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Access to Education and Teenage Pregnancy

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Access to Education and Teenage Pregnancy

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Access to Education and Teenage Pregnancy

Abstract

Little is known about the causal impact of education opportunities on the decision of young women to have children. Expanding education opportunities may lead to a greater number of young women putting off childbearing until after their teenage years. In this study we look at the effect of one of the largest secondary school expansions on record, providing quasi-experimental evidence to uncover the causal impact of education opportunity on teenage fertility. After achieving near universal enrolment in primary education in the mid-1990s, Brazil went through an ambitious program of expanding secondary schooling. Between 1996 and 2009 more than 10,269 secondary schools were introduced, increasing the average enrolment rate for teens age 15 to 19 from 21% to 48%. We combine data from the Brazilian School Census, and Brazilian Vital Statistics data capturing 45 million live births by age of mother into an extraordinarily rich data set. Plausibly exogenous variation in the introduction of schools across municipalities over time is used to estimate the effect of education opportunity on teenage births. We find a significant negative effect of secondary school availability on teenage pregnancy. Our results suggest that the addition of one school at age 15 will reduce average cumulative births by 19 by, on average, 4.4 births or 4.6% relative to the mean. These results suggest that the expansion in secondary schools across Brazil can account for roughly 27% of the large decline in teenage childbearing observed between 1997 and 2009 in Brazil.

JEL Classifications: I20, I26, J13

Keywords: Secondary education, teenage pregnancy, Brazil.

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1. Introduction

As a policy issue teen pregnancy has received a great deal of attention in middle as well as high income countries. This is driven by a number of robust stylized facts: relative to women who give birth after their teen years, teen mothers have lower levels of education, lower employment and lower earnings. Further, this correlation is observed throughout the life cycle. However, the direction of causality is difficult to disentangle: to what extent does teenage motherhood lead to poorer outcomes versus to what extent do poorer future outcomes (actual or perceived) lead to the decision for young women to have children?

Casual observation suggests a strong negative relationship between school availability and teenage childbearing in Brazil. Starting from 12,684 secondary schools in 1996, by 2009 this number has increased by more than 57% to 19,964. Over the same period, the number of births by teenage girls had decreased 19%. In Figure 1 we plot this relationship over time[1]. Evidence based on the cross-section presents a very similar picture. In Figure 2A we present the state-level relationship between school density and rate of teen pregnancy.[2] There is a clear negative relationship suggesting that a one-unit increase in schools per 1,000 teens is associated with a decrease of about 21 births per 1,000 teens.[3] The negative relationship persists when plotting the data at the level of the municipalities (Figure 2B). The suggested relationship in these figures cannot though be interpreted as causal; many other confounding factors are likely to exist. For example, in Figure 2A states with relatively low-school density and high teenage birth rates tend to be the poorer states in the north of Brazil, while the states with relatively high-school density and low teenage birth rates tend to be the more prosperous states in the South-East.

In this paper we use variation from the expansion of secondary school across municipalities in Brazil to identify the effect of access to secondary schools on birth outcomes. Our main results suggest that an additional secondary school will lead to a decrease in teenage childbearing, on average, by approximately 4.5% relative to the mean number of births for a given cohort. Back of the envelop calculations based on our estimates suggest that approximately 27% of the total decline in teenage childbearing observed in Figure 1 can be attributed to the expansion of

[1] The plot captures the sample used in the primary analysis: all municipalities with populations less than 500,000.
[2] The plots in figure 2 are based on the based on the 2002 cross-section, which we use as midpoint for the period for which we have data available. Earlier or later time periods deliver very similar results.
[3] The correlation is statistically different from 0 at the 5% level of significance.

secondary schools. We also show that there is a persistent impact of a decrease in child births to age 23 (the oldest age for which we are able to perform our analyses). This result is consistent with an increase in human capital increasing the opportunity cost associated with having children and some women forgoing child bearing as young adults in consequence. Consistent with this interpretation of our results we find that the negative effect into early adulthood persists when a school is introduced into an urban setting, but dissipates when a school is introduced into a rural setting. This would be expected if the returns to secondary education are lower, and therefore the opportunity cost to have children is lower, in rural farming areas.

Brazil is particularly well suited to study our research question. The school expansion that we examine constitutes one of the largest expansions of secondary schools on record, and provides variation in the number of secondary schools over time and across 4,885 Brazilian municipalities. We use information from 14 waves of the Brazilian school census, containing detailed information on the entirety of Brazilian schools, to create a new data set reflecting the availability of secondary schools in every Brazilian municipality between 1996 and 2009. This information is combined with data from Vital Statistics in Brazil capturing the universe of live births over the same period. This creates a rich and unique dataset. To our knowledge this is the first paper to document and utilize data on the observed rapid growth of secondary schools across Brazil over the last two decades.

The current study fits into a literature focused on estimates the causal relationship between educational attainment and the propensity for teenage motherhood. Previous studies exploit exogenous variation from changes to mandatory schooling laws. Black, Devereux and Salvanes (2008) look at variation in teen births resulting from changes to minimum drop-out age laws in the US and Norway. They estimate a 4.7% and 8.8% decrease in teenage childbearing following the implementation of laws mandating a minimum school leaving age of 16 and 17 respectively. Expanding on these findings, Monstad, Propper and Salvanes (2008) find that the change in mandatory drop-out age in Norway lead to postponement of births from teenage years to the mid-thirties. For the UK, Geruso and Royer (2014) estimate that an extra year of schooling—induced by a change in minimum leaving ages—will lead to a local average treatment effect of a 30% reduction in births at ages 16 and 17.

Our study differs from these studies in an important way. In contrast to mandatory schooling laws, which impact the margin of the population that do not attend school but for the law, our strategy measures the impact for teens who attend school when availability is improved, but absent a law. It is not *a priori* obvious that our margin reflects young women who will change their childbearing behaviour. Put another way, the margin we exploit is precisely those women who would be non-compliers in the previous studies; they respond to changes in secondary school opportunities. This paper contributes to the literature by estimating the effect of improved school accessibility—via the introduction of new schools into a municipality—on teenage childbearing. Despite this important difference, our estimates are very similar, in sign and magnitude, to the findings of these previous studies.

Our paper is closer in spirit to a relatively little explored angle in the literature that focuses on cost of attending school and its impact on teenage fertility. Duflo, Dupas and Kremer (2010) provide experimental evidence on lowering the cost of attending primary school—in the form of providing free uniforms—on fertility for young women in Kenya. Their results suggest that the provision of educational opportunities have a large, negative, impact on the fertility of young women during the last three years of primary schooling. Following Currie and Moretti (2003), we interpret improved access—in terms of geographic distance—to school as a decrease the cost of attending.

In this sense the current paper also builds on the wider literature on economic opportunities and fertility. Lundberg and Plotnick (1995) find, for white teenagers in the US, teenage childbearing decisions respond to policy-created economic incentives associated with childbearing. More recently evidence looks at responses to indirect incentives. Arkes and Klerman (2009) find, in the US, pro-cyclical fertility patterns for young women aged 15–17. This is re-enforced by the findings of Ananat, Gassman-Pines and Gibson-Davis (2013) who show that, for counties in North Carolina, local job losses of 1 percent of the working age population result in an on average 2 percent decrease in teenage childbearing. We show that in urban areas schools have a persistent negative impact on childbearing while in rural areas the negative impact rapidly dissipates in early adulthood. To the extent that the returns to secondary education are higher in urban centres, this is consistent with a medium-run impact of human capital accumulation on fertility.

The current study also informs an active debate regarding the direction of causation between economic outcomes and teenage childbearing. It is not clear if the negative correlation between long-term economic outcomes is the result of teenage child bearing itself, or if teenage child bearing is a response to low later life outcomes. The evidence on the effect of teenage childbearing on later life outcomes is mixed. Klepinger, Lundberg and Plotnick (1999) find that young motherhood substantially reduces time spent in formal education and work experience obtained and therefore later-year earnings. Recent evidence, by Hotz, McElroy and Sanders (2005), Fletcher and Wolfe (2009) and Ashcraft, Fernandez-Val and Lang (2013) all find negative, but modest effects of teenage motherhood on education and labour market outcomes. Lang and Weinstein (2015), using pre-Roe versus Wade data, find a negative effect of teen motherhood on education which is particularly large for teens from more disadvantaged backgrounds. Kearney and Levine (2012) argue that causation runs in the opposite direction. They document geographic variation in rates of teen pregnancy across the United States and argue that the variation reflects geographic differences in economic opportunity—both perceived and real. Our findings are consistent with Kearney and Levine. To the extent that secondary education offers an opportunity to increase human capital and labor market earnings, improved access to secondary education represents a real improvement in economic opportunity, for at least some teens. If Kearney and Levine are correct, we should expect to see a negative relationship between secondary schools and birth outcomes.

The remainder of this paper is organized as follows. In Section 2 we provide a background discussion on the provision of secondary education in Brazil. In Section 3 we discuss the data to be used in the main analysis. In Section 4 we review the empirical strategy used for our main result, to be presented in Section 5. Section 6 discusses, and presents evidence on, some of the possible mechanisms underlying the main result. Section 7 concludes.

2. Background information

Secondary education in Brazil is largely the responsibility of the 26 states and is preceded by primary schooling—compulsory for children 6 to 14 years of age—lasting nine years. Of the 15,219 public secondary schools in 1997 for the municipalities in our study, 97% were indeed under state control. State Secretariats of Education are responsible for the regulation and general management of secondary schools, including the hiring of teachers and curriculum content (JBIC 2005). There is no minimum age for initial enrolment to secondary school, but it is targeted at age 15 and students must have completed primary school first.[4] There is no maximum age limit, and due to frequent late enrolment and grade retention in primary schools, age-grade mismatch at secondary school is frequent (Foureaux Koppensteiner, 2014). In 2010

[4] Recently primary education has been extended to 9 years and starts at the age of 6. For the most of our analysis before the mid-2000, primary education started at the age of 7 and lasted for 8 years.

about 30% of students in the first grade of secondary school were above the target age (IBGE 2012).

Until the beginning of the 1990s secondary education was an overlooked part of the education system in Brazil (Guimarães de Castro & Tiezzi 2004). It was highly geared to the education of the elites preparing for entrance to higher education and considered of little relevance for the education of the broader population. Following the end of military dictatorship, the new constitution of 1988 made access to secondary education a key aim on the political agenda, mandating secondary education to be available (although not mandatory) for all those completing primary education. Significant changes were made in 1996 when the newly established government of Fernando Henrique Cardoso passed the General Education Law (Lei de Diretrizes e Bases da Educação Nacional: LDB). The LDB outlined the *progressive universalization of access to free secondary education*, gradually increasing access to state-funded public secondary schools (Marchelli 2010). Following the rapid expansion of primary education, which was virtually universal by the early 1990s, secondary education started to expand (Moore, DeStephano, Terway and Balwanz 2008, Di Gropello 2006, De Felizio 2009). The number of students in secondary schools increased from under 5.7 million to 8.3 million (INEP 2003, INEP 2011). This increase is mirrored by a steep increase in education expenditure; between 2000 and 2009 Brazil reports the largest increase in education spending as a percentage of total public expenditure for 33 countries for which data is available (OECD 2012).

The expansion of the secondary system reflected the additional demand from the increasing number of students finishing primary schooling, due to a combination of higher enrolment numbers and improvements in completion rates in primary education towards the second half of the 2000s (Guimarães de Castro and Tiezzi 2004). In unison with the secondary school expansion, efforts were undertaken, through new curricular guidelines, to broaden the secondary curriculum towards more professional education moving away from exclusively preparing for access to the higher education system (MEC 2002, De Moura Castro 2009). Thus, secondary schools where changing their appeal to a larger segment of the Brazilian population.

In Figure 1 we illustrate the increase in secondary schools across Brazil for the period 1997 to 2009.[5] Overall, there was a 57% increase in the number of secondary schools, from 12,684 in 1997 to 19,964 in 2009. This was driven primarily by a 68 percent increase in the number of

[5] In the next section we discuss in detail the source of the data used in this paragraph.

publicly funded schools, from 9,068 to 15,219. There was also a notable 31 percent increase in the provision of private secondary education, from 3,616 to 4,745.[6]

The school expansion had a non-trivial impact on school access across Brazilian municipalities. In Figure 3 we depict the proportion of municipalities which had low school density—defined as less than 1 classroom per 100 youth age 15 and 16, or capacity for roughly 1 in 3 teens of typical secondary school age.[7] The number of municipalities with no secondary school decreased from 401 in 1996 to 11 in 2009. Figure 4 also illustrates that the school expansion had a similar effect across different sizes of municipalities in terms of school density.

3. Data

The primary data used in this study comes from two sources: the Brazilian school census (Censo Escolar) and Brazilian vital statistics data from the Ministry of Health. In addition we use auxiliary data including population estimates for Brazilian municipalities from the Brazilian Census Bureau and municipal expenditure data from a variety of sources. These data are discussed below, followed by a discussion of the minimal comparable areas which are used to link geographic areas over time. Population information and descriptive statistics for the municipalities in our sample are reported in tables 1 and 2. Sources of the data are described in the Data Appendix.

3.1 Schooling data

We use 14 waves of the Brazilian School Census to create a data set on the number of secondary schools, the number of classrooms, and students, by municipality, between 1996 and 2009. The school census is collected annually by the Anisio Teixeira Institute of Research on Education (INEP), at the Ministry of Education, and contains detailed annual summaries for the universe of public and private schools in Brazil.[8] The census data contain a large array of information on enrolment by grade, age and sex, information on the number of classes, physical characteristics of the schools as well as information on teachers. These data also provide a

[6]These numbers exclude the 33 municipalities with population greater than 500,000. These municipalities also exhibited a significant expansion in secondary schools of 58% for publicly funded schools and 24% for privately funded schools.
[7]Capacity assumes a maximum of 35 students per class room. As discussed in more detail below, average classroom enrolment in the sample municipalities is 36.05 students with a standard deviation of 7.98.
[8] The data can be downloaded at the website of INEP (www.inep.gov.br).

source of information regarding primary school enrolment, the availability of nursery classrooms and pre-school classrooms, which are used in the analysis.

3.2 Childbearing data

Data on birth outcomes come from the microdata of Brazilian vital statistics from close to 45 million births occurring between 1996 and 2009. Vital statistics data is based on birth certificates issued by health institutions or midwifes attending homebirths and are collected through the states' health secretariats. The vital statistics microdata are publically available through the System of Information on Life Births (SINASC) of the IT department of the Brazilian public health system (DATASUS). The microdata provide information on the pregnancy, mother and newborn, including information on the age, education and marital status of the mother, gestational length, and the municipality of residence of the mother. For all births, the data provide information on the mother's place of residence (municipality) in addition to the location of occurrence of birth.

For each year we collapse these data to create a count of births by municipality and age of the mother (age at date of conception using information on gestational length recorded in the birth certificates). The annual data are then merged to provide a municipal panel of births by age of mother. Brazilian vital statistics data have an excellent coverage of all occurring births; information from the 2010 population census shows that more than 99 percent of all births occurring between 2000 and 2010 are registered and enter into the vital statistics data we use. The advantage of using vital statistics data to learn about fertility in the population comes from the universal coverage of the data for the entirety of Brazilian municipalities over the time period of interest. The information of residence of the mother during pregnancy is particularly important, as information on the place of birth may be misleading if there is a discrepancy between place of residence of the mother and the place of occurrence of birth, which is more likely for relatively small municipalities that do not have clinics with birth facilities. The data then allows us to learn about all pregnancies conceived in any given year in the municipality where the mother is ordinarily resident.

Figure 6 displays, for the period of 1996 to 2009, the distribution of births per 1,000 women in Brazil by age of conception (in years). The figure reveals a peak in fertility in the early 20's with a substantial fraction of these births occurring before women reach age 20. This confirms that not only teen pregnancy rates are substantially higher in Brazil compared to countries such as the USA, the UK or Germany, but overall fertility happens at a much earlier age. Around

22% of the 45 million births occurring over this period are births by teenage mothers. With a teenage pregnancy rate of 84 per 1,000 women in the 15-19 years age group, Brazil ranges clearly above the OECD average (for example 45, 29 and 10 per 1,000 women in the USA, UK and Germany respectively), but below many low-income countries for which data is available (for example 207 per 1,000 women for Niger with the highest rate of teen pregnancies).[9]

In the maps of Figure 3a, teen pregnancy rates by municipality are depicted for the years 1997 and 2009 revealing substantial geographic variation in the distribution of teen pregnancy rates across the country. This is particularly evident from the 2009 map showing lower levels of teen pregnancies in the richer South-eastern states in Brazil, including São Paulo, Minas Gerais and Rio de Janeiro.

3.3 Auxiliary data

Population estimates

The Brazilian Census Bureau (IBGE) provides official population estimates for each municipality based on the 1990 and 2000 census and the 1996 and 2006 population counts. These data provide population estimates by sex and age group that we use in all the regressions to account for cohort sizes.

Municipality controls

We also use a rich set of municipality-level time-varying data on the characteristics of the municipalities from a variety of sources. These include municipality GDP, the fraction of municipality level expenditure on education, health, welfare, justice and security provided by IBGE. In addition we include information on the number of health institutions, number of nurses employed in these institutions, number of *Bolsa Famíli*a recipients and the total amount of *Bolsa Família* payments in the municipality. These data are available annually for the 1996-2009 time period.[10]

3.4 Minimal comparable areas

The municipality is our primary unit of observation. There are currently 5,570 municipalities in Brazil and they constitute the country's smallest administrative divisions similar to US counties. We link information on the availability of schools with the vital statistics data using

[9]Age specific fertility rates, as pregnancies per 1,000 women aged 15-19 for the period 1995-2010 (UN World Population Prospects 2015).
[10]The *Bolsa Família* programme was introduced in 2004.

unique municipality codes. This is complicated by the fact that a number of municipality boundaries were redefined over the period. Specifically, we see 533 new municipalities in 1997, 54 municipalities by 2001 and an additional 58 by 2010. To account for this we create *minimal comparable areas* (MCA). IBGE (2011) provides information on the origins of municipalities since 1996 which we use to build stable geographic area definitions. If, for example, two municipalities were created by splitting one municipality, the two new municipalities are recoded to the same MCA resulting in 4,885 of such units. For simplicity, we will continue to refer to minimal-comparable-areas as municipalities.

Municipality size varies tremendously in Brazil. For the analysis, we restrict the sample to municipalities with populations less than 500,000 residents (by 2000 census count) and exclude the largest cities. This is to ensure that the included municipalities are small enough to credibly link the population of interest to the introduction of secondary schools. This results in 4,850 municipalities, or 99% of all Brazilian municipalities and 71% of the overall population. Summary statistics with respect to the population distribution for included municipalities are reported in Table 1.

4. Estimation strategy

Empirical Strategy

As pointed out in the introduction, a key empirical challenge in estimating the causal effect of school availability on teenage motherhood is addressing the potential confounding effect of unobservable municipality characteristics that are correlated with the availability of number of secondary schools and with fertility decisions of teenagers. For example, if the perceived return to education is low this may impact both the number of secondary schools—in response to low demand—and the timing of fertility. This will create a spurious correlation between incidence of teenage childbearing and low availability of secondary schools. To overcome this case of erroneous inference we use variation in the number of secondary schools available in each municipality over time to identify the effect of school access on teenage childbearing in a framework similar to difference-in-differences.

The following equation describes the relationship between childbearing and schools we estimate:

$$B_{ic}^{a} = \alpha^{a} S_{ic} + X_{ic}^{a\prime}\Gamma^{a} + \delta_{c}^{a} + \eta_{i}^{a} + \epsilon_{ic}^{a} \qquad (1)$$

where B_{ic}^{a} is the cumulative number of births in municipality i for cohort c that are conceived between age 15 and age a. S_{ic} is the number of secondary schools in municipality i in the year that cohort c was 15 years of age. To illustrate, for the cohort that is 19 in 2007, S_{ic} is the number of secondary schools in municipality i in 2003. X_{ic}^{a} is a vector of observable municipal control variables, some of which may vary with cohort age. δ_{c}^{a} captures cohort fixed effects (i.e. time effects) and η_{i}^{a} captures cohort (time)-invariant municipality specific unobservables. ϵ_{ic}^{a} reflects idiosyncratic cohort varying unobservables.

The coefficient of interest, α^{a}, is identified by the change in S_{ic} across cohorts and reflects the average effect of an additional secondary school on cohort childbearing. This identification strategy assumes that unobservables, ϵ_{ic}^{a}, are independent across cohorts. This assumption would be violated if, as an example, cross-cohort peer effects are important in determining teen-childbearing.

Our identification strategy relies on a number of lagged variables; specifically, the number of classrooms 4-years prior to observation and enrolment in year-8 primary school 5 years prior (discussed below). The data cover years 1997–2009. Therefore, our primary estimates are based on the change in secondary school availability between 1998 and 2005 and reflect outcomes for cohorts age 19 between 2001 and 2009. This provides 9 years across 4,850 municipalities for a total of 43,650 observations.

There are three specific challenges of which we need to be concerned in the estimation of Equation 1. The first is that birth-outcomes and school supply may both be driven by characteristics of teen cohorts. Strong primary school performance for a particular cohort may lead to the introduction of secondary schools. Strong academic performance may also be the result of cohort-specific unobservable characteristics, which are plausibly correlated with low teen birth. This may lead us to incorrectly conclude on a negative causal relationship between schools and teen births. To address this, in all regressions we include cohort-specific enrolment numbers for the final-year primary classes. Weaker cohorts, reflected by students having dropped out of primary school or being held back in earlier primary years, will have lower enrolment numbers in their final year.

A second challenge to identification is the potential existence of unobserved municipal-level policy or infrastructure changes which are correlated with school introductions. If, for example, unknown to the researcher, family planning clinics are introduced alongside secondary schools, we will incorrectly attribute the effect of such clinics to the schools. We take a number of steps to mitigate this. First, we attempted to address this by looking for evidence in the literature and policy documentation for or against the existence of such confounding factors. In particular, we were interested in programmes that include family planning components, such as the Family Health Programme (Programa Saúde da Família). The majority of the rollout of this programme happened a few years after the Millennium and the rollout was implemented by the Ministry of Health and we find no evidence for coordination with the rollout of the secondary school expansion lead by the states' education secretariats. Second, we attempt to account for possible unobserved municipal changes by controlling for municipal expenditures across a number of services[11] including municipal health expenditure. Third, we conduct an event study to look at the possibility of systematic pre-trends. The results of this analysis strongly suggest that birth outcomes did not systematically vary prior to the introduction of secondary schools.

The third challenge to identification may arise due to selective migration. This may be a concern if we think that the introduction of a secondary school may induce an inflow of academically engaged (and less sexually active) teens and/or an outflow of non-academic (and more sexually active) teens, or visa-versa. Because Equation 1 reflects the total number of births, estimates will not be impacted by flows of non-sexually active teens, only by those who are sexually active.

School expansion, enrolment and education outcomes

Before considering the effect of the expansion of secondary schools on teen childbearing it is useful to understand whether school expansions had a meaningful impact on enrolment in secondary school. It is possible that the introduction of a new school leads to the reallocation of existing students among schools, but has little effect on aggregate enrolment numbers. To examine this we look at enrolment using data from the school census.

[11] Specifically we control for (per-capita) spending on welfare, education, health, transportation, and housing as well as per-capita and per-recipient Bolsa Família transfers, per-capita income and per-capita total municipal spending. See data appendix for sources.

Using the school census we consider a change in aggregate enrolment following the introduction of a secondary school into a municipality, estimating the following regression equation:

$$e_{it}^{k} = \vartheta_{1}^{k} S_{it} + \rho_{i}^{k} + \theta_{t}^{k} + \tau_{it}^{k}, \qquad (2)$$

where e_{kt}^{k} is the number of students of type $k \in \{male, female, age15, \dots\ age18, adult\}$ enrolled in secondary school in municipality *i* in year *t*. S_{it} is the number of year-one secondary classrooms in municipality *i* and year *t*. θ_{t}^{k} captures type-specific time trends in enrolment, ρ_{i}^{k} capture sex-specific municipality fixed effects, and τ_{it}^{k} captures all other unobserved influences on student enrolment. The estimated correlation between the change in classrooms and enrolment, $\hat{\vartheta}_{1}^{k}$, provides information about average, contemporaneous, change in total municipal enrolment following the addition of a year-one classroom.

Estimates are reported in Table 2 for total enrolment (Column 1), female enrolment (Column 2), male enrolment (Column 3) and enrolment by age in columns 4 through 9. We find a strong, positive, correlation between schools and enrolment numbers for both sexes; the introduction of a secondary school leads to an average enrolment increase of 27.3 female and 16.9 male students. While school enrolment for adults is common in Brazil, the increase in enrolment appears to be largely due to an increase in teenage enrolment, particularly focused on ages 15, 16 and 17. For age 18 the increase in enrolment is still positive, but less than one-fifth the magnitude of age 17.We find that the expansion did not have a significant effect on adult secondary school enrolment.

These results suggest that the introduction of schools had a non-trivial impact on enrolment, and this effect was particularly large for women.

5. Results

In Table 3 we report estimates of α^{a}, from Equation (1), for each age of last conception $a = \{15, 16, \dots, 19\}$. In the final column we also include the results of a regression looking at all conceptions before age 15. All regressions include controls for primary school enrolment (year 8 corresponding to cohort age 14), contemporaneous nursery and preschool availability, the number of males and females in each cohort/municipality combination, and time and municipality fixed effects. Panel A reports the preferred specification, using the number of schools available at age 15. Panels B and C report alternative measures of the secondary school explanation, using the number of year-one secondary classrooms and the number of secondary teachers.

The results in Table 3 suggest that the secondary school expansion had a significant negative effect on teenage childbearing. The estimate in Column 1 suggest that the addition of a secondary school decreased the total number of births by age 19 by 4.44 births; a 4.56% decrease relative to the mean number of births[12]. Similar results are found when the number of year-one classrooms or the number of secondary teachers is used.

For all specifications the estimated effect before age 15 is statistically indistinguishable from 0, economically small and of a positive value. This suggests that the school expansion did not have a meaningful impact on the childbearing behaviour of young women before the age they would have been expected to enter into secondary school (although it is noted that the number of births resulting from conceptions before age 15 is a small proportion of the total number of teenage births).

These estimates suggest that the school expansion had a non-trivial impact on teenage fertility in Brazil. To think about the economic impact, we can consider how much of the variation over time and cross sectional variation in births by age 18 can be explained by the school expansion. The magnitudes presented in Table 3 suggest that the school expansion can explain 27% of the total decrease in fertility by age 18 observed over the time period in Figure 1.

4.2 Robustness checks

In Table 4 we present the results of a number of robustness checks. First, we test the assumption that the introduction of secondary schools is not driven by, directly or indirectly, municipal teen child bearing. To do this we regress the number of classrooms on a number of different lagged birth outcomes. Columns A1 and A2 look at all births for ages 14 to 19 in first and second lags, while columns A3 to A6 consider lagged births for younger groups only. Only the estimated coefficient in A5 is statistically significant and all coefficients are small in magnitude. Taken literally, the largest coefficient (in column A6) implies that one additional birth for ages 13–14 (almost a 25% increase over the mean) will lead to an increase of 0.01 schools. We interpret these results as evidence that school introductions where not driven by patterns in teenage fertility.

[12] A given cohort in a municipality has, on average, 97.57 births between the ages of 15 and 19.

Second, we examine the impact of school introductions on births in older cohorts. It should be emphasised that there are no explicit age restrictions to entering secondary education in Brazil. As such there is no discontinuous age cut-off at which we can say the “treatment” will apply. However, we expect that it is much less likely to impact older age groups than younger. For this reason we re-estimate Equation (1) to look at the effect of 1998–2005 school introductions on birth outcomes for individual ages 35–40 (Table 4, Panel B) and 5-year age groups from 20 to 44 (Table 4, Panel C). It is unlikely that these older age groups would be directly impacted by the school introductions; this provides us with a test of other unobserved factors that may confound our results.

As an additional robustness check we also add municipality-specific time trends. The results are reported in appendix Table A1. Estimates for this specification are qualitatively similar (with the exception of older birth-ages when using classrooms as the measure of school availability) to the results in Table 3, and several remain statistically significant. However, it should be pointed out that estimates are reduced in magnitude by approximately one quarter.

We also look at results by the reported race of the child. The results can found in appendix Table A2. For each racial/age grouping we report the coefficient and the coefficient as a percent of the mean number of births. We exercise caution in interpreting these results, in particular because information on race relates to the child and is self-declared (by the mother/parents) and there is evidence for substantial differences in the racial affiliation across Brazil. However, a couple of things are worth noting. First, the largest responses as a proportion of mean births are estimated for Asian and Black mothers. The estimates for white mothers are also negative and significant. However, results for one of the largest groups, mixed race (*Pardo*), and the smallest group, indigenous, are less clear. For both of these groups the results are largely insignificant, and suggest that, if anything, the school expansion had a positive effect on childbearing. There is significant geographic variation and variation over time in the reporting of children as Pardo. Further, this variation may be correlated with race (Marteleto, 2012). Therefore, we exercise caution in interpreting these results.

4.3 Event study

Here we explore the dynamics of the behavioural response of teenage childbearing to the introduction of secondary schools. This will also provide supporting evidence for our assumptions by allowing us to examine evidence of pre-trends. The complexity in conducting an event study in this framework is that some units experience multiple “events”—by having multiple schools introduced at different points in time—and an “event” may vary in magnitude—as some municipalities receive multiple schools at once. To account for this we follow the methodology outlined in Sandler and Sandler (2014). For each age group, a, we run the following regression:

$$b_{it}^{a} = \sum_{d=-D}^{D} \lambda_d^a 1[t - e_i = d] * \Delta S_{it} + X_{it}^{a\prime}\Omega^a + \nu_t^a + \xi_i^a + \mu_{it}^a.$$

The outcome, b_{it}^{a}, captures the number of births for age group a in municipality i in year t. $1[t - e_i = d]$, a binary indicator equal to 1 when the event (a school introduction), e_i, is d periods away, is interacted with ΔS_{it}, capturing the magnitude of the event. λ_d^a reflects the average births for age group a d periods away from a change in school availability. The vector X_{it}^{a} includes the same municipality-time varying controls included in Equation (1). The regression also includes time and municipality fixed effects, captured by ν_t^a and ξ_i^a. We present the results for each λ_d^a, normalizing $\lambda_{-1}^a = 0$, in Figure 6.

There are two key things that are important to note in Figure 6. First, for all age groups, we do not observe pre-trends in the data. This provides strong support for the assumptions that there are no unobserved variables that confound our results. Second, we do observe a clear downward trend in births for each of the age groups following the change in the availability of secondary schools. In the supplementary appendix we include corresponding figures for age groups we expect to be much less impacted, in terms of school attendance, by the expansion of secondary schools (specifically 25 year-olds and 35 year-olds). We do not observe a corresponding trend for either of these groups.

Dynamics and exploration of mechanisms through which school introductions impact teenage births

We have provided evidence that the introduction of secondary schools across Brazilian municipalities had a significant negative impact on teenage childbearing. Here we discuss and provide evidence for some of the possible mechanisms leading to the negative correlation between school introductions and teenage childbearing. To do this we focus on the dynamics of the impact at each age over the medium-run.

The main results beg the question, do young women put off childbearing until they have completed their secondary education, or is there a permanent change in their fertility? While our data do not allow us to look at completed levels of fertility (as the variation in schools we are exploiting was relatively recent) we can look at what happens in early adulthood. Here we examine the outcomes to age 23.

There are two mechanisms through which we might expect the availability of secondary schools to impact on childbearing, similar to what was outlined in Black, Devereux and Salvanes (2008). We associate travel distance to school to be a cost of attending secondary education. The addition of a secondary school means that for all teenagers the cost of attending secondary school will weakly decrease. The decrease will be largest for those who live closest to the new school. The decrease in this cost will be such that it changes the choice set (or perceived choice set) available to some young women, and some of these young women will forgo childbearing in their teen years to free up time for the attendance of secondary education. This is the first mechanism by which we might expect to see a change in the rate of teenage childbearing. Notice that this mechanism is different than the "incarceration effect" described in Black, Devereux and Salvanes (2008). As previously noted, an important characteristic of the variation we use is that it is based on a change in the cost of attending secondary school, without a change to the decision constraints (i.e. school attendance is not mandatory). We can rule out a strict incarceration effect as in Black, Devereux and Salvanes (2008), as attendance at school is not required regardless of parenting status. By increasing the availability of secondary schools (in terms of reducing the geographic distance for some young women) the school expansion lowers the cost of acquiring human capital for young women. This means that having children in the teenage years becomes relatively expensive (to the extent that children make school attendance more difficult). Therefore, we see some young women put off childbearing in favour of secondary school attendance. If this cost of human capital mechanism is not important, we would not expect to see a decrease in childbearing for ages 15 to 17. However, as shown in Table 3, we see a 2–3.6% decrease in childbearing for these ages.

The second mechanism works through the change in future opportunities that education provides by changing human capital. This "future human capital effect", noted Black, Devereux and Salvanes (2008), suggests that we should see a decrease in childbearing which continues after secondary education. If there is no effect of human capital on childbearing, then we should see an increase in childbearing for women as young adults.

The estimated values for α^a in Equation (1) reflect the effect of schools at age 15 on total cumulative births for a cohort. To see the effect of a unit increase in the number of schools has on the dynamics of births by age group, consider taking the difference of Equation (1) for any two ages:

$$B_{ic}^{19} - B_{ic}^{18} = \sum_{a=15}^{19} b_{ic}^{a} - \sum_{a=15}^{18} b_{ic}^{a} = b_{ic}^{19},$$

which can be written as

$$b_{ic}^{19} = (\alpha^{19} - \alpha^{18})S_{ic} + X_{ic}^{19'}(\Gamma^{19} - \Gamma^{18}) + (X_{ic}^{19} - X_{ic}^{18})'\Gamma^{18} + (\delta_{c}^{19} - \delta_{c}^{18}) + (\eta_{i}^{19} - \eta_{i}^{18}) + (\epsilon_{ic}^{19} - \epsilon_{ic}^{18})$$

The coefficient on S_{ic} in the above equation reflects the incremental effect of secondary schools on births at each age. To focus on the dynamics of the estimated effect, we present estimated coefficients, $(\alpha^{a} - \alpha^{a-1})$ for $a = \{15, \dots, 23\}$, graphically in figures 7 and 8.

These plots allow us to examine the change in the effect of an additional school as the cohort ages. In Figure 7 we see a u-shaped pattern in fertility by age following the addition of a secondary school. This begins with a modest reduction at 15 years of age, and steadily increase until age 19. After age 19 we see a slow decline in the magnitude of the effect. However, the effect remains negative through age 23. This suggests that there is, in terms of aggregate births, a human capital effect in the medium run.

We expect that a human capital effect would be stronger in areas where the potential return to secondary education is higher. We expect this is the case for urban versus rural areas. In Figure 8 we repeat the previous analysis, breaking up the variable S_{ic} to separately reflect urban and rural schools.[13] The results are plotted in Figure 8. Interestingly, the increasing magnitude of the effect is very similar for both types of schools until age 19. However, after age 19 we see a decline in the magnitude of the effect for rural schools, with a positive (although statistically insignificant) point estimate for the age 23 group. Urban school show a very modest decreases after age 19, but roughly hold steady at an average effect between -1.0 and -1.5. We interpret this as support for the hypothesis that the human capital effect is an important mechanism in our estimates.

[13] We use the definition of urban-rural by IBGE, the Brazilian census bureau, at the level of the municipalities.

6. Conclusions

In this paper we estimate the effect of improved access to secondary education on the childbearing of young women. The empirical strategy exploits variation from one of the largest expansions of secondary schools on record. We combine information from 14 waves of the Brazilian school census, Brazilian vital statistics, and information on population estimates and municipal expenditures, to create a novel and rich data set. The expansion of secondary schools, over time and across municipalities, provides quasi-experimental variation which we exploit to estimate the effect of secondary school access on teenage childbearing.

We find that the average effect of an additional secondary school is an average decrease of 4.44 births, or 4.6% relative to the mean, by age 19. Given that an additional school increases enrolment, on average, by approximately 10.6%, these estimates suggest a local average effect of a 40% decrease in childbearing before age 19.

We also show that there is a persistent impact of a decrease in child births to age 23 (the oldest age for we are able to perform our analyses). This result is consistent with an increase in human capital increasing the opportunity cost associated with having children and some women forgoing child bearing as young adults. Consistent with this interpretation of our results we find that the negative effect into early adulthood persists when a school is introduced into an urban setting, but dissipates when a school is introduced into a rural setting. This would be expected if the returns to secondary education are lower, and therefore the opportunity cost to have children is lower, in rural areas.

In terms of magnitude, these finds are consistent with previous studies that look at the effect of changes to mandatory schooling laws on teenage childbearing. These findings also provide support for the Kearney and Levine (2012) argument that economic opportunity is an important determinant of teenage pregnancy.

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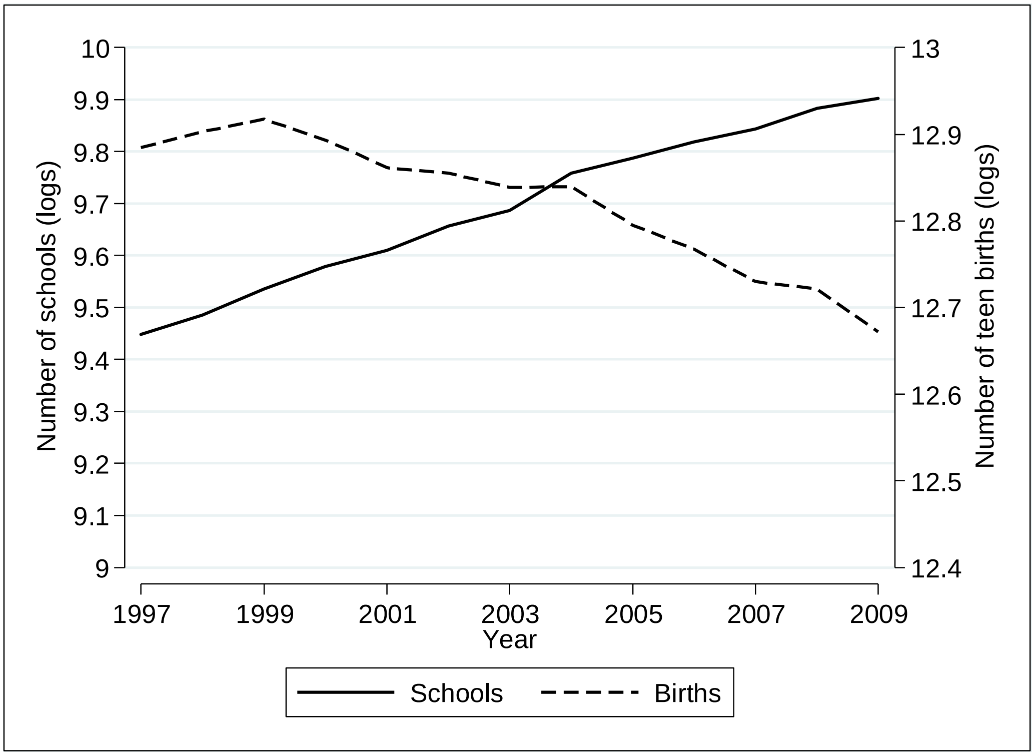
Figure 1: Secondary schools and teenage births in Brazil over time

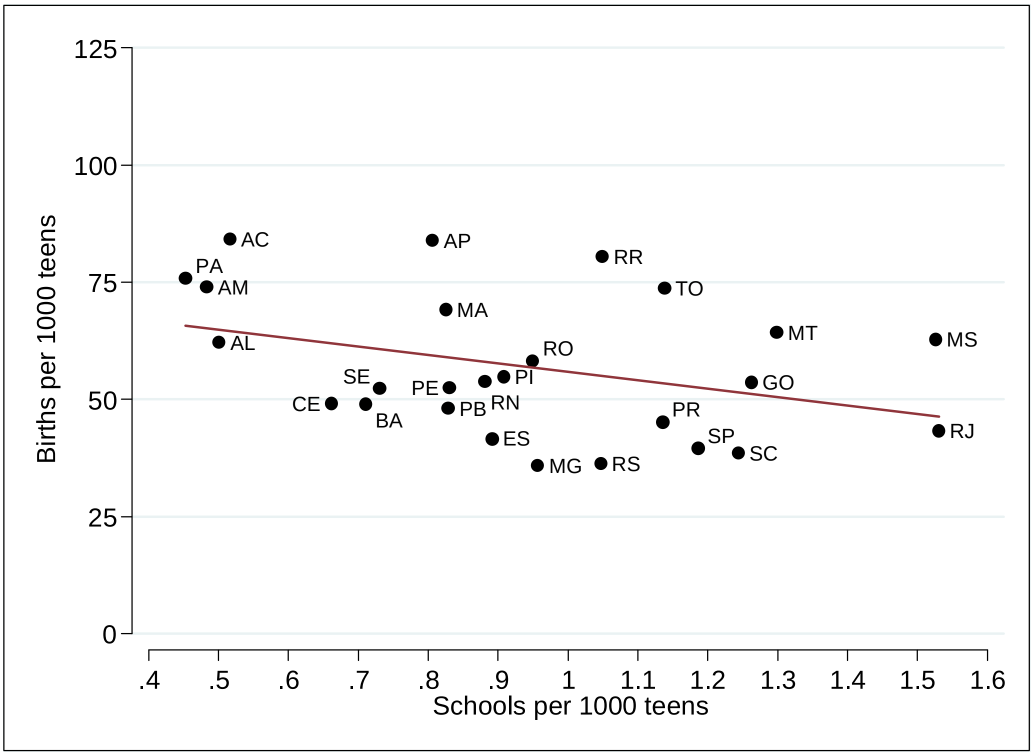


Notes: Teen births include all births for ages 13 to 18. Municipalities with populations less than 500,000 included.

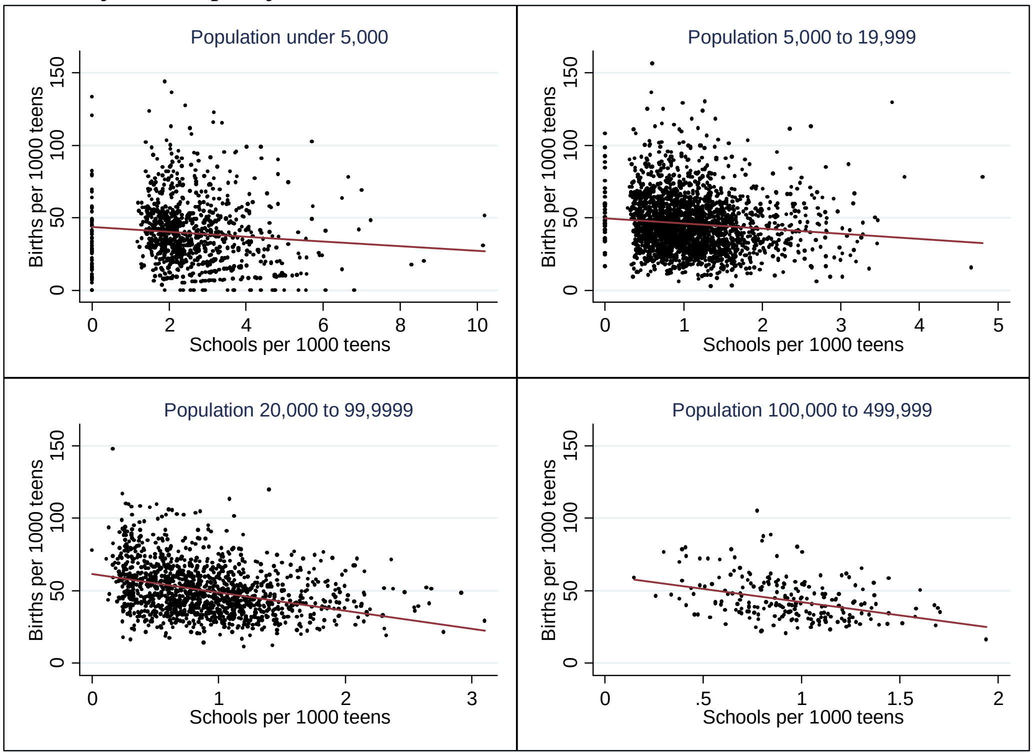
Source: School data comes from Censo Escolar 1997–2009; births by age from Vital Statistics Brazil.

Figure 2: School density and teen birth rates

A. By state



B. By municipality

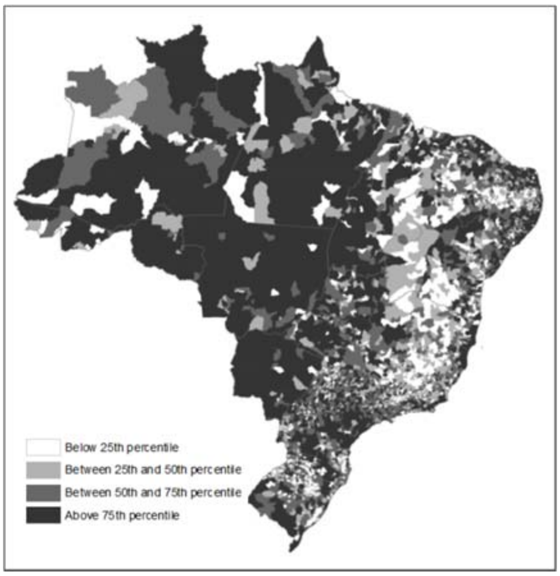


Notes: Figures capture municipalities with populations of less than 500,000. Linear fitted lines weighted by population.

Source: School data comes from Censo Escolar 2002; official population estimates from the Brazilian Census Bureau; births by age from Vital Statistics Brazil.

Figure 3a: Births rates by percentile

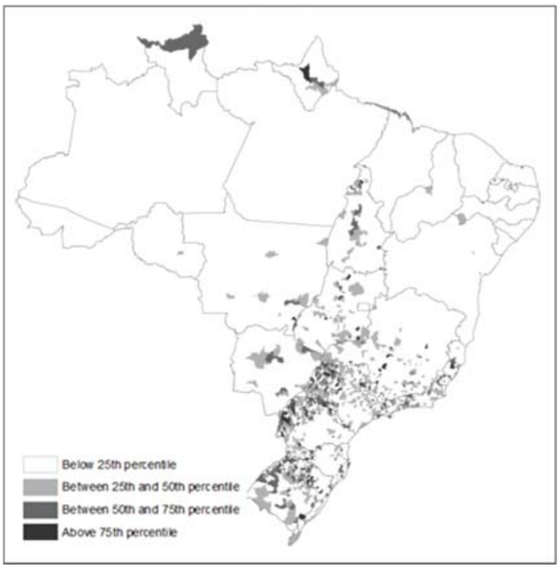
1997



2009

Figure 3b: Classroom density by percentile

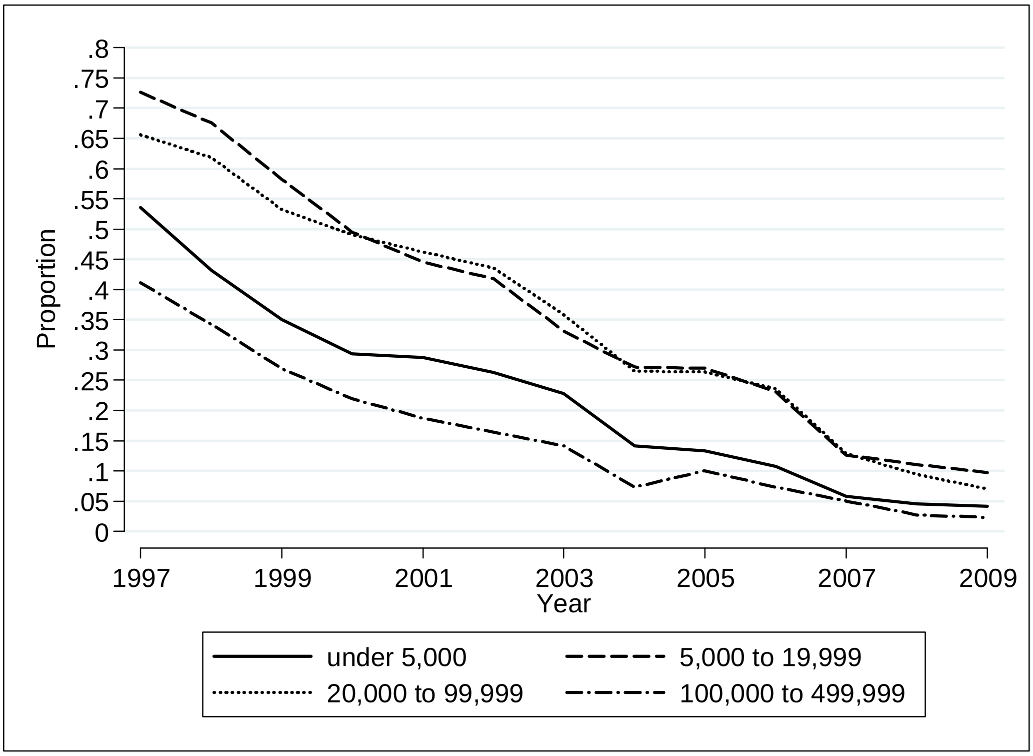
1997



2009

Source: Birthrates from Vital Statistics Brazil, classrooms from Censo Escolar 1996 and 2009. Percentiles held constant at 1996 cut-offs.

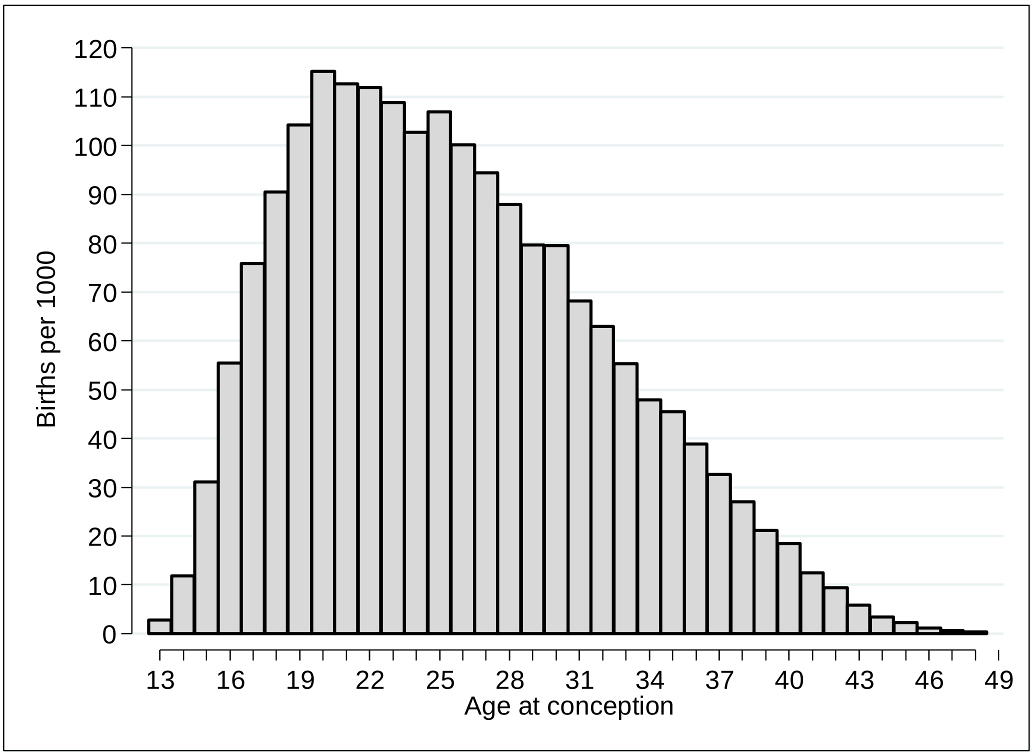
Figure 4: Proportion of municipalities with low secondary classroom density



Notes: Low classroom density is defined as less than one year-1 classroom per 100 youth age 13 to 18.

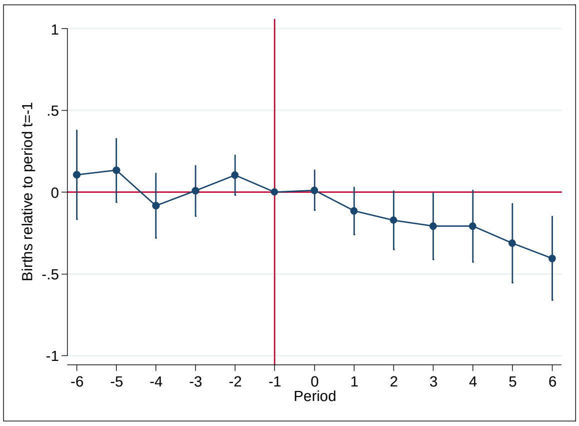
Source: School data comes from *Censo Escolar* 1998–2010, official population estimates from the Brazilian Census Bureau.

Figure 5: Births per 100 by age

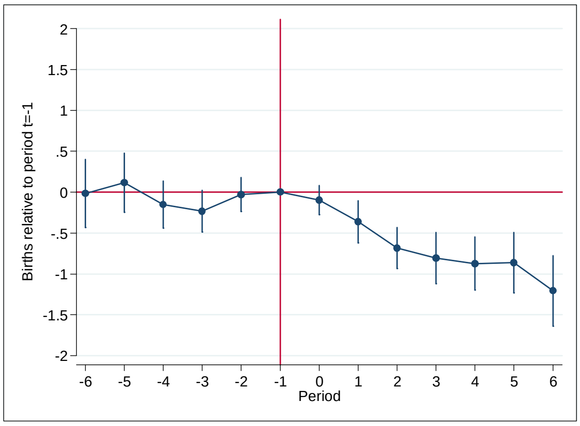


Source: Vital Statistics Brazil.

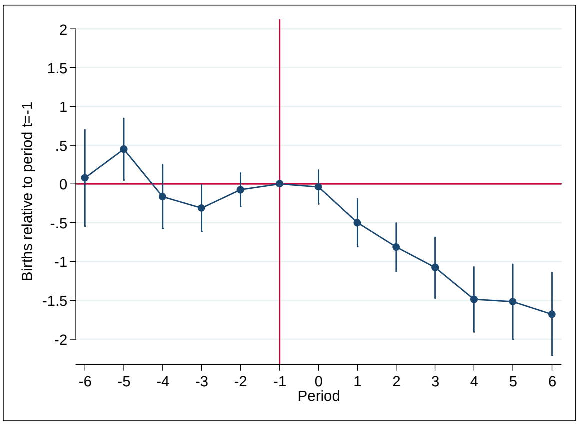
Figure 6: Event study of births before and after school introduction by age



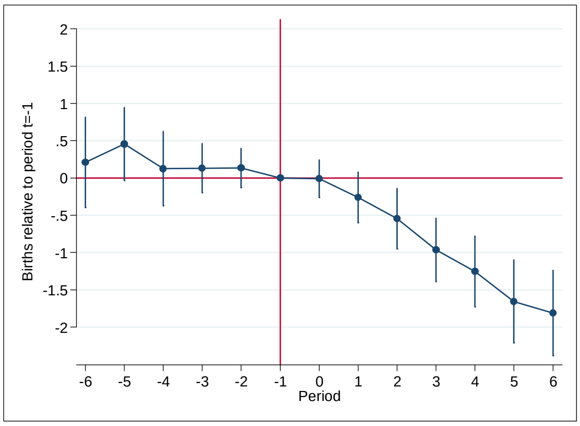
a) Births at age 15



b) Births at age 16



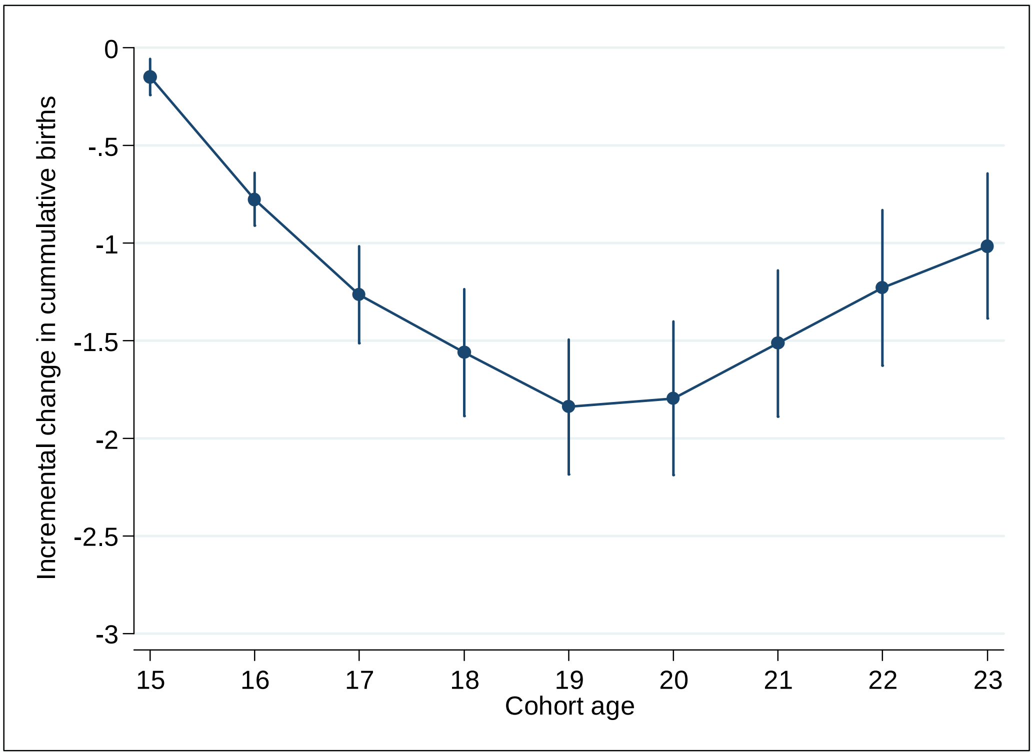
c) Births at age 17



d) Births at age 18

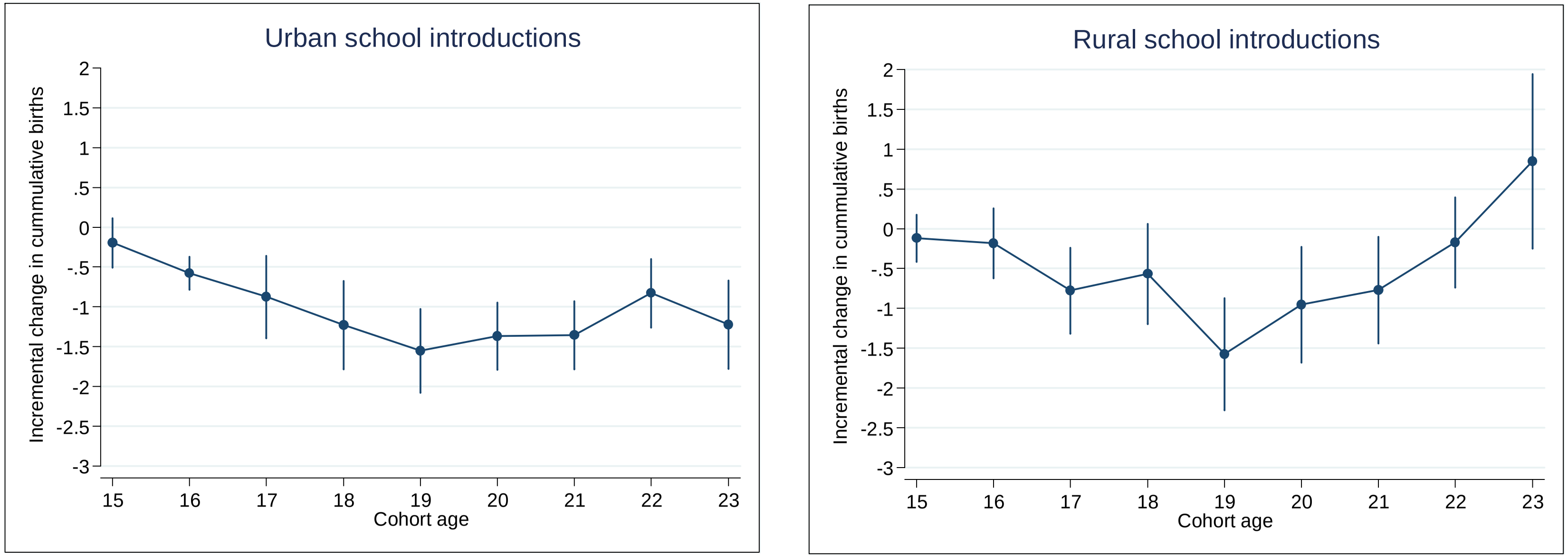
Notes: Bars indicate 95% confidence intervals. Points reflect coefficient estimates from a regression capturing the years from school introduction (relative to births at period -1). Regressions include age-specific male and female populations, primary enrolment, nursery and preschool classrooms, year fixed effects and municipality fixed effects. Details of regression in main text.

Figure 7: Secondary schools and incremental cohort births, medium run



Notes: Bars indicate 95% confidence intervals. Points reflect the effect of schools introduced at age 15 on the incremental births between ages. Regressions include age-specific male and female populations, primary enrolment, nursery and preschool classrooms, year fixed effects and municipality fixed effects.

Figure 8: Secondary schools and incremental cohort births, urban versus rural school introductions



Notes: Bars indicate 95% confidence intervals. Points reflect the effect of schools introduced at age 15 on the incremental births between ages. Regressions include age-specific male and female populations, primary enrolment, nursery and preschool classrooms, year fixed effects and municipality fixed effects.

Table 1: Descriptive statistics

	Mean	*Min*	*Max*
Number of municipalities	4,850		
Population			
Total	25,958	690	551,857
Teenage	3,290	70	72,727
Cohort	512	10	12,357
	Mean	*SDB*	*SDW*
Births (aggregate cohort)	101.06	(183.89)	[17.66]
Schools	3.31	(5.60)	[1.49]
Rural	0.23	(0.66)	[0.58]
Urban	3.08	(5.36)	[1.27]
Public	2.47	(3.63)	[1.24]
Private	0.84	(2.28)	[0.55]
Schooling controls			
Primary enrolment, yr. 8	416.18	(806.65)	[229.12]
Nursery rooms	9.35	(22.49)	[14.06]
Preschool rooms	37.48	(66.44)	[18.16]
Municipality expenditures			
Bolsa Familia p.c.†	5.92	(3.59)	[2.21]
Bolsa Familia p.r.†	71.45	(10.39)	[12.06]
Welfare p.c.	50.89	(50.41)	[87.83]
Education p.c.	244.36	(119.58)	[196.43]
Health p.c.	180.71	(93.11)	[129.74]
Transportation p.c.	48.86	(64.00)	[57.99]
Housing p.c.	79.39	(69.01)	[93.20]
Total p.c.	559.29	(341.02)	[525.23]

Notes: Between standard deviation (SDB) reported in parenthesis, within standard deviation (SDW) reported in brackets. Aggregate cohort births reflect total cumulative birth for cohorts at age 19. Municipality expenditures are reported in nominal Brazilian Reais (R$), per-capita (p.c.) and per-recipient (p.r.).

Source: School data comes from Censo Escolar 1999–2009; official population estimates from the Brazilian Census Bureau; municipal expenditures come from the Ministry of Finance. See Data Appendix for details.

†Reported averages and standard deviation based on years 2004 and later. Bolsa Familia was not implemented prior to 2004.

Table 2: Secondary schools and enrolment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Total	*Females*	*Males*	*Under 15*	*Age 15*	*Age 16*	*Age 17*	*Age 18*	*Adults*
Schools at 15	44.251	27.301	16.949	1.686	23.459	29.080	31.561	5.661	-13.471
	(15.491)***	(7.921)***	(7.638)**	(0.596)***	(1.655)***	(2.911)***	(2.910)***	(2.209)***	(7.422)
R2†	0.179	0.164	0.183	0.036	0.264	0.240	0.263	0.171	0.245
Observations	43,650	43,650	43,650	43,650	43,650	43,650	43,650	43,650	43,650
Municipalities	4850	4850	4850	4850	4850	4850	4850	4850	4850

Notes: Robust standard errors reported in parenthesis. ***, ** and * denote statistical significance at 1%, 5% and 10%. Regressions include male and female populations sizes corresponding to each age, year fixed effects and municipality fixed effects.

†R-squared for within variation reported.

Table 3: Secondary schools and aggregate cohort births

	Age of conception					
A	15–19	15–18	15–17	15–16	15	<15
Schools at 15	-4.444	-2.625	-1.627	-0.860	-0.190	0.045
	(0.603)***	(0.408)***	(0.248)***	(0.128)***	(0.049)***	(0.043)
R2†	0.315	0.286	0.219	0.119	0.024	0.017
B						
Classrooms at 15	-0.662	-0.349	-0.212	-0.089	-0.011	0.024
	(0.199)***	(0.141)**	(0.085)**	(0.044)**	(0.015)	(0.016)
R2†	0.301	0.274	0.207	0.107	0.021	0.016
C						
Teachers at 15	-0.329	-0.192	-0.099	-0.051	-0.010	0.000
	(0.026)***	(0.017)***	(0.012)***	(0.008)***	(0.003)***	(0.002)
R2†	0.356	0.315	0.229	0.123	0.024	0.017
Mean births‡	97.569	69.652	44.402	23.719	8.682	4.523
Observations	43,650	43,650	43,650	43,650	43,650	38,800
Municipalities	4,850	4,850	4,850	4,850	4,850	4,850

Notes: Robust standard errors reported in parenthesis. ***, **, and * denote statistical significance at 1%, 5% and 10%. Regressions include regression includes cohort primary enrolment, nursery and preschool classrooms, cohort-specific male and female populations, municipality and cohort fixed effects.

†R-squared for within variation reported.

‡Total number of births averaged by cohort and municipality for each age group.

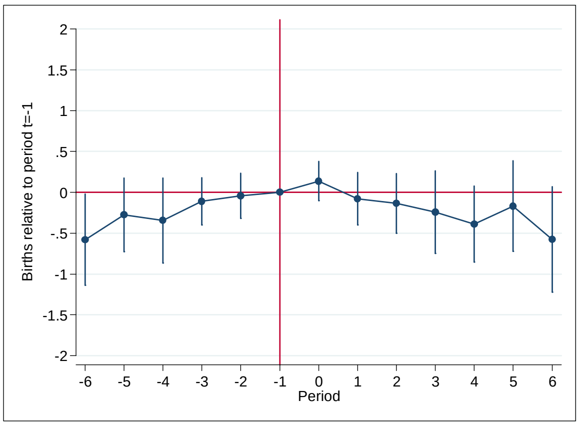
Table 4: Robustness: Child birth as a predictor of schools & older age groups

A						
Outcome: Schools	(A1)	(A2)	(A3)	(A4)	(A5)	(A6)
	Ages 14–19 (lagged)	Ages 14–19 (2 x lagged)	Ages 14–18 (lagged)	Ages 14–17 (lagged)	Ages 14–16 (lagged)	Ages 13–14 (lagged)
Cohort births	-0.003	0.000	-0.003	-0.004	-0.009	0.010
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)***	(0.007)
R2†	0.219	0.185	0.218	0.218	0.220	0.217
Observations	38,800	33,950	38,800	38,800	38,800	38,800
Municipalities	4,850	4,850	4,850	4,850	4,850	4,850
B						
Outcome: Total births	(B1)	(B2)	(B3)	(B4)	(B5)	(B6)
Age groups	35	36	37	38	39	40
Schools (lagged 4 years)	0.019	-0.008	0.032	-0.054	-0.037	0.039
	(0.067)	(0.056)	(0.047)	(0.037)	(0.032)	(0.031)
R2†	0.113	0.068	0.060	0.047	0.037	0.030
Observations	38,800	38,800	38,800	38,800	38,800	38,800
Municipalities	4,850	4,850	4,850	4,850	4,850	4,850
C						
Outcome: Total births	(C1)	(C2)	(C3)	(C4)	(C5)	(C6)
Age groups	15–19	20–24	25–29	30–34	35–39	40–44
Schools (lagged 4 years)	-4.444	-4.955	0.636	0.305	0.328	0.025
	(0.603)***	(0.840)***	(0.626)	(0.286)	(0.135)**	(0.051)
Mean births‡	97.6	140.7	103.9	61.1	30.0	8.3
R2†	0.113	0.068	0.060	0.047	0.037	0.030
Observations	38,800	38,800	38,800	38,800	38,800	38,800
Municipalities	4,850	4,850	4,850	4,850	4,850	4,850

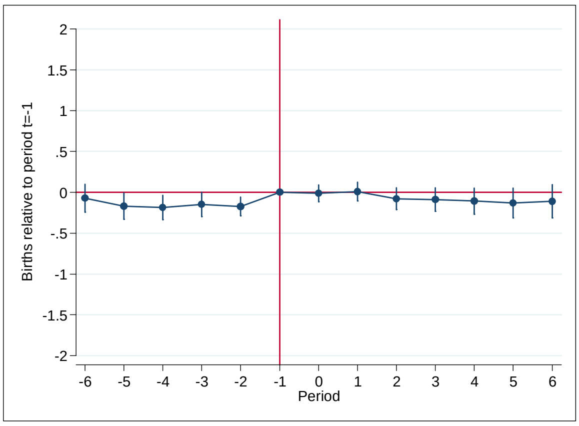
Notes: Robust standard errors reported in parenthesis. ***, **, and * denote statistical significance at 1%, 5% and 10%. Regressions include regression includes cohort primary enrolment, nursery and preschool classrooms, cohort-specific male and female populations, municipality and cohort fixed effects.

Appendix

Figure A1: Event study of births before and after school introduction by age



b) Births at age 25



b) Births at age 35

Table A1: Secondary schools and aggregate cohort births, municipal time trends included

	Age of conception					
	15–19	15–18	15–17	15–16	15	<15
Schools at 15	-1.050	-0.407	-0.280	-0.299	-0.139	-0.102
	(0.396)***	(0.270)	(0.185)	(0.132)**	(0.060)**	(0.064)
R2†	0.995	0.994	0.992	0.988	0.972	0.950
Classrooms at 15	0.100	0.134	0.077	-0.011	-0.029	-0.006
	(0.105)	(0.074)**	(0.043)**	(0.027)	(0.019)	(0.015)
R2†	0.995	0.994	0.992	0.988	0.972	0.950
Teachers at 15	-0.111	-0.058	-0.019	-0.010	-0.001	-0.003
	(0.019)***	(0.013)***	(0.009)***	(0.006)	(0.004)	(0.003)
R2†	0.995	0.994	0.992	0.988	0.972	0.950
Observations	43,650	43,650	43,650	43,650	43,650	38,800
Municipalities	4,850	4,850	4,850	4,850	4,850	4,850

Notes: Robust standard errors reported in parenthesis. ***, **, and * denote statistical significance at 1%, 5% and 10%. Regressions include regression includes cohort primary enrolment, nursery and preschool classrooms, cohort-specific male and female populations, municipality and cohort fixed effects.

†R-squared for within variation reported.

Table A2: Secondary schools and aggregate cohort births, by reported race of child

	Age of conception					
	15–19	15–18	15–17	15–16	15	<15
	Race: White					
Schools at 15	-2.861	-1.748	-0.981	-0.491	-0.098	-0.049
	(0.540)***	(0.375)***	(0.233)***	(0.123)***	(0.046)**	(0.025)**
R2†	0.232	0.207	0.177	0.125	0.046	0.018
Mean births‡	40.227	28.090	17.464	9.066	3.217	1.527
Coefficient/mean	-7.11%	-6.22%	-5.62%	-5.42%	-3.06%	-3.19%
	Race: Black					
Schools at 15	-0.234	-0.213	-0.156	-0.081	-0.028	-0.011
	(0.082)***	(0.072)***	(0.054)***	(0.030)***	(0.010)***	(0.004)**
R2†	0.111	0.098	0.082	0.056	0.022	0.009
Mean births‡	1.860	1.270	0.773	0.403	0.140	0.080
Coefficient/mean	-12.59%	-16.77%	-20.22%	-20.10%	-20.14%	-14.13%
	Race: Asian					
Schools at 15	-0.197	-0.169	-0.108	-0.049	-0.017	-0.013
	(0.088)**	(0.065)***	(0.040)***	(0.019)***	(0.007)**	(0.004)***
R2†	0.148	0.111	0.069	0.037	0.022	0.014
Mean births‡	0.376	0.242	0.139	0.068	0.022	0.012
Coefficient/mean	-52.42%	-69.98%	-77.74%	-73.00%	-78.00%	-103.54%
	Race: Pardo					
Schools at 15	1.798	1.473	0.630	0.236	0.065	0.150
	(0.811)**	(0.630)**	(0.418)	(0.230)	(0.086)	(0.052)***
R2†	0.102	0.071	0.042	0.037	0.039	0.060
Mean births‡	49.368	36.137	23.620	12.937	4.858	2.611
Coefficient/mean	3.64%	4.08%	2.67%	1.83%	1.35%	5.74%
	Race: Indigenous					
Schools at 15	-0.021	0.028	0.056	0.060	0.052	0.051
	(0.045)	(0.053)	(0.053)	(0.047)	(0.030)*	(0.029)*
R2†	0.010	0.008	0.012	0.015	0.023	0.030
Mean births‡	0.750	0.572	0.398	0.235	0.103	0.091
Coefficient/mean	-2.86%	4.88%	14.12%	25.53%	50.63%	56.07%
Observations	43,650	43,650	43,650	43,650	43,650	38,800

Notes: Robust standard errors reported in parenthesis. ***, **, and * denote statistical significance at 1%, 5% and 10%. Regressions include regression includes cohort primary enrolment, nursery and preschool classrooms, cohort-specific male and female populations, municipality and cohort fixed effects.

†R-squared for within variation reported.

Data appendix

Variable	**Notes**	**Source**	**Link**
GDP	Municipality gross national product at current prices (R$)	SIDRA/IBGE	http://goo.gl/OpQffe
Municipality spending	Total local government (municipality) expenditure at current prices (R$)	IPEADATA	http://goo.gl/lSI3nz
Welfare spending	Local government (municipality) expenditure on assistance and welfare at current prices (R$)	IPEADATA	http://goo.gl/lSI3nz
Education spending	Local government (municipality) expenditure on education and culture at current prices (R$)	IPEADATA	http://goo.gl/lSI3nz
Health spending	Local government (municipality) expenditure on health and sanitation at current prices (R$)	IPEADATA	http://goo.gl/lSI3nz
Judicial spending	Local government (municipality) judicial expenditure at current prices (R$)	IPEADATA	http://goo.gl/lSI3nz
Security spending	Local government (municipality) expenditure on national security and public defense at current prices (R$)	IPEADATA	http://goo.gl/lSI3nz
Health institutions	Number of public health institutions per 1,000 population, including general and specialized hospitals, policlinics, health centers (*posto de saúde*), basic health centers (*unidade básica de saúde*)	CNES/ DATASUS	http://goo.gl/tdwW
Nurses	Number of qualified hospital nurses according to the Brazilian Classification of Professions (CBO-2002) per 1,000 population	CNES/ DATASUS	http://goo.gl/tdwW
Bolsa Família recipients	Number of *Bolsa Família* recipients per 1,000 population	DATASUS	http://goo.gl/tdwW
Bolsa amount	Average *Bolsa Família* amount per recipient at current prices (R$)	DATASUS	http://goo.gl/tdwW

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