0.00822)	(0.00953)	(0.0125)	(0.0148)	(0.0161)	(0.0202)
Observations	3,892	3,294	3,710	3,666	3,418	3,098	2,426	1,910	1,472	1,032	700
R-squared	0.770	0.915	0.856	0.763	0.705	0.718	0.679	0.698	0.704	0.747	0.717
High school socioeconomic level											
Ln weight	-0.0226	-0.000103	-0.0133	-0.0421	-0.0286	-0.0672	-0.0295	-0.0833	0.0156	-0.154*	-0.0364
	(0.0661)	(0.000184)	(0.0103)	(0.0332)	(0.0455)	(0.0422)	(0.0341)	(0.0546)	(0.0634)	(0.0914)	(0.0772)
Gender-Female	-0.0894***	-0.000854	-0.00204	-0.0169***	-0.0309***	-0.0294***	-0.0235***	-0.0375***	-0.0393***	-0.0611***	-0.0353***
	(0.0105)	(0.000855)	(0.00186)	(0.00491)	(0.00731)	(0.00628)	(0.00582)	(0.00857)	(0.00964)	(0.0134)	(0.0129)
Observations	2,690	2,352	2,640	2,614	2,546	2,380	1,966	1,582	1,252	956	656
R-squared	0.759	0.978	0.911	0.717	0.635	0.662	0.709	0.642	0.658	0.703	0.628

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.31 – TFE Non-cumulative Age grade distortion - Mother Schooling

Variables	(1) Grade distortion	(2) At age 7	(3) At age 8	(4) At age 9	(5) At age 10	(6) At age 11	(7) At age 12	(8) At age 13	(9) At age 14	(10) At age 15	(11) At age 16
Low mother education											
Ln weight	-0.0698	-0.0195	-0.0203	-0.118***	-0.0408	-0.131**	-0.109	-0.208**	-0.0670	-0.0685	-0.199*
	(0.0677)	(0.0138)	(0.0183)	(0.0427)	(0.0546)	(0.0606)	(0.0669)	(0.0847)	(0.0855)	(0.100)	(0.105)
Gender-Female	-0.145***	-0.00570**	-0.00824***	-0.0357***	-0.0558***	-0.0709***	-0.0776***	-0.117***	-0.110***	-0.116***	-0.0940***
	(0.0105)	(0.00247)	(0.00270)	(0.00638)	(0.00837)	(0.00850)	(0.00946)	(0.0124)	(0.0141)	(0.0162)	(0.0195)
Observations	4,256	3,716	4,076	3,992	3,670	3,274	2,574	2,040	1,540	1,126	718
R-squared	0.762	0.909	0.883	0.751	0.711	0.723	0.695	0.697	0.690	0.741	0.723
High mother education											
Ln weight	-0.00797	0.0222	-0.00423	-0.0139	-0.0491	-0.0649*	0.00205	0.0431	0.0284	-0.0862	0.127
	(0.0607)	(0.0175)	(0.00841)	(0.0210)	(0.0372)	(0.0378)	(0.0362)	(0.0543)	(0.0639)	(0.1000)	(0.143)
Gender-Female	-0.0758***	4.51e-05	-0.00346*	-0.0113***	-0.0236***	-0.0245***	-0.0244***	-0.0331***	-0.0431***	-0.0519***	-0.0248
	(0.0102)	(0.00187)	(0.00204)	(0.00418)	(0.00644)	(0.00586)	(0.00615)	(0.00855)	(0.0115)	(0.0147)	(0.0166)
Observations	2,516	2,322	2,436	2,426	2,404	2,296	1,794	1,374	1,042	710	464
R-squared	0.705	0.921	0.863	0.649	0.618	0.579	0.623	0.642	0.691	0.602	0.612

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.32 – TFE Non-cumulative Age grade distortion - Number of Children

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Variables	Grade distortion	At age 7	At age 8	At age 9	At age 10	At age 11	At age 12	At age 13	At age 14	At age 15	At age 16
First children											
Ln weight	0.0455	0.00884	-0.0209	0.0284	-0.0373	-0.0856	-0.112	-0.0714	0.137	-0.108	-0.0326
	(0.0835)	(0.0255)	(0.0243)	(0.0312)	(0.0577)	(0.0664)	(0.0804)	(0.0832)	(0.0909)	(0.102)	(0.112)
Gender-Female	-0.0986***	0.000316	-0.0117***	-0.0211***	-0.0240***	-0.0467***	-0.0305***	-0.0494***	-0.0749***	-0.0718***	-0.0547***
	(0.0130)	(0.00280)	(0.00396)	(0.00619)	(0.00832)	(0.00923)	(0.00970)	(0.0120)	(0.0176)	(0.0171)	(0.0209)
Observations	1,696	1,486	1,650	1,626	1,586	1,514	1,154	902	698	500	336
R-squared	0.752	0.944	0.786	0.672	0.675	0.678	0.625	0.634	0.602	0.770	0.563
Has other children											
Ln weight	-0.128**	-0.0122	-0.0181	-0.126***	-0.0720	-0.125**	-0.0664	-0.155**	-0.145**	-0.150*	-0.203*
	(0.0590)	(0.0111)	(0.0145)	(0.0350)	(0.0451)	(0.0506)	(0.0524)	(0.0707)	(0.0732)	(0.0896)	(0.110)
Gender-Female	-0.134***	-0.00337*	-0.00579***	-0.0284***	-0.0501***	-0.0579***	-0.0633***	-0.0950***	-0.0926***	-0.0971***	-0.0713***
	(0.00946)	(0.00194)	(0.00212)	(0.00531)	(0.00722)	(0.00711)	(0.00781)	(0.0102)	(0.0118)	(0.0137)	(0.0173)
Observations	5,008	4,286	4,816	4,736	4,446	4,022	3,178	2,522	1,938	1,404	952
R-squared	0.763	0.919	0.899	0.759	0.699	0.715	0.693	0.691	0.689	0.718	0.708

Note: Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Chapter III
Violence exposure: effects on birth weight and schooling accumulation

3 Violence exposure: effects on birth weight and schooling accumulation

Abstract

This paper aims to estimate for Brazil the effects of prenatal exposure to a violent environment on birth weight and whether the *in-utero* and early life violence shocks can have further impacts, particularly on schooling accumulation. The economic literature has shown that *in-utero* exposure to adverse environments has negative impacts on initial endowment and that early life conditions are essential to explain several outcomes throughout the life course. In this context, maternal stress is the primary mechanism explaining the reduction in birth weight due to violence exposure. Using administrative data of birth, school enrollment and homicide mortality records from Brazil, we create a unique dataset containing information of infants born between 1999 and 2006. The estimation shows that violence rates lead to a small reduction in birth weight, mainly through its effects on the second trimester of gestation. The results for the human capital accumulation show that there is a weak association between exposure to violence during the first semester of life and the probability of completing elementary and high school.

Keywords: prenatal exposure, violence, educational outcomes.

3.1 Introduction

Brazil is one of the most violent countries in the world. According to the homicide dataset compiled by WorldBank (2010), in the period 1995-2008 Brazil was one of the top 20 countries with the highest homicide mortality rate[1]. Moreover, according to a national survey conducted in 2009 (PNAD- Pesquisa Nacional de Amostra por Domicílio[2]), approximately half of the Brazilian population felt unsafe in the place they live[3]. Economic literature has shown that *in-utero* exposure to disadvantaged environments, such as a situations of victimization, has negative impacts on initial endowment (i.e., low birth weight) and that early life conditions are essential to explain outcomes related to health, education and labor, throughout the life course (BLACK; DEVEREUX; SALVANES, 2007; ALMOND; MAZUMDER, 2013; CURRIE, 2011). More recent literature has pointed to long-term consequences of the exposure to adverse shocks during early childhood (0-3), such as long-term impacts on health, cognitive and non-cognitive skills (ALMOND; CURRIE; DUQUE, 2017; HECKMAN, 2007). In light of this literature, this paper aims to examine, for the Brazilian context, the effects of prenatal exposure to a violent environment on birth weight and the eventual impacts of *in-utero* and early life violence shocks in later life, particularly on educational accumulation.

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1 These figures are similar to the ones in The Global Study on Homicide 2013, prepared by the UNODC (2014), using data from 2012. Brazil was among the top 15 countries with the highest homicide mortality rate (25,2 people per 100,000 inhabitants), 8.1 times higher than Chile, for instance. The most violent countries according to homicide rate are mainly from Latin America and the Caribbean and Sub-Saharan Africa.

2 Características da vitimização e do acesso à justiça no Brasil - IBGE (2009)

3 More recently, in the 2017 Social Progress Index, which includes data from 128 countries, Brazil was placed at 121 in the dimension concerning personal safety which includes indicators of level of violent crime and perceived criminality (SPI, 2017).

In a contribution to the research on the effects of violence on health at birth, (CAMACHO, 2008) relies on the randomness of landmine explosions in Colombia to show that the maternal stress triggered by the explosion during the first trimester of pregnancy is associated with lower child birth weight. For Brazil, Koppensteiner e Manacorda (2016) show that in small municipalities one extra homicide during the first trimester of pregnancy leads to 8% increase in the chances of a child being born low birthweight. More recently, Brown (2018) finds evidence that *in-utero* exposure to the Mexican drug war is also associated with a substantial decrease in birth weight.

Maternal stress is the primary mechanism explaining the reduction in birth weight in adverse and violent environments. Medical literature lists two leading causes of a child's low birth weight: premature birth and intrauterine growth restriction. Premature births are defined as births occurred before 37 weeks of gestation due to several of causes, many of them yet to be well understood by the medical research. The intrauterine growth restriction defines a fetus that has grown below its potential and is caused by three factors that can occur together or separately: i) maternal characteristics (age, health, nutrition, alcoholism and smoking habits), ii) placental factors (placental dysfunctions and cord insertion) and iii) fetal condition (congenital anomalies and twin pregnancy) (UNICEF; WHO, 2004; KRAMER, 1987).

The biological mechanism relating maternal stress to a child's lower birth weight seems to be, according to medical literature, the release of glucocorticoids (cortisol) in response to stressing events. During pregnancy it is normal to observe increased levels of cortisol, which is an essential hormone for fetus maturation and preparation for delivery, especially at the end of the gestational period. However, excessive levels of cortisol can accelerate the fetus' maturation process, leading to a shorter pregnancy (DAVIS; SANDMAN., 2010). Therefore, maternal stress is more likely to affect birth weight through a reduction of gestational length.

Considering the educational impacts of prenatal and early childhood exposure to a violent environment, Duque (2017) shows that children exposed to violent massacres in Colombia during the prenatal period and when they are between 0 and 3 years old perform worse in cognitive test scores. The *in-utero* exposure to maternal stress, and the consequent increase in the level of cortisol, is associated with what the medical literature calls *perinatal programming*. Glucocorticoids act as a crucial factor shaping the development of the neural systems, which is a key regulator of future cognitive and non-cognitive skills (DAVIS; SANDMAN., 2010; WELBERG; SECKL, 2001). In addition to this biological channel, violence exposure may compromise the whole family environment in which the children has grown. For instance, Ronda (2017) shows that maternal mental distress substantially affects children development through a reduction in the quality of maternal time invested.

Violence in Brazil is remarkably distinct from the type of events most of economic literature has a dealt with. The high homicide rate in Brazil is not an escalation of violence (BROWN, 2018) nor a sustained armed conflict (QUINTANA-DOMEQUE; RóDENAS-SERRANO, 2017; CAMACHO, 2008). Instead, violence and its extreme expression through a homicide is part of a daily environment of fear and victimization in Brazil. In this context, variations in the homicide rate within a city can generate extra fear sensation triggering higher levels of stress.

In order to contribute to the literature, this paper uses administrative data of birth, school enrollment and homicide mortality records from Brazil, so as to create a panel of individuals containing information on birth weight, Apgar score[4], maternal characteristics, school attendance and

[4] Apgar score is an index assessing five vital signs of a child immediately after birth. The data provide the Apgar score at first and fifth minute of life.

the homicide rate in the municipality of residence at the time of birth. This unique dataset containing births from 1999 to 2006, allows the estimation of the impacts of the level of the homicide rate during pregnancy, our measure of violence, on birth weight. For educational outcomes, the homicide rates during the prenatal period and first year of life are used to estimate the impacts of the early-life exposure to violence on human capital accumulation, measured by the probability of completing elementary school (9^{th} grade) at the age of 15 and high school (12^{th} grade) at the age of 18.

We use an identification strategy that compares individuals whose mothers lived in the same areas, but were exposed to different homicide rates over the gestational period. To do so, the estimations account for fixed effects at municipality-month of birth level, in order to control for unobservable characteristics of the area of residence that can affect violence levels and outcomes of interest. In addition to that, the specification controls for birth cohort, mother's characteristics and year-area variant characteristics. Exploring the variation in homicide rates within areas, the estimation shows that violence rates lead to a small reduction on birth weight, mainly through its effects on the second trimester of gestation. These results differ from Koppensteiner e Manacorda (2016), who, using a similar data for the period 2000 to 2010 shows that, in small cities, the homicide rate in the first trimester of pregnancy is associated with reduced birth weight. The results might be different either because our dataset contains only the infants that were matched with the school records, or because the cohorts are not the same. Differences can still be, less likely, due to slight differences in the identification strategy. Further research is needed to determine the exact cause of the divergences, but both results consistently show that violence has a meaningful impact on initial endowments.

The results for the human capital accumulation show that there is a weak association between violence exposure during the first semester of life and the probability to complete elementary and high school. The effect, even small, is larger for children with low educated mothers.Furthermore, biological channels other than birth weight, such as *perinatal programming*, seem to be the main factor underlying the effects. To the best of our knowledge, these are the first estimates for Brazil of the impacts of a violent environment on schooling accumulation.

Taken together, the evidences that homicide rates may affect initial endowments and human capital accumulation show that the costs of daily violence in Brazil have impacts beyond the direct economic costs of crime. The remaining of the paper is organized as follows. In Section 3.2, we present the dataset and descriptive statistics. In Section 3.3 we discuss the identification strategy. Section 3.4 displays the results and, finally, Section 3.5 concludes.

3.2 Data

The System of Information on Live-Born Infants (SINASC- *Sistema de Informação sobre Nascidos Vivos*) is an administrative record created in 1990 by the Brazilian Health Ministry, in order to collect information on the births to support the design of health public policy. Since then, the quality and coverage of the data have improved and at least since 1999 it covers more than 90% of the actual number of births. The data provide information about prenatal visits, about the birth (date, place, type), about the pregnancy (duration, singleton or twins), about the mother (age, education, marital status) and about the newborn's health (birthweight and Apgar score).

The School Census is an administrative record created in 1995 by INEP (*Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira*), a department of the Brazilian Ministry of

Education. Since 2007, the School Census provides desegregated information at student level using a unique identifier. Despite a few inconsistencies on the student code, such as duplicates, the data structure allows to create a panel of students with information on the school, grade and class of enrollment in each year. The dataset contains also individual characteristics of students, such as age, gender, municipality of residence. The last cross section of school census available is for 2017 so that it is possible to create a panel covering ten years, from 2007 to 2017.

SINASC and School Census are matched using individuals' date of birth, gender, municipality of birth and the municipality of residence as identifiers. Seeking to ensure a minimum quality of the birth register and to select cohorts that are old enough to have relatively long schooling information, SINASC from 1999 to 2006 is merged with the panel of students. Roughly 17% of all birth registers in this period in SINASC are successfully matched to an educational record.

A third administrative record, also created by the Health Ministry, provide information regarding all deaths that occurred in Brazil. This data set, the System of Information on Mortality (SIM- *Sistema de Informação sobre Mortalidade*) was created few years before SINASC aiming to support policymakers providing the profile of mortality in Brazil. The dataset informs all deaths occurred in Brazil containing individual characteristics (age, gender, municipality of residence) and circumstances of the death, such as the date and municipality of occurrence and the ICD-10 (International Statistical Classification of Diseases and Related Health Problems) of the primary cause of death. Within the ICD-10 classification, the chapter XX of external causes of mortality has two subgroups of interest, X85-Y09, which encompass all deaths from assault, and Y35-Y36 for deaths in legal interventions and operations of war. Together these two subgroups are considered as deaths by homicide.

The date and municipality of occurrence of the deaths in SIM allow the compilation of the monthly number of homicides occurred in each city. Then, the monthly amount of homicides is used to create the homicide mortality rate (by 100,000 inhabitants), which is associated to the municipality of residence of the mother for time periods of interest. For the sake of analysis, two events are crucial to the definition of the relevant time periods: the month of birth and the month of a baby's conception. The month of birth is straightforward to determine (the date of birth gives it) whereas we need details on the pregnancy length to better approximate the month of conception, accounting for preterm births. SINASC provides data on the pregnancy length in intervals of four weeks. For each pregnancy length smaller than the range of 37 to 40 weeks, we adjust the month of conception to account for the shorter gestation time. This adjustment ensures a better approximation of the month of conception even if preterm births are not so frequent in the dataset, occurring in 1% of the pregnancies.

The analysis uses quarterly homicide rates. The pregnancy period has three trimesters, counted from the conception month (except for birth occurred in the second trimester, the third trimester is undefined). The month of delivery is part of the last gestational trimester. The 12 months following the birth are broken into quarters, defining the four periods after birth. Finally, the 12 months before conception determine the pre-gestation trimesters. The quarterly rate of a given month considers the sum of all homicides occurred in that month and in the two subsequent months, divided by 100,000 inhabitants. Figure 3.1 shows the quarterly homicide mortality rate for Brazil as a whole during the period January 1996 to December 2007. The years between 2002 and 2006 marked a period of increase in the homicide rate levels.

Taking into account the municipality homicide rate and its variation across municipalities,

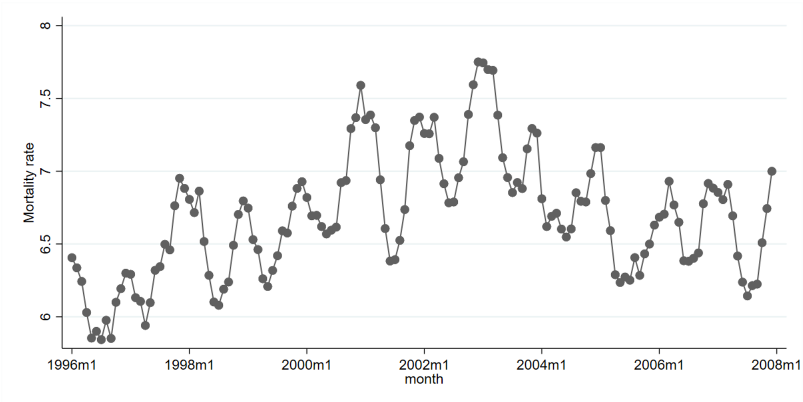

Figure 3.1 – Quarterly homicide mortality rate- Brazil- 1996 to 2007

Table 3.1 shows that, on average, municipalities' homicide rate has increased over time, almost doubling in ten years. The variance is large, which implies significant differences within Brazil. Turning the attention to the sample of interest that considers all birth records matched to a school record, Table 3.1 shows the homicide rate to which children were exposed while *in-utero* in the second trimester of gestation. The sample was exposed to higher levels of homicide rate relative to the Brazilian average.

Finally, it is important to highlight that rate of mortality by homicide does not capture the whole crime environment in an area. Other types of less violent crimes may be under-reported, whereas the nature of homicide makes it a crime less likely to go unnotified. Last, the absence of a centralized and reliable source of information for all crimes in Brazil makes the homicide rate be the best available measure of violence.

Table 3.1 – Quarterly homicide mortality rate per 100,000 inhabitants all municipalities in Brazil (1996 to 2007) and for the sample of births (1999-2006)

Year	All municipalities					Sample of births				
	Obs.	Mean	S.D	Min	Max	Obs.	Mean	S.D	Min	Max
1996	66,084	1.9	5.3	0.0	147.6					
1997	66,084	2.3	5.9	0.0	120.8					
1998	66,084	2.4	6.4	0.0	197.5					
1999	66,084	2.5	6.4	0.0	255.0	473,739	3.2	6.0	0.0	135.6
2000	66,192	2.7	6.6	0.0	123.8	505,438	3.3	6.1	0.0	255.0
2001	66,732	2.7	6.3	0.0	100.2	526,566	3.5	6.1	0.0	122.4
2002	66,720	2.9	6.6	0.0	103.4	547,388	3.7	6.2	0.0	103.4
2003	66,728	3.0	6.6	0.0	99.3	553,300	3.9	6.4	0.0	103.4
2004	66,768	3.1	6.8	0.0	122.2	562,738	3.8	6.1	0.0	98.4
2005	66,768	3.2	6.8	0.0	103.4	573,106	4.0	6.2	0.0	99.5
2006	66,768	3.2	6.9	0.0	143.6	563,176	4.1	6.2	0.0	118.6
2007	66,770	3.3	6.9	0.0	115.9					

Concerning the profile of children in our sample, Table 3.2 shows descriptive statistics on selected characteristics. The average birth weight in the sample is 3251g with a standard deviation of 510g. The Apgar score ranges from 0 to 10, 10 being the maximum, whereas notes below 7 indicate a high risk of neonatal mortality. Apgar is on average 8.1 at the first minute and 9.25 at five minutes of life. Mothers are on average 25 years old. The majority of them (60%) had not completed elementary school at the time of the birth. Curiously, slightly more than 60% of the children completed elementary school at the age of 15, and less than half (41%) did not finish high school at the age of 18.

Table 3.2 – Characteristics at birth and school completion

Variable	Obs.	Mean	S.D	Min	Max
Gender -female	4,305,667	0.50	0.50	0	1
Birth weight	4,260,851	3250.96	510.84	0	9500
Apgar1	3,836,364	8.10	1.35	0	10
Apgar5	3,798,302	9.25	1.16	0	10
Mother age	4,284,221	24.59	6.38	10	64
Mother education-less than complete elementary	4,305,667	0.60	0.49	0	1
Mother education-complete high school or more	4,305,667	0.24	0.43	0	1
Mother education-incomplete high school	4,305,667	0.08	0.28	0	1
Mother education-missing	4,305,667	0.07	0.26	0	1
Born at full term	4,106,055	0.99	0.12	0	1
Elementary school completion at age 15	2,053,347	0.67	0.47	0	1
High school completion at age 18	979,177	0.41	0.49	0	1

The data containing records related to birth and education are used in order to create the outcomes of interest for estimating the impacts of *in-utero* and early life exposure to violence. The birth weight, a measure of health at birth, is our first variable of interest. In addition to that, the panel of students allows identifying the grade in which a student is enrolled in each year. Using this information, the indicators for elementary school completion at the age of 15 and high school completion at the age of 18 presented in Table 3.2 were created. Compulsory education in Brazil starts at the age of 6 in the 1^{st} grade of elementary school. A student that enters school at the correct age and does not repeat any grade nor drops out of school should complete the first cycle of education (*Ensino Fundamental*) or the 9^{th} grade aged 14. Because of school entrance rules, a regular student can complete elementary school until the age of 15. Similarly, for high school completion, the student may complete this educational stage aged 17 or 18, depending on entrance rules. The analysis for elementary school completion uses only students from cohorts from 1999-2002, the others are too young and had not turned 15 years old yet. For high school completion, the cohort born in 1999 is the only that completed 18 years until 2017. In order to increase the sample for this last indicator, the cohort of 2000 is also considered as eligible to complete high school.

3.3 Identification strategy

The main challenge involved in the estimation of the causal impacts of violence exposure on birth weight and capital accumulation is to control for unobservable characteristics that may affect the homicide rate in a given area, health during pregnancy and educational choices of residents of that same region. For instance, regions that experienced higher violence levels can also have inhabitants with lower socioeconomic characteristics and worse provision of public health facilities, as well as schools of lower quality. To address this possible source of endogeneity, the estimations use municipality of birth fixed effect, exploring the variation in homicide rates within the same areas. The estimate is given by Equation 3.1:

$$Y_{ijtc} = \beta_1 H_{jt}^{trim1} + \beta_2 H_{jt}^{trim2} + \beta_3 H_{jt}^{trim3} + \gamma X_i + \delta Z_{jc} + \alpha_c + \alpha_{jt} + u_{ijtc} \tag{3.1}$$

where Y denotes the outcome, either birth weight or school completion, of a child i whose mother lived in city j at the month of birth t and year c. The quarterly homicide rate of the city of

residence, in each gestational trimester is given by H_{jt}^{trim}. The vector of time-invariant characteristics of children, X_i, includes characteristics at birth, maternal age, education, marital status and occupation, number of prenatal visits, pregnancy type (singleton or multiple) pregnancy length, place of birth (hospital or home), delivery type and dummies for Brazil's macro-region. The vector Z_{jc} includes yearly-variant characteristics of municipalities: GDP per capita, infant mortality and local expenditures on public security, health, and education. The cohort fixed effect α_c controls for differential effects across birth years affecting all municipalities. The month-municipality of birth fixed effect α_{jt} absorbs all unobservable aspects relative to a mother's municipality of residence and month of birth. Therefore, β_1 to β_3 identify the effect of variations in the quarterly homicide rate during gestation within residents of the same area, controlling for month-specific aspects that may affect violence, school attendance and birth weight.

For the educational outcomes, we add the quarterly homicide rates in the twelve months after birth to the equation, so as to understand if impacts of early life exposure to a violent environment are persistent over time, affecting schooling accumulation. The vector X_i in this specification includes birth weight, the Apgar score (a measure of initial health), the average IDEB (an index of school quality) and the average socioeconomic status of all schools attended by the student [5]. In order to understand whether the educational outcomes are affected by *in-utero* violence through birth weight, we also estimate the models for school completion without the homicide mortality rates, but keeping the birth weight and the Apgar scores. If the coefficient of birth weight does not change with the inclusion of the variables related to homicide, characteristics other than birth weight determined during gestation (i.e. *perinatal programming*) are the channel through which the school completion is affected.

Including lags and leads of the homicide rate during pregnancy is a robustness check for the identification strategy. We claim that birth weight cannot be affected by pre and post-birth violence while educational outcomes cannot be affected by the lags alone. If it is affected, the model does not account for all sources of endogeneity.

One limitation of our identification strategy is that the effects of violence are aggregated at municipality level rather than a direct measurement of each mother's exposure to violence. Especially within large cities, violence may be concentrated in the most deprived areas. Thus, even mothers that may not have experienced the fear and stress caused by violence are assumed to have gone through this situation, leading to an overstatement of the violence level and, hence, the real effects may be underestimated. To partially address this issue, we also estimate the equation stratified by mother's educational level. The lower educational level is associated with lower income, so that mothers are less likely to live in wealthier and safer areas and to afford own private security. We expect the results for less educated mothers to be larger in magnitude, in comparison to the ones observed for more educated mothers.

The estimates for educational outcomes have an additional limitation regarding the perpetuation of the exposure to victimization through life. Children born in more violent areas can be constantly exposed to fear situations that can affect their human capital accumulation either through psychological and individual health factors or directly via the channel of education supply. As documented by Monteiro e Rocha (2017), schools in the violent areas of Brazil experience more absenteeism on the part of teachers and are more likely to be temporarily closed. Still, the municipality fixed effect may absorb these locality-specific aspects, allowing for the identification of the

[5] IDEB is a National Index of Quality of the Basic Education in Brazil and, as the school socioeconomic status, is an index elaborated and disseminated by INEP. For more informaiton see: `http://portal.inep.gov.br/web/guest/inicio`.

effects of early-life exposure to a violent environment and elucidating how initial disadvantages can be perpetuated through life.

3.4 Results

This section presents the results for Equation 3.1 for birth weight and schooling completion. All estimations use clustered standard errors at the municipality level to account for within-municipality correlation. Table 3.3 shows the results for birth weight. The first column shows that although the point estimation of the homicide rate in the second and third trimester of pregnancy are negative, they are not statistically different from zero, while the coefficient for the first trimester is smaller than the others and positive, but also non-significant. The inclusion of the lags and leads of the homicide rate shows that the effect during the gestational period is indeed negative and statistically significant in the second trimester. The coefficient implies that one extra homicide per 100,000 inhabitants in the mother's municipality of residence, on average, reduces the newborn weight in 0.1g, much less than 1% of the mean. The effect is small and might not account for all sources of endogeneity since it is sensitive to the inclusion of the homicide rate pre and post birth. In fact, the homicide rate at municipality level may not be a good measure of the violent environment to which the mother is locally exposed. The focus on smaller municipalities, however, may not picture a representative scenario of violence in Brazil. For instance, in the sample considered, the overall average quarterly homicide rate in the second trimester of gestation is 3.4 per 100,000 inhabitants, while for municipalities with population up to 5000, this rate is of 1.9, almost half of the overall average. Moreover, 81% of the mothers living in small cities experienced zero homicides during the whole pregnancy. Using data similar to ours, but for a longer period (2000-2010) and a larger sample, Koppensteiner e Manacorda (2016) found that in municipalities with less than 5000 inhabitants, an increase in one homicide increases birth weight in 0.56g, a result that, though small, is five times larger than the effects we found.

In order to understand if the overall result hides different circumstances across socioeconomic groups, columns (3)-(6) shows the estimation for highly and low educated mother. Maternal education is used as a *proxy* for socioeconomic status since the data available do not provide information on maternal wealth. One can see that even though the coefficients of interest are not significant, they have the expected signal (negative). For the group of low educated mothers, the coefficient for the third trimester of gestation is substantially larger than the one observed for the more educated mothers. In sum, there is weak evidence that *in-utero* exposure to violence shocks leads to a reduction in birth weight.

Table 3.3 – Effects of homicide on birth weight

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	All		High mother education		Low mother education	
Hom. 4 tri before concep.		0.0168		0.00439		0.0596
		(0.0617)		(0.0958)		(0.0770)
Hom. 3 tri before concep.		-0.0820		-0.126		-0.0480
		(0.0606)		(0.0968)		(0.0780)
Hom. 2 tri before concep.		0.0289		-0.0121		-0.0245
		(0.0589)		(0.0948)		(0.0751)
Hom. 1 tri before concep.		0.0483		0.0831		0.00747
		(0.0596)		(0.0944)		(0.0746)
Hom. 1 tri pregnacy	0.00554	0.0116	-0.0375	-0.0270	0.0133	0.0254
	(0.0603)	(0.0597)	(0.0928)	(0.0949)	(0.0764)	(0.0758)
Hom. 2 tri pregnacy	-0.0845	-0.107*	-0.0699	-0.0938	-0.0756	-0.0920
	(0.0601)	(0.0600)	(0.0959)	(0.0972)	(0.0757)	(0.0764)
Hom. 3 tri pregnacy	-0.0179	-0.00132	-0.0177	-0.0143	-0.0603	-0.0497
	(0.0594)	(0.0587)	(0.0924)	(0.0937)	(0.0743)	(0.0743)
Hom. 1 tri after birth		-0.0195		0.00517		-0.0207
		(0.0593)		(0.0953)		(0.0742)
Hom. 2 tri after birth		-2.24e-05		-0.00729		-0.0118
		(0.0598)		(0.0978)		(0.0752)
Hom. 3 tri after birth		-0.146**		-0.160*		-0.148**
		(0.0617)		(0.0963)		(0.0754)
Hom. 4 tri after birth		0.00129		-0.0735		-0.00904
		(0.0632)		(0.0993)		(0.0758)
Observations	3,969,288	3,967,855	1,332,188	1,331,623	2,392,633	2,391,762
R-squared	0.159	0.159	0.217	0.217	0.160	0.160

*** p<0.01, ** p<0.05, * p<0.1.
All estimates include as controls: student gender and race, mother age, education, marital status and occupation, number of prenatal visits, pregnancy type (singleton or multiple) pregnancy length, place of birth (hospital, home or other health facility), delivery type (cesarean or vaginal), dummies for Brazil macro-region and for birth cohorts.Clustered standard errors at municipality level are in parentheses.

Table 3.4 shows the results for the probability of having completed elementary school at the age of 15. The first fact to be noticed is that higher birth weight and Apgar score are associated with higher probability of completing the 9 th grade at the age of 15. The inclusion of the homicide rate variables does not change the size of the coefficients for birth weight and Apgar. The stability of the birth weight coefficient is an indication that if maternal stress triggered by violence exposure affects the accumulation of education, birth weight is not the channel through which it happens. Other biological explanations like *perinatal programming* should be a more relevant and plausible channel (DAVIS; SANDMAN., 2010; WELBERG; SECKL, 2001). However, the effects of homicide rate during the gestational period are close to zero and non-significant. The post-birth variables show that exposure to violence in the first six months of life is associated with a small decrease in the probability to complete elementary school before 15 years old. When the effects are analyzed by groups of maternal education, the group with lower education seems to be sensitive to shocks during the second semester of pregnancy.

Considering the probability of high school completion, the results in Table 3.5 show that *in-utero* exposure to violence leads to a lower probability of completing high school at the age 18 or before. The addition of the lags and leads of the homicide rates, however, shows that the impacts may be associated with occurrences after birth, especially during the first six months of life. The analysis by maternal groups shows, once more, that most of the effects are coming from the most disadvantaged groups.

The estimations show a weak relation between violence exposure and human capital accumulation in the sample analyzed. The coefficients estimated are small, implying less than 1% decrease in the probability to complete the stages of compulsory schooling following an early-life violence shock. Nevertheless, as discussed before, the use of a global measurement of violence may not allow to distinguish mothers who have indeed undergone a stressful situation caused by a violent act. The use of more location-sensitive measurements for fear and stress or the restriction of the analysis to smaller areas may lead to gains in internal validity and improvements in the identification of the causal effect of violence. However, the losses in external validity compromise the assessment to the global effects of a violent environment on initial endowment and capital accumulation through life. Furthermore, the absence of reliable sources of geographically disaggregated violence data for Brazil makes the use of an alternative violence measurement unfeasible.

Table 3.4 – Effects of homicide on Elementary School Completion

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		All			High mother education			Low mother education	
Birth weight	3.76e-05***	3.82e-05***	3.82e-05***	2.23e-05***	2.24e-05***	2.23e-05***	4.23e-05***	4.30e-05***	4.30e-05***
	(8.04e-07)	(8.12e-07)	(8.12e-07)	(1.38e-06)	(1.39e-06)	(1.39e-06)	(1.03e-06)	(1.04e-06)	(1.04e-06)
Apgar 1st minute	0.00356***	0.00355***	0.00353***	0.00407***	0.00411***	0.00409***	0.00314***	0.00310***	0.00308***
	(0.000407)	(0.000413)	(0.000413)	(0.000744)	(0.000742)	(0.000742)	(0.000536)	(0.000545)	(0.000545)
Apgar 5th minute	0.000226	0.000420	0.000429	-2.48e-05	-0.000207	-0.000190	9.78e-07	0.000329	0.000340
	(0.000494)	(0.000502)	(0.000502)	(0.000984)	(0.000980)	(0.000982)	(0.000644)	(0.000653)	(0.000653)
Hom. 4 tri before concep.			-0.000150			-0.000169			-0.000236*
			(9.56e-05)			(0.000160)			(0.000130)
Hom. 3 tri before concep.			-3.48e-05			6.29e-05			-0.000216*
			(9.51e-05)			(0.000169)			(0.000127)
Hom. 2 tri before concep.			8.19e-05			-0.000221			0.000166
			(9.21e-05)			(0.000168)			(0.000123)
Hom. 1 tri before concep.			1.84e-05			-7.14e-05			-4.02e-05
			(9.48e-05)			(0.000171)			(0.000125)
Hom. 1 tri pregnacy		0.000134	4.53e-05		-3.01e-05	-0.000144		0.000155	-3.04e-06
		(9.04e-05)	(0.000100)		(0.000162)	(0.000182)		(0.000118)	(0.000133)
Hom. 2 tri pregnacy		-4.52e-05	-6.80e-05		-0.000145	-0.000152		-0.000142	-0.000233*
		(8.91e-05)	(9.78e-05)		(0.000154)	(0.000170)		(0.000121)	(0.000134)
Hom. 3 tri pregnacy		0.000128	0.000146		3.23e-05	-5.55e-05		7.96e-05	0.000168
		(9.17e-05)	(9.92e-05)		(0.000151)	(0.000166)		(0.000119)	(0.000128)
Hom. 1 tri after birth			6.32e-05			0.000142			-6.33e-05
			(9.49e-05)			(0.000163)			(0.000131)
Hom. 2 tri after birth			-0.000195**			-0.000309*			-0.000349***
			(9.52e-05)			(0.000162)			(0.000128)
Hom. 3 tri after birth			-6.20e-05			-0.000173			-0.000123
			(9.94e-05)			(0.000175)			(0.000132)
Hom. 4 tri after birth			-3.63e-05			-0.000153			9.63e-05
			(9.69e-05)			(0.000167)			(0.000129)
Observations	1,534,544	1,515,267	1,514,212	397,096	394,142	393,804	966,881	957,375	956,749
R-squared	0.207	0.208	0.208	0.219	0.219	0.219	0.207	0.207	0.207

*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

All estimates include as controls: student gender and race, mother age, education, marital status and occupation, number of prenatal visits, pregnancy type (singleton or multiple) pregnancy length, place of birth (hospital, home or other health facility), delivery type (cesarean or vaginal), dummies for Brazilian macro-region and for birth cohorts.Clustered standard errors at municipality level are in parentheses.

Table 3.5 – Effects of homicide on High School Completion

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		All			High mother education			Low mother education	
Birth weight	3.51e-05***	3.58e-05***	3.59e-05***	3.13e-05***	3.19e-05***	3.19e-05***	3.36e-05***	3.39e-05***	3.39e-05***
	(1.24e-06)	(1.26e-06)	(1.26e-06)	(2.90e-06)	(2.97e-06)	(2.97e-06)	(1.56e-06)	(1.59e-06)	(1.59e-06)
Apgar 1st minute	0.00410***	0.00421***	0.00420***	0.00652***	0.00635***	0.00637***	0.00269***	0.00269***	0.00268***
	(0.000656)	(0.000667)	(0.000667)	(0.00165)	(0.00165)	(0.00165)	(0.000812)	(0.000822)	(0.000822)
Apgar 5th minute	0.000938	0.000941	0.000947	-0.00114	-0.00134	-0.00136	0.000611	0.000814	0.000835
	(0.000828)	(0.000847)	(0.000847)	(0.00217)	(0.00217)	(0.00217)	(0.00101)	(0.00103)	(0.00103)
Hom. 4 tri before concep.			0.000116			0.000156			-9.64e-05
			(0.000296)			(0.000777)			(0.000392)
Hom. 3 tri before concep.			5.58e-05			0.00103			-2.41e-05
			(0.000303)			(0.000787)			(0.000399)
Hom. 2 tri before concep.			0.000686**			0.000349			0.000731*
			(0.000290)			(0.000766)			(0.000408)
Hom. 1 tri before concep.			0.000139			7.87e-05			0.000346
			(0.000287)			(0.000681)			(0.000411)
Hom. 1 tri pregnacy		0.000181	-1.59e-06		0.000585	0.000717		0.000301	-0.000228
		(0.000242)	(0.000336)		(0.000577)	(0.000845)		(0.000338)	(0.000459)
Hom. 2 tri pregnacy		-0.000563**	-0.000336		-0.000660	0.000207		-0.000440	-0.000583
		(0.000248)	(0.000347)		(0.000610)	(0.000897)		(0.000331)	(0.000452)
Hom. 3 tri pregnacy		-0.000821***	-0.000111		-0.000758	-0.000397		-0.000944***	-2.34e-05
		(0.000240)	(0.000321)		(0.000532)	(0.000761)		(0.000314)	(0.000421)
Hom. 1 tri after birth			-0.000636**			-0.000368			-0.000567
			(0.000300)			(0.000725)			(0.000418)
Hom. 2 tri after birth			-0.000425			0.000234			-0.000858**
			(0.000301)			(0.000741)			(0.000398)
Hom. 3 tri after birth			0.000419			0.000730			-0.000250
			(0.000308)			(0.000735)			(0.000393)
Hom. 4 tri after birth			0.000781***			0.000457			0.00119***
			(0.000299)			(0.000783)			(0.000396)
Observations	688,769	675,603	675,603	136,205	134,822	134,822	401,231	395,469	395,469
R-squared	0.282	0.284	0.284	0.413	0.414	0.414	0.295	0.296	0.296

*** p<0.01, ** p<0.05, * p<0.1.

All estimates include as controls: student gender and race, mother age, education, marital status and occupation, number of prenatal visits, pregnancy type (singleton or multiple) pregnancy length, place of birth (hospital, home or other health facility), delivery type (cesarean or vaginal), dummies for Brazilian macro-region and for birth cohorts.Clustered standard errors at municipality level are in parentheses.

3.5 Final Remarks

Recent literature has found significant impacts of *in-utero* and early life exposure to violence on health and human capital accumulation, with consequences persisting during adulthood. This paper investigates these impacts of violence for Brazil, one of the countries with the highest homicide rates worldwide.

Based on administrative registers of mortality, the homicide rate at the municipal level is used as a measurement of violence. We use administrative data of birth records to associate the municipality of residence during the *in-utero* period to the occurrence of homicides. School records linked to the births provide information about schooling accumulation.

Comparing the variation in the homicide rate within municipalities, we can estimate the effects of violence on birth weight and human capital accumulation. Maternal stress triggered by exposition to violence is the channel through which violence may affect birth weight. The educational outcomes are also affected by early life exposure to violence. However, because of the aggregated nature of the violence indicator, while the effects of homicides occurrences can be locally concentrated, the estimated impacts are small Exploring locally changes in violence level or unexpected rise in violence are possible next steps for further investigation.

3.A Appendix C

Table 3.6 – Homicide and birth weight

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	All		Low mother education		High mother education	
Homicide rate 4 trimester before conception		0.0168		0.00439		0.0596
		(0.0617)		(0.0958)		(0.0770)
Homicide rate 3 trimester before conception		-0.0820		-0.126		-0.0480
		(0.0606)		(0.0968)		(0.0780)
Homicide rate 2 trimester before conception		0.0289		-0.0121		-0.0245
		(0.0589)		(0.0948)		(0.0751)
Homicide rate 1 trimester before conception		0.0483		0.0831		0.00747
		(0.0596)		(0.0944)		(0.0746)
Homicide rate 1 trimester pregnacy	0.00554	0.0116	-0.0375	-0.0270	0.0133	0.0254
	(0.0603)	(0.0597)	(0.0928)	(0.0949)	(0.0764)	(0.0758)
Homicide rate 2 trimester pregnacy	-0.0845	-0.107*	-0.0699	-0.0938	-0.0756	-0.0920
	(0.0601)	(0.0600)	(0.0959)	(0.0972)	(0.0757)	(0.0764)
Homicide rate 3 trimester pregnacy	-0.0179	-0.00132	-0.0177	-0.0143	-0.0603	-0.0497
	(0.0594)	(0.0587)	(0.0924)	(0.0937)	(0.0743)	(0.0743)
Homicide rate 1 trimester after conception		-0.0195		0.00517		-0.0207
		(0.0593)		(0.0953)		(0.0742)
Homicide rate 2 trimester after conception		-2.24e-05		-0.00729		-0.0118
		(0.0598)		(0.0978)		(0.0752)
Homicide rate 3 trimester after conception		-0.146**		-0.160*		-0.148**
		(0.0617)		(0.0963)		(0.0754)
hom_rate_t4_birth_fwd		0.00129		-0.0735		-0.00904
		(0.0632)		(0.0993)		(0.0758)
Gender-Female	-113.9***	-113.9***	-114.9***	-114.9***	-113.2***	-113.2***
	(0.474)	(0.474)	(0.794)	(0.795)	(0.618)	(0.618)
Baby race-white	21.78***	21.77***	13.47***	13.43***	25.67***	25.67***
	(0.925)	(0.925)	(1.296)	(1.296)	(1.098)	(1.098)
Baby race-missing	-14.20***	-14.20***	-24.46***	-24.48***	-17.47***	-17.47***
	(2.688)	(2.688)	(3.588)	(3.590)	(4.027)	(4.027)
Mother age	1.043***	1.042***	-0.218**	-0.218**	1.459***	1.458***
	(0.0575)	(0.0575)	(0.0960)	(0.0959)	(0.0682)	(0.0682)
Mother education- incomplete elementary school	25.19***	25.17***			27.54***	27.51***
	(1.530)	(1.530)			(1.510)	(1.510)
Mother education- incomplete high school	49.13***	49.09***	-0.142	-0.133		
	(1.663)	(1.663)	(1.048)	(1.049)		
Mother education- complete high school	44.03***	43.99***				
	(1.850)	(1.850)				
Mother education- missing	41.82***	41.77***				
	(2.221)	(2.221)				

continue

Continuation - Homicide and birth weight

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	All		Low mother education		High mother education	
Mother civil status-Married or union	20.47***	20.48***	14.94***	14.93***	23.97***	23.99***
	(0.709)	(0.709)	(0.985)	(0.985)	(0.915)	(0.915)
Mother civil status-Widow or Divorced	-8.289***	-8.211***	-9.891**	-9.798**	-5.494	-5.434
	(2.619)	(2.620)	(4.012)	(4.014)	(3.547)	(3.549)
Mother civil status-missing	2.352	2.354	-2.443	-2.458	9.720***	9.751***
	(2.070)	(2.070)	(3.368)	(3.368)	(2.664)	(2.665)
Mother live children-one or more	105.3***	105.3***	99.71***	99.68***	113.1***	113.2***
	(0.837)	(0.838)	(1.088)	(1.089)	(1.042)	(1.042)
Mother live children-missing	1.634	1.629	0.439	0.412	3.869**	3.903**
	(1.399)	(1.400)	(1.818)	(1.820)	(1.799)	(1.800)
Mother occupation-other than Housewife	7.105***	7.098***	1.292	1.311	15.18***	15.16***
	(0.957)	(0.957)	(1.152)	(1.153)	(1.312)	(1.313)
Mother occupation-missing	12.69***	12.70***	7.419***	7.445***	19.10***	19.11***
	(1.606)	(1.606)	(1.922)	(1.921)	(2.047)	(2.047)
Prenatal apoitments- 1 to 3	-3.406*	-3.424*	-17.64***	-17.75***	4.945**	4.935**
	(1.910)	(1.911)	(3.850)	(3.850)	(2.272)	(2.272)
Prenatal apoitments- 4 to 6	40.67***	40.64***	37.39***	37.31***	47.96***	47.94***
	(1.678)	(1.678)	(3.441)	(3.441)	(2.030)	(2.030)
Prenatal apoitments- 7 or more	70.85***	70.83***	67.78***	67.72***	80.84***	80.80***
	(1.586)	(1.586)	(3.407)	(3.408)	(1.987)	(1.987)
Pregnancy lenght-37 to 41 weeks	705.4***	705.4***	780.6***	780.6***	666.6***	666.6***
	(5.512)	(5.511)	(5.734)	(5.734)	(5.851)	(5.852)
Pregnancy lenght-42 or more weeks	785.0***	785.0***	895.0***	894.9***	748.5***	748.5***
	(6.685)	(6.685)	(7.526)	(7.525)	(7.435)	(7.436)
Place of birth- Hospital	14.80	14.78	2.204	2.154	22.97*	23.02*
	(11.90)	(11.90)	(20.91)	(20.90)	(12.73)	(12.73)
Place of birth-Other health facility	53.68***	53.55***	38.48*	38.24*	60.87***	60.89***
	(12.71)	(12.70)	(21.66)	(21.65)	(13.58)	(13.59)
Place of birth- Home	-79.83***	-79.90***	-44.40*	-44.47*	-75.98***	-76.01***
	(14.05)	(14.05)	(24.18)	(24.17)	(14.59)	(14.59)
Place of birth- missing	25.41	25.37	-47.75	-47.83	15.74	15.89
	(21.34)	(21.34)	(59.10)	(59.17)	(32.54)	(32.52)
Birth type-Cesarean	-59.83***	-59.84***	-64.31***	-64.34***	-58.86***	-58.86***
	(0.886)	(0.886)	(1.168)	(1.168)	(1.046)	(1.046)
Birth type-missing	-38.50***	-38.52***	-37.48***	-37.62***	-23.61*	-23.60*
	(11.46)	(11.46)	(11.95)	(11.95)	(12.64)	(12.64)

continue

Continuation - Homicide and birth weight

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	All		Low mother education		High mother education	
Macro region of birth- Northeast	9.052	8.916	22.42	22.36	4.365	4.255
	(18.99)	(19.00)	(25.64)	(25.65)	(20.61)	(20.61)
Macro region of birth- Southeast	-57.74**	-57.91**	-69.39**	-69.46**	-31.59	-31.70
	(25.60)	(25.61)	(28.72)	(28.73)	(30.06)	(30.07)
Macro region of birth- South	-41.35*	-41.46*	-37.65	-37.66	-60.10*	-60.16*
	(24.35)	(24.36)	(27.87)	(27.87)	(31.93)	(31.93)
Macro region of birth- Midwest	-65.80***	-65.97***	-68.20***	-68.20***	-63.46***	-63.58***
	(19.66)	(19.69)	(23.02)	(23.02)	(23.49)	(23.54)
GDP per capita	0.000372***	0.000377***	0.000678***	0.000692***	0.000445***	0.000445***
	(0.000140)	(0.000140)	(0.000173)	(0.000175)	(0.000163)	(0.000163)
Infant mortality rate	0.0351	0.0361	0.0146	0.0165	0.0409	0.0417
	(0.0241)	(0.0242)	(0.0307)	(0.0308)	(0.0295)	(0.0296)
Education expenditure per capita	0.00978*	0.00965*	0.00389	0.00369	0.0138	0.0137
	(0.00548)	(0.00549)	(0.00541)	(0.00543)	(0.00862)	(0.00860)
Health expenditure per capita	-0.0344***	-0.0340***	-0.0208*	-0.0200	-0.0377***	-0.0377***
	(0.0108)	(0.0108)	(0.0124)	(0.0124)	(0.0142)	(0.0142)
Public security expenditure per capita	0.147	0.146	0.0844	0.0836	0.310***	0.308***
	(0.0897)	(0.0895)	(0.121)	(0.121)	(0.107)	(0.107)
Cohort 1999	30.95***	30.83***	44.19***	44.15***	29.35***	29.13***
	(2.928)	(2.945)	(3.862)	(3.875)	(3.557)	(3.570)
Cohort 2000	30.65***	30.56***	43.46***	43.38***	22.88***	22.70***
	(2.384)	(2.399)	(2.984)	(3.007)	(2.872)	(2.885)
Cohort 2001	3.781*	3.743*	16.06***	16.03***	0.0883	-0.0260
	(2.185)	(2.196)	(2.376)	(2.390)	(2.690)	(2.700)
Cohort 2002	4.280**	4.272**	10.73***	10.71***	1.182	1.127
	(1.667)	(1.672)	(2.137)	(2.142)	(1.991)	(1.996)
Cohort 2003	-7.472***	-7.513***	-1.658	-1.683	-9.988***	-10.08***
	(1.442)	(1.444)	(1.874)	(1.877)	(1.801)	(1.802)
Cohort 2004	-5.102***	-5.130***	-1.134	-1.132	-6.932***	-7.010***
	(1.353)	(1.352)	(1.693)	(1.692)	(1.711)	(1.710)
Cohort 2005	3.047***	3.023***	3.900**	3.871**	3.108**	3.057**
	(1.142)	(1.142)	(1.537)	(1.539)	(1.494)	(1.494)
Observations	3,969,288	3,967,855	1,332,188	1,331,623	2,392,633	2,391,762
R-squared	0.159	0.159	0.217	0.217	0.160	0.160

*** p<0.01, ** p<0.05, * p<0.1.

Table 3.7 – Homicide and elementary school completion

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables		All			High mother education			Low mother education	
Birth weight	3.76e-05***	3.82e-05***	3.82e-05***	2.23e-05***	2.24e-05***	2.23e-05***	4.23e-05***	4.30e-05***	4.30e-05***
	(8.04e-07)	(8.12e-07)	(8.12e-07)	(1.38e-06)	(1.39e-06)	(1.39e-06)	(1.03e-06)	(1.04e-06)	(1.04e-06)
Apgar 1st minute	0.00356***	0.00355***	0.00353***	0.00407***	0.00411***	0.00409***	0.00314***	0.00310***	0.00308***
	(0.000407)	(0.000413)	(0.000413)	(0.000744)	(0.000742)	(0.000742)	(0.000536)	(0.000545)	(0.000545)
Apgar 5th minute	0.000226	0.000420	0.000429	-2.48e-05	-0.000207	-0.000190	9.78e-07	0.000329	0.000340
	(0.000494)	(0.000502)	(0.000502)	(0.000984)	(0.000980)	(0.000982)	(0.000644)	(0.000653)	(0.000653)
Homicide rate 4 trimester before conception			-0.000150			-0.000169			-0.000236*
			(9.56e-05)			(0.000160)			(0.000130)
Homicide rate 3 trimester before conception			-3.48e-05			6.29e-05			-0.000216*
			(9.51e-05)			(0.000169)			(0.000127)
Homicide rate 2 trimester before conception			8.19e-05			-0.000221			0.000166
			(9.21e-05)			(0.000168)			(0.000123)
Homicide rate 1 trimester before conception			1.84e-05			-7.14e-05			-4.02e-05
			(9.48e-05)			(0.000171)			(0.000125)
Homicide rate 1 trimester pregnacy		0.000134	4.53e-05		-3.01e-05	-0.000144		0.000155	-3.04e-06
		(9.04e-05)	(0.000100)		(0.000162)	(0.000182)		(0.000118)	(0.000133)
Homicide rate 2 trimester pregnacy		-4.52e-05	-6.80e-05		-0.000145	-0.000152		-0.000142	-0.000233*
		(8.91e-05)	(9.78e-05)		(0.000154)	(0.000170)		(0.000121)	(0.000134)
Homicide rate 3 trimester pregnacy		0.000128	0.000146		3.23e-05	-5.55e-05		7.96e-05	0.000168
		(9.17e-05)	(9.92e-05)		(0.000151)	(0.000166)		(0.000119)	(0.000128)
Homicide rate 1 trimester after birth			6.32e-05			0.000142			-6.33e-05
			(9.49e-05)			(0.000163)			(0.000131)
Homicide rate 2 trimester after birth			-0.000195**			-0.000309*			-0.000349***
			(9.52e-05)			(0.000162)			(0.000128)
Homicide rate 3 trimester after birth			-6.20e-05			-0.000173			-0.000123
			(9.94e-05)			(0.000175)			(0.000132)
Homicide rate 4 trimester after birth			-3.63e-05			-0.000153			9.63e-05
			(9.69e-05)			(0.000167)			(0.000129)
Gender-Female	0.153***	0.153***	0.153***	0.105***	0.105***	0.105***	0.173***	0.173***	0.173***
	(0.00120)	(0.00120)	(0.00120)	(0.00155)	(0.00155)	(0.00155)	(0.00137)	(0.00137)	(0.00137)
Baby race-white	0.0490***	0.0492***	0.0492***	0.0375***	0.0377***	0.0377***	0.0518***	0.0520***	0.0519***
	(0.00122)	(0.00123)	(0.00123)	(0.00211)	(0.00212)	(0.00212)	(0.00145)	(0.00145)	(0.00145)
Baby race-missing	0.0282***	0.0285***	0.0285***	0.0235***	0.0239***	0.0239***	0.0319***	0.0322***	0.0322***
	(0.00218)	(0.00220)	(0.00220)	(0.00410)	(0.00414)	(0.00414)	(0.00317)	(0.00321)	(0.00321)

continue

Continuation - Homicide and elementary school completion

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables		All			High mother education			Low mother education	
Mother age	0.00344***	0.00345***	0.00345***	0.00310***	0.00311***	0.00310***	0.00338***	0.00339***	0.00339***
	(7.80e-05)	(7.85e-05)	(7.85e-05)	(0.000135)	(0.000136)	(0.000136)	(9.71e-05)	(9.77e-05)	(9.78e-05)
Mother education- incomplete elementary school	0.147***	0.147***	0.147***				0.144***	0.144***	0.144***
	(0.00217)	(0.00218)	(0.00218)				(0.00219)	(0.00220)	(0.00220)
Mother education- incomplete high school	0.272***	0.272***	0.272***	-0.0317***	-0.0318***	-0.0318***			
	(0.00251)	(0.00252)	(0.00252)	(0.00155)	(0.00155)	(0.00155)			
Mother education- complete high school	0.302***	0.302***	0.302***						
	(0.00288)	(0.00289)	(0.00289)						
Mother education- missing	0.160***	0.161***	0.161***						
	(0.00293)	(0.00295)	(0.00295)						
Mother civil status-Married or union	0.0581***	0.0582***	0.0582***	0.0487***	0.0487***	0.0486***	0.0608***	0.0610***	0.0610***
	(0.00109)	(0.00109)	(0.00109)	(0.00170)	(0.00171)	(0.00171)	(0.00131)	(0.00132)	(0.00132)
Mother civil status-Widow or Divorced	0.0172***	0.0176***	0.0176***	0.0162**	0.0170***	0.0171***	0.0142***	0.0143***	0.0142***
	(0.00399)	(0.00401)	(0.00401)	(0.00647)	(0.00651)	(0.00652)	(0.00523)	(0.00525)	(0.00525)
Mother civil status-missing	0.0597***	0.0600***	0.0600***	0.0492***	0.0488***	0.0489***	0.0612***	0.0617***	0.0619***
	(0.00229)	(0.00232)	(0.00231)	(0.00405)	(0.00408)	(0.00407)	(0.00310)	(0.00313)	(0.00312)
Mother live children-one or more	-0.0800***	-0.0800***	-0.0799***	-0.0607***	-0.0608***	-0.0608***	-0.0849***	-0.0851***	-0.0851***
	(0.00104)	(0.00104)	(0.00104)	(0.00160)	(0.00160)	(0.00160)	(0.00133)	(0.00134)	(0.00134)
Mother live children-missing	-0.00716***	-0.00712***	-0.00717***	-0.00467*	-0.00508*	-0.00519**	-0.00934***	-0.00936***	-0.00939***
	(0.00155)	(0.00157)	(0.00157)	(0.00258)	(0.00259)	(0.00259)	(0.00216)	(0.00218)	(0.00218)
Mother occupation-other than Housewife	0.0296***	0.0297***	0.0296***	0.0362***	0.0360***	0.0360***	0.0305***	0.0307***	0.0307***
	(0.00143)	(0.00144)	(0.00144)	(0.00190)	(0.00190)	(0.00190)	(0.00200)	(0.00200)	(0.00200)
Mother occupation-missing	0.0158***	0.0163***	0.0164***	0.0220***	0.0219***	0.0222***	0.0142***	0.0148***	0.0147***
	(0.00241)	(0.00243)	(0.00243)	(0.00353)	(0.00353)	(0.00352)	(0.00323)	(0.00325)	(0.00326)
Prenatal apoitments- 1 to 3	0.00275	0.00303	0.00300	-0.0230***	-0.0238***	-0.0241***	0.0102***	0.0103***	0.0104***
	(0.00203)	(0.00207)	(0.00207)	(0.00518)	(0.00527)	(0.00526)	(0.00246)	(0.00250)	(0.00250)
Prenatal apoitments- 4 to 6	0.0573***	0.0576***	0.0575***	0.0251***	0.0244***	0.0239***	0.0649***	0.0650***	0.0650***
	(0.00175)	(0.00178)	(0.00178)	(0.00432)	(0.00439)	(0.00437)	(0.00227)	(0.00230)	(0.00230)
Prenatal apoitments- 7 or more	0.0773***	0.0779***	0.0779***	0.0417***	0.0412***	0.0409***	0.0900***	0.0903***	0.0904***
	(0.00170)	(0.00173)	(0.00174)	(0.00422)	(0.00430)	(0.00429)	(0.00225)	(0.00229)	(0.00229)
Pregnancy lenght-37 to 41 weeks	-0.00342*	-0.00691***	-0.00682***	-0.000295	-0.00320	-0.00299	-0.00374	-0.00630**	-0.00624**
	(0.00176)	(0.00198)	(0.00198)	(0.00311)	(0.00332)	(0.00332)	(0.00232)	(0.00259)	(0.00259)
Pregnancy lenght-42 or more weeks	-0.0276***	-0.0317***	-0.0316***	-0.0183***	-0.0214***	-0.0213***	-0.0268***	-0.0298***	-0.0298***
	(0.00307)	(0.00323)	(0.00322)	(0.00567)	(0.00584)	(0.00583)	(0.00403)	(0.00421)	(0.00420)
Place of birth- Hospital	-0.00300	-0.00548	-0.00538	-0.0364*	-0.0437**	-0.0433**	7.33e-05	0.000652	0.000739
	(0.0144)	(0.0145)	(0.0145)	(0.0210)	(0.0208)	(0.0209)	(0.0168)	(0.0172)	(0.0172)
Place of birth-Other health facility	-0.0191	-0.0214	-0.0213	-0.0340	-0.0395*	-0.0387*	-0.0198	-0.0188	-0.0187
	(0.0150)	(0.0150)	(0.0150)	(0.0221)	(0.0221)	(0.0221)	(0.0175)	(0.0179)	(0.0178)

continue

Continuation - Homicide and elementary school completion

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables		All			High mother education			Low mother education	
Place of birth- Home	-0.0248	-0.0285*	-0.0284*	-0.0634*	-0.0674**	-0.0667**	-0.0169	-0.0164	-0.0162
	(0.0165)	(0.0166)	(0.0166)	(0.0338)	(0.0339)	(0.0339)	(0.0188)	(0.0192)	(0.0192)
Place of birth- missing	-0.00216	-0.00419	-0.00414	-0.0620	-0.0687	-0.0693	0.0444	0.0437	0.0439
	(0.0215)	(0.0223)	(0.0223)	(0.0505)	(0.0505)	(0.0506)	(0.0341)	(0.0347)	(0.0347)
Birth type-Cesarean	-0.0393***	-0.0391***	-0.0391***	-0.0199***	-0.0196***	-0.0196***	-0.0427***	-0.0427***	-0.0427***
	(0.000884)	(0.000886)	(0.000886)	(0.00140)	(0.00141)	(0.00140)	(0.00117)	(0.00118)	(0.00118)
Birth type-missing	-0.0171**	-0.0194**	-0.0194**	-0.00298	-0.00563	-0.00559	-0.0213*	-0.0223*	-0.0222*
	(0.00832)	(0.00914)	(0.00914)	(0.0137)	(0.0146)	(0.0146)	(0.0110)	(0.0120)	(0.0120)
Macro region of birth- Northeast	-0.0338**	-0.0360**	-0.0357**	-0.00865	-0.0114	-0.0115	-0.0492**	-0.0497**	-0.0492**
	(0.0171)	(0.0170)	(0.0170)	(0.0325)	(0.0324)	(0.0325)	(0.0226)	(0.0226)	(0.0226)
Macro region of birth- Southeast	-0.0152	-0.0179	-0.0176	-0.00159	-0.00417	-0.00443	-0.0296	-0.0309	-0.0301
	(0.0205)	(0.0204)	(0.0204)	(0.0283)	(0.0284)	(0.0284)	(0.0294)	(0.0294)	(0.0294)
Macro region of birth- South	-0.0154	-0.0170	-0.0167	-1.10e-05	-0.00104	-0.00113	-0.0398	-0.0404	-0.0396
	(0.0247)	(0.0246)	(0.0246)	(0.0301)	(0.0302)	(0.0302)	(0.0383)	(0.0379)	(0.0379)
Macro region of birth- Midwest	-0.0133	-0.0132	-0.0127	0.0195	0.0199	0.0197	-0.0196	-0.0165	-0.0154
	(0.0160)	(0.0161)	(0.0161)	(0.0266)	(0.0265)	(0.0266)	(0.0223)	(0.0226)	(0.0226)
GDP per capita	-1.31e-06**	-1.29e-06**	-1.29e-06**	1.97e-07	1.99e-07	1.97e-07	-1.69e-06**	-1.68e-06***	-1.67e-06***
	(5.67e-07)	(5.51e-07)	(5.48e-07)	(4.80e-07)	(4.80e-07)	(4.80e-07)	(6.79e-07)	(6.46e-07)	(6.39e-07)
Infant mortality rate	3.81e-05	3.48e-05	3.61e-05	9.01e-07	1.33e-06	2.78e-06	3.49e-05	3.38e-05	3.69e-05
	(2.74e-05)	(2.76e-05)	(2.76e-05)	(4.63e-05)	(4.66e-05)	(4.66e-05)	(3.55e-05)	(3.57e-05)	(3.57e-05)
Education expenditure per capita	2.01e-05***	1.94e-05***	1.92e-05***	-1.95e-06	-2.87e-06	-2.30e-06	2.56e-05***	2.53e-05***	2.49e-05***
	(5.72e-06)	(5.51e-06)	(5.52e-06)	(9.60e-06)	(9.73e-06)	(9.63e-06)	(7.21e-06)	(7.03e-06)	(7.05e-06)
Health expenditure per capita	-5.14e-05***	-5.00e-05***	-4.95e-05***	-2.83e-06	-2.97e-07	-1.38e-06	-6.01e-05***	-6.01e-05***	-5.93e-05***
	(1.33e-05)	(1.30e-05)	(1.30e-05)	(2.12e-05)	(2.14e-05)	(2.13e-05)	(1.69e-05)	(1.66e-05)	(1.66e-05)
Public security expenditure per capita	-5.05e-05	-6.61e-05	-6.38e-05	-8.27e-05	-9.66e-05	-9.57e-05	-9.72e-05	-0.000111	-0.000103
	(0.000142)	(0.000146)	(0.000145)	(0.000121)	(0.000124)	(0.000123)	(0.000157)	(0.000161)	(0.000159)
Average school quality-IDEB	0.00264	0.00279	0.00286	0.00753***	0.00745***	0.00754***	0.00407	0.00417	0.00426
	(0.00225)	(0.00225)	(0.00225)	(0.00220)	(0.00219)	(0.00219)	(0.00263)	(0.00264)	(0.00264)
Average school SES	0.00250***	0.00247***	0.00247***	0.00322***	0.00323***	0.00322***	0.00136***	0.00135***	0.00134***
	(0.000325)	(0.000326)	(0.000326)	(0.000333)	(0.000334)	(0.000335)	(0.000405)	(0.000405)	(0.000405)
Cohort 1999	0.0250***	0.0250***	0.0247***	0.0204***	0.0204***	0.0195***	0.0280***	0.0276***	0.0271***
	(0.00310)	(0.00312)	(0.00312)	(0.00459)	(0.00461)	(0.00462)	(0.00410)	(0.00412)	(0.00412)
Cohort 2000	-0.000212	-0.000382	-0.000612	0.00582	0.00574	0.00494	-0.000365	-0.000617	-0.000957
	(0.00262)	(0.00262)	(0.00262)	(0.00373)	(0.00373)	(0.00374)	(0.00347)	(0.00349)	(0.00349)
Cohort 2001	0.00454***	0.00447***	0.00434***	0.00777***	0.00770***	0.00735***	0.00460***	0.00449***	0.00423***
	(0.00118)	(0.00118)	(0.00119)	(0.00170)	(0.00171)	(0.00172)	(0.00151)	(0.00151)	(0.00151)
Observations	1,534,544	1,515,267	1,514,212	397,096	394,142	393,804	966,881	957,375	956,749
R-squared	0.207	0.208	0.208	0.219	0.219	0.219	0.207	0.207	0.207

*** p<0.01, ** p<0.05, * p<0.1.

Table 3.8 – Homicide and high school completion

Variables	(1)	(2) All	(3)	(4)	(5) High mother education	(6)	(7)	(8) Low mother education	(9)
Birth weight	3.51e-05***	3.58e-05***	3.59e-05***	3.13e-05***	3.19e-05***	3.19e-05***	3.36e-05***	3.39e-05***	3.39e-05***
	(1.24e-06)	(1.26e-06)	(1.26e-06)	(2.90e-06)	(2.97e-06)	(2.97e-06)	(1.56e-06)	(1.59e-06)	(1.59e-06)
Apgar 1st minute	0.00410***	0.00421***	0.00420***	0.00652***	0.00635***	0.00637***	0.00269***	0.00269***	0.00268***
	(0.000656)	(0.000667)	(0.000667)	(0.00165)	(0.00165)	(0.00165)	(0.000812)	(0.000822)	(0.000822)
Apgar 5th minute	0.000938	0.000941	0.000947	-0.00114	-0.00134	-0.00136	0.000611	0.000814	0.000835
	(0.000828)	(0.000847)	(0.000847)	(0.00217)	(0.00217)	(0.00217)	(0.00101)	(0.00103)	(0.00103)
Homicide rate 4 trimester before conception			0.000116			0.000156			-9.64e-05
			(0.000296)			(0.000777)			(0.000392)
Homicide rate 3 trimester before conception			5.58e-05			0.00103			-2.41e-05
			(0.000303)			(0.000787)			(0.000399)
Homicide rate 2 trimester before conception			0.000686**			0.000349			0.000731*
			(0.000290)			(0.000766)			(0.000408)
Homicide rate 1 trimester before conception			0.000139			7.87e-05			0.000346
			(0.000287)			(0.000681)			(0.000411)
Homicide rate 1 trimester pregnacy		0.000181	-1.59e-06		0.000585	0.000717		0.000301	-0.000228
		(0.000242)	(0.000336)		(0.000577)	(0.000845)		(0.000338)	(0.000459)
Homicide rate 2 trimester pregnacy		-0.000563**	-0.000336		-0.000660	0.000207		-0.000440	-0.000583
		(0.000248)	(0.000347)		(0.000610)	(0.000897)		(0.000331)	(0.000452)
Homicide rate 3 trimester pregnacy		-0.000821***	-0.000111		-0.000758	-0.000397		-0.000944***	-2.34e-05
		(0.000240)	(0.000321)		(0.000532)	(0.000761)		(0.000314)	(0.000421)
Homicide rate 1 trimester after birth			-0.000636**			-0.000368			-0.000567
			(0.000300)			(0.000725)			(0.000418)
Homicide rate 2 trimester after birth			-0.000425			0.000234			-0.000858**
			(0.000301)			(0.000741)			(0.000398)
Homicide rate 3 trimester after birth			0.000419			0.000730			-0.000250
			(0.000308)			(0.000735)			(0.000393)
Homicide rate 4 trimester after birth			0.000781***			0.000457			0.00119***
			(0.000299)			(0.000783)			(0.000396)
Gender-Female	0.145***	0.145***	0.145***	0.138***	0.137***	0.137***	0.136***	0.136***	0.136***
	(0.00124)	(0.00125)	(0.00125)	(0.00268)	(0.00270)	(0.00270)	(0.00160)	(0.00162)	(0.00162)
Baby race-white	0.0420***	0.0419***	0.0418***	0.0436***	0.0434***	0.0434***	0.0409***	0.0409***	0.0409***
	(0.00188)	(0.00190)	(0.00190)	(0.00424)	(0.00429)	(0.00429)	(0.00208)	(0.00208)	(0.00208)
Baby race-missing	0.000101	-0.000917	-0.000930	0.00715	0.00720	0.00704	0.0149***	0.0138***	0.0138***
	(0.00353)	(0.00359)	(0.00359)	(0.00853)	(0.00868)	(0.00868)	(0.00462)	(0.00473)	(0.00473)

continue

Continuation - Homicide and high school completion

Variables	(1)	(2) All	(3)	(4)	(5) High mother education	(6)	(7)	(8) Low mother education	(9)
Mother age	0.00514***	0.00513***	0.00513***	0.00567***	0.00567***	0.00567***	0.00421***	0.00420***	0.00420***
	(0.000116)	(0.000117)	(0.000117)	(0.000283)	(0.000284)	(0.000284)	(0.000138)	(0.000139)	(0.000139)
Mother education- incomplete elementary school	0.107***	0.107***	0.107***				0.109***	0.109***	0.109***
	(0.00264)	(0.00265)	(0.00265)				(0.00265)	(0.00267)	(0.00267)
Mother education- incomplete high school	0.237***	0.237***	0.237***	-0.0534***	-0.0542***	-0.0542***			
	(0.00323)	(0.00325)	(0.00325)	(0.00346)	(0.00348)	(0.00348)			
Mother education- complete high school	0.290***	0.291***	0.291***						
	(0.00412)	(0.00414)	(0.00414)						
Mother education- missing	0.121***	0.121***	0.122***						
	(0.00470)	(0.00476)	(0.00476)						
Mother civil status-Married or union	0.0525***	0.0528***	0.0527***	0.0615***	0.0617***	0.0617***	0.0520***	0.0523***	0.0523***
	(0.00161)	(0.00161)	(0.00161)	(0.00341)	(0.00342)	(0.00342)	(0.00191)	(0.00191)	(0.00191)
Mother civil status-Widow or Divorced	-0.00469	-0.00341	-0.00337	-0.000801	0.000681	0.000752	-0.00472	-0.00370	-0.00361
	(0.00635)	(0.00640)	(0.00639)	(0.0139)	(0.0139)	(0.0139)	(0.00775)	(0.00777)	(0.00777)
Mother civil status-missing	0.0459***	0.0460***	0.0461***	0.0452***	0.0463***	0.0461***	0.0513***	0.0519***	0.0521***
	(0.00429)	(0.00436)	(0.00435)	(0.00910)	(0.00920)	(0.00921)	(0.00503)	(0.00510)	(0.00508)
Mother live children-one or more	-0.0887***	-0.0886***	-0.0886***	-0.0724***	-0.0729***	-0.0729***	-0.0802***	-0.0805***	-0.0805***
	(0.00156)	(0.00157)	(0.00157)	(0.00325)	(0.00327)	(0.00327)	(0.00202)	(0.00204)	(0.00203)
Mother live children-missing	-0.00900***	-0.00898***	-0.00893***	-0.00560	-0.00560	-0.00559	-0.00733**	-0.00691**	-0.00686**
	(0.00273)	(0.00278)	(0.00278)	(0.00606)	(0.00616)	(0.00616)	(0.00343)	(0.00347)	(0.00347)
Prenatal apoitments- 1 to 3	0.00526*	0.00566**	0.00567**	-0.0402***	-0.0414***	-0.0414***	-0.00229	-0.00165	-0.00156
	(0.00274)	(0.00277)	(0.00277)	(0.00930)	(0.00944)	(0.00943)	(0.00313)	(0.00318)	(0.00318)
Prenatal apoitments- 4 to 6	0.0381***	0.0386***	0.0385***	-0.000714	-0.00247	-0.00250	0.0311***	0.0317***	0.0318***
	(0.00245)	(0.00248)	(0.00248)	(0.00729)	(0.00748)	(0.00748)	(0.00294)	(0.00298)	(0.00298)
Prenatal apoitments- 7 or more	0.0670***	0.0678***	0.0678***	0.0300***	0.0286***	0.0286***	0.0585***	0.0593***	0.0594***
	(0.00223)	(0.00228)	(0.00227)	(0.00687)	(0.00711)	(0.00711)	(0.00289)	(0.00294)	(0.00294)
Pregnancy lenght-37 to 41 weeks	-0.00912***	-0.00852***	-0.00854***	0.00368	-0.00107	-0.00110	-0.00735**	-0.00719*	-0.00728*
	(0.00268)	(0.00312)	(0.00312)	(0.00619)	(0.00681)	(0.00680)	(0.00337)	(0.00379)	(0.00378)
Pregnancy lenght-42 or more weeks	7.15e-05	0.000364	0.000437	-0.0198*	-0.0259**	-0.0257**	-0.0290***	-0.0293***	-0.0294***
	(0.00527)	(0.00561)	(0.00561)	(0.0113)	(0.0116)	(0.0116)	(0.00570)	(0.00610)	(0.00610)
Place of birth- Hospital	0.0143	0.000335	-0.000185	-0.0138	-0.0351	-0.0344	0.0183	0.0116	0.0113
	(0.0213)	(0.0214)	(0.0213)	(0.0692)	(0.0711)	(0.0712)	(0.0235)	(0.0242)	(0.0242)
Place of birth-Other health facility	0.0135	0.000955	0.000513	0.0164	-0.00521	-0.00465	0.00977	0.00495	0.00487
	(0.0218)	(0.0219)	(0.0218)	(0.0706)	(0.0727)	(0.0728)	(0.0246)	(0.0253)	(0.0252)
Place of birth- Home	-0.0280	-0.0429*	-0.0434*	-0.150*	-0.159*	-0.158*	-0.0187	-0.0252	-0.0254
	(0.0234)	(0.0236)	(0.0236)	(0.0890)	(0.0910)	(0.0910)	(0.0260)	(0.0267)	(0.0266)
Place of birth- missing	0.00481	-0.00686	-0.00718	-0.0718	-0.108	-0.109	-0.0351	-0.0337	-0.0334
	(0.0285)	(0.0291)	(0.0290)	(0.130)	(0.129)	(0.129)	(0.0390)	(0.0386)	(0.0385)

continue

Continuation - Homicide and high school completion

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables		All			High mother education			Low mother education	
Birth type-Cesarean	-0.0490***	-0.0487***	-0.0487***	-0.0305***	-0.0305***	-0.0306***	-0.0423***	-0.0419***	-0.0419***
	(0.00138)	(0.00139)	(0.00139)	(0.00289)	(0.00292)	(0.00292)	(0.00176)	(0.00176)	(0.00176)
Birth type-missing	-0.0359***	-0.0441***	-0.0443***	-0.0127	-0.00932	-0.00944	-0.0409**	-0.0551***	-0.0552***
	(0.0119)	(0.0131)	(0.0131)	(0.0248)	(0.0269)	(0.0269)	(0.0174)	(0.0190)	(0.0190)
Macro region of birth- Northeast	0.0211	0.0246	0.0243	-0.0715	-0.0708	-0.0704	0.0117	0.0133	0.0136
	(0.0364)	(0.0363)	(0.0362)	(0.0975)	(0.0970)	(0.0971)	(0.0389)	(0.0391)	(0.0390)
Macro region of birth- Southeast	-0.0198	-0.0197	-0.0200	-0.0977	-0.0977	-0.0981	-0.0393	-0.0401	-0.0396
	(0.0409)	(0.0411)	(0.0411)	(0.0758)	(0.0757)	(0.0755)	(0.0498)	(0.0502)	(0.0501)
Macro region of birth- South	-0.000916	0.00371	0.00353	-0.0321	-0.0313	-0.0316	-0.0143	-0.0101	-0.00928
	(0.0467)	(0.0468)	(0.0467)	(0.0809)	(0.0809)	(0.0809)	(0.0545)	(0.0552)	(0.0549)
Macro region of birth- Midwest	-0.0279	-0.0263	-0.0269	-0.126**	-0.125**	-0.126**	-0.00531	-0.00154	-0.00170
	(0.0346)	(0.0344)	(0.0344)	(0.0598)	(0.0598)	(0.0597)	(0.0407)	(0.0410)	(0.0410)
GDP per capita	-4.50e-06	-4.52e-06	-4.53e-06	-4.92e-06	-4.81e-06	-4.81e-06	-4.86e-06	-4.87e-06	-4.91e-06
	(3.40e-06)	(3.47e-06)	(3.46e-06)	(4.41e-06)	(4.55e-06)	(4.55e-06)	(3.62e-06)	(3.65e-06)	(3.66e-06)
Infant mortality rate	9.93e-05	9.26e-05	9.35e-05	-4.93e-05	-5.13e-05	-4.83e-05	0.000139	0.000136	0.000138
	(7.65e-05)	(7.71e-05)	(7.70e-05)	(0.000187)	(0.000188)	(0.000187)	(9.06e-05)	(9.06e-05)	(9.04e-05)
Education expenditure per capita	-3.86e-05	-4.10e-05	-4.15e-05	8.44e-06	7.97e-07	-2.37e-06	1.88e-06	8.46e-07	4.27e-07
	(2.80e-05)	(2.86e-05)	(2.86e-05)	(5.91e-05)	(5.96e-05)	(5.96e-05)	(2.86e-05)	(2.89e-05)	(2.92e-05)
Health expenditure per capita	8.04e-05	8.56e-05	8.63e-05	-2.95e-05	-1.34e-05	-7.35e-06	6.78e-06	9.29e-06	9.78e-06
	(5.83e-05)	(5.96e-05)	(5.94e-05)	(0.000119)	(0.000120)	(0.000120)	(5.95e-05)	(6.01e-05)	(6.07e-05)
Public security expenditure per capita	-0.000170	-0.000290	-0.000297	-0.000868	-0.000967	-0.000984	0.000430	0.000267	0.000263
	(0.000454)	(0.000481)	(0.000481)	(0.000809)	(0.000832)	(0.000831)	(0.000423)	(0.000452)	(0.000451)
Average school quality-IDEB	-0.00276	-0.00283	-0.00285	-0.00336	-0.00445	-0.00446	-0.00528*	-0.00515*	-0.00515*
	(0.00256)	(0.00257)	(0.00257)	(0.00404)	(0.00404)	(0.00404)	(0.00295)	(0.00296)	(0.00296)
Average school SES	0.00488***	0.00492***	0.00492***	0.00676***	0.00687***	0.00688***	0.00186***	0.00187***	0.00187***
	(0.000415)	(0.000414)	(0.000414)	(0.000693)	(0.000695)	(0.000695)	(0.000490)	(0.000489)	(0.000488)
Cohort 1999	0.256***	0.256***	0.256***	0.301***	0.301***	0.302***	0.237***	0.237***	0.237***
	(0.00356)	(0.00357)	(0.00357)	(0.00661)	(0.00664)	(0.00664)	(0.00368)	(0.00369)	(0.00369)
Observations	688,769	675,603	675,603	136,205	134,822	134,822	401,231	395,469	395,469
R-squared	0.282	0.284	0.284	0.413	0.414	0.414	0.295	0.296	0.296

*** p<0.01, ** p<0.05, * p<0.1.

Bibliography

ADHVARYU, A.; NYSHADHAM, A. Endowments at birth and parents' investments in children. *The Economic Journal*, v. 126, n. 593, p. 781–820, 2016.

ALAN, S.; ERTAC, S. Good Things Come to Those Who (Are Taught How to) Wait: Results from a Randomized Educational Intervention on Time Preference. *Human Capital and Economic Opportunity Working Group*, 2015. Disponível em: <https://ideas.repec.org/p/hka/wpaper/2015-003.html>.

ALMOND, D.; CHAY, K. Y.; LEE, D. S. The Costs of Low Birth Weight. *Quarterly Journal of Economics*, v. 120, n. 3, p. 1031–1083, Aug 2005. Disponível em: <https://ideas.repec.org/p/nbr/nberwo/10552.html>.

ALMOND, D.; CURRIE, J.; DUQUE, V. Childhood circumstances and adult outcomes: Act ii. *National Bureau of Economic Research, Inc*, n. 23017, 2017.

ALMOND, D.; MAZUMDER, B. Fetal origins and parental responses. *Annual Review of Economics*, v. 5, n. 1, p. 37–56, 2013. Disponível em: <https://doi.org/10.1146/annurev-economics-082912-110145>.

APGAR, V. A proposal for a new method of evaluation of the newborn infant. *Current Researches in Anesthesia and Analgesia*, v. 32, p. 260–267, July-August 1953.

BARROS, R. P. de. Políticas públicas para a redução do abandono e evasão escolar de jovens. 2017.

BEHRMAN, J. Mother's Schooling and Child Education: A Survey. *University of Pennsylvania Department of Economics*, DP025, 1997. Disponível em: <https://pdfs-.semanticscholar.org/2af2/531743684d8bbc678476bf00e74b52ff33b8.pdf>.

BERRY, J.; KARLAN, D.; PRADHAN, M. The impact of financial education for youth in ghana. *National Bureau of Economic Research*, Working Paper 21068, 2015. Disponível em: <http://www.nber.org/papers/w21068>.

BHARADWAJ, P.; EBERHARD, J. P.; NEILSON, C. A. Health at birth, parental investments, and academic outcomes. *Journal of Labor Economics*, v. 36, n. 2, p. 349–394, 2018. Disponível em: <https://doi.org/10.1086/695616>.

BHARADWAJ, P.; LøKEN, K. V.; NEILSON, C. Early life health interventions and academic achievement. *American Economic Review*, v. 103, n. 5, p. 1862–91, August 2013. Disponível em: <http://www.aeaweb.org/articles?id=10.1257/aer.103.5.1862>.

BLACK, S. E.; DEVEREUX, P. J.; SALVANES, K. G. Why the Apple Doesn't Fall Far: Understanding Intergenerational Transmission of Human Capital. *American Economic Review*, v. 95, n. 1, p. 437–449, March 2005. Disponível em: <https://ideas.repec.org/a-/aea/aecrev/v95y2005i1p437-449.html>.

BLACK, S. E.; DEVEREUX, P. J.; SALVANES, K. G. From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes. *The Quarterly Journal of Economics*, v. 122, n. 1, p. 409–439, 2007. Disponível em: <https://ideas.repec.org/a-/oup/qjecon/v122y2007i1p409-439..html>.

BLICKSTEIN, I.; KALISH, R. B. Birthweight discordance in multiple pregnancy. *Twin Research*, Cambridge University Press, v. 6, n. 6, p. 526–531, 2003.

BORGES, G. M.; SILVA, L. O. da. Fontes de dados de fecundidade no brasil: características, vantagens e limitações. In: ERVATTI, L. R.; BORGES, G. M.; JARDIM, A. de P. (Ed.). *Mudança Demográfica no Brasil no Início do Século XXI: Subsídios para as projeções da população*. Instituto Brasileiro de Geografia e Estatística - IBGE, 2015, (Estudos e Análises Informação Demográfica e Socioeconômica-número 4). cap. 1, p. 10–29. Disponível em: <https://biblioteca.ibge.gov.br/visualizacao/livros/liv93322.pdf>.

BREINING, S. et al. Spillover effects of early-life medical interventions. *IZA Discussion Paper No. 9086*, 2015.

BROWN, R. The mexican drug war and early-life health: The impact of violent crime on birth outcomes. *Demography*, v. 55, n. 1, p. 319–340, Feb 2018. Disponível em: <https://doi.org/10.1007/s13524-017-0639-2>.

BRUHN, M. et al. The impact of high school financial education: Evidence from a large-scale evaluation in brazil. *American Economic Journal: Applied Economics*, v. 8, n. 4, p. 256–295, 2016. Disponível em: <http://www.aeaweb.org/articles?id=10.1257-/app.20150149>.

CAMACHO, A. Stress and birth weight: Evidence from terrorist attacks. *American Economic Review*, v. 98, n. 2, p. 511–15, May 2008. Disponível em: <http://www-.aeaweb.org/articles?id=10.1257/aer.98.2.511>.

CAMBIASO, O. et al. Discordance of cord insertions as a predictor of discordant fetal growth in monochorionic twins. *Placenta*, n. 47, p. 81–86, 2016.

CARPENA, F. et al. The Abcs of Financial Education: Experimental Evidence on Attitudes, Behavior, and Cognitive Biases. *World Bank Policy Research Working Paper*, n. 7413, 2015. Disponível em: <ttps://ssrn.com/abstract=2661139>.

CARRILLO, B.; FERES, J. G. Low birth weight and infant mortality: Lessons from brazil. *ANPEC Annals*, p. 1–20, 2017. Disponível em: <https://www.anpec.org.br/nordeste-/2017/submissao/arquivos_identificados/012-dd2cf788ae718dfdcde059ed52ac845a.pdf>.

CRUZ-MARTINEZ, R. et al. Cerebral blood perfusion and neurobehavioral performance in full-term small-for-gestational-age fetuses. *American Journal of Obstetrics & Gynecology*, v. 210, n. 5, p. 474.e1–474.e7, November 2009.

CURRIE, J. Inequality at birth: Some causes and consequences. *American Economic Review*, v. 101, n. 3, p. 1–22, May 2011. Disponível em: <http://www.aeaweb.org-/articles?id=10.1257/aer.101.3.1>.

CURRIE, J.; MORETTI, E. Mother's education and the intergenerational transmission of human capital: Evidence from college openings. *The Quarterly Journal of Economics*, v. 118, n. 4, p. 1495–1532, 2003. Disponível em: <http://dx.doi.org/10.1162-/003355303322552856>.

DAVIS, E. P.; SANDMAN., C. A. The timing of prenatal exposure to maternal cortisol and psychosocial stress is associated with human infant cognitive development. *Child development*, v. 81, n. 1, p. 131–148, 2010.

DREXLER, A.; FISCHER, G.; SCHOAR, A. Keeping it simple: Financial literacy and rules of thumb. *American Economic Journal: Applied Economics*, v. 6, n. 2, p. 1–31, 2014. Disponível em: <http://www.aeaweb.org/articles?id=10.1257/app.6.2.1>.

DUBE, J.; DODDS, L.; ARMSON, A. B. Does chorionicity or zygosity predict adverse perinatal outcomes in twins? *American Journal of Obstetrics & Gynecology*, v. 186, n. 3, p. 579–583, 2002.

DUNCAN, G. J.; SOJOURNER, A. J. Can intensive early childhood intervention programs eliminate income-based cognitive and achievement gaps? *The Journal of human resources*, v. 48, n. 4, p. 945–968, 2013.

DUQUE, V. Early-life conditions and child development: Evidence from a violent conflict. *SSM - Population Health*, v. 3, p. 121 – 131, 2017. ISSN 2352-8273. Disponível em: <http://www.sciencedirect.com/science/article/pii/S2352827316300891>.

EHRENSTEIN, V. Association of apgar scores with death and neurologic disability. *Clinical Epidemiology*, v. 1, p. 45–53, 2009.

EREN, O.; DEPEW, B.; BARNES, S. Test-based promotion policies, dropping out, and juvenile crime. *Journal of Public Economics*, v. 153, p. 9 – 31, 2017. ISSN 0047-2727. Disponível em: <http://www.sciencedirect.com/science/article/pii-/S0047272717301044>.

EVANS, D. K.; POPOVA, A. What Really Works to Improve Learning in Developing Countries? An Analysis of Divergent Findings in Systematic Reviews. *World Bank Policy Research Working Paper*, n. 7203, 2015.

FERNANDES, D.; LYNCH, J.; NETEMEYER, R. G. Financial literacy, financial education, and downstream financial behaviors. 2014.

FIGLIO, D. et al. The effects of poor neonatal health on children's cognitive development. *American Economic Review*, v. 104, n. 12, p. 3921–55, December 2014. Disponível em: <http://www.aeaweb.org/articles?id=10.1257/aer.104.12.3921>.

HANUSHEK, E. A.; WOESSMANN, L. Education and economic growth. In: PETERSON, P. (Ed.). *International Encyclopedia of Education*. Oxford: Elsevier, 2010. p. 245–252.

HANUSHEK, E. A.; WOESSMANN, L. Do better schools lead to more growth? cognitive skills, economic outcomes, and causation. *Journal of Economic Growth*, v. 17, n. 4, p. 267–321, Dec 2012. ISSN 1573-7020. Disponível em: <https://doi.org/10.1007/s10887-012-9081-x>.

HECKMAN, J.; CARNEIRO, P. Human capital policy. *National Bureau of Economic Research*, n. 9495, 2003. Disponível em: <http://www.nber.org/papers/w9495>.

HECKMAN, J. J. The economics, technology and neuroscience of human capability formation. *National Bureau of Economic Research*, n. 13195, June 2007. Disponível em: <http://www.nber.org/papers/w13195>.

HECKMAN, J. J.; MOSSO, S. The economics of human development and social mobility. *Annual Review of Economics*, v. 6, n. 1, p. 689–733, 2014. Disponível em: <https://doi.org/10.1146/annurev-economics-080213-040753>.

IBGE, I. B. de Geografia e E. *Pesquisa Nacional por Amostra de Domicílios - Características da vitimização e do acesso à justiça no Brasil 2009*. Instituto Brasileiro de Geografia e Estatística - IBGE, 2009. (Suplemento). Disponível em: <https://biblioteca.ibge.gov.br/visualizacao/livros/liv47311.pdf>.

IKEDA, M.; GARCíA, E. Grade repetition. *OECD Journal: Economic Studies*, v. 2013/1, 2014. Disponível em: <https://www.oecd-ilibrary.org/content/paper/eco_studies-2013-5k3w65mx3hnx>.

INEP. *INDICADOR DE NÍVEL SOCIOECONÔMICO (Inse) DAS ESCOLAS*. [S.l.], 2014. Disponível em: <http://download.inep.gov.br-/informacoes_estatisticas/indicadores_educacionais/2011_2013/nivel_socioeconomico-/nota_tecnica_indicador_nivel_socioeconomico.pdf>.

JACOB, B. A.; LEFGREN, L. Remedial education and student achievement: A regression-discontinuity analysis. v. 86, p. 226–244, 02 2004.

JENSEN, R. The (perceived) returns to education and the demand for schooling. *The Quarterly Journal of Economics*, v. 125, n. 2, p. 515–548, 2010. Disponível em: <http://dx.doi.org/10.1162/qjec.2010.125.2.515>.

KAISER, T.; MENKHOFF, L. Does financial education impact financial literacy and financial behavior, and if so, when? *DIW Berlin, German Institute for Economic Research*, n. 1562, 2016. Disponível em: <https://EconPapers.repec.org-/RePEc:diw:diwwpp:dp1562>.

KIBEL, M. et al. Placental abnormalities differ between small for gestational age fetuses in dichorionic twin and singleton pregnancies. *Placenta*, n. 60, p. 28–35, 2017. ISSN 1521-6934.

KOPPENSTEINER, M. F.; MANACORDA, M. Violence and birth outcomes: Evidence from homicides in brazil. *Journal of Development Economics*, v. 119, p. 16 – 33, 2016. ISSN 0304-3878. Disponível em: <http://www.sciencedirect.com/science/article/pii-/S0304387815001297>.

KRAMER, M. S. Determinants of low birth weight:methodological assessment and meta-analysis. *Bulletin of the World Health Organization*, v. 5, n. 65, p. 663–737, 1987.

LARROQUE, B. et al. School difficulties in 20-year-olds who were born small for gestational age at term in a regional cohort study. *Pediatrics*, v. 108, n. 1, p. 111–115, 2001.

LAVENTHAL, N. T.; TREADWELL, M. C. Ethical considerations in the care of complicated twin pregnancies. *Seminars in Fetal and Neonatal Medicine*, n. 23, p. 7–12, 2018.

LUSARDI, A. Numeracy, financial literacy, and financial decision-making. *National Bureau of Economic Research*, n. 17821, 2012. Disponível em: <http://www.nber.org-/papers/w17821>.

LUSARDI, A.; MITCHELL, O. S. Financial literacy around the world: an overview. *Journal of Pension Economics and Finance*, Cambridge University Press, v. 10, n. 4, p. 497–508, 2011.

LUSARDI, A.; MITCHELL, O. S. The economic importance of financial literacy: Theory and evidence. *Journal of Economic Literature*, v. 52, n. 1, p. 5–44, March 2014. Disponível em: <http://www.aeaweb.org/articles?id=10.1257/jel.52.1.5>.

LUSARDI, A.; MITCHELL, O. S.; CURTO, V. Financial literacy among the young. *The Journal of Consumer Affairs*, Wiley, v. 44, n. 2, p. 358–380, 2010. Disponível em: <http://www.jstor.org/stable/23859796>.

MANDELL, L. *Starting Younger: Evidence Supporting the Effectiveness of Personal Financial Education for Pre-High School Students.* 2009.

MANI, A. et al. Poverty impedes cognitive function. *Science*, American Association for the Advancement of Science, v. 341, n. 6149, p. 976–980, 2013. Disponível em: <http://science.sciencemag.org/content/341/6149/976>.

MCEWAN, P. J. Improving learning in primary schools of developing countries: A meta-analysis of randomized experiments. *Review of Educational Research*, v. 85, n. 3, p. 353–394, 2015. Disponível em: <https://doi.org/10.3102/0034654314553127>.

MONTEIRO, J.; ROCHA, R. Drug battles and school achievement: Evidence from rio de janeiro's favelas. *The Review of Economics and Statistics*, v. 99, n. 2, p. 213–228, 2017. Disponível em: <https://doi.org/10.1162/REST_a_00628>.

NILSSON, J. P. Alcohol availability, prenatal conditions, and long-term economic outcomes. *Journal of Political Economy*, v. 125, n. 4, p. 1149–1207, 2017. Disponível em: <https://doi.org/10.1086/692694>.

OECD. Pisa 2015 results in focus. n. 67, 2016. Disponível em: <https://www.oecd-ilibrary.org/content/paper/aa9237e6-en>.

OREOPOULOS, P. et al. Short-, medium-, and long-term consequences of poor infant health: An analysis using siblings and twins. *The Journal of Human Resources*, [University of Wisconsin Press, Board of Regents of the University of Wisconsin System], v. 43, n. 1, p. 88–138, 2008. Disponível em: <http://www.jstor.org/stable/40057340>.

PAEPE, M. D. et al. Placental characteristics of selective birth weight discordance in diamniotic-monochorionic twin gestations. *Placenta*, n. 31, p. 380–386, 2010.

QUINTANA-DOMEQUE, C.; RóDENAS-SERRANO, P. The hidden costs of terrorism: The effects on health at birth. *Journal of Health Economics*, v. 56, p. 47 – 60, 2017. ISSN 0167-6296. Disponível em: <http://www.sciencedirect.com/science/article/pii-/S0167629617308093>.

ROCHA, R.; SOARES, R. R. Evaluating the impact of community-based health interventions: evidence from brazil's family health program. *Health Economics*, v. 19, n. S1, p. 126–158, 2010. Disponível em: <https://onlinelibrary.wiley.com/doi/abs/10-.1002/hec.1607>.

RONDA, V. The effect of maternal psychological distress on children's cognitive development. *Working Paper*, 2017.

SANZ-CORTES, M. et al. Brainstem and cerebellar differences and their association with neurobehavior in term small-for-gestational-age fetuses assessed by fetal mri. *American Journal of Obstetrics & Gynecology*, v. 120, n. 5, p. 452.e1–452.e8, May 2014.

SCHWERDT, G.; WEST, M. R.; WINTERS, M. A. The effects of test-based retention on student outcomes over time: Regression discontinuity evidence from florida. *Journal of Public Economics*, v. 152, p. 154 – 169, 2017. ISSN 0047-2727. Disponível em: <http://www.sciencedirect.com/science/article/pii/S004727271730097X>.

SIMõES, C. C. da S. *Relações entre as Alterações Históricas na Dinâmica Demográfica Brasileira e os Impactos Decorrentes do Processo de Envelhecimento da População*. Instituto Brasileiro de Geografia e Estatística - IBGE, 2016. (Estudos e Análises Informação Demográfica e Socioeconômica-número 4). Disponível em: <https:/-/biblioteca.ibge.gov.br/visualizacao/livros/liv98579.pdf>.

SOARES, T. M. et al. Fatores associados ao abandono escolar no ensino médio público de minas gerais. *Educação e Pesquisa*, v. 41, n. 3, p. 757–772, jul./set. 2015.

SPI, S. P. I. *2017 Social Progress Index Report*. Social Progress Imperative, 2017. Disponível em: <http://www.socialprogressimperative.org/wp-content/uploads/2017-/06/SPI2017-Report-final.pdf>.

TOWNSEND, R.; KHALIL, A. Fetal growth restriction in twins. *Best Practice & Research Clinical Obstetrics & Gynaecology*, 2018. ISSN 1521-6934. Disponível em: <http://www.sciencedirect.com/science/article/pii/S1521693418300452>.

UNICEF; WHO. Low birth weight, country, regional and global estimates. *World Health Organization*, New York, n. ISBN:92-806-3832-7, 2004.

UNODC. *The Global Study on Homicide 2013*. United Nations Office on Drugs and Crime, United Nations publications, 2014. Disponível em: <http://www.unodc.org-/documents/gsh/pdfs/2014_GLOBAL_HOMICIDE_BOOK_web.pdf>.

WELBERG, L. A. M.; SECKL, J. R. Prenatal stress, glucocorticoids and the programming of the brain. *Journal of Neuroendocrinology*, v. 13, n. 2, p. 113–128, 2001. Disponível em: <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2826.2001-.00601.x>.

WHO. Who statement on caesarean section rates. *World Health Organization*, Geneva, n. WHO/RHR/15.02, 2015.

WHO. Who recommendations on antenatal care for a positive pregnancy experience. *World Health Organization*, Geneva, p. 1–156, 2016.

WHO; UNICEF. Home visits for the newborn child: a strategy to improve survival. *World Health Organization and United Nations Children's Fund*, New York, 2009.

WORLDBANK. *Homicide rate dataset 1995 – 2008*. World Bank Social Development Department, 2010. Disponível em: <http://siteresources.worldbank.org/EXTCPR-/Resources/407739-1267651559887/Homicide_Rate_Dataset.pdf>.

XU, L.; ZIA, B. Financial Literacy Around the World: An Overview of the Evidence with Practical Suggestions for the Way Forward. *World Bank Policy Research Working Paper*, n. 6107, 2015.