Mother's Education and Infant Health: Evidence from Closure of High Schools in China*

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Abstract

This paper examines the effect of maternal education on infant health by exploiting exogenous variation in women's exposure to the wholesale closure of rural high schools immediately after the Cultural Revolution, from 1977 to 1984, in China. Using the 1992 Chinese Children Survey microdata combined with unique data on the year the school closures started by county, this study focuses on narrow comparisons in educational attainment and infant health among rural women born quarters apart yet having distinct exposures to the closures of high schools within county. Results show a sharp decline of 22.5 percent in high school completion for women at age 17 years and 9 months by the first quarter in the first year of the school closures. Using the discontinuous change in high school completion induced by the closures, I find that one more year of maternal high school education has no effect on prematurity, low birthweight, neonatal mortality and infant mortality.

JEL Codes: D1, I1, I2, J2

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1 Introduction

Maternal education could affect infant health by increasing household income or directly improving health behaviors. A better educated woman earns more in the labor market and is also more likely to marry a man with more schooling and higher earnings. An increased household income would enable a woman to have better access to health care services and spend more on health inputs, especially during pregnancy. Because better educated women may acquire more health information or process it better, they may use health inputs more efficiently or have better allocations of these inputs (Grossman, 1972; 2006). More educated women are also more likely to avoid risky behaviors. For example, an additional year of schooling induced by college openings was found to decrease maternal smoking by over 30 percent (Currie and Moretti, 2003).

The robust positive association between maternal education and child health has been widely documented (e.g., Strauss and Thomas, 1995; Gakidou et al., 2010) and has motivated policy-makers to promote female education in developing countries (World Bank, 1993). Such education policies will be effective in improving infant health to the extent that maternal education has a causal effect on child health, which has been debatable due to possibly omitted variables, such as a woman's predetermined socioeconomic status. Studies that exploit various school expansion programs as exogenous sources of a decline in the costs of schooling find a positive effect of maternal education on infant health in the US, Indonesia and Taiwan (Currie and Moretti, 2003; Breierova and Duflo, 2004; Chou et al. 2010). In contrast, Lindeboom et al. (2009) using changes in British compulsory schooling laws do not find an effect, and McCrary and Royer (2011) comparing women born just before and just after the school entry date in the US also show no effect of maternal education on infant health. Thus, findings from the design-based literature are mixed.[1]

In this paper, I provide new evidence on the effect of maternal education on infant health by exploiting the largest negative supply-side shock in history: the nationwide closures of rural high schools in post-Mao China, which induced a sharp increase in the costs of high school education for the rural population. Immediately after the death of Mao Zedong in 1976, an education reform was initiated in 1977 to close rural secondary schools built during the Cultural Revolution, with the most acute reductions occurring in high schools (Pepper, 1996). With an official justification of better serving the economic reform, the education reform completely reverted the priorities of the Cultural Revolution to concentrate education resources on selected urban schools. Figure 1a shows that the total number of high schools decreased by more than 80 percent between 1977 and 1983; the decline was larger for rural high schools, the target of the closure movement. A distinct feature of these closures is that they were not driven by the change in the overall demand for high schools. Figure 1b shows that both overall population and rural population aged 15-18 had been increasing from 1977 to 1983.

[1] These studies use different education interventions or policies targeting at different margins of schooling, and the subpopulation affected by each intervention is different.

The identification strategy focuses comparisons on rural women born quarters apart but who had different exposures to the closures of high schools within county. The variation in women's exposure status across narrowly defined cohorts comes from two sources. First, when the closures of high schools started in a given county, individuals aged 18 who had just graduated from high school were relatively unexposed, while those aged 17 were more exposed to the shock. The second source of variation is generated by the school entry date policy. From 1967 to the late 1970s, one should be 7 years old at the beginning of the spring semester, usually in February or March, to start primary school. Individuals born in the first quarter went to schools one year earlier and thus graduated one year earlier, which would allow them to avoid the closures, compared to those born in the second quarter of the same year. Consequently, a sharp decline in high school completion is expected for individuals at age 17 years and 9 months (age 17.75 hereafter) by the first quarter in the first year of the closures. Assuming women born quarters apart are otherwise similar, I can compare high school completion and infant health between women just above and just below age 17.75 within county. The relationship between maternal education and infant health is assessed by relating the differences in infant health to the differences in high school completion induced by the closures.

To perform these comparisons, I have collected unique data on the year the closures of rural high schools started by county from two-thirds of all county gazetteers ever published in which local history was recorded from 1949 to the 1980s. While the central decision to close rural high schools applied to every county, the timing of the closures varied by county from 1977 to 1984. These data are combined with the 1992 Chinese Children Survey microdata, a national representative survey that covers a wide range of infant health outcomes and parental characteristics. The analysis sample includes 400 counties that were rural at the time of the closures and that are matched in both of these data.[2] The matched data allow me to assign the exposure status to each rural woman by her age in the first quarter of the first year of the school closures, and then examine the effects of her exposure to the closures on educational attainment and infant health.

There are four main reasons the identification strategy provides credible evidence on the causal effect of maternal education on infant health. First, the identifying assumption on the similarity of women on either side of age 17.75 within county is plausible because their parents were unlikely to strategically plan births to avoid the shock. The closure decision was made shortly after the end of Mao's era and was unpredictable in more than ten years ago. The school entry date was changed from September 1st to the spring semester in 1967, before which year women around 17 at the time of the closures had been born. Due to this policy change, women born in the first quarter are not more planned than those born in the second quarter. Moreover, because I also control for quarter of birth effects, the criticism on Angrist and Krueger (1991) regarding seasonality of birth (Bound et al., 1995) is less of a concern in this study. Second, this assumption is also testable by

[2] I use the county code in the 1982 Census to define rural areas at the time of the closures. An administrative unit is defined as a county if the last two digits of the county code in 1982 is between 21 and 80 (definition of the State Bureau of Statistics).

examining the continuity of predetermined familial characteristics.[3] Third, to confound the effects of the high school closures, other concurrent reforms should have closely followed the timing of the school closures by county and have had differential impacts on women just older and just younger than 17.75 in the first quarter of the reform year. I find that controlling for one's exposure to land reform between 1978 and 1984 does not change the estimated effects of the high school closures. And I also provide evidence that the closures of middle schools after the Cultural Revolution do not confound my findings. Finally, internal migration had been under strict control in China from the 1950s until the first relaxation in 1985 (Wang, 2005). A natural concern about endogenous mobility induced by policy changes is less important for the school closures between 1977 and 1984.

Consistent with expectations for educational attainment, the results show a sharp drop in high school completion for women at age 17.75 in the first quarter of the first year of the school closures. The decline of 2.7 percentage points from 12 percent at age 18 suggests that 22.5 percent of women on the margin were affected by the negative shock. Estimates are precise, indicating a strong first stage. Similar to McCrary and Royer (2011), I find negligible effect of a woman's exposure to the closures on her selection into motherhood and maternal age at first birth, reducing concerns about endogenous sample selection. Using the discontinuous change in high school completion induced by the closures, I find that one more year of maternal high school education has little effect on infant health, as measured by prematurity, low birthweight, neonatal mortality and infant mortality. Lastly, to understand why there is no effect of women's high school completion on infant health, I examine the income channel, as captured by women's employment status and whether working on a nonfarm job. I find no effect on these labor market outcomes either.

It is somewhat surprising that I find no effect of maternal education on infant health in light of the literature in developing countries (Breierova and Duflo, 2004; Chou et al., 2010). Interpreting my findings requires considerations of the research design in this paper. First, the estimated effects are specific to a subpopulation of women affected by the high school closures. When local rural schools were closed, parents could send their children to urban schools to continue schooling. Because the closures of rural schools increased the costs of completing high school, my estimates are most relevant to women from low socioeconomic background who were more likely to comply with the closures. Second, in the narrow comparisons between women on either side of age 17.75, the margin of maternal education affected by the closures is one more year in high school, specifically, the last year in high school.

On the other hand, findings in this paper cast doubts on two arguments in the literature. The first argument is that maternal education improves infant health through women's learning in school. However, it is very difficult to disentangle the effect of learning from staying in school longer and thus less likely to be pregnant under age 18, which could also improve infant health (Royer, 2004). School opening programs targeting lower levels of schooling could be different from interventions

[3]I provide evidence below that a number of predetermined characteristics of these women and their parents are balanced on either side of the age cutoff.

at exit of high school in terms of separating these two channels. For example, in Breierova and Duflo (2004), women's exposure to the primary school construction program reduced the number of children born before age 15. It is unclear that the positive effect of maternal education on infant health is not confounded by endogenous fertility choice. In contrast, in this paper using closures of high schools, women on the margin were very close to 18, and therefore no effect of women's exposure on teenage pregnancy is detected.

The second argument is that maternal education could directly improve health behavior. It is also not easy to separate direct improvement in health behavior from income change, as they are often closely related. Using a 1992 survey, when China was under the transition from a planned economy to a market oriented economy, my findings on labor market outcomes are consistent with previous studies that find zero or even negative earnings returns to education in the same period (Gregory and Meng, 1995; Li and Zhang, 1998). If one more year in high school indeed improves maternal health behavior, even without an income channel, we would still expect an effect on infant health. However, we do not observe it.

The contribution of this paper is in its ability to uniquely isolate the effect of maternal high school education on infant health by exploiting the unexpected and massive school closures. If we relate this study to the other two design-based studies in Indonesia and Taiwan (Breierova and Duflo, 2004; Chou et al., 2010), there is a non-linear relationship between maternal education and infant health in developing countries. Maternal schooling at lower levels has an positive effect on infant health, while this effect disappears among the highest educated women. From a policy perspective, education interventions targeting lower levels of schooling might be more effective in improving infant health in developing countries.

The rest of this paper is organized as follows. Section 2 introduces the background of the closures of rural high schools in China and discusses the assignment of treatment status. Section 3 describes the county-level data on the timing of the closures and the microdata on mothers and children. Section 4 presents the identification strategy. Section 5 presents results by outcomes of interests. Robustness checks are presented in Section 6. The last section concludes.

2 The Closures of Rural High Schools

First introduced in this section are the closures of rural high schools right after the Cultural Revolution from the late 1970s through the early 1980s. I then discuss key institutional information for determining one's exposure status to the school closures within county, which directly guides the identification strategy in this study. Lastly, using data I collected on the timing of the school closures by county and county characteristics prior to the shock, I provide quantitative evidence for understanding the regional variation in the timing of the closures.

2.1 Historical accounts on the closures of rural high schools

In May 1966, Mao Zedong launched the Cultural Revolution, a decade-long social movement that brought a radical agenda to politics and education policies. An essential goal of the Cultural Revolution was to eliminate differences between peasants and the remainder of the population (Deng and Treiman, 1997). The revolution in the education system was to deliberately destroy the old "elite education system" and construct a new "mass education system" (Pepper, 1996). Colleges were closed from 1966 to 1972 and college entrance examinations were eliminated for an entire decade. No formal teaching was carried out and all levels of schools stopped recruiting new students in cities from 1966 to 1968 (Meng and Gregory, 2002). Education policy priorities shifted to peasant youth by popularizing middle schools and expanding high schools in the countryside.[4] To speed up the expansion at a lower cost, junior high classrooms were attached to primary schools and senior high classrooms were added to middle schools in rural communes, which enabled rural children to go to secondary schools within walking distance (Han, 2001; Thogersen, 2002). For the rural population, the middle school enrollment rate increased from 34 percent in 1965 to 75 percent in 1976 and the high school enrollment rate rose from 9 percent to 62 percent (Ministry of Education, 1984).

Soon after Mao's death in September of 1976, the post-Mao shift in ideology in the Chinese Communist Party led to a complete reversal of education policies during the Cultural Revolution (Pepper, 1996). An education reform to reconstruct the education system was proposed by Deng Xiaoping in 1977 (Ministry of Education, 1984). Immediately, a college entrance examination was reintroduced at the end of that year. Education priorities were changed from expanding secondary education in the countryside to developing a few urban-based and quality-oriented secondary schools in urban areas, which concentrated the best teachers and resources for training the most talented students (Ministry of Education, 1984).

The decision to close rural secondary schools built during the Cultural Revolution was made by the central government (Pepper, 1996). The cutbacks were most severe at the high school level, for which the national enrollment rates in 1981-1982 were down by two thirds from those in 1978.[5] The official justification of closing rural high schools was that, to best serve economic development, high schools should be college preparatory, and because only a small proportion of students were able to enter college, it was unnecessary to keep a large enrollment rate in high schools, particularly in rural areas where students hardly had a chance to compete (Pepper, 1990).[6] Urban teachers who were sent to teach in rural high schools during the Cultural Revolution and the send-down youth returned to the cities after 1976, which also accelerated the closures of rural schools (Pepper, 1996).[7]

[4]See Andreas (2004), Han (2001), Pepper (1996) and Thogersen (2002) for details of the school expansion in rural areas during the Cultural Revolution.

[5]Guangming Daily, Oct. 12th, 1981.

[6]In Lai Shui county in Hebei province, education officials also argued that "The commune high schools were eliminated to concentrate forces to run one good "keypoint" school in the county town. We set our sights on the college examinations and took the best teachers to the only one high school. The aim was to produce most talented students who could pass the college examinations" (Andreas, 2004).

[7]The "send-down" movement during the Cultural Revolution resulted in one out of every three urban adolescents

At the local level, from 1977 to the early 1980s, county governments gradually started to close rural high schools, and the closures usually continued for two or three years, until only one or a few high schools were kept in the urban areas of every county or city.[8]

To understand the changes in high school supply by county, I have collected the number of high schools from 1965 to the late 1980s from county gazetteers. Quantitative records on education during the Cultural Revolution are very rare.[9] Among more than 1800 county gazetteers ever published that record local history from 1949 to the 1980s, only 65 counties record the complete year-by-year number of high schools during this period. Combining these numbers with the first year of the school closures for each of the 65 counties,[10] I plot the average number of high schools per county by the year relative to the first year of the closures in Figure 2. As expected, a sharp decline of roughly 30 percent of high schools occurred in the first year of the closures. The decline was persistent and there was no sign of a recovery for ten years. In addition, the pre-existing upward trend, especially in the few years just before the first year of the closures, is consistent with the qualitative records on county gazetteers that rural communes continued to expand rural high schools before the county government made the closure decision.[11] These features suggest that the decision to close rural high schools was unexpected at the county level and lead us to expect a similar pattern of educational attainment using the microdata.

A natural concern is related to education quality of these rural schools built during the Cultural Revolution. Compared to education in other time periods, the regular curricula in high schools during the Cultural Revolution were shortened and political education was given a higher weight. On the other hand, urban teachers were sent to teach in rural schools, and some of the urban send-down youth also taught in rural schools. They might provide better teaching quality than rural teachers. Moreover, Andreas (2004) argues that, while "better quality" in education reform referred to a higher promotion rate from high schools to colleges, rural high schools built during the Cultural Revolution were to develop practical curricula that were more relevant for employment and income growth in the countryside. Whether there is an improvement in education quality after the Cultural Revolution is also not clear. In Li et al (2005) using a twins sample in cities in 2005, they find zero earnings return to high school education alone. Overall, the concern about changes in education quality remains an empirical question and requires data on individual earnings to test.

(most aged 16–19), approximately 17 million youths, being sent to the countryside for manual labor for from 1 or 2 to as many as 10 years during the period 1966-76 (Li et al., 2010).

[8] The chapter on secondary education from various issues of county gazetteers.

[9] Most county gazetteers record missing data on the number of schools in the late 1960s because the regular work of the county statistics bureau was interrupted during the most violent years in 1966-1968. Another reason is that the official guideline of publishing local data for politically sensitive periods on county gazetteers was "be rough, not in detail" (Vermeer, 1992).

[10] The sample of counties that report the timing of the school closures is much larger. See Section 3.1 for the data description.

[11] From the chapter on secondary education in various issues of county gazetteers.

2.2 Determining one's exposure status within county

One's exposure to the closures of high schools depends on one's year of birth, quarter of birth and the first year of the closures in the county of birth. Three pieces of institutional information are crucial to assign one's exposure status within county.

First, who were affected by the closures of rural high schools? Little is known about individual exposure to the shock from existing studies on this particular event (Pepper, 1996; Andreas, 2004). To answer this question, I conducted interviews with local teachers who taught in high schools in the late 1970s in three counties of Sichuan province. All of the interviewees recalled that when rural high schools were closed, most students simply dropped out, even though they were allowed to continue in the few urban high schools in town. Teacher Liu said,

> At the beginning, the high school in town became very crowded as students from rural communes came in, but many of them disappeared after a month or two. They stopped coming because the travel and boarding costs were too high for rural families and students had to walk for two or three hours to school. While it was the proximity of high schools in local communes that made rural children able to go during the Cultural Revolution, the only high school in town was not a real alternative for most students living in rural areas.

The important message is that individuals who just graduated from high school by the first year of the closures were able to avoid the shock, yet the students in their final year of high school were the oldest ones affected.

To determine the age of the oldest individuals exposed to the school closures, the second piece of information is the age at graduation from high school from the late 1970s to the early 1980s. The minimum entry age of primary schools was set at 7 in 1951.[12] From the mid 1960s to 1982, students spent five or six years in primary schools, two or three years in middle schools and two years in high schools.[13] The years of schooling in primary schools or middle schools could vary across counties, or even vary across schools within the same county because some schools were chosen to implement trials that involved shortened years of schooling.[14] Therefore, age at graduation from high school was not universal and varied from 16 to 18 at the time of the closures. Although the exact number of years in schools is not observed either at the county level or at the individual level, I compare individuals at age 18 in the first year of the closures who mostly had graduated with those at age 17 who were the oldest ones at risk of dropout when the negative shock arrived.

Lastly, the school entry date policy further enables comparisons among individuals born quarters apart within county. The school entry date was in the spring semester, usually in February or March, from 1967 to the late 1970s.[15] Individuals born in the first quarter were more likely to go to school

[12] *China Education Yearbook: 1949-1981.*

[13] *China Education Yearbook: 1949-1981.*

[14] *Major Educational Events in People's Republic of China: 1949-1982.*

[15] People's Daily, May 12th, 1969; *Major Educational Events in People's Republic of China: Secondary Education.*

one year earlier and thus graduate one year earlier, compared to those born in the other three quarters of the same year. Because graduation was in the month of January, no matter what month the first few schools were closed, those who reached age 18 by the first quarter in the first year of the closures would mostly have graduated, while those born in the other three quarters of the same year were still likely to be in the final year and at risk of dropout. Thus, the comparisons are narrowed down to between individuals born in the first and second quarter of the same year in the same county. A natural concern about school entry date policy is that parents could strategically plan births to ensure an earlier school enrollment of their children. It is unlikely in this setting because the school entry date changed from September 1st to the spring semester in 1967, and individuals around age 17 from the late 1970s to the early 1980s were born before the change.

Putting it all together, within county, the oldest cohort exposed to the closures of high schools were at age 17 years and 9 months in the first quarter of the first year of the closures. For example, in counties that closed schools in 1979, individuals born in the first quarter of 1961 were 18 and had just graduated by the first quarter of 1979, while those born in the second quarter of 1961 were 17.75 and were the oldest ones affected.

2.3 Regional variation on the timing of the closures

Because the timing of the school closures varied from 1977 to 1984 at the county level, I focus on comparisons between individuals on either side of age 17.75 in the first quarter of the first year of the closures within county. Different from cross-region comparisons (e.g., difference-in-difference), the validity of this within-county approach does not rely on the assumption that the timing of the closures was as good as randomly assigned. Nevertheless, I provide quantitative evidence that the timing of the closures is uncorrelated to a number of initial county characteristics suggested by previous studies.

The hypothesis based on qualitative evidence is that counties that built more rural high schools during the Cultural Revolution were under greater pressure to comply with the closure decision of the central government, and therefore had to close their schools earlier (Pepper, 1996; Andreas, 2004). Not surprisingly, the closing of these schools was met with great resistance from commune leaders and rural parents, who refused to give up their own schools and whose children would lose their only chance to go to secondary school (Rosen, 1985). Education officials in counties that delayed their closing action argued that their counties were less developed and already had very low high school enrollment rates, but finally all counties had to comply with the closure decision (Pepper, 1996).[16]

Using data collected from county gazetteers on the timing of the school closures by county and selected county characteristics right before 1977, I am able to empirically test this hypothesis in the

[16] In a county in Hebei province, rural high schools were retained at the beginning, but soon after the provincial education bureau began to rank counties based on their pass rates in college entrance examinations, county officials had to give up their rural high schools to be able to compete with other counties (Andreas, 2004).

sample of counties matched in both the county-level data and the microdata.[17] Table 1 reports the estimated correlation between the first year of the school closures (1977-1984) and each of the initial county characteristics. For education characteristics in Panel A, estimates on the initial number of high schools, the number of classrooms and the enrollment rate are consistent with the qualitative evidence in that counties with higher initial education level closed schools earlier. However, these estimates are very small and imprecise, except for the number of classrooms that is significant at 10 percent level. The correlation between the closure timing and the number of send-down youth received, which is a proxy for part of the teacher supply, is very weak. For initial economic conditions in Panel B, there is no strong evidence that the closure timing is correlated with county government revenue, government expenditure on education and health, grain output per capita and population density in 1976. Overall, these weak correlations suggest that the timing of the closures appears to be idiosyncratic, at least for these observable education and economic measures.

3 Data

Two core datasets are used in this study. One is unique data on the timing of the school closures by county that I collected from county gazetteers. The other is the 1992 Chinese Children Survey conducted by the State Statistics Bureau of China and UNICEF, a nationally representative microdata on child health and parental characteristics.

3.1 County-level data on the timing of the closures

The timing of the closures of rural high schools is recorded on county gazetteers. Following a thousand-year long tradition of recording local history, the most recent collection of county gazetteers that compile county records from 1949 to the 1980s have been published since 1985 (Vermeer, 1992). County gazetteers document local events and statistics about geography, politics, economy and culture, which are originally from official archives and policy documents of county governments (Xue, 2010). In the chapter on education, both qualitative and quantitative records are rough for the ten years of the Cultural Revolution, which keeps me from exploring the expansion of rural secondary schools during this period. In contrast, records in the post-Mao period are more available and detailed, which are valuable for studying the closures of rural high schools.[18]

I have collected the year each county began to close rural high schools from 1247 county gazetteers, which represent 68 percent of all county gazetteers ever published in the recent collection.[19] The other 32 percent do not report the year of closure, or some of them report "the late

[17]Since county statistics before 1980 have not been made systematically public, county gazetteers are the only sources to collect county characteristics in the 1970s. The sample size of counties for each characteristic is determined by the availability of that characteristic on gazetteers.

[18]These records are also more reliable because they are not under the restriction of "be rough, not in detail" that is placed on recording politically sensitive periods.

[19]A few city and district gazetteers are included in this sample

1970s" or "the early 1980s", which are not useful for the identification strategy. I plot the percentage of counties that started to close rural high schools from 1977 to 1984 by the solid line in Figure 3.[20] While a very small proportion of counties closed schools as early as 1977 or after 1981, the vast majority of the county governments made the closure decisions between 1978 and 1981. More than half of the counties had closed rural high schools by 1979 and over 96 percent had closed by 1981. To define a rural sample where the school closures occurred, I use the administrative code in the 1982 Census to exclude cities and districts in 1982, which is close to the time of the closures.[21] There are 400 rural counties in 27 provinces matched by using these county-level data with the 1992 Chinese Children Survey microdata. The dashed line in Figure 3 shows that the matched counties are representative of all counties collected in the distribution of the timing.

3.2 1992 Chinese Children Survey

The 1992 Chinese Children Survey (the 1992 CCS hereafter) covers 522,371 households from 1088 counties in 29 provinces. Although information from both parents is available, this study focuses on mothers for two reasons. First, the mother's education has been found to have a larger effect on infant health than the father's (Chou et al., 2010). Second, the data quality for women is much better than that for men in the 1992 CCS. Before the empirical analysis, I compare the patterns of education levels by one's year and quarter of birth in the 1992 CCS with those in the 1990 Census. The education patterns for women in both of these data are very similar, but the patterns for men are not always consistent. A possible explanation is that more than 80 percent of the survey forms in the 1992 CCS were answered by women. The inconsistency for men could be due to measurement errors on reported men's educational attainment, year of birth or month of birth.

For every individual, the highest level of completed education is reported, while years of schooling are not observed. As discussed in Section 2, the years of schooling in primary schools and middle schools varied in the 1960s and 1970s. It is not possible to construct a consistent measure on one's years of schooling from the reported education level. I measure the education outcome by one's high school completion, the margin that was directly affected by the closures of high schools and that I can precisely measure for the whole sample. Notably, the years of schooling in high school had been 2 years from the 1960s until 1983 when it was changed to 3 years.[22] In the narrow comparisons among individuals on either side of age 17.75 in the first quarter between 1978 and 1981, their years of schooling in high school did not change due to the 1983 policy change.

In the 1992 CCS, every woman who had ever been pregnant since 1976 reported a complete pregnancy history for every birth and detailed birth outcomes (yet not restricted to births after 1976). I use four measures of poor infant health that are commonly studied in the related literature.

[20]The geographical distribution of the timing of the school closures at the county level is shown in Figure 4. The darker the shaded area, the later a county started to close rural high schools.

[21]A few city or district gazetteers report the timing of the closures, but it is impossible to tell in which county the first closure occurred.

[22]*Major Educational Events in People's Republic of China: Secondary Education.*

The first one is the incidence of prematurity because premature infants are at higher risk of death in the first year, especially in the first month. Because gestational age is reported in completed months, I define prematurity as gestational age less than 9 months. I also examine neonatal mortality and infant mortality rates. The last measure is low birthweight, which is widely used to measure poor infant health and is linked to later life consequences.[23] If low birthweight is affected by maternal education, we would expect long-term intergenerational effects as well. The limitation of the last measure is that only 36 percent of mothers reported the birth weight of their first birth (in grams). Low birthweight is defined as less than 2500 grams in this subsample.

Because one's county of birth is not observed in the 1992 CCS, I match the microdata with the county-level data on the timing of the school closures by using a woman's county of residence in 1992. One might be concerned that a woman's county of birth might not be her county of residence in 1992 if she migrated. This concern is less likely to affect the main findings because internal migration had been under strict restrictions by the early 1990s in China.[24] I discuss later that endogenous mobility for continuing schooling at the time of the closures was nearly impossible. Using the 1990 Census, I find that the migration rate of rural women is as low as 5 percent among the same birth cohorts in my sample. Moreover, I provide evidence that a woman's decision to migrate was unlikely to be affected by her exposure to the closures.

In the matched counties, a woman's exposure status is assigned by her year of birth, quarter of birth and the timing of the school closures. The sample of women includes rural women at age 12-23 by the first quarter in the first year of the closures, who were 24 quarters above age 17.75 and 24 quarters below. They were born between 1953 and 1970 and at age 22-39 in 1992. Among all women in the sample, 92 percent of them had ever been pregnant since 1976 and are therefore in the sample of mothers.

The sample of births for analyzing infant health includes the first births. My findings are comparable with those in other quasi-experimental studies using the sample of first borns (Currie and Moretti, 2003; McCrary and Royer, 2011). Few other restrictions are made on the sample of births except for a minor one. Because some birth outcomes of nonsingleton births, for example, birth weight and infant mortality rate, could be very different from those of singleton births, I exclude nonsingleton births (1.41 percent). I also find that having multiple births is unrelated to a woman's exposure to the school closures.

The summary statistics of women and mothers in the sample are presented in Table 2, as well as tabulations for the first births and for all births. There are 7.3 percent of women who have completed high school and only 0.17 percent have a college degree, suggesting that women with a high school education are at the very high end of the education distribution among these cohorts. Compared to all women in the sample, mothers are slightly less likely to complete high school and to work off-farm. The marriage rates in both samples are very high, which are 97 and 99.96 percent,

[23] See Almond et al. (2005) for a review on this literature.

[24] See a detailed discussion on internal migration in China in Section 4.2.

respectively. Infant health measures of first births do not differ much from those in the sample of all births. Compared to all births, the first births have slightly lower birth weight but are less likely to experience neonatal or infant death. First-time mothers are slightly more likely to have prenatal visits, especially in the first trimester, and to deliver their births in hospital.

4 Empirical Framework

4.1 Identification strategy

Assuming a woman's decision to become a mother is unaffected by her exposure the school closures, the identification strategy exploits the fact that mothers on either side of age 17.75 by the first quarter of the year the school closures started had different exposures to the closures within county of birth. The first stage compares high school completion of mothers and the reduced form examines infant health of the first births. The difference in high school completion induced by the closures is related to differences in infant health outcomes to quantify the causal effect of maternal education on infant health. The identifying assumption is that mothers on either side of age 17.75 within county are similar along all dimensions except for their distinct exposures to the school closures.

To assign one's exposure status, I first define one's cohort as one's age in quarter by the first quarter in the first year of the closures in one's county of birth in equation (1):

$$age_i = T_j - y + \frac{1-q}{4}, \tag{1}$$

where i indexes individual, j county of birth, y year of birth and q quarter of birth. T_j indicates the first year of the school closures in one's county of birth. Recall that individuals at age 17.75 were the oldest ones at risk of being exposed to the closures of high schools, while those at age 18 had just graduated and were able to avoid the shock.

A discontinuous drop in high school completion is expected at age 17.75 by the first quarter in the first year of the closures. Consider the first stage equation:

$$\begin{aligned} S_i \quad &= \alpha + \beta 1\{age_i \leq 17.75\} + f(age_i)\gamma + f(age_i) * 1\{age_i \leq 17.75\}\delta \\ &\quad + \theta_q + \lambda_j + \phi_j * [f(age_i) + f(age_i) * 1\{age_i \leq 17.75\}] + \epsilon_i \end{aligned} \tag{2}$$

where S_i is equal to 1 if mother i born in county j, year y and quarter q completed high school and is 0 otherwise. The indicator variable $1\{age_i \leq 17.75\}$ is equal to 1 when the mother was at age 17.75 or younger by the first quarter in the first year of the closures in her county of birth and is 0 otherwise. The analysis sample includes pre-exposure cohorts at age 18-23 (as integers) and post-exposure cohorts at age 12-17 (as integers). $f(.)$ is a flexible polynomial function of age_i. As suggested by both the national trend of school supply in Figure 1a and the trend at the county level in Figure 2, the closures of high schools is expected to induce both a decline in the mean level and a trend reversal of high school completion at the individual level. Thus, all specifications include the age polynomial function interacted with the indicator, $1\{age_i \leq 17.75\}$, to allow for a change in slope at age 17.75. I include quarter of birth effect, θ_q, to account for any seasonal differences. The coefficient of interest, β, captures the difference in the probabilities of completing high school on either side of age 17.75.

To perform cross-cohort comparisons within county, I control for county fixed effects, λ_j, and county specific quadratic trends, $\phi_j * [f(age_i) + f(age_i) * 1\{age_i \leq 17.75\}]$, which also allow for a change in the slope of each county specific trend at age 17.75. By absorbing heterogeneity in time invariant county characteristics and pre-existing county trends, this approach is essentially comparing women born in the first and second quarter of the same year but who had different exposures to the closures in the same county. The interpretation of β is the average departure at 17.75 from county specific trends of high school completion.

The reduced form on infant health is expressed in equation (3):

$$\begin{aligned} Y_i &= \alpha + \rho 1\{age_i \leq 17.75\} + f(age_i)\gamma + f(age_i) * 1\{age_i \leq 17.75\}\delta \\ &\quad + \theta_q + \lambda_j + \phi_j * [f(age_i) + f(age_i) * 1\{age_i \leq 17.75\}] + \epsilon_i \end{aligned} \tag{3}$$

where Y_i includes infant health measures of the first child of mother i. The coefficient of interest, ρ, measures the effect of a mother's exposure to the school closures on infant health. If maternal education improves infant health, ρ is expected to be positive for each of the four measures of poor infant health, including prematurity, low birthweight, neonatal mortality and infant mortality. The effect of female high school education on infant health could be captured by dividing the reduced form estimate ρ by the first stage estimate β. I also perform an instrumental variables estimation using the indicator variable, $1\{age_i \leq 17.75\}$, as the instrument of high school completion, to directly measure the effect of maternal education on infant health.

4.2 Discussions on the identifying assumptions

The first assumption about sample selection would be invalid if a woman's decision to become a mother was affected by her exposure to the closures of high schools. Existing studies on education and fertility have found that women's education affects their selection into motherhood (Black et al., 2008; Osili and Long, 2009; Duflo et al., 2011).[25] Maternal age at first birth is another concern. Royer (2004) finds that a pre-term birth is more likely if a mother has her first child before age 18 or after age 35. The closures of high schools kept teenage girls out of schools, and this might have shifted a woman's age at first birth to be less than 18 and thus have had negative effect on infant health. It would be difficult to differentiate the effect on infant health of women not staying in schools in their teen years from that of lower education levels and less knowledge learned in schools. Therefore, before proceeding to investigate educational attainment and infant health, I first examine

[25] Black et al. (2008) find that female education reduces teenage childbearing in Norway and the US. Duflo et al. (2011) also show that subsidizing girls' education leads to a significant reduction in teenage pregnancy in Kenya. Osili and Long (2009) present evidence that better educated women have fewer births before age 25 in Nigeria.

the reduced form effects of a woman's exposure to the closures on her motherhood choice and her maternal age at first birth.

The second assumption in identifying the causal effect of maternal education on infant health is that mothers on either side of age 17.75 are comparable, except for their different exposures to the closures of high schools. This assumption is plausible because both the closures of high schools and the change in the school entry date policy were unexpected. It is unlikely that parents of these women were able to precisely predict both of these changes and respond in planning births accordingly to avoid the closures. This assumption is also testable, at least by testing the continuity of observable and predetermined characteristics between women just beyond age 17.75 and those just below. I provide evidence in Section 6.1 that these women are very similar.

Another concern about endogenous responses arises from the fact that the timing of school closures varied across counties. In counties that closed schools later, parents might have had expectations on the negative shock, and their children might have had dropped out voluntarily before the county government made the closure decision. If such responses had existed, we would expect a decline in high school completion among cohorts older than 17.75 by the first quarter of the first year of the closures. In Section 5.2, by plotting women's high school completion by their age at the time of the school closures, I do not find any sign of a decline among the pre-exposure cohorts.

There are also two alternative hypotheses that might explain the discontinuous change in high school completion at age 17.75. The first hypothesis is related to concurrent reforms after the Cultural Revolution. For other reforms to confound the effects of the school closures, they should have followed the timing of the closures closely by county and affected educational attainment and infant health differently for women on either side of 17.75 by the first quarter of the reform year. From a comprehensive reading on Chinese history in the 1970s and 1980s, I find land reform between 1978 and 1984 as a potential confounder. The reform replaced collective farming in Mao's era with household farming, and is widely documented to have greatly improved agricultural productivity since the late 1970s (e.g. Lin, 1992). As a consequence, the opportunity cost of schooling increased following the reform, which resulted in higher dropout rates in rural areas since 1978 (Lin, 1993; Hannum, 1999). To isolate the potentially confounding effects of land reform, I have collected the reform timing by county from county gazetteers. I provide direct evidence in Section 6.2 that land reform does not account for any effects of the school closures.

The second hypothesis is that, because many rural middle schools were also closed after the Cultural Revolution, as well as a decrease in the number of rural primary schools, women younger than 18 at the time of high school closures might have had dropped out due to the closures of schools at lower levels a few years ago. If the decline in high school completion at age 17.75 is induced by the closures of primary schools or middle schools, we should observe discontinuous changes of women's primary school completion and middle school completion at 17.75 by the time of the high school closures. I test this hypothesis directly in Section 6.3 and show no sign of a discontinuity in women's completion of schooling at lower levels.

Finally, an advantage of this study is that internal migration in China, especially rural-to-urban migration, had been strictly restricted by the household registration system (the *Hukou* system) by the early 1990s. The first relaxation of the *Hukou* system was in 1985 when the Ministry of Public Security authorized a temporary urban resident permit (urban *hukou*) for those temporarily migrating for business (Wang, 2005). The next substantial change was a new urban *hukou* for rural migrants open to more cities endorsed by the central government in 1992 (Chan and Zhang, 1999). The *Hukou* system has two important implications for potential concerns about migration in this study. First, before the first relaxation of the *Hukou* policies in 1985, it was not possible for individuals to move to other counties to continue education when rural high schools were closed from 1977 to 1984. Second, the migration rate in the rural population was still very low in the early 1990s when the 1992 CCS was conducted. In the 1990 Census, only 5.1 percent of women born in 1953-1972 who are at risk of becoming mothers in my sample migrated from rural areas. In Section 6.4, I provide evidence that a woman's migration decision is unlikely to be affected by her exposure to the closures in the analysis sample.

5 Main Results

5.1 Fertility choices

The effect of education on fertility choices would lead to either a sample selection problem or a complication in interpreting the effect of maternal education on infant health, or both. To provide direct evidence on these possible concerns, I begin my empirical analysis by estimating the reduced form effects of a woman's exposure to the school closures on her selection into motherhood and maternal age at first birth.

The graphical presentation on the relationship between observed motherhood and one's age by the first quarter in the first year of the school closures is in Figure 5a. Each point presents the fraction of mothers observed in each cell by age in quarter. The vertical bar at age 17.75 denotes the oldest cohort exposed to the closures. If a woman's decision to become a mother is affected by her exposure to the closures, we would expect a break in the trend at age 17.75. However, the pattern on either side of the vertical bar is smooth. Panel A in Table 3 presents the estimated effect of a woman's exposure to the closures on her selection into motherhood, which is estimated by fitting a quadratic cohort trend in equation (3). The estimated effect, -0.0067, is extremely small relative to the sample mean of 0.92, and it is statistically insignificant. There is no evidence that women on either side of age 17.75 have different probabilities of becoming mothers. This finding reduces the concern about endogenous sample selection induced by one's exposure to the school closures.

The same is true for maternal age at first birth as shown in Figure 5b. The trend declines in a manner by age in year, and it appears continuous at age 17.75. To examine whether the closures of high schools shifted maternal age at first birth to under 18, I separately estimate the effect of a woman's exposure to the closures for each possible maternal age at first birth. Panel B in Table 3 reports one estimate for each specific maternal age at first birth from 13 to 36. I do not find evidence that mothers exposed to the closures are more likely to have their first birth before age 18. The main effects of one's exposure to the closures are to reduce the probability of having the first birth at 22 by 2.5 percentage points and increase the probability at age 21 by 3.3 percentage points. As suggested by Royer (2004), these changes are unlikely to have negative effect on infant health. There are very small decreases at age 15 and 17 that are significant at 10 percent level, which would have small positive effect on infant health, if any, the opposite to the effect of the school closures. Therefore, if a woman's exposure to the school closures has any negative effect on infant health, it is implausible to attribute the effect to the change in maternal age at first birth induced by the closures.

That I find negligible effect of the school closures on fertility choices is interesting in light of the literature on education and fertility in developing countries. I provide two possible interpretations. First, while education interventions targeting lower levels of schooling have been found to affect teenage pregnancy (Black et al., 2008; Duflo et al., 2011), women at the margin of being affected by the closure of high schools in this study were close to 18. Second, it is not surprising that the closures mainly shifted maternal age at first birth from 22 to 21, because "late marriage and late births" had been a family planning policy since the 1970s and the 1980 marriage law set a legal marriage age at 20 for women.

5.2 Educational attainment

After having found negligible effect of women's exposure to the school closures on fertility choices, this subsection turns to educational attainment using the sample of mothers. Figure 6 shows the relationship between high school completion and one's age by the first quarter of the year the school closures started. Three main features should be noted in this figure. First, consistent with expectations, a sharp and sizable drop in the fraction of mothers who completed high school appears at age 17.75. The rate of high school completion decreases from 12 percent at 18 to 8.6 percent at 17.75, roughly a 28 percent decline. Second, the trends away from age 17.75 are very smooth. There is no sign of a discontinuous change at any other point. If concerns arise about voluntary dropout prior to the first year of the school closures in counties that closed schools later, we would observe that the trend starts to decline among individuals older than age 17.75. However, such a decline is not observed. The smoothness of the pre- and post- exposure trends and the sharp discontinuity on either side of age 17.75 together support interpreting the discontinuous change in education as the effect of the high school closures. Finally, this figure also provides visual guidance for choosing an appropriate polynomial order to fit the cohort trend. Because the pre-exposure trend is linear, I use linear trend for the main specification. I also report results using a quadratic or a cubic polynomial as robustness checks.

Estimates of the drop in high school completion at age 17.75 are presented in Table 4. I report the first stage estimates for the sample of all mothers in column (1)-(4) and for the subsample of mothers who report the birth weight of their first birth in column (5)-(8) separately.[26] Column (1) reports the baseline estimate by fitting a quadratic cohort trend without any covariates. I find a decline of 2.8 percentage points in high school completion induced by the school closures, an effect size slightly smaller than that observed in Figure 6. Controlling for quarter of birth effects in column (2) and adding county fixed effects in column (3) do not change the point estimate and the standard error. The point estimate changes slightly to 2.7 percentage points when county specific trends are controlled for in column (4). It is a 22.5 percent decline from the high school completion rate at age 18. I focus on the estimate in column (4) because it is the average departure from county specific cohort trends as captured by the within-county comparisons. These effects are all precisely estimated and the precision is not changed by controlling for additional covariates. The estimated effects in column (5)-(8) are very similar in magnitude relative to the mean level in the subsample of mothers. The first stage estimates by fitting a quadratic or a cubic cohort trend and controlling for all covariates are reported in Appendix Table 1. The estimate using a quadratic polynomial shows a decline of 1.8 percentage points, and the one using a cubic polynomial shows a 3.1 percentage points decline.

The effect of the school closures on high school completion might be heterogeneous across regions. First, because the goal of the reform was to close high schools built during the Cultural Revolution, counties that built more schools had to close more, generating a larger negative shock to high school students. Second, the increase in the costs of continuing schooling in urban schools after the closures might be larger in less densely populated areas. In the first row in Table 6, the first two columns report the first stage and reduced form estimates by the pre-existing education level. Because only a few county gazetteers report the number of high schools built during the Cultural Revolution, I measure the pre-existing education level by the fraction of mothers that completed high schools among pre-exposure cohorts at age 18-23 at the time of the closures. Interestingly, the school closures have no effect on high school completion in counties below the median education level, while the decline in high school completion is as high as 32 percent in counties above the median. The next two columns present estimates in counties by population density. Consistent with the expectations, the decline of high school completion induced by the school closures in less densely populated areas (30 percent) is higher than that in more populated areas (19 percent).

A final remark is on interpreting the incomplete education in high school for women affected by the school closures. Compared to women at age 18 who had just graduated from high school when the closures started, those at age 17.75 who had to drop out have one year less education for the last year in high school. In the discussions on infant health and other outcomes below, I interpret high school completion as one more year of high school education.

[26] I find no statistically significant effect of being exposed to the school closures on reporting the birth weight of the first birth.

5.3 Infant health outcomes

This subsection focuses on the analysis of infant health for the first births. Figure 7 shows the reduced form graphs on gestational age (7a), prematurity (7b), neonatal mortality rate (7c), infant mortality rate (7d), birth weight (7e) and low birthweight (7f). If one more year of high school education improves infant health, we would expect that the incidence of poor infant health measures, including prematurity, low birthweight, neonatal mortality and infant mortality rate, would have both a declining pattern among pre-exposure cohorts and a discontinuous increase at age 17.75. However, trends of these four measures are generally noisy. The probabilities of prematurity and low birthweight jump at age 17.75, but these changes might not be statistically different from zero.

Consistent with visual impressions, reduced form estimates on infant health outcomes in Panel A of Table 5 are all statistically insignificant. A mother's exposure to the school closures shortens her gestational age by 0.009 months, less than half a day. The probability of prematurity is increased by 0.003 percentage points, which is economically very small relative to 2.2 percent at age 18 and not statistically different from zero. The estimated effect on the probability of neonatal mortality (in 1 month) is an decrease of 0.0018 percentage points, while the estimated decrease in the probability of infant mortality (in 1 year) is 0.0016 percentage points. Both effects have the opposite sign to the expectations, but they are small relative to the mean levels at age 18 and imprecisely estimated. In the last two columns, I use the subsample of mothers who report the birth weight of their first birth. A mother's exposure to the closures decreases the birth weight of her first birth by 10.35 grams, a very small effect relative to 3288 grams at age 18. The sign of the estimate on low birthweight is opposite to the expectation. Again these estimates are also statistically indistinct from zero.

Panel B in Table 5 reports the instrumental variables estimates of the effect of maternal high school completion on infant health, using a mother's exposure to the school closures as the instrument of her high school completion. One more year of high school education increases gestational age of the first child by 0.33 months. The estimated effects on prematurity of -0.093 is economically large relative to the sample average, which provides suggestive evidence on a large effect of maternal education on reducing the risk of prematurity, but the estimate is statistically indistinguishable from zero. The estimate on neonatal mortality (0.07 relative to the sample mean at 0.014) and infant mortality (0.065 relative to the sample mean at 0.02) are large in magnitude but have opposite sign according to expectations and very little precision. Finally, the estimates on birth weight and low birthweight are large in economic terms but both are imprecise. Based on the instrumental variables estimates, a number of null hypotheses of a large effect of maternal education on infant health could be rejected. Using one-sided tests at the 5 percent significant level, I can rule out that one more year of female high school education decreases the probability of prematurity by over 28 percentage points, reduces the risk of neonatal mortality by more than 10.4 percentage points or the risk of infant mortality by more than 13.5 percentage points, and lowers the incidence of low birthweight by more than 15.3 percentage points.

To ensure that the findings on infant health are not driven by the polynomial order choice, I report the reduced form results using a quadratic or cubic model in Appendix Table 1. Consistent with estimates using a linear cohort trend, those using a higher polynomial order are statistically insignificant, except for gestation age using a quadratic model, which is significant at 10 percent level. The magnitudes of estimates using a quadratic model are very close to those in Table 5, while estimates for poor infant health measures using a cubic trend are slightly larger in magnitude.

If the relationship between maternal education and infant health is nonlinear, we might expect an effect in counties with higher pre-existing education level and with lower population density. In the first two columns of Table 6, reduced form estimates on infant health measures in both types of counties are all imprecisely estimated. There is no evidence that a larger decline in maternal high school completion has led to larger changes in infant health outcomes. Similarly, in the next two columns by population density, estimates in two categories of counties are close in magnitude and are all statistically insignificant. Despite the heterogeneous effects of the school closures on high school completion, these reduced form estimates further confirm that maternal high school completion has little effect on infant health.

5.4 Other outcomes relevant to infant health

This subsection discusses the effects of women's exposure to the school closures on their labor market outcomes, health behaviors, their husbands' education and labor market outcomes, which are potential channels through which maternal education might affect infant health. Table 7A reports reduced form estimates using the 1992 CCS. First, if there are positive returns to high school completion in the labor market, we would expect that women affected by the negative shock are less likely to be working or working in better jobs associated with higher earnings. However, estimates on being employed and off-farm employment have the opposite sign to the expectations. These estimates are very small and statistically not different from zero. The estimated effect on working in white-collar jobs is negative, but it is very small and imprecise. These results are consistent with previous studies that find zero or even negative earnings returns to education from the late 1970s to the early 1990s in rural China (Gregory and Meng, 1995; Li and Zhang, 1998). In the next three columns, estimates on any prenatal health check, having a check in the first trimester and the child delivered in hospital all have positive sign and are imprecise. These findings are not surprising given no negative effects of women's exposure to the school closures in the labor market.

If assortative mating is present in the marriage market, better educated women would marry better educated and wealthier men. Because data on men in the 1992 CCS are of low quality, I use the sample of the same 400 counties in the 1990 Census to examine paternal education and labor market outcomes. In Table 7B, I first report the first stage for women. The decline in high school completion of 2.5 percentage points is very close to the estimate using the 1992 CCS. The reduced form estimates show that the school closures reduce a woman's probability of marrying a man with high school completion by 1.3 percentage points. However, this estimate does not provide a direct evidence on assortative mating because the school closures affected both men and women. I also find a decline in men's high school completion of 4.1 percentage points induced by the school closures.[27] This negative shock might change the husband's education through either lowering the wife's education or changing the education distribution of available men in the marriage market. Reduced form estimates on men's labor market outcomes are of the same sign as those of women's in Table 7A, suggesting that women tend to marry men with similar labor market performances. But these estimates are small and statistically insignificant.

Overall, there is little evidence that women's exposure to the high school closures affects their labor market outcomes and health behaviors. The interpretation for the finding on spousal education needs further investigation on the general equilibrium effects of the school closures on the marriage market, which is on my research agenda.

6 Robustness

In this section, I first provide evidence that women on either side of age 17.75 are similar along a number of predetermined dimensions. Next, I test two alternative hypotheses on the decline of women's high school completion and show that they are unlikely to confound my findings. Finally, I provide evidence that concerns about migration are less important in this study.

6.1 Testing continuity of predetermined female characteristics

If there were other negative selections on women at age 17.75 in the first quarter of the school closures, it would not be plausible to attribute the decline in high school completion to the sole effect of the school closures. For example, if less educated parents of women (called grandparents hereafter) were more likely to give birth in the second quarter of 1961, we might expect a decline of women's education at age 17.75 by the first quarter of 1979 due to a lower endowment from grandparents, regardless of whether high schools were closed in 1979. Because I conduct comparisons within county, this negative selection would compromise the estimated effect of the closures on maternal education in counties that closed high schools in 1979 and then overestimate the average discontinuous change in education at age 17.75 from county specific trends.

An ideal test would be on the continuity of predetermined women characteristics on either side of age 17.75 by the first quarter of the first year of the closures. It is unfortunate that little is known about women before their marriages in the 1992 CCS. Alternatively, using the 1988 Two per Thousand Fertility Survey, I conduct indirect tests on whether women born in the second quarter are systematically different from those born in the first quarter in each year of 1960-1963, who were

[27]It is not reported in this version of the paper but is available upon request.

around age 17.75 when schools were closed between 1978 and 1981.[28] These tests provide informative evidence because the identification strategy is essentially comparing women born in the first and second quarter of the same year but who had distinct exposures to the closures within county. The specification is an analogue to the reduced form in equation (3); only the regressor of interest is an indicator variable that is equal to 1 if born in the second quarter or later of a particular year in 1960-1963 and 0 otherwise. The analysis sample includes rural women born 6 years before and 6 years after the particular year in each test.

Appendix Table 2 reports estimates on an extensive set of grandparental and maternal characteristics of women at risk of becoming mothers in this study, including grandparental education, grandmother's age at birth, parity, months of breastfeeding, mortality in one month and mortality in one year. Each panel shows results from testing discontinuous changes between the first and second quarters in each year from 1960 to 1963 separately. Each estimate is for a different characteristic. Most of the 45 estimates are small in magnitude and are not statistically different from zero, suggesting little selection of female births in the second quarter of these years. Only two estimates are significant at 5 percent level. Women born in the second quarter of 1961 were less likely to die in a month or in a year, and the estimated differences are large in economic terms. If these women are of better quality compared to those born in the first quarter of the same year, we would expect an increase of education at age 17.75 in counties that closed schools in 1979, which, however, goes in the opposite direction to the decline of women's high school completion. Only one estimate, middle school completion of grandparents whose wives gave birth in the second quarter of 1962, is significant at the 10 percent level and is very small in magnitude. These findings support the validity of the identifying assumption in that women at risk of being around age 17.75 at the time of the closures are similar in terms of predetermined and observable characteristics.

6.2 Alternative hypothesis 1: Land reform

There are 306 counties that report the timing of both school closures and land reform and that are matched with the 1992 CCS. In Figure 8a, I plot the fraction of counties that enacted these two reforms from 1977 to 1984. In general, the closures of high schools started earlier than land reform. The correlation of the timing of these two reforms is as low as -0.08, suggesting that these reforms were not coincident at the county level. Moreover, I plot high school completion of women by their age in the first quarter of the first year of land reform in Figure 8b. There is no obviously discontinuous change of high school completion at age 17.75 by the time of land reform, which is in contrast with the sharp drop in high school completion at age 17.75 in the first year of the school closures shown in Figure 6. Both figures suggest that land reform is unlikely to be a confounder.

In a more direct test, I control for one's exposure to land reform in the first stage and reduced form estimation on the effects of the school closures in the subsample of 306 counties. One's exposure

[28] The county identifier is not released in this fertility survey, which keeps me from matching it with the data on the timing of the closures by county.

to land reform is measured by an indicator variable that is equal to 1 if one was at age 17.75 by the first quarter in the first year of land reform and 0 otherwise. Every column (1) in Table 8 reports the estimated effect of the school closures without the control of land reform, and every column (2) reports the estimated effects of both reforms. Consistent with the observation in Figure 8b, the effect of one's exposure to land reform has very small and statistically insignificant effect on high school completion. The first stage estimates on the effect of the school closures in both columns are very close. Reduced form estimates show that a woman's exposure to the school closures decreases her gestational age by 0.015 months at 5 percent significant level and increases the probability of prematurity by 0.006 percentage points at 10 percent significant level. These results provide suggestive evidence on a positive effect of maternal education on reducing prematurity in this subsample of counties. The inclusion of one's exposure to land reform does not alter the estimated effects of one's exposure to the school closures on most infant health measures, except for a sign reversal on low birthweight, but estimates in both columns for low birthweight are imprecise.

6.3 Alternative hypothesis 2: Closures of middle schools or primary schools

If rural middle schools were closed two years before the closures of high schools, or the number of primary schools went down five years earlier, the decline in high school completion could be induced by these closures instead of high school closures. In Figure 9a and 9b, however, there is no obviously discontinuous decline in middle school completion or primary school completion at age 17.75 by the time of the high school closures. These smooth patterns on either side of age 17.75 reduce concerns about closures of schools at lower levels. In Appendix Table 3, I also report the estimated effects of being at age 17.75 or younger when high school closures started on one's primary school completion and middle school completion. Consistent with Figure 9a and 9b, none of these estimates are negative. For primary school completion, all estimates are positive and those using higher order polynomial are very small and imprecise. Similarly, while the estimate on middle school completion by fitting a linear trend is positive, those using a quadratic or cubic polynomial are negative, small in magnitude and statistically insignificant.

6.4 Migration

Two possible concerns about migration might lead to bias in my estimates. First, if women who completed high school were more likely to migrate and thus are not observed in my sample, even a female migration rate as low as 5 percent could possibly result in a downward bias of the first stage estimate. Second, because women who migrated from other counties are matched with the timing of the school closures in their county of residence in 1992, the mismatch of their treatment status is also likely to yield downward bias of the first stage estimate. In this subsection, I provide evidence that these concerns are unlikely to confound my results.

A direct test on whether one's exposure to the school closures affects the decision to migrate is not possible using the 1992 CCS or the 1990 Census because 1) information on migration is not reported in the 1992 CCS; and 2) the county of birth is not observed for migrants in the 1990 Census. Alternatively, I compare the migration pattern of rural women in the 1990 Census with the pattern of high school completion in the 1992 CCS by their year of birth in Appendix Figure 1. If one's decision to migrate was affected by one's exposure to the school closures, we would expect that the fraction of migrants increases among birth cohorts old enough to avoid the closures and falls among those under age 18 when most counties closed schools and a large number of schools were closed. As shown in Figure 1a and Figure 3, by 1980, the closure decision had been made in more than 82 percent of counties, and the total school supply had been down by 58 percent; by 1983, the closure decision had been made in 99 percent of counties, and the drop in school supply had been more than 80 percent. Mapping these numbers to Appendix Figure 1, the 1962 birth cohort was the oldest cohort affected by the closures in 1980, and the 1965 cohort was the oldest affected by the closures in 1983. The solid line shows a sharp drop of high school completion in the 1961 cohort. The decline is of a much larger scale among the 1962-1965 cohorts. Moreover, the decline is persistent among younger cohorts. In contrast, the dotted line shows that, compared to the female migration rate among older cohorts, there are larger increases among those born in 1962-1965, and a decline appears at the 1968 cohort. The opposite patterns of high school completion and migration rate between the 1962 cohort and the 1967 cohort clearly run counter to the hypothesis that rural women who completed high school were more likely to migrate.

To examine how serious the problem might be due to mismatch of one's treatment status, I estimate the first stage effect in two samples in the 1990 Census: the sample of all rural women and the sample of rural nonmigrant women. If the mismatch leads to substantial bias, we would expect that the first stage estimate in the sample of all rural women (with mismatch for migrants) is different from that in the sample of nonmigrant women (no mismatch). I report the results in Appendix Table 4. In these 400 counties, there are only 2.5 percent of rural women who migrated from other counties. The point estimates and standard errors in both samples are exactly the same, which eliminates the concern about mismatch bias.

7 Conclusion

This study provides new evidence on the effect of maternal education on infant health by exploiting the massive closures of rural high schools right after the Cultural Revolution in China. Compared to women just a few quarters older and who had just graduated from high school by the year the school closures started, women still in the final year are 22.5 percent less likely to complete high school. I find that a woman's exposure to the school closures has negligible effect on her selection into motherhood and maternal age at first birth, which suggest that the estimated effects on infant health are not confounded by their fertility choices. The large decline in women's high school completion induced by the school closures, however, has little effect on infant health, as captured by prematurity, low birthweight, neonatal mortality and infant mortality.

The narrow focus of the comparisons among women born quarters apart yet having distinct exposures to the school closures within county provides credible evidence. First, both the closures of high schools and the change in the school entry date policy were unpredictable by parents of these women. Second, I provide evidence that women being compared are very similar in terms of observable, predetermined characteristics. Third, I rule out two alternative hypotheses for interpreting the discontinuously change in high school completion. One is land reform between 1978 and 1984, and another is the closures of middle schools or primary schools prior to the closures of high schools. Finally, for the particular period of time in rural China studied in this paper, concerns about migration are less important. I also provide evidence that migration is unlikely to bias my estimates.

That I do not find an effect of maternal education on infant health is specific to a subpopulation of women from low socioeconomic background and refers to maternal education in the last year in high school. Moreover, the income channel through which maternal education affects infant health might have been weakened by the poor functioning labor market in the 1980s and early 1990s in rural China. Further studies on other education interventions targeting different levels of schooling or different subpopulations in developing countries are particularly valuable for understanding the intergenerational education-health link.

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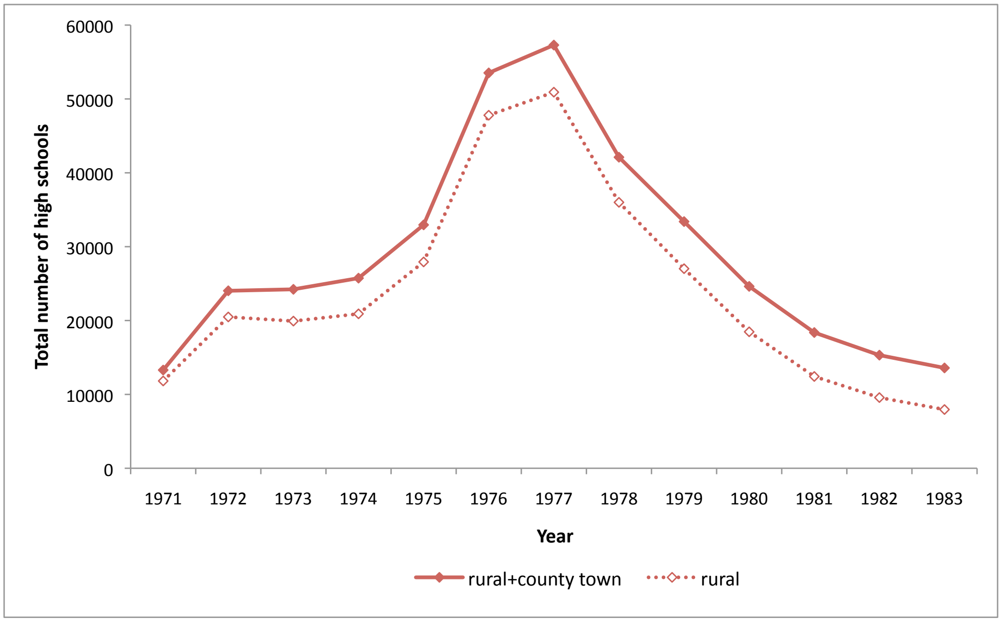
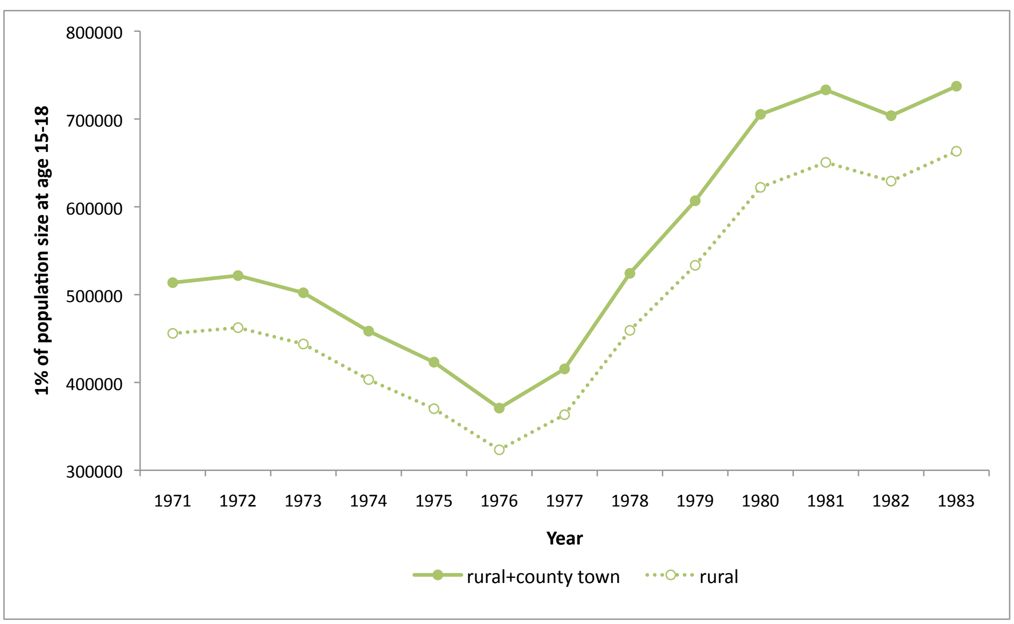
Figure 1a: Supply of high schools - total number of high schools in counties



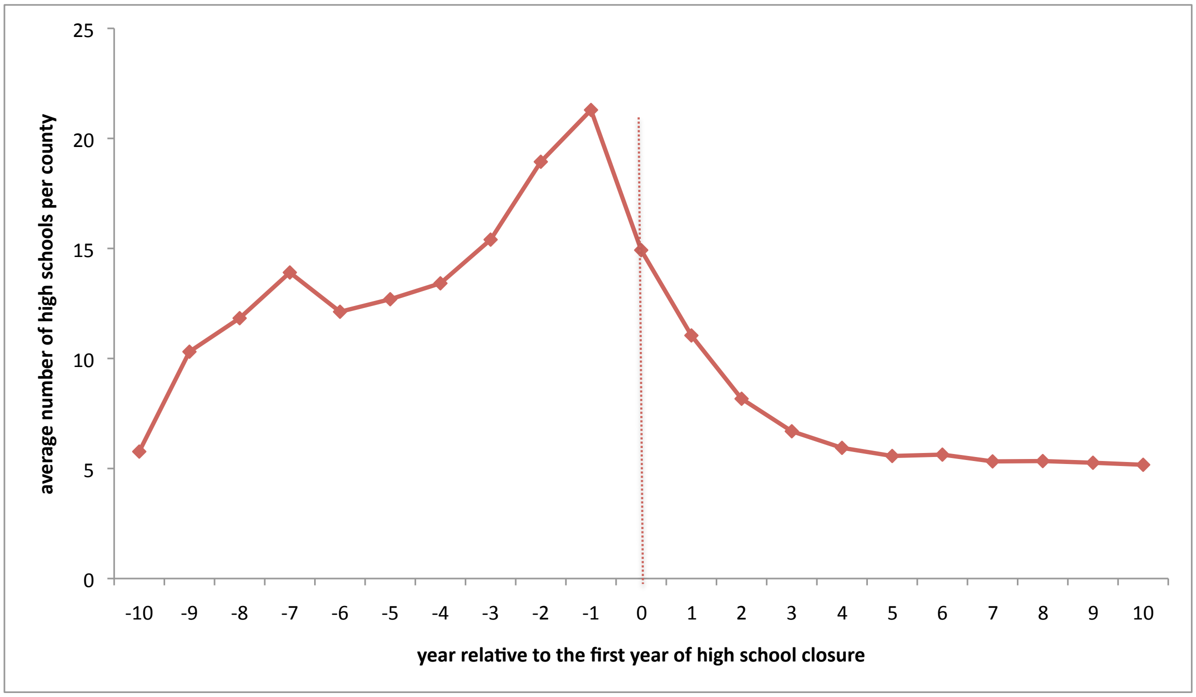
Data Source: *Achievement of Education in China: Statistics 1949-1983* (Ministry of Education, 1984)

Figure 1b: Demand for high schools - 1 percent of the cohort size at age 15-18 in counties



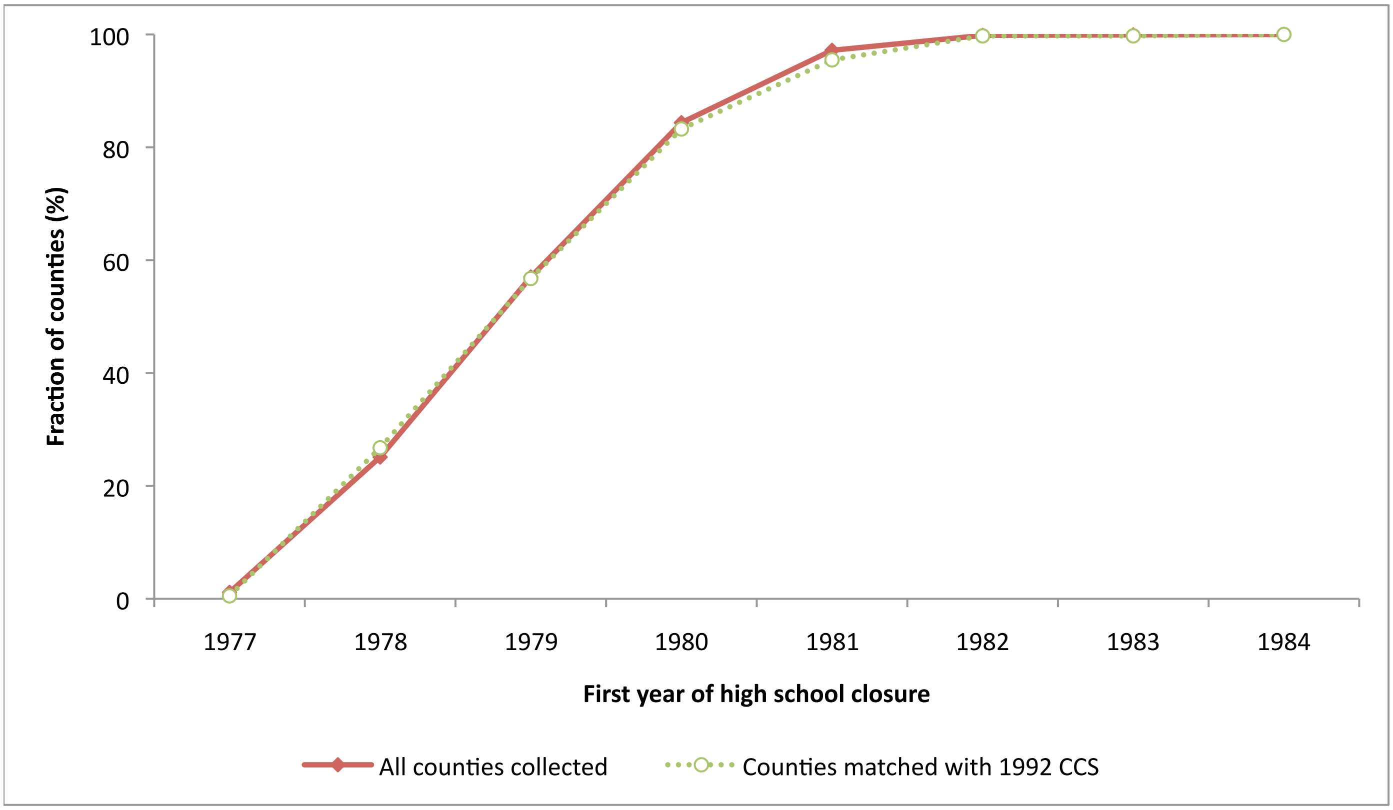
Data Source: Author's tabulation using 1 percent sample of 1990 Census

Figure 2: Average number of high schools per county by event time



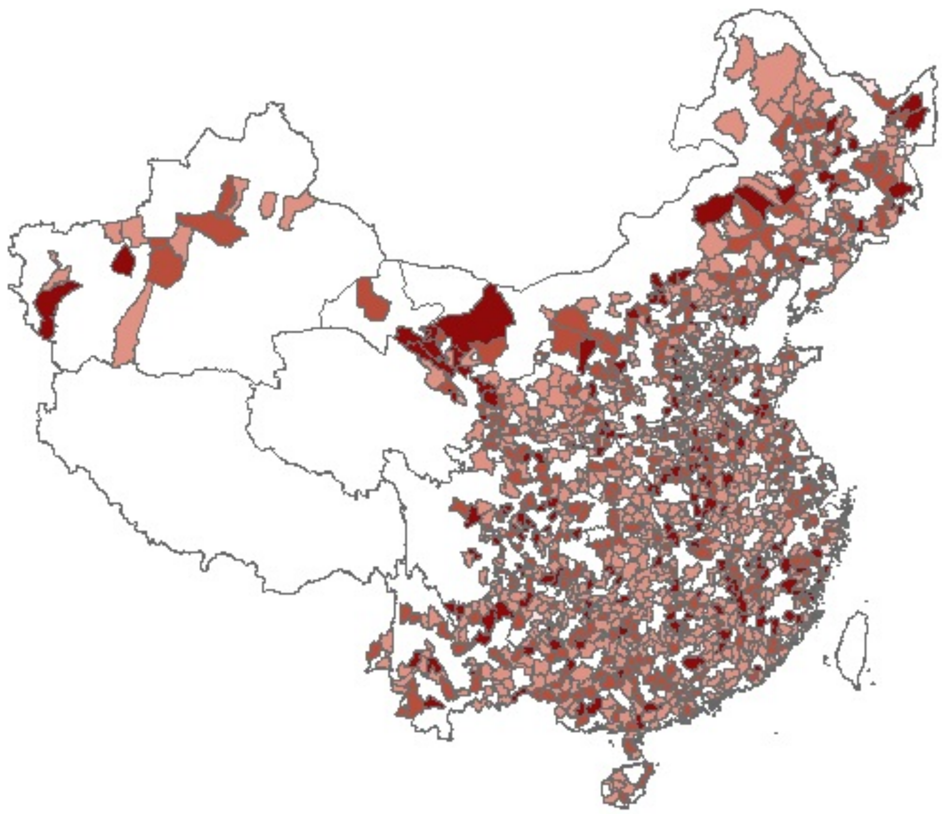
Note: Author's tabulation of data on the number of high schools and the year the high school closures started by county in 65 counties from which complete records on the year-by-year number of high schools from 1965 to the late 1980s are recorded on gazetteers.

Figure 3: the first year of the school closures by county: 1977-1984



Note: Author's tabulation of the data on the year the high school closures started by county. The solid line represents 1247 counties and the dotted line represents 400 counties that are matched with the 1992 Chinese Children Survey microdata.

Figure 4: Geographical distribution of the timing of the school closures (1977-1984)



Note: Author's tabulations of the data on the year the high school closures started by county of 1247 counties. The shading corresponds to the timing of the closures, where darker shading indicates later year of the closures.

Figure 5a: Motherhood observed

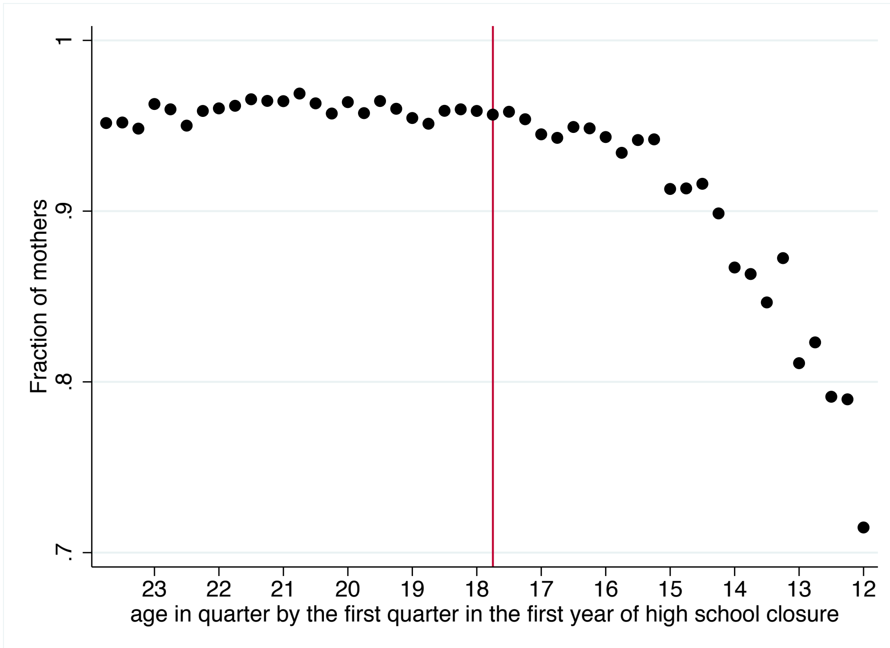
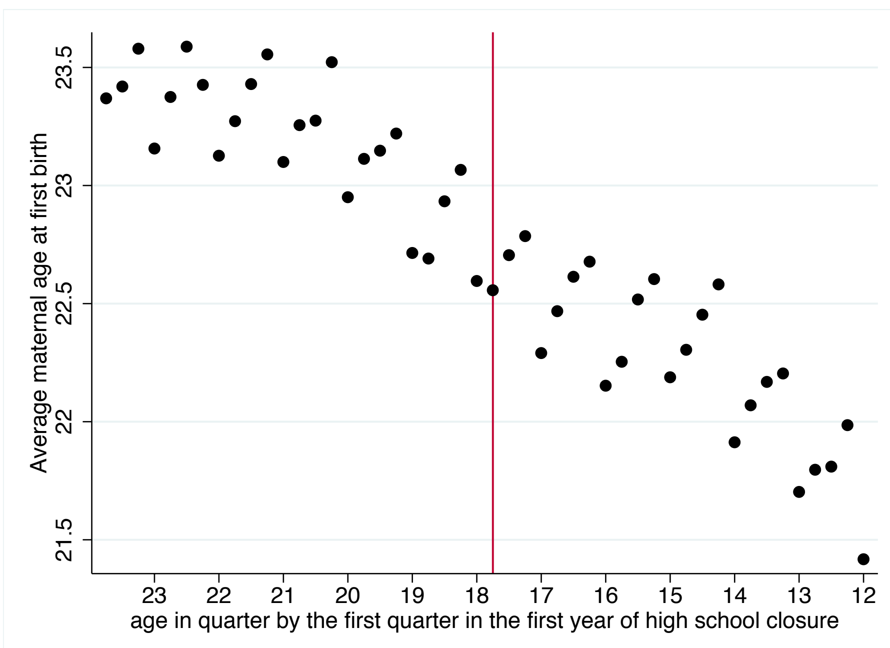


Figure 5b: Maternal age at first birth

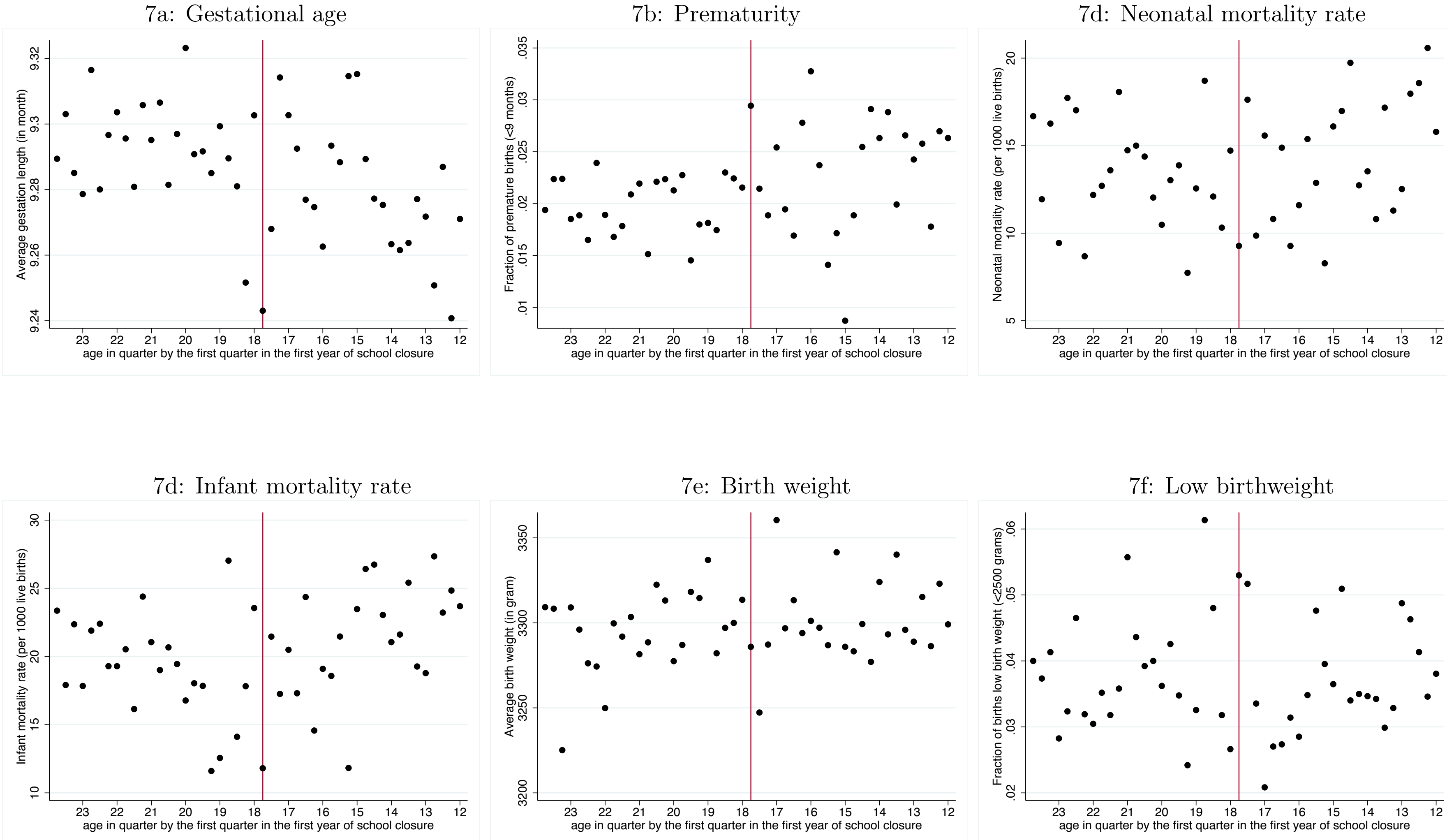


Note: Points present the fraction of women who become mothers in Figure 5a, and the average maternal age at first birth in Figure 5b. The vertical bars denote the first cohort exposed to the high school closures.

Figure 6: High school completion

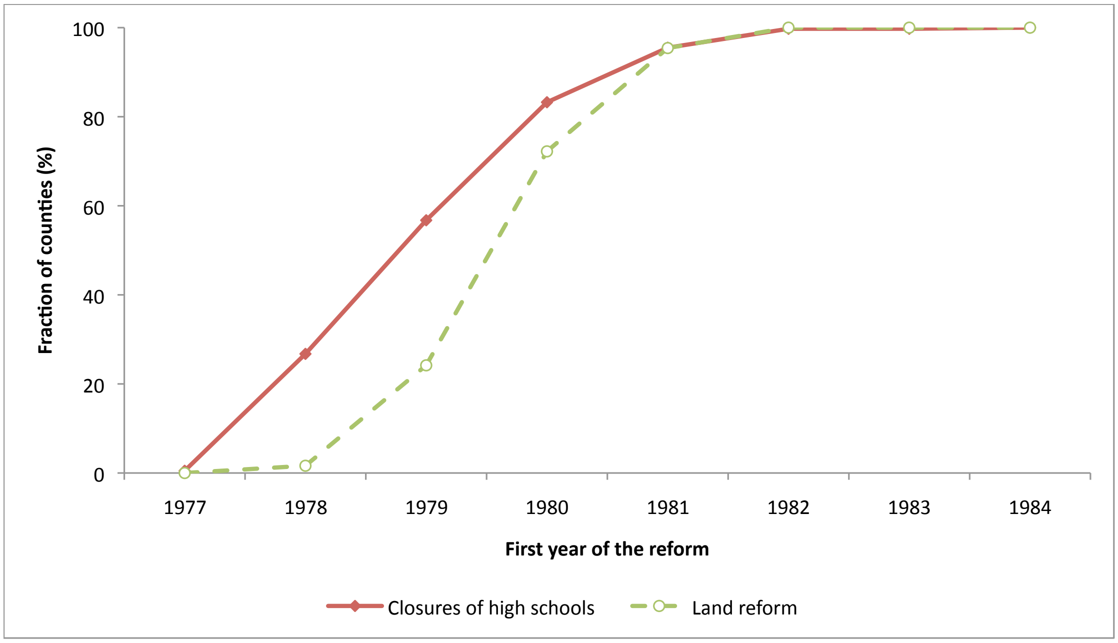
Note: Points present the fraction of mothers who completed high school in each age in quarter cell. The vertical bars denote the first cohort exposed to the high school closures.

Figure 7: Infant Health Outcomes



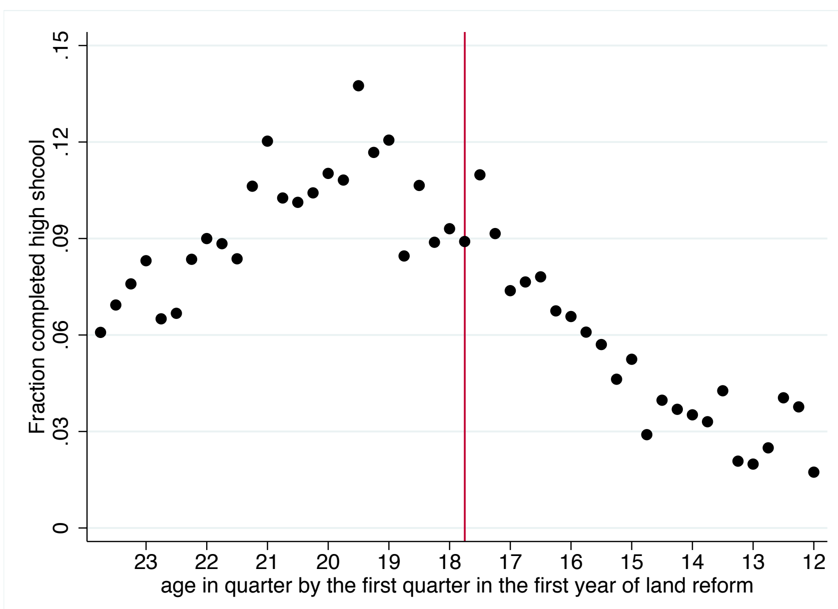
Note: Points present the mean of an infant health measure in each age in quarter cell in each of the six figures. The vertical bars denote the first cohort exposed to the high school closures.

Figure 8a: The timing of high school closures and land reform



Note: Author's tabulations of the data on year the high school closures started and the first year of land reform by county in 306 counties.

Figure 8b: High School Completion and Land Reform



Note: Points present the fraction of mothers that completed high school in each age in quarter cell. The vertical bar is at age 17.75 by the first quarter in the first year of land reform.

Figure 9a: Middle school completion

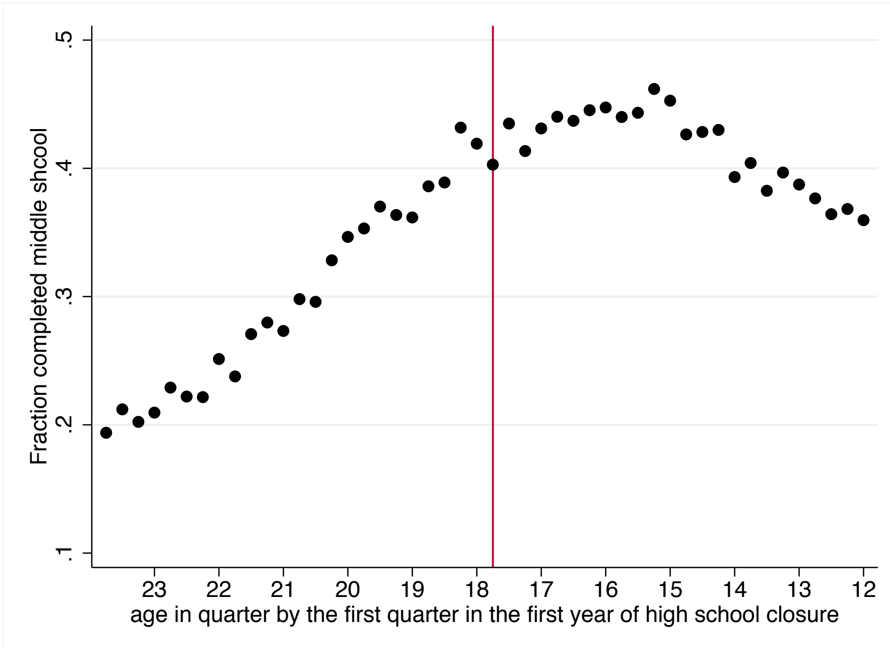
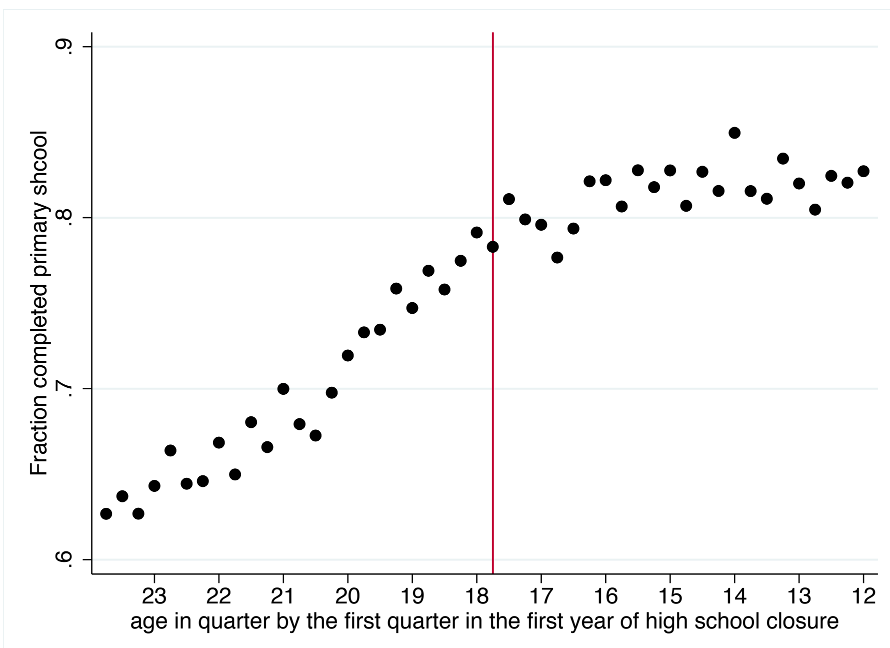


Figure 9b: Primary school completion



Note: Points present the fraction of mothers who completed middle school or primary school in each age in quarter cell. The vertical bars denote the first cohort exposed to the closures of high schools.

Table 1: Correlates of the closure timing with county characteristics prior to the closure

	Dependent variable: First year of high school closure (1977-1984)			
	Panel A: Education characteristics			
	number of schools built in 1965-1976	number of classrooms built in 1965-1976	ln(enrollment rate in 1976)	ln(number of send-down youth received in 1966-1976)
Point estimate	-0.006	-0.002*	-0.031	0.029
SE	[0.004]	[0.001]	[0.143]	[0.093]
Observations	107	68	143	73
R-squared	0.018	0.027	0.000	0.001
	Panel B: Economic characteristics in 1976			
	ln(fiscal revenue)	ln(fiscal expenditure on education and health)	ln(grain output per capita)	ln(population density)
Point estimate	-0.105	-0.281	0.231	-0.061
SE	[0.113]	[0.181]	[0.279]	[0.071]
Observations	119	103	162	235
R-squared	0.006	0.018	0.005	0.003

Notes: Robust standard errors are reported in brackets. The dependent variable is the first year of high school closure, from 1977 to 1984, the larger the later a county closed schools. Point estimates are obtained by regressing the first year of school closure on each county characteristic separately. In the sample of 400 matched counties, the sample size of each characteristic varies by the availability of the data in county gazetteers. Results using ordered logit model are very similar.

Table 2: Summary Statistics

Panel A: Women and Mothers				
	Women		**Mothers**	
	mean	obs.	mean	obs.
no schooling	0.235	66383	0.24	61059
primary school	0.396	66383	0.4	61059
middle school	0.294	66383	0.29	61059
high school	0.073	66383	0.071	61059
college	0.0017	66383	0.0014	61059
working	0.9	66383	0.9	61059
in an off-farm job	0.062	59683	0.057	54831
in a white-collar job	0.021	59683	0.02	54831
married	0.97	66383	0.9996	61059
age at first birth			22.7	61059
			(2.41)	
Panel B: All Births and First Birth				
	First Birth		**All Birth**	
	mean	obs.	mean	obs.
B1: Infant Health Outcomes				
gestational age (in months)	9.28	61047	9.29	125826
	(0.52)		(0.52)	
prematurity (gestational age<9 months)	0.022	61047	0.019	125826
neonatal mortality rate (per 1000 births)	14	58329	15	122375
infant mortality rate (per 1000 births)	20	58329	22	122375
birth weight (in grams)	3299	22444	3312	41865
	(542)		(538)	
low birth weight	0.037	22444	0.034	41865
B2: Health Behaviors of Mothers				
any prenatal visit	0.51	59752	0.44	123273
prenatal visit in the first trimester	0.145	59752	0.112	123273
delivered in hospital	0.246	58300	0.179	122307

Table 3: Reduced form on fertility choices

Panel A: Motherhood observed	
1{age at school closure=<17.75}	-0.0067
	[0.0054]
Dependend variable mean	0.92
Observations	66383
R-squared	0.139

Panel B: Maternal age at first birth

Dependent variable: Each specific maternal age at first birth					
13	0.0002	21	0.0329***	29	-0.0038
	[0.0002]		[0.0105]		[0.0031]
14	0.0003	22	-0.0249**	30	0.0008
	[0.0006]		[0.0108]		[0.0016]
15	-0.0013*	23	0.0037	31	-0.0020*
	[0.0007]		[0.0100]		[0.0012]
16	0.0020	24	-0.0061	32	-0.0013*
	[0.0013]		[0.0094]		[0.0008]
17	-0.0039*	25	-0.0045	33	-0.0003
	[0.0021]		[0.0081]		[0.0004]
18	-0.0043	26	-0.0013	34	0.00002
	[0.0035]		[0.0065]		[0.0002]
19	0.0072	27	-0.0036	35	-0.0003*
	[0.0059]		[0.0048]		[0.0002]
20	0.0120	28	-0.0012	36	-0.0002
	[0.0074]		[0.0030]		[0.0001]
sample average			22.7		
Observation			61059		

Note: Robust standard errors clustered at county level are reported in brackets. The sample in Panel A includes women at age 12-23 by the first quarter in the first year of school closure, while the sample in Panel B includes the same cohorts of mothers. In Panel B, each dependend variable is an indicator for a specific maternal age at first birth, and each parameter is from a separate regression on a specific maternal age. All regressions include a quadratic cohort trend and its interaction with the indicator of at or younger than age 17.75 by the school closure, quarter of birth effects, county fixed effects and county specific quadratic trend.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: First stage

	High school completion							
	All mother sample				Birth weight sample			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1{age at school closure=<17.75}	-0.028***	-0.028***	-0.028***	-0.027***	-0.037***	-0.037***	-0.035***	-0.036***
	[0.005]	[0.005]	[0.005]	[0.005]	[0.010]	[0.010]	[0.010]	[0.010]
Linear cohort trend	X	X	X	X	X	X	X	X
QOB FE		X	X	X		X	X	X
County FE			X	X			X	X
County specific linear trend				X				X
Dependent variable mean at age 18	0.12				0.16			
Dependent variable mean	0.073				0.095			
Observations	61059	61059	61059	61059	22444	22444	22444	22444
R-squared	0.009	0.009	0.049	0.069	0.012	0.012	0.074	0.114

Note: Robust standard errors clustered at county level are reported in brackets. This table reports the first stage estimates, β_1, in equation (2). The dependend variable is an indicator that is equal to 1 if one completed high school, and 0 otherwise. The sample of mothers includes those at age 12-23 by the first quarter in the first year of school closure. The sample in column (1)-(4) include all mothers, while the sample in column (5)-(8) include mothers that report the birth weight of their first birth.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Reduced form and IV estimation on infant health

	Gestational age (in months)	Prematurity	Mortality in 1 month	Mortality in 1 year	Birth weight (in grams)	Low birthweight
	Panel A: Reduced form					
1{age at school closure=<17.75}	-0.009	0.003	-0.0018	-0.0016	-10.35	-0.004
	[0.007]	[0.003]	[0.0022]	[0.0026]	[14.59]	[0.005]
Dependent variable mean at age 18	9.3	0.022	0.015	0.024	3314	0.027
Observations	61,047	61,047	58,329	58,329	22444	22444
R-squared	0.554	0.048	0.033	0.035	0.183	0.089
	Panel B: IV estimation					
high school completion	0.334	-0.093	0.070	0.065	246.29	0.135
	[0.244]	[0.092]	[0.087]	[0.100]	[380.36]	[0.144]
Dependent variable mean	9.3	0.022	0.014	0.02	3299	0.037
Observations	61,047	61,047	58,329	58,329	22,444	22,444
F statistic in first stage	28.35	28.49	23.77	23.77	14.09	14.09

Table 6: Heterogeneous effects of the school closures

	Pre-existing education level		Population density in 1982	
	below median	above median	below median	above median
	(1)	(2)	(1)	(2)
High school completion	0.004	-0.054***	-0.029***	-0.030***
	[0.005]	[0.008]	[0.007]	[0.008]
	29367	31692	27716	29649
	(0.11)	(0.17)	(0.096)	(0.154)
Gestational age	-0.007	-0.011	-0.004	-0.011
	[0.010]	[0.009]	[0.009]	[0.010]
	29363	31684	27713	29642
Prematurity	0.005	0.001	0.0003	0.004
	[0.004]	[0.003]	[0.003]	[0.004]
	29363	31684	27713	29642
Mortality in 1 month	-0.001	-0.003	-0.003	-0.001
	[0.004]	[0.003]	[0.003]	[0.003]
	27625	30704	26272	28536
Mortality in 1 year	0.001	-0.004	-0.001	-0.002
	[0.004]	[0.003]	[0.004]	[0.003]
	27625	30704	26272	28536
Birth weight	-10.662	-10.647	-13.252	-8.201
	[22.812]	[18.932]	[21.315]	[20.002]
	10299	12145	8276	12525
LBW	0.005	-0.011	-0.003	-0.005
	[0.008]	[0.007]	[0.010]	[0.007]
	10299	12145	8276	12525

Note: This table reports estimates of both the first stage and the reduced form estimates on infant health outcomes by various categories of counties. All column (1) report estimates in the sample of counties below the median of each category and all column (2) report estimates in counties above the median. All regressions include a linear cohort trend and its interaction with the indicator of at or younger than age 17.75 by the school closure, quarter of birth effects, county fixed effects and county specific linear trend.Robust standard errors clustered at county level are reported in brackets. The dependent variable mean of high school completion at age 18 is reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

The pre-existing education level is measured by the fraction of high school completion among pre-exposure cohorts is calculated from mothers at age 18-23 by the first quarter in the first year of the school closure in the 1992 CCS. The median is 6.2 percent.

Population density is from the GIS data of 1982 Census. The median is 227 residents per square kilometers.

Table 7A: Other relevant outcomes (1992 CCS)

	Reduced form					
	Labor market outcomes			Prenatal care and delivery		
	working	off-farm employment	white-collar jobs	any prenatal check	prenatal check in the 1st trimester	delivered at hospital
1{age at school closure=<17.75}	0.002	0.002	-0.001	0.003	0.002	0.001
	[0.004]	[0.004]	[0.003]	[0.009]	[0.006]	[0.007]
Observations	61059	54831	54831	59752	59752	58300
R-squared	0.419	0.224	0.067	0.254	0.161	0.257

Note: Robust standard errors clustered at county level are reported in brackets. This table reports reduced form estimates on the effects of maternal exposure to the school closures on other outcomes. Each parameter is from a separate regression on one outcome. The sample of mothers includes those at age 12-23 by the first quarter in the first year of school closure. All regressions include a linear cohort trend and its interaction with the indicator of at or younger than age 17.75 by the school closure, quarter of birth effects, county fixed effects and county specific linear trend.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7B: Paternal characteristics (1990 Census)

	first stage	Reduced form			
	wife	husband			
	high school completion	high school completion	working	off-farm employment	white-collar jobs
1{wife's age at school closure=<17.75}	-0.025***	-0.013***	0.001	0.003	-0.001
	[0.004]	[0.005]	[0.001]	[0.004]	[0.002]
Observations	145110	145110	145110	144801	144801
R-squared	0.069	0.058	0.009	0.188	0.041

Note: Robust standard errors clustered at county level are reported in brackets. Using the sample of the same 400 counties in the 1990 Census, this table reports first stage estimate for women and reduced form estimates on their husbands' education and labor market outcomes. Each parameter is from a separate regression on one outcome. The sample of women includes those at age 12-23 by the first quarter in the first year of school closure. All regressions include a linear cohort trend and its interaction with the indicator of at or younger than age 17.75 by the school closure, quarter of birth effects, county fixed effects and county specific linear trend.

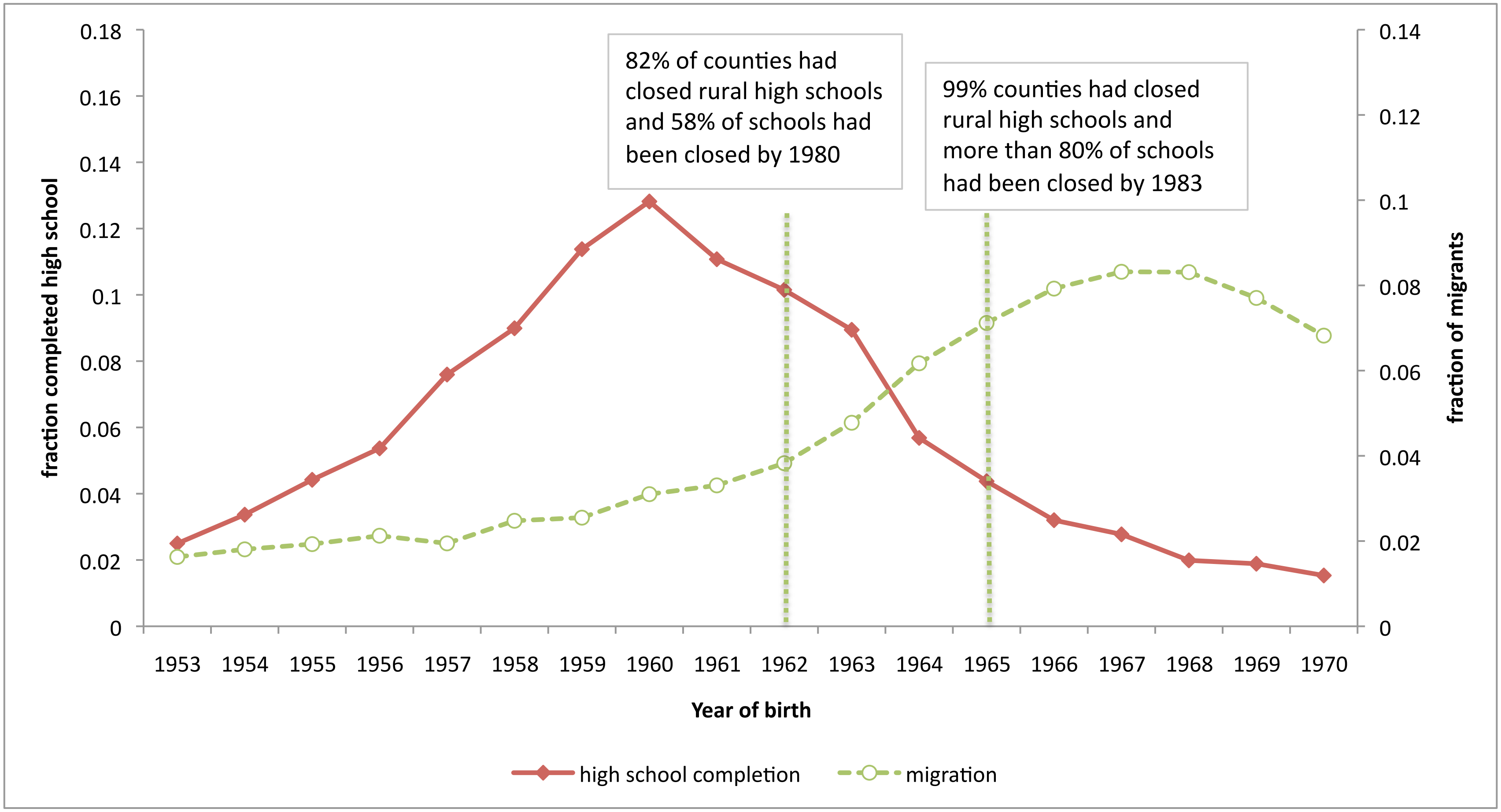
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8: First and reduced form including one's exposure to the land reform

	First stage		**Reduced form**					
	Mother completed high school		Gestational age		Prematurity		Mortality in 1 month	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
1{age at school closure=<17.75}	-0.017***	-0.016***	-0.015**	-0.016**	0.006*	0.005*	-0.003	-0.004
	[0.006]	[0.005]	[0.0074]	[0.008]	[0.003]	[0.003]	[0.003]	[0.003]
1{age at land reform=<17.75}		-0.002		0.004		0.002		0.003
		[0.006]		[0.009]		[0.003]		[0.003]
Observations	47553	47553	47543	47543	47543	47543	45311	45311
R-squared	0.069	0.069	0.533	0.533	0.048	0.048	0.033	0.033
			Mortality in 1 year		Birth weight		Low birthweight	
			(1)	(2)	(1)	(2)	(1)	(2)
1{age at school closure=<17.75}			-0.003	-0.004	-9.38	-16.99	-0.003	0.0002
			[0.003]	[0.003]	[17.65]	[18.28]	[0.007]	[0.007]
1{age at land reform=<17.75}				0.005		23.99		-0.01
				[0.003]		[21.35]		[0.008]
Observations			45311	45311	16573	16573	16573	16573
R-squared			0.035	0.035	0.176	0.176	0.090	0.090

Note: Robust standard errors clustered at county level are reported in brackets. Using 306 counties that have timing information on both high school closure and land reform, this table reports estimates of both the first stage and the reduced form on infant health outcomes. The sample of mothers include those at age 12-23 by the first quarter in the first year of school closure. All column (1) control for a linear cohort trend and its interaction with the indicator of at or younger than age 17.75 by the school closure, quarter of birth effects, county fixed effects and county specific linear trend. All column (2) also include an indicator variable that is equal to 1 if one was 17.75 or younger by the first quarter in the first year of land reform.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Appendix Figure 1: High school completion and Migration



Note: Data used to plot the solid line are from the 1992 Chinese Children Survey, and data used to plot the dotted line are from the 1990 Census.

Appendix Table 1: Estimates using a quadratic or cubic polynomial

	First stage	Reduced form					
	high school completion	Gestational age	Prematurity	Mortality in 1 month	Mortality in 1 year	Birth weight	Low birthweight
	Panel A: quadratic polynomial						
1{age at school closure=<17.75}	-0.018**	-0.0179*	0.0033	-0.0010	-0.0037	-9.2738	-0.0015
	[0.008]	[0.0099]	[0.0038]	[0.0031]	[0.0038]	[24.1047]	[0.0089]
Observations	61059	61047	61047	58329	58329	22444	22444
R-squared	0.082	0.560	0.061	0.049	0.050	0.211	0.124
	Panel B: cubic polynomial						
1{age at school closure=<17.75}	-0.031***	-0.0151	0.0057	-0.0022	-0.0070	-5.1309	0.0076
	[0.011]	[0.0139]	[0.0049]	[0.0044]	[0.0055]	[35.7882]	[0.0124]
Observations	61059	61047	61047	58329	58329	22444	22444
R-squared	0.095	0.567	0.075	0.064	0.066	0.240	0.162

Note: Robust standard errors clustered at county level are reported in brackets. Each parameter is from a separate regression on one outcome. The sample of mothers includes those at age 12-23 by the first quarter in the first year of school closure. In Panel A, all regressions include a quadratic cohort trend and its interaction with the indicator of being at age 17.75 or younger, quarter of birth fixed effects, county fixed effects and county specific quadratic trends. In Panel B, all regressions include a cubic cohort trend and its interaction with the indicator of being at age 17.75 or younger, quarter of birth fixed effects, county fixed effects and county specific cubic trends.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Appendix Table 2: Test the continuity of predetermined characteristics

	Grandparental characteristics								
	grandmother			grandfather		Women characteristics			
	middle school completion	high school completion	age at birth	middle school completion	high school completion	parity	months of breastfeeding	mortality in 1 month	mortality in 1 year
					Panel A: 1960				
1{born in Q2 or after}	-0.009	0.003	0.066	0.011	-0.005	-0.015	-0.276	0.003	-0.001
	[0.007]	[0.004]	[0.110]	[0.016]	[0.009]	[0.037]	[0.334]	[0.008]	[0.011]
Dependent variable mean	0.05	0.01	24.4	0.2	0.06	2.15	15.04	0.044	0.094
Observations	103696	103696	103696	87954	87954	103682	103695	103696	103696
R-squared	0.189	0.205	0.252	0.205	0.200	0.157	0.134	0.072	0.092
					Panel B: 1961				
1{born in Q2 or after}	0.002	0.002	-0.117	0.003	0.004	-0.054	0.226	-0.017**	-0.029**
	[0.008]	[0.004]	[0.124]	[0.015]	[0.009]	-0.055	[0.357]	[0.009]	[0.012]
Dependent variable mean	0.05	0.01	24.6	0.2	0.06	2.17	15.04	0.044	0.093
Observations	99349	99349	99349	84401	84401	99336	99348	99349	99349
R-squared	0.196	0.215	0.229	0.208	0.204	0.150	0.137	0.073	0.093
					Panel C: 1962				
1{born in Q2 or after}	0.006	-0.001	0.088	-0.022*	-0.005	-0.017	0.348	-0.005	0.005
	[0.006]	[0.003]	[0.106]	[0.012]	[0.008]	[0.037]	[0.249]	[0.007]	[0.009]
Dependent variable mean	0.05	0.01	24.7	0.2	0.06	2.2	15.04	0.043	0.093
Observations	94323	94323	94323	80237	80237	94310	94322	94323	94323
R-squared	0.200	0.218	0.208	0.209	0.209	0.144	0.140	0.076	0.096
					Panel D: 1963				
1{born in Q2 or after}	0.010	0.000	-0.028	0.007	0.003	0.000	0.320	0.007	0.004
	[0.006]	[0.003]	[0.100]	[0.011]	[0.006]	[0.033]	[0.227]	[0.005]	[0.008]
Dependent variable mean	0.05	0.01	25	0.2	0.06	2.24	15.02	0.043	0.091
Observations	88562	88562	88562	75470	75470	88550	88561	88562	88562
R-squared	0.206	0.229	0.188	0.213	0.217	0.141	0.141	0.079	0.099

Note: Robust standard error clustered at county level are reported in brackets.This table reports estimates on the mean shift of the dependent variable at being born at the second quarter or after for each year from 1960 to 1963. For each year, the sample includes rural female births born 24 quarters before and 24 quarters after the second quarter of that particular year. All regressions include a quadratic cohort trend and its interaction with the indicator of being borning in the second quarter or after for that year (1960-1963), quarter of birth fixed effects, year of birth fixed effects, county fixed effects and county specific quadratic trend. * significant at 10%; ** significant at 5%; *** significant at 1%.

Appendix Table 3: Test primary school and middle school completion

	Primary school completion			Middle school completion		
	linear	quadratic	cubic	linear	quadratic	cubic
1{age at high school closures=<17.75}	0.026***	0.0001	0.003	0.022***	-0.0172	-0.020
	[0.007]	[0.0094]	[0.015]	[0.008]	[0.0134]	[0.020]
Dependent variable mean		0.765			0.369	
Observations	61059	61059	61059	61059	61059	61059
R-squared	0.252	0.287	0.297	0.193	0.205	0.215

Note: Robust standard errors clustered at county level are reported in brackets. This table reports the effects of one's exposures to high school closures on primary school completion and middle school completion. The sample of mothers includes those at age 12-23 by the first quarter in the first year of school closure. All regressions include a cohort trend and its interaction with the indicator of being at age 17.75 or younger, quarter of birth effects, county fixed effects and county specific trends. Estimates using linear, quadratic or cubic polynomial are reported separately.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Appendix Table 4: Test mismatch bias using 1990 Census

	High school completion	
	(1)	(2)
	all rural women	rural nonmigrant women
1{age at school closure<=17.75}	-0.027***	-0.027***
	[0.004]	[0.004]
Observations	210,162	204,809
R-squared	0.062	0.063

Note: Robust standard errors clustered at county level are reported in brackets. This table reports first stage estimates using 1990 Census. The dependent variable is an indicator that is equal to 1 if one completed high school and 0 otherwise. The sample of women includes those at age 12-23 by the first quarter in the first year of school closure. The sample in column (1) includes all rural women, while the sample in column (2) only include rural nonmigrant women who resided in the same county in 1985.
* significant at 10%; ** significant at 5%; *** significant at 1%.