Neither Nature nor Nurture: The Impact of Maternal Education on Child Health

By WEI HUANG, XIAOYAN LEI, GUANGJUN SHEN, AND ANG SUN*

The impact of maternal education on child health has been well documented. Using the variations of exposure to China's Compulsory Schooling Law, we find a new channel that cannot be attributed to what is conventionally thought of as nature nor nurture. We find that maternal education lowers the incidence of teenage pregnancy, increases women's awareness of and having prenatal checkups, and raises the likelihood of induced abortion following certain prenatal checkups. The birth outcome data confirm the maternal behavior evidence. The findings show that in countries where abortions are allowed, maternal education improves child health by selecting against abnormal/unhealthy fetuses.

* Huang: National University of Singapore, No. 21 Lower Kent Ridge Road, Singapore 119077 (e-mail: rsthw@nus.edu.sg). Lei: Peking University, No. 5 Yiheyuan Rd., Beijing 100872 (e-mail: xylei@nsd.pku.edu.cn). Shen: Sun Yat-sen University, No. 135 Xingangxi Rd., Guangzhou, Guangdong 510275 (e-mail: shengj6@mail.sysu.edu.cn). Sun: Renmin University of China, No. 59 Zhongguancun St., Beijing 100872 (e-mail: ang.sun@gmail.com).

I. Introduction

The correlation between maternal education and child health has been well known in the field of economics and public health. Traditional wisdom attributes this linkage to either *nature*--the genetically encoded advantages that cause a higher level of maternal education and healthier children, or *nurture*—higher maternal education level enabling better prenatal and child care. However, what is less well known is that maternal education could affect child health through selecting safer pregnancy timing and against high-risk embryos to avoid adverse birth outcomes and birth defects. These are major causes of neonatal mortality, disability and health issues during 0-5 ages.

This mechanism can play an important role in improving child health especially in the developing world. According to the World Health Organization (WHO) in 2010, an estimated 270,000 deaths during the first 28 days of life were reported due to congenital anomalies globally, which are proved to be associated with teenage pregnancy and insufficient prenatal screening. According to March of Dimes (MOD) Global Report on Birth Defects, 94% of these births occurred in the middle and low-income countries in 2010. In China, nationwide population-based figure for all monitored birth defects was 5.6 %, and the overall number of birth defects identified during neonatal period was 153 out of 10,000 births in 2012 (WHO, 2016). In other words, about every 30 seconds in China, a baby is born with birth defects.[1]

In this work, we investigate the impact of female schooling on women's selection behaviors, i.e., reducing the incidence of teen pregnancy and aborting high-risk fetuses. China's Compulsory Schooling Law (CSL), implemented from 1986 to 1991, provides arguably exogenous variation in maternal education and thus a natural setting for this study. The CSL aimed to promote mass education. In practice, it was more intensively implemented in provinces with a traditionally low middle-school completion rate. The temporal and regional variations of the CSL allow for implementing difference-in-

[1] India is another country with very high birth defects prevalence, with a rate varying from 6.1 to 7 %.

differences (DID) analysis.

Using the National Family Planning and Reproductive Health (NFPRH)data, we find that women exposed to CSL were7.5 percent less likely to get pregnant during their teenage years. We also find that these women are 4.6 percent more likely to perform prenatal examinations. Interestingly, among these women, induced abortions following a prenatal examination increased by 21.3 percent, while no effects of CSL are detected regarding induced abortions without conducting prenatal check-ups or spontaneous abortions. In a heterogeneity analysis, we find that this increase in induced abortions was more obvious in regions with a traditionally high risk of birth defects that could be detected by prenatal tests; it was negligible if the local prevalent birth defects could not be detected by these tests. These findings support the premise that women who were exposed to the CSL are likely to avoid teen pregnancy and use prenatal screening tests to abort fetuses with high risk factors.

Had no such selections, these children, if born, would have disproportionately high health risks. Therefore, the absence of these children contributes to the improvement of child health caused by the CSL. Using China's National Disease Surveillance Points (DSPs) birth outcome data, we find that one year of exposure to the CSL increased the likelihood of newborns falling into the range of normal birth weight, that is, between 2.5 and 4 kilograms (5.5 and 8.8pounds), by 0.2 percentage points on average. It decreased the rate of birth defects by 0.09 percentage points, which amounts to 9.4 percent of the mean rate of birth defects.

This study carries important implications. First, since the occurrence of birth defects can cause huge medical and social costs to the affected households, our results provide an important pathway from education to economic growth, by showing how maternal education affects prenatal checkups and selective abortions. The social cost would have been huge if these babies with birth defects had been born. According to our back-of-the-envelope calculation, the number of births with birth defects would have been more than 93,000 more each year if the CSL had not been enacted in China.[2]

Second, this study provides a novel mechanism of the causal effect of maternal education on child health. This new mechanism sheds light on the traditional literature, which separates the causal effect of education from the genetically encoded advantages that cause a higher level of maternal education and healthier children.[3] To interpret how the impact of maternal schooling is realized, the existing evidence indicates all kinds of *nurture* channels, such as improving the ability to acquire knowledge about health and child care (Thomas, Strauss, and Henriques 1991; Glewwe 1999), providing better prenatal care (Currie and Morreti 2003), providing better immunization and preventative care (Güneş 2015), increasing child-rearing resources through increasing the likelihood of mothers being married and reducing fertility(Currie and Morreti 2003), and decreasing smoking during pregnancy (Currie and Morreti 2003; Güneş 2015). Our results suggest that selective births play an important role in the nexus between maternal education and child health, especially in a developing country like China.

The remainder of the paper is organized as follows. Section 2describes the background of the CSL, women's age at first pregnancy, and screening-test-related abortions in China. Section 3 presents the DID estimands of the causal effects of the CSL on teenage pregnancy and screening-test-related abortions. Section 4 presents the DID estimands of the causal effect of the CSL on child health and evaluates the importance of the channels that we propose. Section 5 presents the heterogeneity analysis by comparing the patterns across provinces with the traditional prevalence of birth defects that can and cannot be detected by prenatal tests. Section 6 provides robustness checks on the assumptions of the DID estimation and measurement errors on selective induced abortions. Section 7 concludes.

[2] An estimated 900,000 births occur with serious birth defects in China each year (WHO 2016). The number would be 993,377 (= 900,000/(1 - 9.4%)) because one additional year of exposure to the CSL decreased the number of birth defects by 9.4 percent (see section 5).

[3] In an effort to estimate the effect of maternal education on children's health, prior research exploits the exogenous changes in compulsory schooling laws (Güneş 2015; Black, Devereux, and Salvanes 2008) or school construction (Currie and Morreti 2003). There is also research analyzing adopted subjects to avoid the contamination of unobservable intergenerational connections (Chen and Li 2009).

II. China's Compulsory Schooling Law and Women's Childbirth Experiences

A. Compulsory Schooling Law

In China, primary education generally lasts for six years, and secondary education is divided into junior secondary and senior secondary stages, each taking three years to complete. The nine-year schooling in primary and junior secondary schools pertains to compulsory education. The Compulsory Schooling Law of the People's Republic of China was promulgated in 1986.This law made significant progress. According to the statistics for 2002, the net enrollment rate of primary school age children reached 98.58 percent, and the proportion of primary school graduates continuing their studies in junior secondary schools (including vocational ones) was 97.0 percent.

The law essentially has four components. First, education is mandatory and free. As stipulated in Article 2, "Compulsory education means education which is uniformly provided by the State and which all the school-age children and adolescents must receive, and constitutes a public welfare undertaking which must be guaranteed by the State….no tuition or miscellaneous fees shall be charged for provision of compulsory education. The State guarantees funds for compulsory education, to ensure implementation of the system of compulsory education."[4] In addition, Article 25 prohibits schools from collecting any fees or seeking profits by selling commodities, services, and so forth to students or doing so in disguised form.

Second, the CSL stipulates that children should enroll in school once they have reached age six and no later than age seven (Article 7).[5] To facilitate migrant school-age children to receive education, Article 12 allows school-age children to go to the school

[4] In addition, Article 42 states that the funds for compulsory education shall be guaranteed by the State Council and the local people's governments at various levels according to the provisions of this law. The percentage increase in government funds allotted for compulsory education by the State Council and the local people's governments at various levels shall be higher than the percentage increase in regular government revenues.

[5] If, due to physical conditions, school-age children or adolescents need to postpone schooling or be suspended from school, their parents or other statutory guardians shall submit an application to such an effect for approval to the local people's governments of the towns or townships or to the administrative departments of education of the people's governments at the county level.

near where their parents or guardians work or reside and requires local governments to provide equal conditions for them to receive compulsory education. Therefore, those beyond junior-secondary school age upon implementation of the CSL were not affected; those between primary admission and junior completion age were partially exposed; and those below the primary admission age were fully exposed. We use such variations in exposure years across birth cohorts to identify the effects of maternal education on the rate of birth defects.

Third, compulsory education aims to promote mass education. The State Council and the local people's governments at the county level or above are required to "rationally allocate educational resources, promote balanced development of compulsory education, help the schools started on weak foundations to improve the conditions for school running…The State arranges for and encourages the economically developed areas to support the underdeveloped areas in providing compulsory education."(Article 6)In practice, the CSL is more intensively implemented in provinces with traditionally high middle-school incompletion rates(Huang 2016).Based on this fact, we use the pre-implementation middle-school incompletion rate as a proxy for program intensity.

Fourth, the CSL contains measures to ensure the quality of teachers and school construction. Article 16 states that under the CSL, "establishment of schools shall be in compliance with the standards for running schools prescribed by the State and meet the need of instruction and teaching, and shall meet the requirements for location and the standard for construction, as are prescribed by the State, in order to ensure safety of the students and the teaching and administrative staff." In addition, Article 30 requires all teachers to obtain the qualifications for teachers as prescribed by the state.

B. Teenage Pregnancy

In China, the teenage fertility rate (births per 1,000 women ages 15-19) increased to 7 by 2012. As documented by a large volume of literature (Chen et al. 2007; Smith and Pell 2001), this pattern is a source of societal concern, since teenage mothers have an increased risk of having low-birth-weight babies, premature babies, and babies who die during the first year of life.

Adverse birth outcomes are generally associated with deleterious social environment, inadequate prenatal care, inadequate diet, cigarette smoking, drug abuse, or biological immaturity. Teenage mothers are more likely than older mothers to be poor, less well educated, and unmarried nonwhite (in the U.S. context), and they are less likely to have received early prenatal care—all known risk factors for their babies to have low birth weight (Frettset al. 1995).

The research also finds evidence suggesting that biological immaturity per se causes medical risks to the baby. Frettset al. (1995) investigated teenage pregnancy in Utah in the United States—a state where the population is largely white and middleclass. Nevertheless, their analysis shows a strong correlation between young mothers and high intrinsic risk of adverse pregnancy outcomes. Similarly, Chen et al. (2007) carried out a retrospective cohort study of 3,886,364 nulliparous pregnant women younger than age 25 with a live singleton birth during 1995 and 2000 in the United States. The study found that for all the teenage groups exposed to very different socioeconomic environments, teenage pregnancies were associated with increased risks of pre-term delivery, low birth weight, and neonatal mortality. These findings strongly suggest that adverse birth outcomes are at least partially caused by biological immaturity.[6]

Prior research has found that female education could lower the incidence of teenage pregnancy (Black, Devereux, and Salvanes 2008). Consequently, female education would help to avoid the risk of adverse birth outcomes, by reducing the incidence of inadequate care by teenage mothers or the biological consequences of immature births.

---

[6] Frettset al. (1995) summarize studies of animals and point out that a few epidemiologic studies suggest that young age alone is an independent risk factor for adverse outcomes of pregnancy.

C. Birth Defects, Premarital and Prenatal Checkups, and Induced Abortions

WHO estimates that there were around 900,000 babies born with birth defects in China in 2012 (WHO 2016). This number amounts to 5.6 percent of the newborns, constituting the second leading cause of infant deaths in the country. Although this rate per se does not seem alarming, its fast increase in recent years has attracted attention from scholars and thrown up red flags for policy makers. According to the China Women and Children Health Report, using China's National Birth Defects Hospital Monitoring data (the monitor extends from 28-weeks of gestation to seven days after birth), the rate of birth defects increased from 0.877 per 1,000 births in 1996 to 1.50 per 1,000 births in 2010, an increase of 70.9 percent. Appendix Table A.1 lists the most frequent birth defects and their corresponding incidence.

The reason behind the soaring rate of birth defects is controversial. On the one hand, the impact of environmental pollution on infant health cannot be ignored (Chen, Ebenstein, Greenstone and Li 2013). Drug abuse and toxic foods such as tainted milk powder, pork, and so forth could also play a role. On the other hand, the rise of the rate of birth defects could be due to the continuous improvement of technology, so that more abnormal embryos are detected.

The focus of this paper is not to probe the driving force behind the rising rate of birth defects. However, this high and still rising rate demonstrates the significant importance of prenatal checkups and presumably induced abortion if the embryos are detected to be abnormal. In this paper, we focus on prenatal checkups and induced abortions. Birth defects occur before a baby is born, mostly in the first trimester of pregnancy when the baby's organs are forming. The package of ordinary prenatal checkups in China includes one ultrasound B screening at each gestation trimester. The screening tests conducted atweeks12, 18-22, and 31 during pregnancy are the so-called abnormal row B ultrasound tests, which are meant to detect abnormal embryos. Additional diagnostic tests will follow if the screening tests exhibit high risk.

Once a birth defect is detected, most families would choose to terminate the pregnancy because of the high costs involved in raising a child with a birth defect or disability. Such costs could include the difficulties for disabled children to access education, ubiquitous stigmatization and discrimination (Waitzman et al., 1994; Case and Canfield, 2009), and very costly or even unaffordable medical treatments. According to the Chinese Birth Defects Prevention Report 2012, the economic burden for Down's syndrome among newborns is more than 10 billion yuan per year. Reports in *China Daily* suggest that around 95 percent of Chinese women terminate their pregnancy after learning the syndrome is detected in the fetus.

However, despite the rising rate of birth defects, according to the China Women and Children Health Report, the rate of prenatal checkups remains very low, mostly due to lack of knowledge about the importance of medical visits. For example, some young people are not clear about the difference between prenatal and regular medical checkups, so they believe that prenatal checkups are unnecessary as long as they have a yearly general health examination; some are reluctant to conduct such checkups because of concerns about intrusion on their privacy.

III. Identification Strategies

As described in section 2.1, two main features of the CSL allow for a DID estimation strategy to assess its impact. First, the law stipulates that children should start school by age six and attend nine years of compulsory education. These stipulations imply that only children younger than age 15 years upon implementation of the law were exposed to the CSL; the older cohorts make a natural comparison group.[7]Second, to promote mass education and enhance education equality across the provinces, the CSL was more intensively implemented in provinces with traditionally high middle-school incompletion rates. Therefore, our identification strategy is to combine differences across regions in the initial middle-school incompletion rate before the implementation

[7] China's Compulsory Schooling Laws were announced on April 12, 1986 and were supposed to start to take effect on July 1, 1986. In practice, the timing of de facto implementation spanned from 1986 to 1991 across the provinces. This five-year variation in implementation timing does not lead to sufficient identification power, we therefore explore the variation in cohorts according to age upon the de facto implementation by province.

across cohorts induced by the timing of the CSL. The strategy is similar to that proposed by Duflo (2001).

Thus, we exploit the variation in the treatment intensity across provinces and cohorts and apply this strategy to a regression framework. If an individual was older than 15 years upon the CSL implementation, then she was too old to be affected. By contrast, individuals who were age six years or younger were fully exposed to the new schooling system, and those who were between ages six and 15 upon the implementation were partially exposed. Similar to Huang (2016), to capture the treatment intensity across cohorts, we construct a linear term for the length of time of exposure for each individual. We use the prior middle-school incompletion rate as a measure of treatment intensity across regions. The regression specification is as follows:

(1) $S_{ijk} = \alpha + exposure_{jk} \times CSL_j \cdot \beta + X_{ijk} \cdot \delta + Z_{jk} \cdot \theta + h_k + prov_k + \varepsilon_{ijk}$

where S_{ijk} is the years of schooling of individual *i* born in province *j* in year *k*; and $exposure_{jk}$ is the normalized length of time exposed to the CSL if one was born in province *j* in year *k*. For example, those who were younger than the school entrance age, that is, six years, before year *k* were fully exposed to the CSL; thus, $exposure_{jk}$=9.Those who were older than the age of completing middle school, that is, 15 years, before year *k* were not exposed to the CSL; thus, $exposure_{jk}$=0. Those who were between ages six and 15 upon implementation of the CSL were partially exposed to the CSL, that is, they were exposed by a fraction of the nine-year compulsory education; thus, $exposure_{jk}$=$\left(15 - \left(CSLyear_j - birth\_year_{ij}\right)\right)$. CSL_j is the provincial intensity of the CSL measured by the middle-school incompletion rate of those ages 15-30 years upon implementation of the CSL; $X_{ijk}$are the individual controls, including dummies for Han or minorities;$Z_{jk}$are the province-level controls, including the gross domestic product (GDP) per capita, GDP growth rate, and ratio of industry and services to agriculture; and h_k and $prov_k$ are birth year and province fixed effects, respectively. The errors are clustered at the province-year level.

The reduced-form regression is specified as follows:

$$(2)\ y_{ijk} = \alpha + exposure_{jk} \times CSL_j \cdot \beta + X_{ijk} \cdot \delta + Z_{jk} \cdot \theta + h_k + prov_k + \varepsilon_{ijk}$$

where y_{ijk} are the main pregnancy-related behavioral outcomes, including the incidence of teenage pregnancy, premarital checkups, and induced abortion following a prenatal checkup.

The major challenge of this identification design is that the pre-intervention middle-school incompletion rate could be systematically correlated with the time trend in the improvement in female schooling. For example, if female schooling increases in all regions and those with a higher rate of illiteracy experience a sharper increase even in the absence of the support of the CSL, then the CSL effect will be overestimated. To test this parallel trend (in absence of the law) assumption, we examine the differences in female schooling in regions with different rates of illiteracy among cohorts not exposed to the CSL. If the regional difference between cohorts not exposed to the CSL is close to zero, then this will lend supporting evidence to the parallel trend assumption.

As another robustness check, we generalize equations (1) and (2) to a cohort-by-cohort interaction term analysis:

$$(3)\ s_{ijk} = \alpha + \sum_{l=6}^{18} 1\{yrCSL_j - k = l\} \times CSL_j \cdot \gamma_l + \sum_{l=6}^{18} 1\{yrCSL_j - k = l\} \cdot \rho + X_{ijk} \cdot \delta + Z_{jk} \cdot \theta + h_k + prov_k + \varepsilon_{ijk}$$

$$(4)\ y_{ijk} = \alpha + \sum_{l=6}^{18} 1\{yrCSL_j - k = l\} \times CSL_j \cdot \gamma_l + \sum_{l=6}^{18} 1\{yrCSL_j - k = l\} \cdot \rho + X_{ijk} \cdot \delta + Z_{jk} \cdot \theta + h_k + prov_k + \varepsilon_{ijk}$$

In these estimates, we measure the time dimension of exposure to the program with 13age-upon-implementation dummies. Individuals age 19 and older upon implementation of the CSL form the control group, and this dummy is omitted from the regression. Each coefficient γ_l can be interpreted as an estimate of the impact of the CSL on a given cohort.

There could be a plausible concern about migration, such that the province in which the subject was surveyed is not the same as that where she received compulsory education. However, during the period of interest, cross-province migration was rare,[8] meaning the error is likely to be minimal.

Finally, to obtain a structural estimand of maternal schooling years on pregnancy-related behaviors, we apply a two-stage least squares regression using equation (1) as the first stage and obtain the locally average treatment effect estimands.

IV. Evidence on Maternal Behaviors

A. Data and Statistics

Our main analysis uses the 2001 NFPRH survey data. The Chinese National Family Planning Commission collected data across all 31 provinces, autonomous regions, and municipalities from July to September 2001. The survey aimed to assess a nationally representative sample of women of reproductive age (15-49 years). Random sampling, using lists held by local authorities, was carried out across 346 cities/counties and 1,041 villages. Interviews were carried out in the women's homes by local health workers and covered a range of demographic and reproductive health issues.

The reproductive module surveys women's whole pregnancy history, which provides an opportunity to test whether any risk reduction measures were applied. For each pregnancy, NFPRH asked the time, outcome (including live birth, stillbirth, spontaneous abortion, and induced abortion), prenatal care, and place of birth if the baby was delivered. To avoid potential difficulties in interpretation, we confine our sample to the first pregnancy of each woman, because the following pregnancies could be consequences of the first one.

Among all the outcomes, we focus on prenatal checkups and induced abortions. We are

[8] For example, Johnson (2003) estimates migration among the provinces of China by comparing the provincial populations from the 1990 and 2000 censuses. His calculation shows net interprovincial migration over this period to be between 16.3 million and 39.7 million, accounting for 1-3 percent of the population.

particularly interested in induced abortions following/in case of having a prenatal checkup, because prenatal tests are unlikely to be applied on unwanted pregnancies. By contrast, induced abortions following prenatal checkups can be presumed as explained by terminating high-risk pregnancies detected by prenatal tests.

[Insert Table 1 Here]

Table 1 reports the summary statistics. We confine our sample to those born between 1965 and 1981.[9]Column (1) in Table 1 reports the means and standard deviations (in the parentheses) of the whole working sample. In columns (2) to (4), we break the sample into three subgroups, that is, those at the age of receiving primary education (between ages six and 12 years), receiving middle-school education (between ages 13 and 15 years), and individuals older than middle-school education completion age (ages 16 years and older). We do not include those who were fully exposed to the CSL (younger than age six upon implementation of the CSL) in this sample. To observe the history of pregnancy in the 2001 NFPRH survey, we confine the sample to those older than age 20 years in2001, which is older than age six years in 1986, when the CSL was inaugurated.

We compare the means of individual characteristics and outcomes of education attainment and pregnancy-related behaviors between the partially exposed cohorts in columns (2) and (3) and the non-exposure cohorts in column (4) in Table 1. The predetermined individual characteristics are balanced between the groups to the extent that ethnicities and residency status (*hukou*) do not vary between groups, suggesting that the cohorts in column (4) make a reasonable reference group. The outcomes exhibit an obvious cross-cohort difference. Years of schooling increase with years of exposure to the CSL: compared with the no-exposure cohorts, those who were at the age of receiving middle school education on average attained 0.596 year more education, and those who were at the age of receiving primary education on average attained

[9] There was a five-year time window for the implementation of the CSL, from 1986 to 1991, across the provinces.

1.558years more education. The differences are significant at the 1 percent level.

As is evident in Table 1, the likelihood of teen pregnancy drops with the increase in years of exposure to the CSL. The likelihoods of having prenatal checkups and receiving an induced abortion following a prenatal checkup also show a substantial increase with the degree of exposure to the CSL. In particular, the likelihood of having an induced abortion after a prenatal checkup is 0.1838 for those who were fully exposed to the CSL, compared with 0.0376 for those who were not exposed to it.[10]

B. Regression Results and Interpretation

Women's Education.—The DID estimands of equation (1) are reported in Table 2. Columns (1) to (4) show the results of different specifications. We control individual characteristics in column (1) and additionally control local labor market conditions in column (2). The DID validity is based on maintaining the assumption of the parallel trend of women's schooling across provinces with different initial middle-school incompletion rates. As a sensitivity check, in column (3), we control the province-specific year trend. In column (4), we conduct a more conservative estimation by controlling the interaction of the province and year dummies in addition to the fixed effects specified in equation (1). Along with the time trend, this allows us to remove any province-specific transitory shocks on female schooling. For this reason, we prefer this estimand in regression (1) and the following.

[Insert Table 2 Here]

In column (4), the coefficient of the interaction of exposure and CSL intensity is 0.1554, significant at the 1 percent level. This coefficient means that when a subject is fully exposed to the CSL (exposure=1), if the pre-implementation middle-school incompletion rate is 100 percent higher than the benchmark province (the one with the lowest incompletion rate), then female schooling will be 0.1554 year more than that of

[10] The unexpectedly high ratio of 0.1838 could be due to misunderstanding the pregnancy test as a prenatal test, or it could include sex selective abortions against girls. We address these issues in section 6.2.

the benchmark province. That is, supposing full exposure, the coefficient is the slope of the intensity of the CSL, measured by the middle-school incompletion rate.

To obtain a more straightforward interpretation, we define the "effectiveness" of the CSL by calculating the increase in schooling at the mean intensity, which is 0.4929. The effectiveness reported in Table 2 can be interpreted as one additional year of exposure to the CSL increasing female schooling by 0.08year on average.

Fitting the generalized cohort-by-cohort DID equation specified in equation (3), the estimands of all the γ_l are reported in column (1) in Appendix Table A.1. Figure 1 plots the estimands of γ_l.Each diamond on the solid line is the coefficient of the interaction between a dummy for being a given age upon implementation of the CSL and the intensity of the CSL in the locality, measured by the middle-school incompletion rate (the 95-percent confidence interval is plotted by the broken lines). A testable restriction on the pattern of the γ_l coefficients is that γ_l should be 0 for $l >$ 15, because women who were ages 16 and older upon implementation did not benefit from the CSL. Another restriction is that the pattern of the γ_l coefficients should start increasing for values less than some threshold (the oldest age at which an individual could have been exposed to the CSL and still benefit from it).

[Insert Figure 1 Here]

It is evident that in Figure 1 that the CSL had no effect on the education of the cohorts who were not exposed to it, and the CSL had a positive effect on the education of younger cohorts. All the coefficients are significantly different from 0 after age 11. Figure 1 lends confidence to the validity of our identification strategy and the finding that the CSL had a positive effect on female education.

Teen Pregnancy.—Fitting the reduced-form regression of equation (2), we consider the outcome of a dummy indicator for whether a woman had ever been pregnant during her teenage years. The results are reported in Table 3, column (1). The coefficient of the interaction of exposure and CSL intensity is -0.0132, meaning that one additional year of exposure to the CSL decreased the chance of teen pregnancy by 0.65 percentage point. Considering the mean teen pregnancy rate of 8.71 percent in the NFPRH sample, this decrease is quite substantial, amounting to a reduction of 7.5 percent (0.65/8.71). Fitting the generalized cohort-by-cohort regression specified in equation (4), the results are reported in column (2) in Appendix Table A.1. Figure 2 plots the pattern of cohort-specific effects of the CSL on teen pregnancy. Consistent with Figure 1, all the coefficients of γ_l are significantly different from 0 for l <11.

[Insert Table 3 and Figure 2 Here]

The CSL could have reduced the probability of teen pregnancy through the channel of mandating women to stay in school until a certain age cutoff. In China, the age of completing mandatory education according to the CSL is 15. However, similar to the findings of Black, Devereux, and Salvanes (2008), the CSL has little effect on the probability of pregnancy at the binding age (younger than age 16 in our case), but it has a relatively large and increasing effect on older ages. These findings suggest that it is not a promising mechanism that the probability of pregnancy for women at a very young age is too low to be affected because young women are immature or compelled to stay in school.

Another mechanism documented by prior research (Huang, Lei, and Sun2018; Blundell and MaCurdy 1999) is that education is likely to lower expected fertility and weaken son preference, which in the life-cycle context could cause women to postpone marriage and childbearing. We test this premise by fitting equation (2) and report the results in Table 4. In columns (1) and (2), the estimands show a reduction in expected fertility and expected number of boys. In the province with the average pre-implementation middle-school incompletion rate (0.4929), one additional year of exposure to the CSL lowers expected fertility by 0.0155 and the number of boys by 0.0141. The esimands in column (3) indicate that in the province with average intensity of the CSL, one more year of exposure to the CSL postpones first marriage age by 2.7 months. In column (4), we do not find evidence that schooling enables women to use contraceptive measures, as suggested by Koch et al (2014), but the standard errors (reported in parentheses) are quite large.

[Insert Table 4 Here]

Abnormality Screening Tests and Selective Abortion.—In this subsection, we investigate women's awareness of and having premarital checkups and whether they had prenatal checkups for their first pregnancy. NFPRH asks the subjects whether they are aware of and have had a premarital checkup. Premarital checkups differ from regular health checks in that the former assess the health of individuals and counsel couples on family health matters before their marriage. The primary focus of a premarital health check is to detect infectious diseases, particularly sexually transmitted diseases, fertility problems, and any other abnormalities that may affect any children a couple may have. In Table 5, column (1) shows that in a province with average middle-school incompletion rate (0.4929), an additional year of exposure to the CSL increases awareness of premarital checkups by 1.4 percentage points, which amounts to an increase of 1.8 percent (0.0139/0.7832) compared with the mean awareness. Column (2) assesses that one additional year of exposure to the CSL increases the incidence of having a premarital checkup during the first pregnancy by 0.04, compared with the mean rate of 0.59, which amounts to an increase of 7.2 percent (0.0422/0.5897).

[Insert Table 5 Here]

NFPRH does not have information on women's awareness of prenatal testing. It only records whether women had prenatal checkup(s) during each pregnancy. We focus on the first pregnancy and find that in the province with average CSL intensity, one additional year of exposure to the CSL increases the likelihood of having had prenatal checkup(s) during the first pregnancy by 3.25 percentage points, which amounts to an increase of4.6percent (0.0325/0.7137).

The key variable of interest is the incidence of induced abortion. In particular, we focus on induced abortions following prenatal checkups. This kind of induced abortion is likely to be driven by the incentive of terminating a high-risk pregnancy. The results of fitting equation (2) are reported in column (1) in Table 6. In the province with average CSL intensity (0.4929), an additional year of exposure to the CSL increases the incidence of selective abortion, that is, an induced abortion following a prenatal checkup, by 0.0148. Compared with the mean of 0.0694, this amounts to an increase of 21.3 percent (0.0148/0.0694), which is quite substantial.

[Insert Table 6 Here]

We conduct a robustness check using two placebo outcomes, the incidence of induced abortions without any prenatal checkups and that of natural abortions. If a woman wants to end an unwanted pregnancy, it is plausible to assume that she will not undertake the costs of having prenatal tests. Therefore, such induced abortions are unlikely to be related to selecting against high-risk fetuses. Column (2) in Table 6 shows that the coefficient of the interaction of exposure and CSL intensity is not significant. This robustness check helps to rule out the concern that provinces with high CSL intensity could also have a steeper upward trend of induced abortions. Column (3) shows that the CSL has no effect on the incidence of natural abortions, which also lends confidence that the empirical design is reasonable.

As another sensitivity check, we investigate the effect of the CSL on selective abortions by fitting the generalized cohort-by-cohort reduced-form regression of equation (4) and report the results in column (3) in Appendix Table A.1. We plot all the coefficients of the interactions of cohort dummies and CSL intensity in Figure 3. The figure shows a very similar pattern of the coefficients to that shown in Figures 1 and 2. The effect of the CSL starts increasing for cohorts who were age 13 years upon the implementation and starts to be statistically greater than zero from the cohort who were age 11 years upon the implementation.

[Insert Figure 3 Here]

To uncover the mechanisms through which this relationship is working, we consider two mechanisms. First, school education could directly involve knowledge about birth defects and measures that could be taken to avoid such adverse outcomes, or it could increase the ability to acquire information, not the information per se, which enables women to learn such information on their own (Thomas, Strauss, and Henriques 1991; Glewwe 1999). Second, education could change individuals' risk attitudes toward being more risk averse (Jung 2014). For example, there is evidence that schooling reduces maternal smoking during pregnancy (Currie and Morreti 2003; Güneş 2015). In this context, women could be more willing to remove the risk of having a baby with a birth defect by performing prenatal screening tests and an induced abortion if any defects are detected.

The increasing awareness of premarital checkups supports the first mechanism. We cannot investigate whether the second mechanism is effective, because NFPRH does not have information about women's attitudes toward risk or risk behaviors such as smoking. Column (4) in Table 4 considers the CSL's impact on taking contraceptive measures. This could be considered a test of attitude toward risk to the extent that using contraceptive measures to avoid unwanted pregnancies reflects risk aversion. The estimands show no significant effect, suggesting that the "acquiring knowledge" effects likely play a role. Regardless of whether there is an "increasing risk aversion" effect, there are likely to be other mechanisms that lead to the increasing incidence of selective abortions. Unfortunately, the nature of our data prohibits us from distinguishing much beyond this point.

Heterogeneity Analysis on Selective Abortions.—If the CSL increased women's demand for abnormality screening tests and selective abortions, such increase would be more obvious in regions with traditionally high rates of birth defects.

The commonly occurring birth defects caused by single gene recessive disorder in China include phenylketonuria, congenital hypothyroidism, glucose-6-phosphate dehydrogenase (G6PD) deficiency, and thalassemia deficiency. Thalassemia exhibits huge geographical variation: the prevalence is much higher in the five provinces in

Southern China (Guangxi, Hainan, Yunnan, Guangdong, and Guizhou). Many medical studies have shown that the frequency of carriers of G6PDdeficiency or thalassemia is 5 percent or more in Southern China, and in some areas the carrier frequency is over 20 percent (Zhao et al. 2013). Therefore, we would expect to see a more prevalent pattern of the effect of the CSL in these five provinces.

We test this prediction by fitting the following difference-in-difference-in-differences regression. The conjecture of greater effect in regions with higher demand for abnormality screening tests and selective abortions due to traditionally high rates of birth defects predicts the coefficient of the triple interaction term, τ, to be positive.

$$(5) Abortion_{ijk} = \alpha + bdefect_j \times exposure_{jk} \times CSL_j \cdot \tau + bdefect_j \times exposure_{jk} \cdot \mu$$

$$+exposure_{jk} \times CSL_j \cdot \beta + X_{ijk} \cdot \delta + Z_{jk} \cdot \theta + h_k + prov_k + \varepsilon_{ijk}$$

We define $bdefect_j = 1$ if province j is one of the abovementioned five provinces in Southern China with a high prevalence of birth defects. The result is reported in column (1) in Table 7. τ =0.0421 and is significant at the 5 percent level.

[Insert Table 7 Here]

To conduct a more thorough analysis, we analyze different types of birth defects. Appendix Figure A.1 plots the incidence of a few of the most common birth defects in China in 1996 and 2000. The data are published in China's Birth Defect Prevention Report (Ministry of Health 2012). Among the published birth defect rates, some abnormalities can be easily detected by prenatal testing, for example, peromelia can be detected by professionals with an adequate ultrasound B machine. However, others, such as mental disability and vision or hearing loss, cannot be detected by most prenatal tests.[11]

We further divide birth defects into two categories by whether the defect can be detected

[11] These defects are generally diagnosed by newborn screenings one year after birth.

by prenatal testing. We redefine variable $bdefect_j$ as the rate of birth defects in 1987in province j.[12] We expect to see a greater effect if the prevalent birth defect is detectable ($\tau > 0$) and no difference in the magnitude of the effect of the CSL otherwise ($\tau = 0$).

In column (2) in Table 7, we examine the heterogeneity in the effect of the CSL across regions with different rates of peromelia. As expected, the rate of selective abortions in provinces with high risk of this ultrasound B detectable birth defect is most responsive to the CSL.As placebo tests, we examine two non-detectable defects—mental disability and vision or hearing loss. As expected, the effect of the CSL does not change according to variations in the prevalence of these non-detectable defects.

V. Birth Outcomes

If the CSL leads to selecting pregnancy timing and healthier fetuses, this should be reflected by a decrease in newborn abnormalities and other adverse birth outcomes, such as abnormal birth weight. We investigate these two outcomes by fitting equation (2) using China's DSP birth outcome data.

China's DSPs comprise 145 reporting sites selected by stratified cluster random sampling, covering a 1 percent representative sample of China's population. Data collected at the village level are reported to prevention units in township hospitals. From the prevention units, the data are transmitted through county health and epidemic-prevention stations to provincial centers and then to the Chinese Academy of Preventive Medicine.During 1991 to 2000,the DSPs collected birth data on basic demographic information of the parents and birth outcomes, including birth weight, birth defects, and delivery syndromes.

To be consistent with the analysis of women's pregnancy-related behaviors using the 2001 NFPRH survey, we include the same birth cohorts as those in the NFPRH sample, that is, the cohort born between 1965 and1981.

[12] Ideally, we would use the predetermined birth defect rates. The earliest data available are from the first China National Sample Survey on Disability, which was conducted in 1987, one year after the announcement of the CSL (Zheng et al. 2012).

[Insert Table 8 Here]

Using DSP birth data, we fit equations (1) and (2). The results are presented in Table 8. In column (1), we report the effect of the CSL on women's schooling. The coefficient of the interaction of exposure and CSL intensity is slightly greater than that using the NFPRH data. In columns (2) and (3), we present the effect of the CSL on the incidence of birth defects. The most conservative estimand shows a 0.09 percent reduction in birth defects, which accounts for 9.4 percent of the mean rate of birth defects (0.96 percent). Columns (4) and (5) report the effect of the CSL on the likelihood of a newborn having normal birth weight (2,500-4,000 grams). The chance of birthweight falling into the normal range increases by 0.25 percent.

These results support our premise that the CSL enables women to select better pregnancy timing and select against high-risk embryos, leading to better birth outcomes and newborn health conditions. A caveat is that we should not over-extrapolate the results to attribute all improvement in birth outcomes to women's selective behaviors. Better neonatal care could be another driving force. The NFPRH data collect some information on prenatal care, such as whether a woman has taken iron or calcium tablets during her pregnancy. The DID estimands are reported in Table 9. No evidence on taking these supplements is detected. We admit that other channels of prenatal care may exist, for example, having more prenatal tests per se could presumably mean better chances of consulting professionals, receiving medical treatment, and so forth. However, given the current data, we cannot separate the effect of selection from such types of prenatal care.

[Insert Table 9 Here]

VI. Robustness Checks

A. Tests on the Parallel Trend Assumptions

The intensity of the CSL was related to pre-implementation middle-school incompletion rates, which differed widely across provinces. Our reduced-form DID estimand can be interpreted as the causal effect of the CSL, under the assumption that in the absence of the CSL, the increase in female schooling years/changes in pregnancy-related outcomes would not have been systematically different in low and high CSL intensity regions. That is, the time trend of the outcome variables across provinces with different initial middle-school incompletion rates should be the same.

The identification assumption should not be taken for granted. For example, a plausible concern is mean reversion, that is, provinces that initially had high middle-school incompletion rates could pick up faster. We test the parallel assumption following the strategy proposed by Duflo (2001). The idea is that individuals ages 16 or older upon the implementation of the CSL were not exposed to the CSL. The changes in the outcomes of interest between cohorts within this reference age group should not be systematically different across provinces.

[Insert Table 10 Here]

Table 10presents the results of this control experiment. Within the reference age group, we consider two subgroups—those ages 16-17 and those ages 18-20 upon implementation of the CSL. We categorize provinces according to the median provincial middle-school incompletion rate. Each panel in Table 10 is a two-by-two matrix. The entries are the mean and standard deviation of the outcome variable within each subgroup. The DID of the means of the subgroups are presented in column (3). These estimated DIDs should not be statistically different from 0.

In Table 10, we apply this experiment on three main variables of interest: years of schooling, incidence of teen pregnancy, and incidence of induced abortion following a prenatal checkup. For all three variables, the DID estimands are close to zero. These results provide some suggestive evidence that the DIDs presented in Tables 2 to 6 are not driven by inappropriate identification assumptions.

B. Alternative Measures of Selective Abortions

In section 4.2.3, we used induced abortions following a prenatal test as a measure of terminations of high-risk pregnancies. However, there are two plausible concerns about the accuracy of this measure. First, some women may think of a pregnancy test as a prenatal test. Second, son preference would imply that women could select against female fetuses rather than high-risk fetuses. In both cases, our sample would include abortions that are not relevant to abnormality screening. If female education lowers the incidence of misreporting in the first case, or sex selective abortions in the second case, the effect of the CSL on selective abortions against high-risk fetuses would be overestimated.

In this subsection, we impose extra restrictions on the benchmark definition. That is, in addition to “having a prenatal test” before an abortion, as a sensitivity check, we impose the restriction of “taking calcium tablets during the pregnancy,” “taking iron tablets during the pregnancy,” “the pregnancy was planned,” and “the pregnancy was in wedlock.” We use these alternative measures to address the issue that some women may misunderstand a pregnancy test as a prenatal test. The rationale is straightforward: if a woman wants to terminate an unwanted pregnancy, she is less likely to take nutrition supplements during the pregnancy. Similarly, the restrictions “planned pregnancy” and “pregnancy in wedlock” lower the likelihood that the pregnancy was unwanted.

[Insert Table 11 Here]

The results using the four alternative measures are reported in columns (1) to (4) in Table 11. The DID estimators are comparable to those reported in the benchmark analysis in column (1) in Table 6.

To address the concern that women select against female rather than high-risk fetuses, we apply two exercises. First, we redo the benchmark regression, confining the sample to provinces implementing the “One-Son-Two-Children” policy, which allows families to have a second child if the first is a girl. The incentive of sex selective abortions for the first birth in these places will be rather weak. The estimator using this subsample is reported in column (5) in Table 11. The coefficient of the interaction term is very similar to the benchmark analysis, suggesting that sex selective abortion is less likely to be the main driving force behind the causal link between CSL exposure and the increase in induced abortions.

The other robustness check is to examine directly the sex ratio of first births. Had the CSL exposure caused more sex selective abortions, we should have observed a more skewed sex ratio (higher ratio of the number of boys to the number of girls). We use the DSP birth data to estimate the effect of the CSL on the likelihood of the firstborn being a son and report the results in Table 12. The coefficients with and without controlling for individual characteristics are not statically significant and are small in magnitude. The results do not support the skepticism that the increase in induced abortions was driven by an increase in prenatal sex selection. Instead, as shown in column (2) in Table 4, the demand for sons decreased due to exposure to the CSL, which could to some extent explain the negative sign of the coefficients in Table 12. However, at the same time, increasing awareness of the availability of ultrasound B screening could increase prenatal selection, which would offset the effect of weakened son preference. In addition, 19 of 30 provinces were under the “One-Son-Two-Children” policy during the period of interest, and the incentive to conduct sex selection during the first pregnancy may have been weak (Li 2007; Sun and Zhao 2016).

[Insert Table 12 Here]

C. Effect of CSL Exposure on Husband’s Years of Schooling

The decision to have a selective abortion is unlikely to be made by women alone. Instead, it is a collective decision of the household, that is, the husband and wife. Therefore, if women who were more exposed to the CSL had a greater chance to marry a more educated husband, then the effect of CSL exposure will be magnified.

We replace the number of years of schooling of women with that of their husbands in equation (1). Fitting the equation using the NFPRH data, we find that women's CSL exposure enabled them to marry more educated husbands. The results are reported in Appendix Table A.2.

Two mechanisms could play a role behind this result of marriage matching. First, assuming the age gap between spouses remains the same,[13]women's longer exposure to the CSL also means longer exposure to the pool of their potential spouses. Second, higher education could equip women with an advantage in the marriage market, which helps them to marry a more educated husband.

Therefore, considering that selective abortion is likely to be a joint decision of both spouses, although the effect of CSL exposure on women's schooling may not be sizable, the outcome of selected abortion could be magnified by women marrying more educated husbands.

VII. Concluding Remarks

Although it is never easy, the option of having an abortion due to birth defects is a common choice for families all over the world, especially in places where the cost of raising a child with birth defects is extremely high. We estimate the impact of China's CSL on women's termination of pregnancy following a prenatal test. We also find that exposure to the CSL led women to avoid teen pregnancy, which is believed to have high risk of adverse birth outcomes. Using China's DSP birth outcome data, we find that the CSL caused a substantial decrease in birth defects and increased the likelihood of normal birth weight.

Although it is well known that improving maternal education can effectively improve children's health, it is less well known that selecting better timing for pregnancy and

[13] The assumption is plausible because the age gap is generally determined by culture and population structure (Ran et al., 2011), which is unlikely to have changed with implementation of the CSL.

aborting upon detection of birth defects play an important role. In 2012, there were around 900,000 babies born with birth defects in China, constituting the second leading cause of infant deaths in the country. In 2010, 7.9 million births occurred with serious birth defects in the world. Our findings show that improving women's awareness of and having premarital and prenatal tests enables them to have the option of abortion when there exists a high risk of a birth defect. This implication applies to women in most countries where abortions and prenatal screening/diagnostic tests are available.

These findings offer a novel explanation of how women's education affects the health of their children. Without taking the selection mechanism into consideration, the traditional "nurture" effect is likely to be exaggerated.

REFERENCES

Black, Sandra E., Paul J. Devereux, and Kjell G. Salvanes. 2008. "Staying in the Classroom and out of the Maternity Ward? The Effect of Compulsory Schooling Laws on Teenage Births." *Economic Journal*, 118(530): 1025-1054.

Case, Amy P., and Mark A. Canfield. 2009. "Methods for Developing Useful Estimates of the Costs Associated with Birth Defects." *Birth Defects Research Part A Clinical & Molecular Teratology*, 85(11): 920-924.

Chen, Yuyu, and Hongbin Li. 2009. "Mother's Education and Child Health: Is There a Nurturing Effect?" *Journal of Health Economics*, 28(2): 413-426.

Chen, Yuyu, Avraham Ebenstein, Michael Greenstone, and Hongbin Li. (2013). "Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China's Huai River Policy." *PNAS*, 110(32), 12936-12941.

Chen, X. K., S. W. Wen, N. Fleming, K. Demissie, G. G. Rhoads, and M. Walker. 2007. "Teenage Pregnancy and Adverse Birth Outcomes: A Large Population Based Retrospective Cohort Study." *International Journal of Epidemiology*, 36(2): 368-373.

Currie, Janet, and Enrico Moretti. 2003. "Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings" *Quarterly Journal of Economics*, 118(4): 1495-1532.

Duflo, Esther. 2001. "Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment." *American Economic Review*, 91(4): 795-813.

Fretts, Ruth C., J. Schmittdiel, F. H. Mclean, R. H. Usher, and M. B. Goldman. 1995. "Increased Maternal Age and the Risk of Fetal Death." *New England Journal of Medicine*, 333(15): 953-957.

Fretts, R. C., , J., (1995). Increased maternal age and the risk of fetal death. New

England Journal of Medicine, 333(15), 953-7.

Glewwe, Paul. 1999. “Why Does Mother's Schooling Raise Child Health in Developing Countries? Evidence from Morocco.” *Journal of Human Resources*, 34(1): 124-159.

Güneş, Pınar Mine. 2015. “The Role of Maternal Education in Child Health: Evidence from a Compulsory Schooling Law.” *Economics of Education Review*, 47: 1-16.

Huang, Wei. 2016. “Understanding the Effects of Education on Health: Evidence from China.” *Social Science Electronic Publishing*.

Huang, Wei, Xiaoyan Lei, and Ang Sun. 2018. “Fertility Restrictions and Life-cycle Outcomes: Evidence from the One-Chile Policy in China.” *Renmin University of China working paper*.

Johnson, D. Gale. 2003. “Provincial Migration in China in the 1990s.” *China Economic Review*, 14(1): 22-31.

Jung, Seeun. 2015. “Does Education Affect Risk Aversion? Evidence from the British Education Reform.” *Applied Economics*, 47(28): 2924-2938.

Koch, E., B. Calhoun, P. Aracena, S. Gatica, and M. Bravo. 2014. “Women’s Education Level, Contraceptive Use and Maternal Mortality Estimates.” *Public Health*, 128(4): 384-387.

Li, Shuzhuo. 2007. *Imbalanced Sex Ratio at Birth and Comprehensive Intervention in China*. Presented at 4th Asia Pacific Conference on Reproductive and Sexual Health and Rights, Hyderabad, India.

Ministry of Health. 2012. *Birth Defect Prevention in China*. Beijing: Ministry of Health, People’s Republic of China.

Ran, A., A. Delavande, and L. Vasconcelos. 2011. “Marrying up: The Role of Sex Ratio in Assortative Matching.” *American Economic Journal Applied Economics*, 3(3): 124-

157.

Smith, Gordon C. S., and Jill P. Pell. 2001. “Teenage Pregnancy and Risk of Adverse Perinatal Outcomes Associated with First and Second Births: Population Based Retrospective Cohort Study.” *BMJ* 323 (7311): 476.

Sun, Ang, and Yaohui Zhao. 2016. “Divorce, Abortion, and the Child Sex Ratio: The Impact of Divorce Reform in China.” *Journal of Development Economics*, 120(5): 53-69.

Thomas, Duncan, John Strauss, and Maria-Helena Henriques. 1991. “How Does Mother’s Education Affect Child Height?” *Journal of Human Resources*, 26 (2): 183-211.

Waitzman, N. J., P. S. Romano, and R. M. Scheffler. 1994. “Estimates of the Economic Costs of Birth Defects.” *Inquiry: A Journal of Medical Care Organization Provision & Financing*, 31(2): 188-205.

WHO (World Health Organization). 2016. *Remarkable Progress, New Horizons and Renewed Commitment: Ending Preventable Maternal, Newborn and Child Deaths in South-East Asia Region*. New Delhi, India: WHO Regional Office for South-East Asia.

Zhao, X., P. Wang, X. Tao, and N. Zhong. 2013. “Genetic Services and Testing in China.” *Journal of Community Genetics*, 4 (3): 379-390.

Zheng, X., R. Chen, N. Li, W. Du, L. Pei, J. Zhang, Y. Ji, X. Song, L. Tan, and R. Yang. 2012. “Socioeconomic Status and Children with Intellectual Disability in China.” *Journal of Intellectual Disability Research*, 56: 212-220.

Tables

Table 1. Summary Statistics for the National Family Planning and Reproductive Health Data

	(1)	(2)	(3)	(4)
Age upon CSL implementation	All	6-11	12-15	16+
Range of birth years	1966-1981	1974-1981	1970-1980	1966-1978
Number of observations	18,357	4,635	4,740	8,982
Panel A. Predetermined individual characteristics				
Minority	0.8952	0.8977	0.8939	0.8947
	(0.3062)	(0.3030)	(0.3080)	(0.3070)
Urban residency (*hukou*)	0.2490	0.2602	0.2521	0.2415
	(0.4324)	(0.4387)	(0.4343)	(0.4280)
Panel B. Outcomes				
Years of schooling	7.9341	8.9829	8.0207	7.3471
	(3.8206)	(3.6283)	(3.7159)	(3.8524)
Pregnancy during teenage years	0.0871	0.0593	0.0829	0.1035
	(0.2819)	(0.2363)	(0.2758)	(0.3047)
Had a premarital checkup	0.5897	0.7657	0.6626	0.4895
	(0.4919)	(0.4236)	(0.4729)	(0.4999)
Had prenatal checkups during	0.7137	0.8003	0.7801	0.6645
first pregnancy	(0.4521)	(0.3999)	(0.4143)	(0.4722)
Had an induced abortion following a	0.0694	0.1838	0.0791	0.0376
prenatal test	(0.2542)	(0.3874)	(0.2699)	(0.1901)

Source: 2001 National Family Planning and Reproductive Health Survey data.

Note: The sample is confined to those born between 1965 and 1981.

Table 2. Difference-in-Difference Estimands: The Effect of the Compulsory Schooling Law on Women's Years of Schooling

	Years of schooling			
	(1)	(2)	(3)	(4)
Years of exposure ×CSL intensity	0.1145	0.1124	0.1160	0.1554
	(0.0434)	(0.0439)	(0.0459)	(0.0455)
Years of exposure	-0.0351	-0.0188	0.0041	
	(0.0372)	(0.0373)	(0.0560)	
Individual characteristics	×	×	×	×
Labor market controls		×	×	
Province-specific year trend			×	
Province dummies	×	×	×	
Birth year dummies	×	×	×	
Province-year dummies				×
Observations	18,147	18,084	18,147	18,147
R-squared	0.3659	0.3664	0.3706	0.3850
Mean	7.9341			
Effectiveness	0.0213	0.0366	0.0613	0.0766

Source: 2001 National Family Planning and Reproductive Health Survey data.

Note: The sample is confined to those born between 1965 and 1981 (20 years before the NFPRH survey was conducted). The individual characteristics include dummies for Han or minorities. Province controls include gross domestic product (GDP) per capita (in log), GDP growth rate, and the ratio of industry and services to agriculture. The regressions also include a constant term and province–calendar year fixed effects. Standard errors in parentheses are clustered at the province-year level. We define "effectiveness" as the magnitude of the CSL effect caused by one additional year of exposure at the mean level of CSL intensity. Therefore, effectiveness equals the product of the coefficient of the interaction term and the mean middle-school incompletion rate (0.4929 in the NFPRH data).

Table 3. Difference-in-Difference Estimands:
The Effect of the Compulsory Schooling Law on the Incidence of Pregnancy, by Different Age Cutoffs

	Teenage pregnancy (first pregnancy before age 20)	First pregnancy before age 15	First pregnancy before age16	First pregnancy before age17	First pregnancy before age18	First pregnancy before age19
	(1)	(2)	(3)	(4)	(5)	(6)
Years of exposure ×CSL intensity	-0.0132	-0.0003	-0.0005	-0.0023	-0.0047	-0.0091
	(0.0029)	(0.0002)	(0.0003)	(0.0007)	(0.0011)	(0.0021)
Observations	18,147	18,147	18,147	18,147	18,147	18,147
R-squared	0.0757	0.0293	0.0261	0.0380	0.0518	0.0589
Mean	0.0871	0.0005	0.0016	0.0054	0.0166	0.0399
Effectiveness	-0.0065	-0.0001	-0.0002	-0.0011	-0.0023	-0.0045

Source: 2001 National Family Planning and Reproductive Health Survey data.

Note: The sample is confined to those born between 1965 and 1981 (20 years before the NFPRH survey was conducted). The regressions include a constant term and province–calendar year fixed effects. Standard errors in parentheses are clustered at the province-year level. We define "effectiveness" as the magnitude of the CSL effect caused by one additional year of exposure at the mean level of CSL intensity. Therefore, effectiveness equals the product of the coefficient of the interaction term and the mean middle-school incompletion rate (0.4929in the NFPRH data).

Table 4. Difference-in-Difference Estimands:
The Effect of the Compulsory Schooling Law on Beliefs about Ideal Fertility, Marriage Age, and Contraceptive Measures

	Desired number of children	Desired number of boys	Age at first marriage (months)	Contraception (yes=1)
	(1)	(2)	(3)	(4)
Years of exposure ×CSL intensity	-0.0315	-0.0287	5.3934	0.0049
	(0.0073)	(0.0066)	(0.4719)	(0.0093)
Observations	17,993	17,813	15,834	15,663
R-squared	0.2735	0.2366	0.2002	0.1746
Mean	1.6368	0.6043	266.4593	0.8548
Effectiveness	-0.0155	-0.0141	2.6584	0.0024

Source: 2001 National Family Planning and Reproductive Health Survey data.

Note: The sample is confined to those born between 1965 and 1981 (20 years before the NFPRH survey was conducted). The regressions include a constant term and province–calendar year fixed effects. Standard errors in parentheses are clustered at the province-year level. We define "effectiveness" as the magnitude of the CSL effect caused by one additional year of exposure at the mean level of CSL intensity. Therefore, effectiveness equals the product of the coefficient of the interaction term and the mean middle-school incompletion rate (0.4929in the NFPRH data).

Table 5. Difference-in-Difference Estimands:
The Effect of the Compulsory Schooling Law on Women Having Premarital and Prenatal Checkups

	Premarital checkups		Had prenatal checkups
	Awareness	Had	
	(1)	(2)	(3)
Years of exposure ×CSL intensity	0.0282	0.0856	0.0659
	(0.0046)	(0.0091)	(0.0086)
Observations	18,147	12,354	13,170
R-squared	0.1877	0.2687	0.2105
Mean	0.7832	0.5897	0.7137
Effectiveness	0.0139	0.0422	0.0325

Source: 2001 National Family Planning and Reproductive Health Survey data.

Note: The sample is confined to those born between 1965 and 1981 (20 years before the NFPRH survey was conducted). The regressions include a constant term and province–calendar year fixed effects. Standard errors in parentheses are clustered at the province-year level. We define "effectiveness" as the magnitude of the CSL effect caused by one additional year of exposure at the mean level of CSL intensity. Therefore, effectiveness equals the product of the coefficient of the interaction term and the mean middle-school incompletion rate (0.4929in the NFPRH data).

Table 6. Difference-in-Difference Estimands: The Effect of the Compulsory Schooling Law on Induced Abortion Following a Prenatal Checkup

	Induced abortion following an ultrasound B test	Induced abortion without an ultrasound B test	Miscarriage/natural abortion
	(1)	(2)	(3)
Years of exposure ×CSL intensity	0.0301	-0.0024	-0.0008
	(0.0112)	(0.0077)	(0.0060)
Observations	14,730	14,730	14,730
R-squared	0.2882	0.1470	0.0535
Mean	0.0694	0.0578	0.0401
Effectiveness	0.0148	-0.0012	-0.0004

Source: 2001 National Family Planning and Reproductive Health Survey data.

Note: The sample is confined to those born between 1965 and 1981 (20 years before the NFPRH survey was conducted). The regressions include a constant term and province–calendar year fixed effects. Standard errors in parentheses are clustered at the province-year level. We define "effectiveness" as the magnitude of the CSL effect caused by one additional year of exposure at the mean level of CSL intensity. Therefore, effectiveness equals the product of the coefficient of the interaction term and the mean middle-school incompletion rate (0.4929in the NFPRH data).

Table 7. Triple Difference Estimands: The Heterogeneous Effects of the Compulsory Schooling Law on Induced Abortion Following a Prenatal Checkup across Provinces with Different Rates of Birth Defects

	Induced abortion following a prenatal checkup			
	(1)	(2)	(3)	(4)
Years of exposure ×CSL intensity	0.0295	-0.0519	0.0356	-0.0264
	(0.0113)	(0.0340)	(0.0262)	(0.0615)
Years of exposure ×CSL intensity	0.0421			
×South China 5 provinces	(0.0205)			
Years of exposure ×CSL intensity		0.0259		
×province rate of peromelia		(0.0095)		
Years of exposure ×CSL intensity			-0.0002	
×province rate of mental disability			(0.0011)	
Years of exposure ×CSL intensity				0.0092
×province rate of vision or hearing loss				(0.0089)
Observations	14,730	14,352	14,352	14,352
R-squared	0.2882	0.2918	0.2908	0.2911

Source: 2001 National Family Planning and Reproductive Health Survey data.

Note: The sample is confined to those born between 1965 and 1981 (20 years before the NFPRH survey was conducted). The regressions include a constant term and province–calendar year fixed effects. Standard errors in parentheses are clustered at the province-year level. South China 5 provinces in column (1) refers to Guangxi, Hainan, Yunnan, Guangdong, and Guizhou provinces. The commonly occurring birth defects caused by single gene recessive disorder in China include phenylketonuria, congenital hypothyroidism, glucose-6-phosphate dehydrogenase (G6PD) deficiency, and thalassemia. G6PD deficiency and thalassemia exhibit huge geographical variation: the prevalence is much higher in the five provinces in Southern China (Guangxi, Hainan, Yunnan, Guangdong, and Guizhou provinces). In columns (2) to (4), the province rates of birth defects are from the first China National Sample Survey on Disability, which was conducted in 1987.

Table 8. Difference-in-Difference Estimands: The Effect of the Compulsory Schooling Law on Schooling and Birth Outcomes Using the DSP Birth Data

	Maternal years of schooling		Birth defect (yes=1)		Normal birth weight (2,500~4,000 grams =1)	
	(1)		(2)	(3)	(4)	(5)
Years of exposure	0.2333	0.2333	-0.0024	-0.0020	0.0170	0.0053
×CSL intensity	(0.0224)	(0.0224)	(0.0010)	(0.0010)	(0.0025)	(0.0019)
Controls		×		×		×
Observations	437,077	437,077	366,929	394,288	370,644	397,799
R-squared	0.4808	0.4808	0.3809	0.5460	0.3181	0.3527
Mean	9.4823		0.0096		0.8853	
Effectiveness	0.1091	0.1091	-0.0011	-0.0009	0.0079	0.0025

Source: Repeated cross sections of China's National Disease Surveillance Points (DSPs) birth outcome data from 1996 to 2000.

Note: The sample is confined to those born between 1965 and 1981 (20 years before the DSP survey was conducted). Controls include child gender; birth order; mother's ethnicity, occupation, and age; and father's education as dummies. The regressions also include a constant term and province–calendar year fixed effects and county fixed effects. Standard errors in parentheses are clustered at the province-year level. We define "effectiveness" as the magnitude of the CSL effect caused by one additional year of exposure at the mean level of CSL intensity. Therefore, effectiveness equals the product of the coefficient of the interaction term and the mean middle-school incompletion rate (0.4675 in the DSP data).

Table 9. Difference-in-Difference Estimands: The Effect of the Compulsory Schooling Law on Supplementary Outcomes

	Took calcium tablets during pregnancy (yes=1)	Took iron tablets during pregnancy (yes=1)
	(1)	(2)
Years of exposure ×CSL intensity	-0.0021	-0.0094
	(0.0119)	(0.0119)
Observations	13,057	13,005
R-squared	0.1490	0.1205

Source: 2001 National Family Planning and Reproductive Health Survey data.

Note: The sample is confined to those born between 1965 and 1981 (20 years before the NFPRH survey was conducted). The regressions include a constant term and province–calendar year fixed effects. Standard errors in parentheses are clustered at the province-year level. We define "effectiveness" as the magnitude of the CSL effect caused by one additional year of exposure at the mean level of CSL intensity. Therefore, effectiveness equals the product of the coefficient of the interaction term and the mean middle-school incompletion rate (0.4929 in the NFPRH data).

Table 10. Means of Schooling and Pregnancy-Risk Reduction Behaviors, by Cohort and Program Intensity

	Low intensity	High intensity	Difference
	(1)	(2)	(3)
Panel A. Years of schooling			
Ages 16-17	9.0298	6.1116	2.9182
	(0.1003)	(0.0836)	(0.1308)
Ages 18-20	8.9363	5.8530	3.0833
	(0.0776)	(0.0683)	(0.1034)
Difference	0.0935	0.2585	-0.1651
	(0.1257)	(0.1084)	(0.3913)
Panel B. Incidence of teenage pregnancy			
Ages 16-17	0.0698	0.1515	-0.0817
	(0.0066)	(0.0094)	(0.0115)
Ages 18-20	0.0610	0.1182	-0.0572
	(0.0050)	(0.0068)	(0.0085)
Difference	0.0088	0.0333	-0.0245
	(0.0082)	(0.0113)	(0.0182)
Panel C. Induced abortion following an ultrasound B test			
Ages 16-17	0.0611	0.0299	0.0312
	(0.0064)	(0.0045)	(0.0079)
Ages 18-20	0.0496	0.0247	0.0249
	(0.0047)	(0.0033)	(0.0057)
Difference	0.0115	0.0052	0.0063
	(0.0078)	(0.0055)	(0.0136)

Source: 2001 National Family Planning and Reproductive Health Survey data.

Note: Standard errors are in parentheses.

Table 11. Difference-in-Difference Estimands: The Effect of the Compulsory Schooling Law on Induced Abortion, Using Alternative Measures/Samples

	Induced abortion following a prenatal test with the conditions				
	Took calcium tabs	Took iron tabs	Planned pregnancy	Pregnancy in wedlock	In "One-Son-Two-Children" provinces
	(1)	(2)	(3)	(4)	(5)
Years of exposure ×CSL intensity	0.0057	0.0031	0.0071	0.0297	0.0316
	(0.0012)	(0.0008)	(0.0018)	(0.0112)	(0.0177)
Observations	18,147	18,147	18,147	14,729	9,673
R-squared	0.1212	0.0912	0.0651	0.2885	0.3579
Mean	0.0046	0.0027	0.0111	0.0694	0.0469
Effectiveness	0.0028	0.0015	0.0035	0.0146	0.0156

Source: 2001 National Family Planning and Reproductive Health Survey data.

Note: The sample is confined to those born between 1965 and 1981 (20 years before the NFPRH survey was conducted). The regressions include a constant term and province–calendar year fixed effects. Standard errors in parentheses are clustered at the province-year level. We define "effectiveness" as the magnitude of the CSL effect caused by one additional year of exposure at the mean level of CSL intensity. Therefore, effectiveness equals the product of the coefficient of the interaction term and the mean middle-school incompletion rate (0.4929 in the NFPRH data).

Table 12: Difference-in-Difference Estimands: The Effect of the Compulsory Schooling Law on the Likelihood of the Firstborn Being a Son

	Gender of first birth (boy=1, girl=0)	
	(1)	(2)
Years of exposure × CSL intensity	-0.0035	-0.0031
	(0.0034)	(0.0034)
Controls		×
Observations	292,028	290,138
R-squared	0.0088	0.0092

Source: Repeated cross sections of China's National Disease Surveillance Points (DSPs) birth outcome data from 1996 to 2000.

Note: The sample is confined to those born between 1965 and 1981 (20 years before the DSP survey was conducted). Controls include child gender; birth order; mother's ethnicity, occupation, and age; and father's education as dummies. Regressions also include a constant term and province–calendar year fixed effects and county fixed effects. Standard errors in parentheses are clustered at the province-year level.

Appendix Table A.1.Difference-in-Difference Estimands: The Effect of the Compulsory Schooling Law for Women Exposed to Its Implementation at Different Ages

	Maternal years of schooling	Teenage pregnancy	Induced abortion following a prenatal checkup
	(1)	(2)	(3)
Age 6years at CSL (full exposure)	0.0192	-0.0009	0.0044
×CSL intensity	(0.0050)	(0.0004)	(0.0017)
Age 7years at CSL (8 years exposure)	0.0113	-0.0010	0.0019
×CSL intensity	(0.0051)	(0.0003)	(0.0009)
Age 8years at CSL (7 years exposure)	0.0123	-0.0009	0.0021
×CSL intensity	(0.0047)	(0.0003)	(0.0008)
Age 9years at CSL (6 years exposure)	0.0097	-0.0012	0.0019
×CSL intensity	(0.0045)	(0.0002)	(0.0007)
Age 10years at CSL (5 years exposure)	0.0085	-0.0008	0.0018
×CSL intensity	(0.0043)	(0.0003)	(0.0008)
Age 11years at CSL (4 years exposure)	0.0008	-0.0004	0.0018
×CSL intensity	(0.0043)	(0.0003)	(0.0008)
Age 12years at CSL (3 years exposure)	0.0028	-0.0002	0.0009
×CSL intensity	(0.0035)	(0.0003)	(0.0007)
Age 13years at CSL (2 years exposure)	0.0032	-0.0003	-0.0007
×CSL intensity	(0.0032)	(0.0003)	(0.0005)
Age 14years at CSL (1 year exposure)	0.0059	-0.0004	-0.0006
×CSL intensity	(0.0034)	(0.0003)	(0.0004)
Age 15years at CSL (no exposure)	0.0009	-0.0003	-0.0005
×CSL intensity	(0.0033)	(0.0003)	(0.0003)
Age 16years at CSL (no exposure)	0.0011	0.0004	-0.0003
×CSL intensity	(0.0032)	(0.0003)	(0.0003)
Age 17years at CSL (no exposure)	-0.0014	0.0003	-0.0003
×CSL intensity	(0.0028)	(0.0002)	(0.0002)
Age 18years at CSL (no exposure)	0.0011	0.0001	-0.0002
×CSL intensity	(0.0023)	(0.0002)	(0.0002)
Observations	18,147	18,147	14,730
R-squared	0.3854	0.0764	0.3308

Source: 2001 National Family Planning and Reproductive Health Survey data.

Note: The sample is confined to those born between 1965 and 1981 (20 years before the NFPRH survey was conducted). Individuals ages 19-20 compose the reference group. The regressions include a constant term and province–calendar year fixed effects. Standard errors in parentheses are clustered at the province-year level.

Appendix Table A.2.Difference-in-Difference Estimands: The Effect of the Compulsory Schooling Law on Husbands' Years of Schooling

	Years of schooling			
	(1)	(2)	(3)	(4)
Years of exposure × CSL intensity	0.3032	0.3054	0.4066	0.2709
	(0.0839)	(0.0845)	(0.1126)	(0.0715)
Years of exposure	-0.0298	-0.0203	0.0138	
	(0.0443)	(0.0450)	(0.0632)	
Individual characteristics	×	×	×	×
Labor market controls		×	×	
Province-specific year trend			×	
Province dummies	×	×	×	
Birth year dummies	×	×	×	
Province-year dummies				×
Observations	13,390	13,336	13,390	13,390
R-squared	0.3125	0.3133	0.3153	0.3125
Mean	8.7725			
Effectiveness	0.1494	0.1505	0.2004	0.1335

Source: 2001 National Family Planning and Reproductive Health Survey data.

Note: The sample is confined to those born between 1965 and 1981 (20 years before the NFPRH survey was conducted). The individual characteristics include dummies for Han or minorities. Province controls include gross domestic product (GDP) per capita (in log), GDP growth rate, and the ratio of industry and services to agriculture. The regressions also include a constant term and province–calendar year fixed effects. Standard errors in parentheses are clustered at the province-year level. We define "effectiveness" as the magnitude of the CSL effect caused by one additional year of exposure at the mean level of CSL intensity. Therefore, effectiveness equals the product of the coefficient of the interaction term and the mean middle-school incompletion rate (0.4929 in the NFPRH data).

Figures

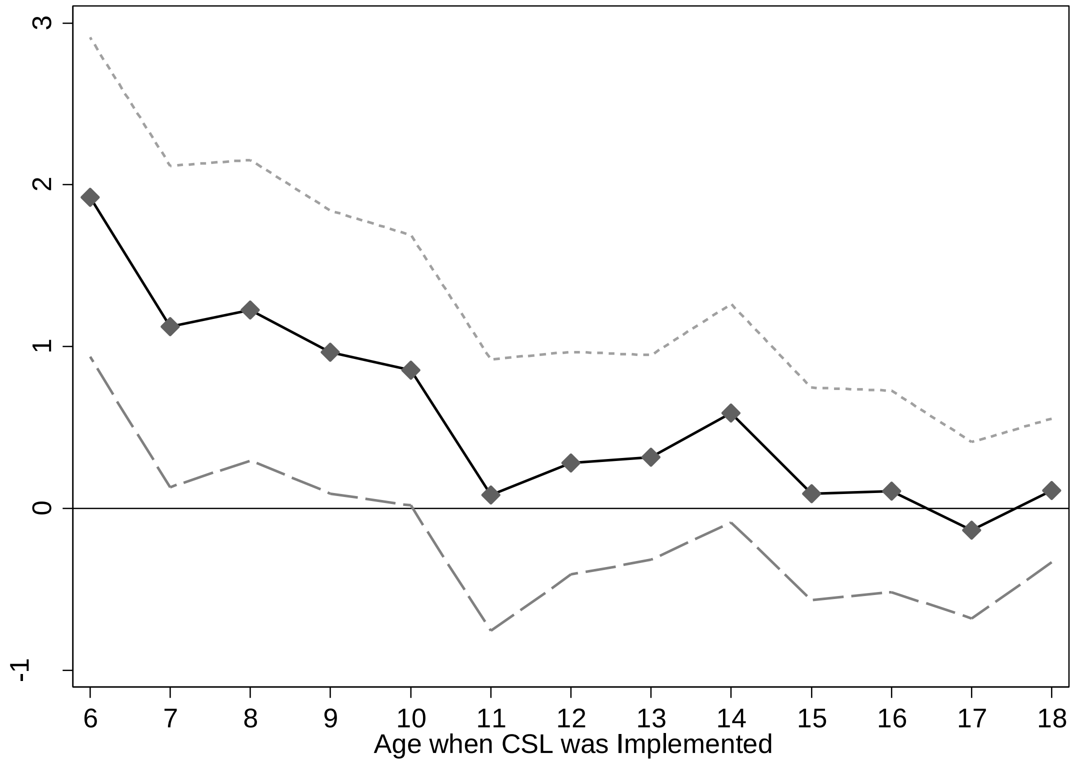

Figure 1. Difference-in-Difference Estimands: The Effect of the Compulsory Schooling Law on Years of Schooling for Women Exposed to the Implementation at Different Ages

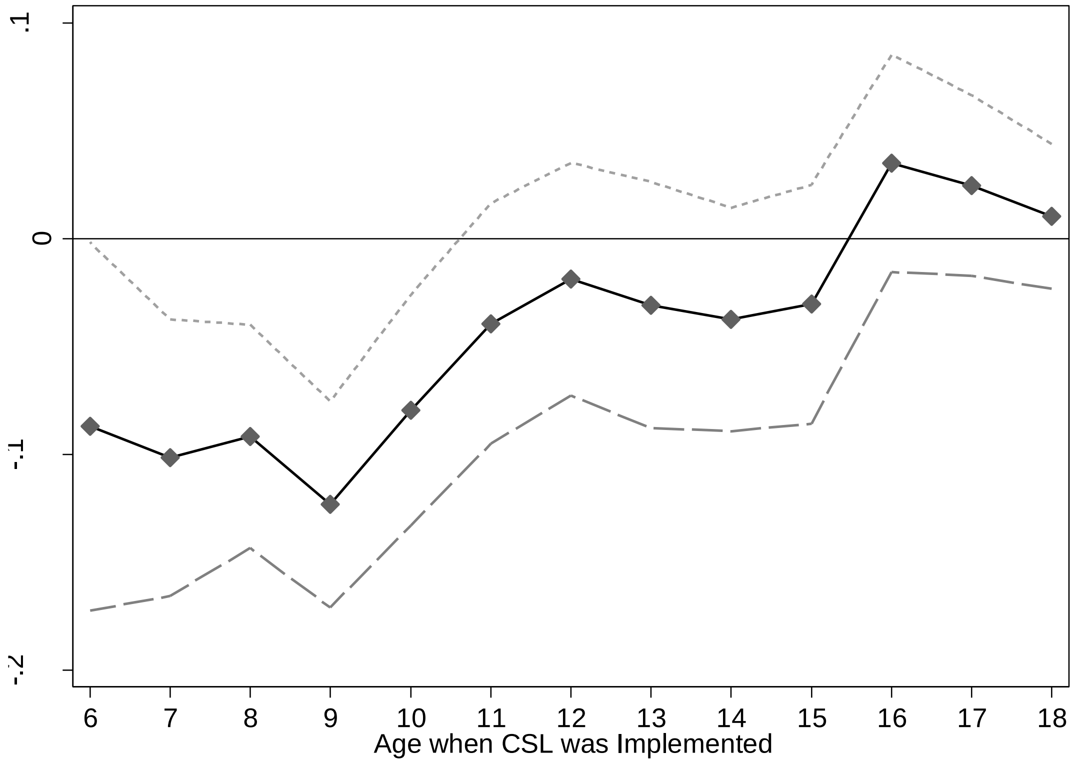

Figure 2. Difference-in-Difference Estimands: The Effect of the Compulsory Schooling Law on the Likelihood of Teenage Pregnancy for Women Exposed to the Implementation at Different Ages

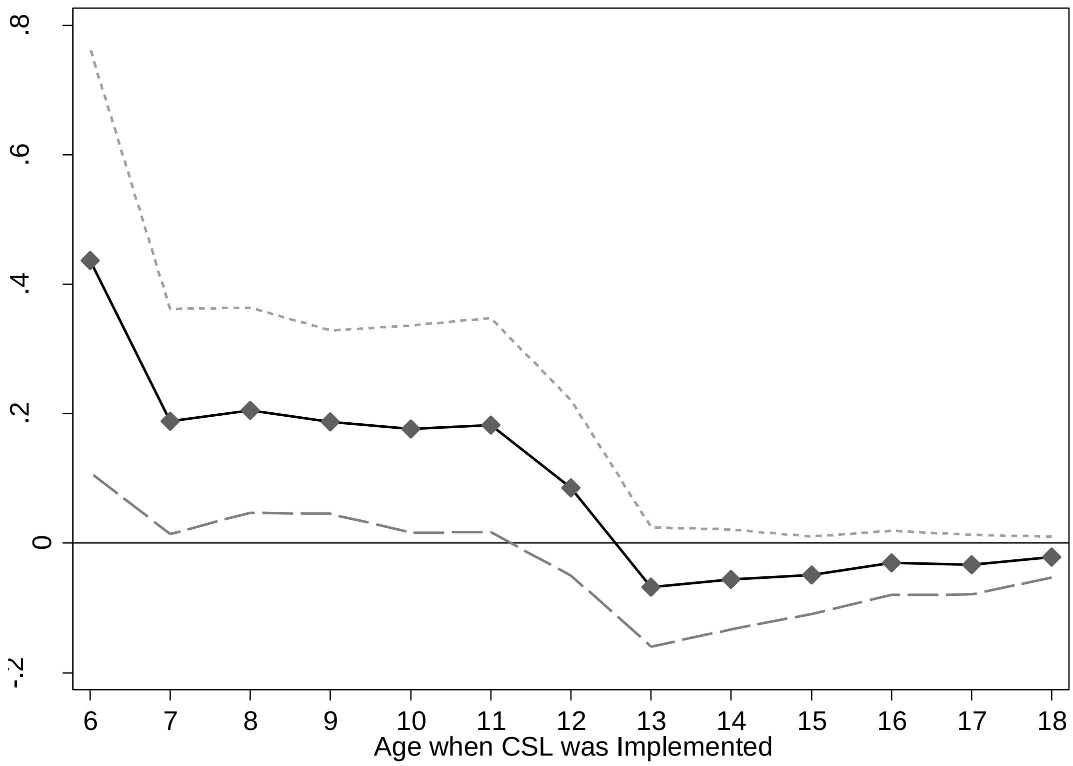

Figure 3. Difference-in-Difference Estimands: The Effect of the Compulsory Schooling Law on the Likelihood of Induced Abortion Following Ultrasound B Screening for Women Exposed to the Implementation at Different Ages

Appendix Figure

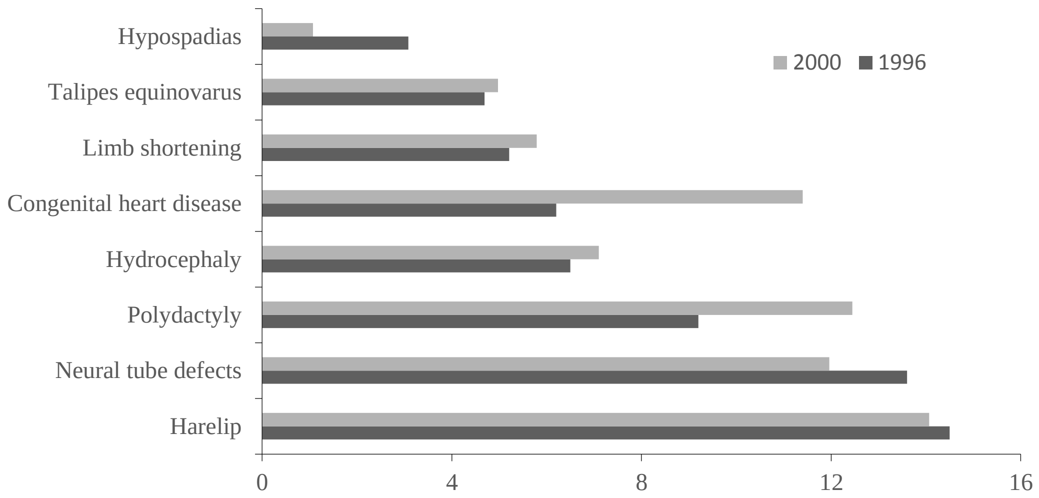

Figure A.1. Rate of Incidence of Birth Defects per 10,000 Births

Source: Ministry of Health 2012.