School entry age and educational attainment in developing countries: Evidence from China’s compulsory education law

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Abstract

We investigate the causal impact of age of enrolment on educational attainment in a developing country setting. Using China’s 1986 Compulsory Education Law, which established a new nationally uniform age threshold for primary school enrolment as a natural experiment, we find that the probability of attending high school falls by 3.6 percentage points when school enrolment is postponed by one year. We provide suggestive evidence that those who start school later are not better learners, and that older students’ higher labor opportunity cost plays an important role in explaining the negative impact of school entry age on educational attainment.

1. Introduction

A large extant literature examines the relationship between the starting age of primary schooling and subsequent education and labor market outcomes in developed countries. Most studies find that delayed enrolment is positively associated with future outcomes including test scores (Weber and Puhani, 2006; Bedard and Dhuey, 2006; McEwan and Shapiro, 2008; Black et al., 2011; Fredriksson and Öckert, 2013), educational attainment (Mühlenweg and Puhani, 2010; Fredriksson and Öckert, 2013) and earnings (Fredriksson and Öckert, 2013). The main explanation for this advantage is that children who start school later exhibit greater “readiness” for learning and a stronger ability to acquire skills (Stipek, 2002).

Much less is known about the long-term impacts of age of enrolment in developing country settings. Pre-school is a sensitive period for brain development, and it is difficult to compensate later in life for disadvantages accumulated during this period (Heckman, 2006). Children are particularly open to acquiring certain skills, such as language, mathematics, etc., during the period between birth and age six (Montessori, 1995). In developed countries, pre-school childhood is usually filled by kindergarten and play time with siblings. Parents are conscious of the importance of conveying proper stimulus, for example by reading books or talking to the child. However, in developing countries, parents often are poorly educated, busy working, and lack awareness of the importance of stimulating their children. In rural China, preschool children frequently do not enroll in kindergarten (only 50.9% enrolment rate as late as 2009, Zhou, 2010).

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Only 30% of rural parents regularly read to their children. In such an environment, readiness to learn may decline with enrolment age because later entrants have missed the optimal period of learning.

A second factor which may lead to different effects of delayed primary school enrolment on educational attainment in developing country settings is greater sensitivity to the opportunity cost of schooling which increases steeply with age in teenage years when there is high demand for unskilled labor. China’s rapid growth and urbanization after economic reforms created such demand, leading to dramatic increases in internal migration and rapidly rising wages for rural migrant workers. As a consequence, many rural youth enter the labor market right after completing middle school. Because age 16 is the legal minimum employment age in China, delaying school enrolment by one year can lead to much greater employment opportunities at the time of middle school graduation. Evidence from China’s mini census data in 2005 shows that for those completing middle school, there is a notable increase in monthly income, migration rate, and employment rate each year from age 15 to age 18 (Fig. 1).

These factors unique to developing country settings may help explain why two previous studies set in China find a negative relationship between delayed enrolment and academic performance. Specifically, they find that a one-year delay in primary school enrolment reduces the probability of attending middle school by 6 percentage points (Chen, 2015) and decreases middle school cognitive test scores by 0.303 standard deviations (Zhang et al., 2017). The studies use samples with limited regional coverage and neither examines outcomes beyond middle school. One previous study finds a positive impact of delayed enrolment on years of schooling in China using a regression discontinuity design that could be sensitive to specification of the running variable (Guo et al., 2017). None of the China studies uses comparison groups unaffected by the Compulsory Education Law.

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2 Based on surveys in China by Rural Education Action Program (REAP), see https://reap.fsi.stanford.edu/research/early_childhood_development.

3 It is important to note that unlike the US which requires students to stay in school until age 16, China only requires that students complete middle school.

4 Chen (2015) uses the rural sample from one province. Zhang et al. (2017) use a middle-school based survey and drop counties where they think the cutoff rule is weakly enforced.
Anecdotal accounts suggest that parents in China prefer that their children start formal schooling as early as possible. Nearly every year representatives to the People’s Congress suggest relaxing the rigid school entry age from six to five and a half, so that children born after September can enroll in the same year as peers born before the end of August. In this paper, we study the impact of school entry age in China on years of schooling, focusing on the probability of high school enrolment, using China’s 1986 Compulsory Education Law as a natural experiment. The Law made nine years of education (6 years of primary school plus 3 years of middle school) compulsory for all children in China. It established nationally for the first time that children were expected to enter school at age six, with a clear cutoff birthdate of August 31st. Before the Law was passed, the criteria for primary school age of enrolment was vague and differed across provinces. As seen in Fig. 2, although the average starting age for primary school was declining over time before the new Law, it dropped sharply for children born after 1980. However, high school attendance rates increased only gradually. If we break down school entry age by birth month and compare the average school entry age of older cohorts and younger cohorts (see Fig. 3), there is a clear increase in attendance age for younger cohorts born after August.

We build upon previous studies of this issue in China while addressing the key limitations of those studies and others that employ a regression discontinuity design based on birthday cutoffs for enrolment eligibility. In addition to potential endogeneity of birth month due to unobserved characteristics of parents who give birth at different times of the year (Buckles and Hungerman, 2013), Barua and Lang (2009) point out that if enforcement of the cutoff rule is imperfect and leads manipulative parents to exert effort to enroll their children earlier, while causing the children of compliant parents to delay enrolment, then a monotonicity assumption needed for the consistency of LATE is violated. Our approach addresses both concerns by exploiting a change in the enrolment cutoff birthdate mandated by China’s Compulsory Education Law, which enables us to focus on the impact of the new cutoff date on cohorts affected by the Law compared to older cohorts not affected by the Law. Using this more convincing identification strategy, we estimate the impact of age of enrolment on high school attendance using two datasets with national coverage—China’s 2005 mini-census data and the 2010 wave of the Chinese Family Panel Study (henceforth CFPS). We find that the Law causes a 0.24 years increase in the age of primary school enrolment for those born after August compared to those born before the end of August, and that an increase in the age of school enrolment by one year reduces the probability of enrolling in high school by 3.6 percentage points. This confirms that the impact of delayed primary schooling in China is opposite to that found in the US and other developed countries.

In addition to this contribution, we conduct additional analyses that explore the importance of the two mechanisms posited above to explain the negative effect of primary school enrolment age on educational attainment in developing country settings, specifically that children who enroll later do not learn as well, and are more influenced by labor market demand when deciding whether to attend high school. Regarding readiness to learn, we analyze the determinants of test scores by grade level using data from a rural sample and find that later-enrolled students are more likely to perform worse at the beginning of primary school. However, the negative impact on test scores does not persist to higher grade levels in middle school. Next, we find that delayed enrolment has a more negative effect in areas with higher opportunity cost, proxied by the size of migration networks. The above evidence suggests that the negative delayed enrolment effect is primarily driven by the higher opportunity cost for older students upon middle school graduation.

The remainder of this study is organized as follows. The second section presents a model of the decision to enroll in high school that formally shows the different ways that age of enrolment may affect the enrolment decision. The data and methodology are described in Section 3, and Section 4 presents the main empirical results. Evidence on mechanisms is presented in Section 5, and Section 6 concludes.

Fig. 3. Average School Entry Age for Older and Younger Cohorts across Birth Month. Data source: CFPS 2010. Note: Older cohorts are people whose age is between province-hukou specific school entry norm and 16 years old when CEL was implemented. Younger cohorts are people who were under province-hukou specific school entry norm when CEL was implemented.

5 “NPC representative Qionghua Fu suggests to relax school entry age” http://cnews.chinadaily.com.cn/2015-04/09/content_20038991.htm
“Primary starting age shouldn’t be limited to September 1st” https://www.sohu.com/a/217151218_161795
2. Model

To motivate the empirical analysis, we present a simple model of the decision to enroll in high school. Following Charles et al. (2018), the decision to attend high school depends upon whether the benefits outweigh the costs. In particular, we highlight the effect of school entry age on cognitive development and opportunity cost.

Students who have just completed middle school in year $t$ face the decision of either going to high school or participating in the labor market (for simplicity we exclude other options). Their age upon finishing middle school is $a_t$ and their age when they begin primary school is thus $a_t - 9$. Assume that everyone works to age sixty and then retires. The lifetime income for middle school graduates (superscript $M$) and high school graduates (superscript $H$) can be expressed as:

$$
\begin{align*}
R^M_t &= \sum_{a_t=9}^{a_t-15} W^M_i(\theta_i|\Lambda_t), & \text{if work after middle school} \\
R^H_t &= \sum_{a_t=9}^{a_t-15} W^H_i(\theta_i|\Lambda_t) - F, & \text{if attend high school}
\end{align*}
$$

$W^M_i$ and $W^H_i$ are the expected wages for middle school and high school graduates given information set $\Lambda_t$, with $W^M_i(\theta_i|\Lambda_t) > W^H_i(\theta_i|\Lambda_t)$. For simplicity, we assume that $W^M_i$ and $W^H_i$ are already adjusted by the discount rate. Wages are a positive function of ability $\theta_i$. $F$ is the tuition fees and other costs of high school, which we assume is paid at the time of school entry.

Then the payoff to attending high school, $R_t$, can be written as

$$R_t = \sum_{a_t=9}^{a_t-15} \pi_i(\theta_i|\Lambda_t) - F - I_t, \quad (1)$$

where $\pi_i$ is the wage premium for completing high school, equal to $W^H_i - W^M_i$, and $I_t$ is the forgone income (opportunity cost) of attending high school. Thus, a student attends high school only when the benefits outweighs the costs, that is, $R_t \geq 0$, and the probability of going to high school increases with $R_t$. We could further introduce a psychic cost of (or preference for) attending school, which is a negative function of cognitive ability. However, this has the same implications as the wage premium being a positive function of ability, so does not change the model predictions.

How does school entry age ($a_t$) affect the decision to attend high school? In the model, we consider three ways for $a_t$ to affect the payoff function. The first is that a younger person can work longer given the same years of schooling, so that delay may reduce the returns to schooling. In reality, this mechanism is expected to be weak because of uncertainty over retirement age given future policy changes and the high frequency of informal work, as well as the severe discounting of benefits more than forty years into the future.

The second effect of age of enrolment is its influence on cognitive development. Stipek (2002) predicts the relationship to be positive because older students are more mature. However, it is possible that younger students learn more from their older peers (Black et al., 2011) who can act as positive role models (Argys et al., 2006). As noted earlier, the impact of the age of enrolment on learning may also depend on the child’s experience prior to enrolment. Birth to age six is a sensitive period for learning (Montessori, 1995), which means the relationship between school entry age and attained education could be negative if pre-school stimulus is absent.

Finally, we consider the impact of the age of enrolment on the labor market opportunity cost of attending high school. Given the evidence presented earlier, we assume that the opportunity cost increases with age, i.e. $\frac{\partial I}{\partial a_t} > 0$. Age sixteen is the minimum legal age of employment in China. At that age, youth can apply for national identity cards which can facilitate employment and migration (De Brauw and Giles, 2017). In practice, many employers prefer hiring workers older than age 18 because of extra responsibilities associated with hiring younger employees. In areas where primary school starts at the age of 6 (7), being born just before or after the cutoff birth date for eligibility affects whether they are 15 or 16 (16 or 17) when they complete middle school, an age range in which differences in age correspond to very different labor market opportunities.

We can rewrite Eq. (1) to capture the channels through which the payoff to attending high school, $R_t$, is influenced by $a_t$:

$$R_t = B_i(\theta_i(a_t), a_t) - F - I_i(a_t), \quad (2)$$

where $B = \sum_{a_t=9}^{a_t-15} \pi_i(\theta_i|\Lambda_t)$. In Eq. (2), $a_t$ influences the wage premium both indirectly through its effect on ability $\theta_i$ and directly through its impact on years of work. Then, the marginal effect of school entry age on the return to attending high school is:

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6 One can consider the high school wage to include the option value of attending college and earning a much higher wage.

7 Cognitive skills can also affect one’s ability to pass competitive exams to get into high school. This effect yields the same prediction as our demand story so reinforces the model’s prediction that higher ability increases the probability of attending high school. We also do not explicitly model the effect of ability on the opportunity cost of schooling. We thus implicitly assume that such an effect is outweighed by the greater premium to high school education for those with greater ability.

8 According to China’s Law of Protection of Minors, any organization or individual that hires minors who have reached the age of sixteen but not the age of eighteen shall observe State regulations regarding job types, working hours, and labour and protective measures, and may not assign such employees to over strenuous jobs, jobs exposed to toxic or hazardous substances, or other jobs that imperil their physical or mental health.
The three terms on the right-hand side of this expression correspond to the three channels through which age of enrolment affects the decision to attend high school. The first term describes the impact on cognitive development, the sign of which is unclear due to the ambiguous relationship between school entry age and cognitive skills. The third term is the impact on opportunity cost; a later age of enrolment increases opportunity cost so negatively affects the payoff to attending high school. Overall, the effect of school entry age on high school enrolment is theoretical ambiguous. If school entry age has no effect or a negative effect on cognitive development, then delayed school enrolment is expected to lower the probability of attending high school. However, if school entry age has a positive effect on cognition, then the overall impact depends on the relative magnitudes of the three channels.

3. Data and methodology

3.1. Data

We use two complementary datasets in the analysis. China’s 2005 mini-census data is a nationally representative sample covering 1% of the total population. The 2010 China Family Panel Study (CFPS) surveyed more than 14,000 households in 25 provinces, and collected individual-, family-, and community-level data. Importantly, it contains detailed educational histories which enable us to compute each individual’s school entry age. We combine those two data sources because CFPS has information on school entry but has limited observations, while the mini-census covers a much larger sample size but lacks information on school entry.

Summary statistics are provided in Table 1. We restrict attention to birth cohorts between 1970 and 1989 because earlier cohorts were too old to be affected by the Compulsory Education Law and many persons in the later cohorts had not completed their middle school by 2005. A comparison between people born in the older cohort group and younger cohort group is consistent with declining enrolment age and increasing educational attainment over time, as seen in Fig. 2. Of greatest relevance to our identification strategy, the decline in school entry age of individuals born before the end of August (0.34 years) is much greater that the decline for those born after August (0.13 years), confirming a delayed effect of being born after August following implementation of the new Law. Also consistent with our story, the high school enrolment rate increases much more for those born before the end of August compared to those born after August. In terms of other characteristics, there are no obvious differences in older and younger cohorts for those born before the end of August and those born after August. The significant DID term of the current hukou status in the mini census may...
reflect the fact that those born with rural hukou who are born after August in younger cohorts are less likely to obtain urban hukou because they receive less education. We control for gender and hukou status in the subsequent analysis.

The CFPS only asks school entry information for individuals who have at least finished primary school, so the school entry age of individuals who never finished primary school is unavailable (10.7% of the total sample). We further drop those with missing values (15.6%) and with school starting age below 4.75 or above 8.75 (18.5%), because only compliant individuals are sensitive to the attendance policy and extreme values also are more likely to reflect measurement error. The age window between 4.75 and 8.75 covers the most likely school entry decisions made by those in the same birth cohort. For example, individuals born in September 1980 could have entered school between 1985 and 1988, with possible school entry ages of 5, 6, 7, and 8. We further drop these individuals from the analysis.

3.2. Identification

China’s Compulsory Education Law (CEL henceforth) was passed in April 1986 and came into force on a national scale in July of the same year. In addition to mandating nine years of compulsory education, the CEL states that “All children who have reached the age of six shall enroll in school and receive compulsory education for the prescribed number of years, regardless of sex, nationality or race. In areas where that is not possible, the beginning of schooling may be postponed to the age of seven. The cutoff date is August 31.”

We exploit a change in the legal age-eligibility threshold mandated by the Compulsory Education Law to capture the exogeneity of school entry age. CEL can have three different effects: (1) increase in education for those who are age 15 and younger due to the mandatory requirement to complete 9 years of schooling; (2) reduction in school entry age for those who haven’t started school because of enforcement of younger school starting age; and (3) increase in school entry age for those who are born after August and haven’t started school compared to those born before the end of August. An interaction term between After8 (birth month after August) and Younger cohort (birth cohort influenced by the policy) is used as an instrumental variable for school entry age. People who are born after August are defined as the treatment group, while people who are born before September are the control group. Compared to peers in the same birth year cohort, CEL only holds back those born after August (After8−1) from starting primary school.

The younger cohort includes those who had not yet started primary school when the CEL was first implemented, and so are affected by both the earlier school entry age as well as the requirement that they complete 9 years of schooling. The older cohort includes those who were already older than the required school entry age but in an age range expected to still be enrolled in primary or middle school when the CEL was first implemented. Such students also were bound by the new 9-year schooling requirement but were not affected by new rules regarding school enrolment age. This way of defining younger and older cohorts enables us to isolate the impact of the new Law’s age eligibility rules for primary school enrolment.

Employing a difference-in-difference strategy relies on the assumption that any unobserved trends or time-specific events have the same effect on those born after August as on those born before the end of August in the same year, and also only affect those who are in the younger cohort (younger than a specific age at the time CEL was first implemented in that province). Fig. 4 plots the coefficients of the interactions between dummy variables for different ages when the CEL was implemented and a dummy for being born after August.

For estimates of the total impact of the Law on educational attainment, see Fang et al. (2012).
Individuals who were born too early to be affected by the school starting age eligibility rule (age 9 and older) show no impact on schooling age of being born after August. In contrast, individuals aged eight and younger show a significantly positive increase in school entry age for if born after August. The positive and significant sign for those aged 7 and 8 likely reflects the fact that local governments had some discretion in adjusting the required age of enrolment under the new Law. Fig. 5 presents the school enrolment age norms by province and hukou status based on the actual enrolment patterns found in the CFPS data. Most provinces initially set mandatory school entry age to be seven, while only a few provinces (such as Shanghai) adopted age six as the school entry age in both urban and rural areas. Some provinces like Beijing set different school entry ages for urban versus rural areas. We use the age of enrolment norms presented in Fig. 5 to define which age children are affected by school enrolment age rules when the CEL was first implemented.

We further examine whether there are treatment-control differences in pre-determined variables (gender, hukou at age 3, and parents’ education level) that change across cohorts. None of them show any systematic changes for older versus younger cohorts (Appendix- Fig. A1 ). Similarly, Fig. 6 plots the coefficient of the interaction between a dummy for being in a younger cohort and dummies for birth month. The new attendance rule only increases school entry age of students born after August. Even though there may be other contemporary policies whose effects vary with age or maturity, they must affect certain cohorts and birth months with the exact same timing as the CEL; otherwise, they aren’t identification concerns.

Our identification strategy takes advantage of differences across provinces in the timing of implementation of the Compulsory Education Law. We also check the robustness of the results to controlling for cohort pre-trends for those born before and after the end of August. Following Bilinski and Hatfield (2019), we add the interaction between after8 and linear birth year to the initial regression model in Equation (4), and transform the interaction term between after8 and younger into after8 and dummies for each post-intervention year. We find that pre-trends are not statistically different for the two groups (Appendix-Table A2) and that controlling for pre-trends does not significantly alter the magnitude of the estimated treatment effect (0.215 assuming parallel pre-trends compared to 0.225 allowing for differential pre-trends). Controlling for pre-trends does increase the standard errors of the estimate, so given the lack of any evidence of differential pre-trends we exclude them in the reported estimates.

Fig. 5. School Entry Norm in Younger Cohorts by Province and Hukou. Data source: CFPS 2010. Note: School entry norm is identified by the most frequently observed school entry age among people born in and before August since 1980 in each province by hukou status.

Fig. 6. Coefficients of the Interaction between Younger Cohort Dummy and Birth Month Dummies in School Entry Age Equation. Data source: CFPS 2010. Note: January is the reference group.
Education Law. Even though it was passed nationally in 1986, the \textit{de facto} implementation was devolved to provincial governments, and the commencement date for each province varied from 1985 to 1994 (see Table 2). Fig. 7 shows that GDP per capita in 1986 predicts strongly whether the Law was implemented after 1987, but cannot explain the timing between 1985 and 1987.

Younger is defined based on the implementation year and new school entry age norm of those with rural or urban \textit{hukou} in each province. Using a difference-in-difference design is very suitable for the Chinese setting. Others have found that enforcement of the cutoff date of August 31st is highly imperfect (Zhang and Xie, 2017; Guo et al., 2017); there exist violators who enter primary school earlier or later than they are supposed to. Barua and Lang (2009) provide a full discussion of the potential problems that may arise when such a

\begin{table}
\centering
\caption{Implementation Date of Compulsory Education Law in Different Provinces.}
\begin{tabular}{ll}
\hline
Province & Implementation date \\
\hline
Zhejiang & 1985/9/1 \\
Jiangxi & 1986/2/1 \\
Heilongjiang & 1986/7/1 \\
Liaoning & 1986/7/1 \\
Hebei & 1986/7/1 \\
Shanxi & 1986/7/1 \\
Ningxia & 1986/7/1 \\
Sichuan & 1986/7/1 \\
Chongqing & 1986/7/1 \\
Beijing & 1986/7/8 \\
Jiangsu & 1986/9/9 \\
Shanghai & 1986/9/10 \\
Shandong & 1986/9/12 \\
Henan & 1986/10/1 \\
Guangdong & 1986/10/7 \\
Yunnan & 1986/10/29 \\
Tianjin & 1986/11/6 \\
Jilin & 1987/2/9 \\
Hebei & 1987/3/1 \\
Shaanxi & 1987/9/1 \\
Anhui & 1987/9/1 \\
Guizhou & 1988/1/1 \\
Xinjiang & 1988/5/28 \\
Fujian & 1988/8/1 \\
Inner Mongolia & 1988/9/15 \\
Qinghai & 1988/10/1 \\
Gansu & 1990/9/3 \\
Hunan & 1991/9/1 \\
Guangxi & 1991/9/1 \\
Hainan & 1991/12/16 \\
Tibet & 1994/7/1 \\
\hline
\end{tabular}
\end{table}

Note: The above dates are from Decisions about Compulsory Education Law, which can be found in each provincial government’s website. We don’t have observations in Xinjiang or Tibet. Their implementation dates are listed for reference.

Fig. 7. GDP per capita at 1986 and Provincial Implementation Year.
3.3. Empirical specification

We estimate the following empirical specification for the determinants of attending high school:

$$H_{ipt} = \alpha_0 + \alpha_1 S_{ipt} + X_{ipt}' \alpha_2 + \lambda_p + \delta_t + \epsilon_{ipt},$$  

(3)

where $H_{ipt}$ is an indicator variable for whether individual $i$ in province $p$ born in year $t$ attends high school. According to the CFPS data, over 95% of individuals who start high school also finish high school. $S_{ipt}$ is school starting age, $X_{ipt}$ is a vector of control variables including gender, hukou type, and parents' education, $\lambda_p$ are provincial fixed effects, $\delta_t$ are birth year fixed effects, and $\epsilon_{ipt}$ is the error term which captures unobserved factors and measurement error. We are concerned that school entry age may be correlated with unobserved factors that affect the high school enrolment decision ($\text{Cov}(S_{ipt}, \epsilon_{ipt}) \neq 0$). To address this potential endogeneity we use exogenous variation in age of enrolment caused by the differential effect of the Compulsory Education Law on those born after August:

$$S_{ipt} = \beta_0 + \beta_1 \text{After8}_p + \text{Younger}_{ipt} + X_{ipt}' \beta_2 + \gamma_p + \text{Younger}_{ipt} + \lambda_p + \delta_t + \mu_{ipt},$$

(4)

Here, $\text{After8}_p$ equals one if the individual is born after August and $\text{Younger}_{ipt}$ equals one if the individual’s birth year cohort is influenced by the new cut-off rule. We also include the control variables $X_{ipt}$, a vector of birth month dummies $\gamma_t$, province fixed effects $\lambda_p$, and birth year fixed effects $\delta_t$. We expect $\beta_1$ to be positive, because the Compulsory Education Law causes a delay in school entry age only for those born after August.

Because nonlinear discrete choice models that control for endogeneity require restrictive assumptions on the error term, we estimate linear probability models of the decision to attend high school. We can estimate a reduced form version of Eq. (3) by replacing school entry age with the instrument (interaction between $\text{After8}_p$ and Younger$_{ipt}$). Because the 2005 mini-census does not contain information on school entry age, we employ a Two-Sample Two-Stage-Least-Square (TS2SLS) estimator to quantify the impact of school entry age on the probability of attending high school.

Following Pacini and Windmeijer (2016), we proceed in four steps. First, we estimate the first stage, Eq. (4), using the 2010 CFPS, and save the coefficients. Second, we apply these coefficients to the 2005 mini-census data to obtain predicted school entry age $S_{ipt}^{\text{Census}}$. Third, we estimate the second stage equation, Eq. (3), using the predicted school entry age to obtain the TS2SLS estimator:

$$H_{ipt} = \alpha_0 + \alpha_1 S_{ipt}^{\text{Census}} + X_{ipt}' \alpha_2 + \gamma_p + \text{Younger}_{ipt} + \lambda_p + \delta_t + \epsilon_{ipt},$$

(5)

Finally, we compute the TS2SLS asymptotic variance of the coefficients as a function of the variances and covariances of the OLS first stage and reduced form estimates (see Pacini and Windmeijer (2016) for more details).

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Angrist and Kruger (1992) were the first to use TSIV to combine two complementary samples, where Sample I has data on the endogenous independent variable $x$ and the instrumental variable $z$, and Sample II has data on the dependent variable $y$ and the instrumental variable $z$. Later, Inoue and Solon (2010) showed that TS2SLS is preferred over TSIV because it is asymptotically more efficient.
5. Results

In this section, we present the main estimation results. We start by presenting the first stage estimation results using the 2010 wave of the CFPS, which shows how the Compulsory Education Law reshaped attendance patterns of those born in different months. Next, we report reduced form estimation results using both the 2005 mini-census data and the 2010 wave of the CFPS. This includes an exploration of impacts on enrolment in different levels of schooling conditional on attending previous levels of schooling. Then, we report the two-sample two-stage least squares (TS2SLS) estimates of the impact of school enrolment age on the probability of high school attendance. We also conduct robustness tests at the end of this section.

5.1. First stage estimation

The 2010 wave of the CFPS contains detailed questions on educational attainment and the information required to calculate school entry age, so it can be used to study the impact of the Compulsory Education Law on the age of primary school enrolment. We present the first-stage estimation results for Eq. (4) controlling for gender, hukou status, the younger cohort dummy as well as province, birth year, and birth month fixed effects in Table 3.

<table>
<thead>
<tr>
<th>DV: School entry age</th>
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<tbody>
<tr>
<td>After8*Younger</td>
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<tr>
<td></td>
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<tr>
<td>Male</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Rural</td>
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<td></td>
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<tr>
<td>Younger cohort</td>
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<td>Constant</td>
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<tr>
<td>Mean of DV</td>
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<tr>
<td>Cragg-Donald Wald F statistic</td>
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<tr>
<td>Kleibergen-Paap rk Wald F statistic</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>R-squared</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses are clustered by municipality. *** p<0.01, ** p<0.05, * p<0.1.
Column (1) use province-hukou specific school entry norm to define younger cohort.
Only samples with school entry age between 4.75 and 8.75 years old are included in the regression. Provincial weights and IPW of falling within the age window are controlled in both columns.

Table 3 uses province-hukou school entry norms presented in Fig. 5 to define the younger cohort, which is also done for all of the subsequent analysis. The Compulsory Education Law increased the age of primary school enrolment by 0.241 years for children born after August, compared to children born before September. The coefficient is statistically significant at the 99% confidence level. Note that the magnitude is smaller than the prediction of 0.5 years if the Law completely shifted from a strict December threshold to a strict September threshold, suggesting that compliance with the new Law was not perfect. The Cragg-Donald Wald F statistic for the instrument in the first stage regression is over 20, passing the rule of thumb test for weak instruments. The first stage estimator without controlling for IPWs is 0.197, significant at 99% confidence level, indicating that the result is not sensitive to using IPW to control for selection bias.

Zhang and Xie (2017) inferred that only half of Chinese families comply with the new attendance rule in CEL. Fertig and Kluve (2005) also found the compliance is particularly weak in West Germany during the month of July and August. Understanding who are the compliers and who are the violators of the new attendance rule is essential for interpreting the effect of school entry age on education. Using the province-hukou specific school entry norms in Table 4, we calculate that 43% of the younger sample are compliers. The actual compliance rate should be higher since we use a rough province-hukou specific norm but the de-facto decisions were made by country level governments. Compared to noncompliers (those who start school too early or too late), compliers are disproportionately urban and have more educated parents. Thus, compliers appear to come from better-off households. If we believe that a higher proportion of children from such households have a clear intent to attend high school to pursue aspirations to enter college regardless of school entry age, then we can view the magnitude of the TS2SLS and 2SLS estimators as being lower-bound estimates of the impact of school entry age for the whole population.

19 Full regression results are available upon request.
5.2. Effect of school entry age on high school enrolment

Next, we report reduced form estimates using both the 2010 CFPS data and the 2005 mini-census data. The mini-census dataset is much larger, so is expected to yield more precise and representative estimates. The dependent variable is a dummy variable for whether the individual attended high school. We estimate Eq. (3), replacing school entry age with the instrument—\( \text{After8} \times \text{Younger} \). Results are presented in Table 5, showing a consistently negative impact of delayed enrolment on high school attendance. As is reported in Column (1), which covers all the provinces using the 2005 mini-census data, the new Law reduces the likelihood that children born after August attend high school by 0.82% compared to those born before August. Restricting the sample to the same 25 provinces covered by the CFPS, the estimate is slightly larger at 0.87% (Column (2)). Both coefficients are significant at the 99% confidence level. This compares to the estimate of 0.4% using the 2010 CFPS data (Column (3)), which is not statistically significant likely due to the much smaller sample size.

In order to confirm that our results on high school attendance are not driven by failure to complete earlier levels of schooling, using the census data we also examine the reduced form impacts of attending different schooling levels, conditional on achieving lower levels

### Table 4
Comparison between compliers, early entrants and late entrants.

<table>
<thead>
<tr>
<th></th>
<th>Compliers</th>
<th>Early entrants</th>
<th>Late entrants</th>
<th>Diff (Early-Complier)</th>
<th>Diff (Late-complier)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>43.45%</td>
<td>42.19%</td>
<td>14.36%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>0.485</td>
<td>0.503</td>
<td>0.501</td>
<td>0.018</td>
<td>0.016</td>
</tr>
<tr>
<td>Rural hukou at 3</td>
<td>0.744</td>
<td>0.792</td>
<td>0.803</td>
<td>0.048***</td>
<td>0.059***</td>
</tr>
<tr>
<td>Father finished high school</td>
<td>0.202</td>
<td>0.221</td>
<td>0.177</td>
<td>0.019*</td>
<td>–0.025**</td>
</tr>
<tr>
<td>Mother finished high school</td>
<td>0.120</td>
<td>0.123</td>
<td>0.066</td>
<td>0.003</td>
<td>–0.054***</td>
</tr>
</tbody>
</table>

Note: Compliers are people who follow the province-hukou specific norm strictly. Early entrants are people who begin school earlier than the local criteria, and late entrants are people who begin school later than the local criteria.

### Table 5
Reduced Form Estimation of Potential Delayed Enrolment on High School Enrolment.

<table>
<thead>
<tr>
<th>DV: High school enrolment</th>
<th>2005 Census</th>
<th>2010 CFPS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>31 provinces</td>
<td>25 provinces</td>
</tr>
<tr>
<td>After8*Younger</td>
<td>–0.00819*** (0.00236)</td>
<td>–0.00870*** (0.00240)</td>
</tr>
<tr>
<td>Gender</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Current hukou</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Birth month</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Birth year</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Province</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Mean of DV</td>
<td>0.318</td>
<td>0.324</td>
</tr>
<tr>
<td>Observations</td>
<td>752,714</td>
<td>656,242</td>
</tr>
</tbody>
</table>

|                          | 2010 CFPS |
|                          | (3)       | (4)       |
|                          | 25 provinces| 25 provinces +restriction on school entry age |
| After8*Younger           | –0.00382 (0.0229) | –0.0141 (0.0308) |
| Gender                   | Y | Y |
| Current hukou            | Y | Y |
| Birth month              | Y | Y |
| Birth year               | Y | Y |
| Province                 | Y | Y |
| Mean of DV               | 0.330 | 0.456 |
| Observations             | 5581     | 10,074 |

Note: Standard errors in parentheses are clustered by municipality.  *** \( p<0.01 \), ** \( p<0.05 \), * \( p<0.1 \).

Column (4) only keeps samples with school entry age between 4.75 and 8.75. Provincial weights are controlled in both datasets.

### Table 6
Reduced Form Estimation of Potential Delayed Enrolment on Different Education Level (2005 Census).

<table>
<thead>
<tr>
<th>DV</th>
<th>2005 Census</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary school</td>
<td>(1)</td>
</tr>
<tr>
<td>Middle school conditional on primary school enrolment</td>
<td>(2)</td>
</tr>
<tr>
<td>High school conditional on middle school enrolment</td>
<td>(3)</td>
</tr>
<tr>
<td>After8*Younger</td>
<td>–0.00184*** (0.00628)</td>
</tr>
<tr>
<td>Gender</td>
<td>Y</td>
</tr>
<tr>
<td>Current hukou</td>
<td>Y</td>
</tr>
<tr>
<td>Birth month</td>
<td>Y</td>
</tr>
<tr>
<td>Birth year</td>
<td>Y</td>
</tr>
<tr>
<td>Province</td>
<td>Y</td>
</tr>
<tr>
<td>Mean of DV</td>
<td>0.975</td>
</tr>
<tr>
<td>Observations</td>
<td>752,714</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses are clustered by municipality.  *** \( p<0.01 \), ** \( p<0.05 \), * \( p<0.1 \).

Provincial weights are controlled in all the columns.  Dependent variables are whether enrolled in primary school, middle school, and high school conditional on enrolment in last stage.

## 5.2. Effect of school entry age on high school enrolment

Next, we report reduced form estimates using both the 2010 CFPS data and the 2005 mini-census data. The mini-census dataset is much larger, so is expected to yield more precise and representative estimates. The dependent variable is a dummy variable for whether the individual attended high school. We estimate Eq. (3), replacing school entry age with the instrument—the interaction term \( \text{After8} \times \text{Younger} \). Results are presented in Table 5, showing a consistently negative impact of delayed enrolment on high school attendance. As is reported in Column (1), which covers all the provinces using the 2005 mini-census data, the new Law reduces the likelihood that children born after August attend high school by 0.82% compared to those born before August. Restricting the sample to the same 25 provinces covered by the CFPS, the estimate is slightly larger at 0.87% (Column (2)). Both coefficients are significant at the 99% confidence level. This compares to the estimate of 0.4% using the 2010 CFPS data (Column (3)), which is not statistically significant likely due to the much smaller sample size.

In order to confirm that our results on high school attendance are not driven by failure to complete earlier levels of schooling, using the census data we also examine the reduced form impacts of attending different schooling levels, conditional on achieving lower levels...
of schooling. Table 6 repeats the reduced form estimations for three dependent variables: entering primary school, entering middle school conditional on primary school enrolment, and entering high school conditional on middle school enrolment. The instrumental variable shows a minimal effect on the probability of enrolling in primary school and the probability of enrolling in middle school. In contrast, for middle school students the probability of attending high school falls by 1.1% if they are born after August. The fact that it is only high school enrolment that is influenced by older age of enrolment consistent with our model and story emphasizing the role of labor market opportunity cost.

Finally, we present our estimates of the impact of delayed enrolment on the probability of high school attendance in Table 7. Our preferred estimate is the TS2SLS estimator reported in Column (3), which combines first-stage estimates using the 2010 CFPS data with reduced form estimates using the 2005 mini-census data, both of which find statistically significant impacts of the instrument. We have made the samples from the two datasets as comparable as possible, covering the same provinces and birth cohorts and with the same control variables. According to the estimates, one year of delayed schooling reduces the probability of attending high school by 3.6 percentage points. Given that 32% of students in the sample attend high school, this impact equals a reduction in high school enrolment of 11.1%. We also report the OLS and IV estimates of the negative impact of delayed enrolment on high school attendance using the 2010 CFPS data, which are 3.3 and 5.8 percentage points, respectively. The IV estimate has a large standard error, making it impossible to reject the hypothesis that it is identical to the TS2SLS estimate which falls between the OLS and IV estimates using the 2010 CFPS data. One possible explanation for the positive bias in the negative OLS coefficient is measurement error in school entry age.

Overall, we extend the findings of previous studies that show negative impacts of delayed enrolment on middle school outcomes in

### Table 7

**Estimation Results of High School Enrolment on School Entry Age.**

<table>
<thead>
<tr>
<th>DV: High school enrolment</th>
<th>2010 CFPS</th>
<th>2005 Census</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data source</td>
<td>OLS</td>
<td>2SLS</td>
</tr>
<tr>
<td>(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| School entry age          | −0.0335*** (0.00933) | −0.0586 (0.127) | −0.0360*** (0.0125) |
| Gender                    | Y          | Y           | Y            |
| Current hukou             | Y          | Y           | Y            |
| Birth month               | Y          | Y           | Y            |
| Birth year                | Y          | Y           | Y            |
| Province                  | Y          | Y           | Y            |
| Mean of DV                | 0.456      | 0.456       | 0.324        |
| Observations              | 5581       | 5581        | 655,637      |

Note: Standard errors in parentheses are clustered by municipality. *** p<0.01, ** p<0.05, * p<0.1. Provincial weights are controlled in each column. Only samples with school entry age between 4.75 and 8.75 are kept in Column (1) and (2). IPW of falling within the age sample is controlled in Column (1) and (2).

### Table 8

**Robustness check.**

<table>
<thead>
<tr>
<th>DV</th>
<th>(1) Exclude Zhejiang</th>
<th>(2) Exclude Aug and Sep</th>
<th>(3) Exclude first influenced birth cohort</th>
<th>(4) First stage TS2SLS</th>
<th>(5) First stage TS2SLS</th>
<th>(6) First stage TS2SLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DV</td>
<td>First stage</td>
<td>TS2SLS</td>
<td>High school enrolment</td>
<td>First stage</td>
<td>TS2SLS</td>
<td>High school enrolment</td>
</tr>
<tr>
<td></td>
<td>School entry age</td>
<td></td>
<td></td>
<td>School entry age</td>
<td>High school enrolment</td>
<td></td>
</tr>
<tr>
<td>After8*Younger</td>
<td>0.218*** (0.0787)</td>
<td>0.230*** (0.0878)</td>
<td>0.232*** (0.0763)</td>
<td>-0.0445*** (0.0157)</td>
<td>-0.0450*** (0.0165)</td>
<td>-0.0453*** (0.0152)</td>
</tr>
<tr>
<td>Kleibergen-Paap rk Wald F statistic</td>
<td>5454</td>
<td>639,275</td>
<td>4572</td>
<td>539,035</td>
<td>5306</td>
<td>652,457</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses are clustered by municipality. *** p<0.01, ** p<0.05, * p<0.1. Gender, current hukou, birth month, younger cohort dummy, birth year, province are controlled in each column. Provincial weights are controlled in each column. Only samples with school entry age between 4.75 and 8.75 are kept. IPW of falling within the age sample is controlled.
China (Chen, 2015; Zhang et al., 2017) to show that the largest enrolment impacts are actually at the high school level. Our findings contrast with the evidence in developed countries, which finds a positive impact of school entry age on educational attainment.

5.3. Robustness checks

We present a series of analyses to show the robustness of the main results presented in Column (1) of Table 3 and Column (3) of Table 7. We begin by re-estimating the main results by dropping Zhejiang Province (see first two columns of Table 8), where the new attendance rule began in 1985, ahead of the national law. The estimation results excluding Zhejiang are stable and robust, even though the first stage estimator is slightly smaller (0.218) while the TS2SLS estimate is slightly larger in magnitude (0.445).

Second, we re-estimate the main results by removing births close to the enrolment cutoff. Birth date manipulation is one common concern in evaluating school enrolment policy. If parents adjust the timing of births based on attendance policy or lie about their child’s birthdate, the negative correlation between school enrolment and education may only reflect family characteristics. Using a recent administrative data from one province in China for the years 2014–2016, Huang et al. (2020) find that a considerable number of births are shifted from the first week of September to the last week of August. The majority of our sample is born before the CEL was implemented, making it unlikely for them to anticipate the new attendance policy and plan births ahead of time. The percentage of August-born babies relative to September-borns is insignificantly different between cohorts two years before the CEL and two years after the CEL.

As shown in the third and fourth columns of Table 8, dropping births in August and September doesn’t affect the first stage or TS2SLS estimates. This is consistent with there being no manipulation of birth month at the cutoff (August).

At last, a change in the enrolment threshold may have a direct impact on the total number of students who enroll in the first year the new birth month eligibility rules are enforced because those born after August may be asked to delay schooling by one year, leaving a smaller grade one class size. We evaluate this grade size effect by excluding the first influenced cohort in Columns (5) and (6). Both the first stage and TS2SLS estimates are consistent with the baseline results, ruling out the possibility that the negative impact is driven by the effect of the new law on the size of one specific schooling cohort.

6. Mechanisms

In this section, we discuss two mechanisms that may help explain the negative impact of delayed enrolment on high school attendance in China, and in developing countries more generally. The first mechanism is that delayed enrolment could reduce children’s learning ability given that children often receive insufficient stimulation when they are not in primary school. Many parents are poorly educated, busy working, and unaware of the importance of providing stimulus to their children, and access to kindergarten and/or nursery school was limited in rural China until recently. Variation in school entry age may lead to differences in the development of cognitive skills (Montessori, 1995; Stipek, 2002), and those with better cognitive skills are more likely to go farther in school.

The second mechanism is the greater labor market opportunity cost of schooling for older students. Children who delay school entry age complete compulsory education at older ages, and can earn higher wages when considering whether to enter the labor market or enroll in high school.

To test the impact of school entry age on cognitive development, we analyze data from the Gansu Survey of Children and Families (GSCF), a longitudinal study of 2000 children in rural villages of Gansu Province who were aged 9 to 12 in the year 2000. Around 85%
of them were successfully followed in 2004. Since all of the respondents were born after CEL was implemented and Gansu strictly enforced the age of enrolment policy for these birth cohorts,\(^{21}\) we use expected school entry age based on the August 31st threshold\(^ {22}\) as an IV for school entry age. The strictness of enforcement reduces concerns about bias caused by non-compliance patterns.

The 2SLS estimators for Chinese and math test scores by grade level are reported in Fig. 8. In the 2000 wave, surveyed students were mainly in grades 2 to 4. Half of the sample was randomly assigned to take the Chinese test, while the other half took the math test. In the 2004 wave, students were mainly in grades 7 to 9, all of whom took both Chinese and math tests. We normalize the test scores to be standard deviations from mean by grade level. School entry age shows a significantly negative impact on Chinese and math test scores in Grade 2 (the coefficient on the math test score is significant at the 10% significance level). The negative impact of a one-year delay in enrolment on the probability of attending high school increases by about 5.3% and

<table>
<thead>
<tr>
<th>DV: High school enrolment Data source</th>
<th>2005 Mini Census</th>
<th>2010 CFPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>After8*Younger</td>
<td>0.0044*</td>
<td>0.00791</td>
</tr>
<tr>
<td></td>
<td>(0.0025)</td>
<td>(0.0260)</td>
</tr>
<tr>
<td>After8*Younger * Migration_city_z</td>
<td>0.0128***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0029)</td>
<td></td>
</tr>
<tr>
<td>After8*Younger * Migration_vil_z</td>
<td>0.0141</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0207)</td>
<td></td>
</tr>
<tr>
<td>Municipality fixed effects</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Village fixed effects</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Mean of DV</td>
<td>0.168</td>
<td>0.142</td>
</tr>
<tr>
<td>Observations</td>
<td>448,679</td>
<td>5837</td>
</tr>
</tbody>
</table>

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

Migration_city_z is the standardized out-migration rate at municipality level. Migrants are defined as people who have left their hukou registration place. Migration_city_z is calculated from 2000 Census.

Migration_vil_z is the standardized share of households with at least one migrant in village. Migration_vil_z is calculated from 2010 CFPS. In column (1), migration rate, birth month, birth year, gender and municipality dummies are controlled for. In column (2), migration rate, birth month, birth year, gender, parents’ education levels and village dummies are controlled. Provincial weights are controlled for in each column.

Next, we examine the relevance of higher labor market opportunity cost at older ages. De Brauw and Giles (2017) find a negative impact of greater regional migration opportunity on high school enrolment, arguing that larger migrant networks for low-skilled jobs reduce migration costs and increase job opportunities, leading more middle-school graduates to forego high school and enter the labor market. We build upon this idea by investigating whether school entry age has a more negative effect on high school attendance when migration job opportunities are greater.

We use two migration-based measures of opportunity cost, one for each dataset. When analyzing the 2005 mini-census data, migrant opportunity is measured by rural people’s historical out-migration rate at the city level as measured in the 2000 Census.\(^ {24}\) For the 2010 CFPS data, we use the village share of households with at least one migrant (not living at home for most of the past year) as reported by village leaders. Both measurements are standardized to be standard deviations from mean values. We test our hypothesis by estimating reduced form specifications for the determinants of attending high school and adding the opportunity cost variable and its interaction with the instrument (After8*Younger) as explanatory variables.

Since the migration measures of labor opportunity cost mainly influence the labor force in rural areas, we restrict the analysis to individuals with rural hukou. Using the 2005 mini-census data, we find that if the out-migration rate increases by one standard deviation, the negative impact of a one-year delay in enrolment on the probability of attending high school increases by about 5.3% and

---

\(^{21}\) See first stage in Appendix-Table A3.

\(^{22}\) Expected school entry age= 7+(9-bmonth)/12 if birth month is between Jan to Aug. Expected school entry age =8+(9-bmonth)/12 if birth month is between Sep to Dec.

\(^{23}\) Impact of school entry age on Math test score in Grade 4 is xx, significant at 10% significance level.

\(^{24}\) Migrants are defined as people whose hukou registered municipality is different from the municipality where they reside.
this difference is statistically significant. The magnitude of this effect is large in comparison to the overall −3.6% impact of delayed schooling on high school enrolment probability.

Using the CFPS data and village outmigration as the labor opportunity cost variable, we find a similar effect, although the small sample size limits the precision of the estimates. We report results using village fixed effects in columns (2) of Table 9. The reduced form coefficient estimate for the interaction term between the instrument and county migration rates is −0.0130 as well but not statistically significant. The lack of significance using village fixed effects may partly be explained by the small sample size per county (around 12 observations). Overall, the results indicate that the opportunity cost story plays an important role in explaining why delayed school entry age reduces the probability of attending high school in China. However, we caution that these findings should be interpreted as suggestive as migration rates may be correlated with other regional differences that could influence the impact of compulsory schooling laws in unknown ways.

7. Conclusion

In this study, we provide the first causal estimates of the impact of primary school entry age on educational attainment in a developing country setting based on an identification strategy that is not subject to bias due to the endogeneity of month of birth or to violations of a necessary monotonicity assumption because imperfect enforcement of age eligibility thresholds leads to the enrolment age of compliers to increase while that of violators decreases. China’s 1986 Compulsory Education Law, which established for the first time nationally uniform eligibility standards for the age of primary school enrolment, introduced exogenous variation in the impact of being born before or after the birthdate threshold in comparison to those born too early to be affected by the law. Using this variation to identify the impact of school entry age on the probability of attending high school, we find that in contrast to nearly all studies in developed countries which find positive effects, the relationship in China is negative and statistically significant. Delaying primary school enrolment reduces the probability of going to high school by 3.6 percentage points.

We propose two potential reasons for why the impacts of primary school enrolment age may have opposite signs in developed and developing countries, and provide empirical tests to assess their importance in the Chinese context. First, in developed countries older children are better prepared to learn, this presumes that when a child is not yet enrolled she is being stimulated by parents or in preschool or kindergarten. However, in developing countries, these conditions may not hold, with parents being unaware of the importance of stimulating their children or too busy to do so, especially if they out-migrate, and unable to send their children to kindergarten because they are not available locally or are too expensive. Using data for a sample of rural children, we show that children who delay enrolment are more likely to have lower test scores at the start of primary school, although they largely catch up at higher grades.

The second, more important reason that children in our developing country setting who delay the start of primary school are less likely to attend high school, is that those who start school later have a higher labor opportunity cost when they finish middle school and are deciding whether to enroll in high school. This is particularly true in China, where there is robust labor demand for unskilled labor and many middle school graduates migrate to other cities or provinces to take increasingly high-paying jobs. We provide evidence using both datasets (mini-census and China Family Panel Study) that the impact of enrolment age on high school attendance is much more negative in locations with greater migration opportunities (i.e., higher demand for unskilled labor).

These results suggest that globally, the relationship between school entry age and later education and labor outcomes may be context-dependent. Further research in different regions or countries may help shed further light on the nature of this dependence. Our findings also highlight a previously under-appreciated channel through which China’s Compulsory Education Law enhanced human capital investments—by requiring that children start primary school earlier. Previously, many families sent their children to school at even older ages. This beneficial effect on human capital is independent of that of the Law’s better known provision that all children should complete 9 years of compulsory education.

Appendix A


References


The 5.3% effect is calculated by dividing the difference in the reduced form effect (−0.0128) by the first stage coefficient reported earlier (0.241).

This makes it challenging to capture within village differences across birth cohorts (before versus after reform) and across birth months (after August).
Fig. A1. Coefficients of the Interaction between Age when CEL was Implemented and Born after August (age 16 and 17 is the reference group).

Fig. A2. Average school entry age across birth month. Note: The actual school entry age is calculated from a rural sample in Gansu. We use age 7 as the school entry criteria to generate expected school entry age since Fig. 8 indicates age 7 is the norm in rural Gansu.

Table. A1
Illustration of Selection of School Entry Age.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>5.67</td>
<td>6.67</td>
<td>7.67</td>
<td>8.67</td>
</tr>
<tr>
<td>Feb</td>
<td>5.58</td>
<td>6.58</td>
<td>7.58</td>
<td>8.58</td>
</tr>
<tr>
<td>Mar</td>
<td>5.50</td>
<td>6.50</td>
<td>7.50</td>
<td>8.50</td>
</tr>
<tr>
<td>Apr</td>
<td>5.42</td>
<td>6.42</td>
<td>7.42</td>
<td>8.42</td>
</tr>
<tr>
<td>May</td>
<td>5.33</td>
<td>6.33</td>
<td>7.33</td>
<td>8.33</td>
</tr>
<tr>
<td>Jun</td>
<td>5.25</td>
<td>6.25</td>
<td>7.25</td>
<td>8.25</td>
</tr>
<tr>
<td>Jul</td>
<td>5.17</td>
<td>6.17</td>
<td>7.17</td>
<td>8.17</td>
</tr>
<tr>
<td>Aug</td>
<td>5.08</td>
<td>6.08</td>
<td>7.08</td>
<td>8.08</td>
</tr>
<tr>
<td>Sep</td>
<td>5.00</td>
<td>6.00</td>
<td>7.00</td>
<td>8.00</td>
</tr>
<tr>
<td>Oct</td>
<td>4.92</td>
<td>5.92</td>
<td>6.92</td>
<td>7.92</td>
</tr>
<tr>
<td>Nov</td>
<td>4.83</td>
<td>5.83</td>
<td>6.83</td>
<td>7.83</td>
</tr>
<tr>
<td>Dec</td>
<td>4.75</td>
<td>5.75</td>
<td>6.75</td>
<td>7.75</td>
</tr>
</tbody>
</table>

Note: For children who are born in 1980, their possible school entry age is listed above. Those who attend primary school in 1986 and 1987 in bold are strict compliers with the attendance law.
Table. A2
First Stage Estimations under Parallel Pre-trends and Differential Pre-trends Assumption.

<table>
<thead>
<tr>
<th>DV = school entry age</th>
<th>(1) Parallel pre-trend</th>
<th>(2) Differential pre-trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>After8_{j=0}</td>
<td>0.121</td>
<td>0.119</td>
</tr>
<tr>
<td></td>
<td>(0.169)</td>
<td>(0.220)</td>
</tr>
<tr>
<td>After8_{j=1}</td>
<td>0.263*</td>
<td>0.261</td>
</tr>
<tr>
<td></td>
<td>(0.139)</td>
<td>(0.210)</td>
</tr>
<tr>
<td>After8_{j=2}</td>
<td>0.223*</td>
<td>0.221</td>
</tr>
<tr>
<td></td>
<td>(0.129)</td>
<td>(0.231)</td>
</tr>
<tr>
<td>After8_{j=3}</td>
<td>0.279**</td>
<td>0.277</td>
</tr>
<tr>
<td></td>
<td>(0.121)</td>
<td>(0.173)</td>
</tr>
<tr>
<td>After8_{j=4}</td>
<td>0.205</td>
<td>0.204</td>
</tr>
<tr>
<td></td>
<td>(0.130)</td>
<td>(0.178)</td>
</tr>
<tr>
<td>After8_{j=5}</td>
<td>0.277*</td>
<td>0.276</td>
</tr>
<tr>
<td></td>
<td>(0.155)</td>
<td>(0.194)</td>
</tr>
<tr>
<td>After8_{j=6}</td>
<td>0.158</td>
<td>0.157</td>
</tr>
<tr>
<td></td>
<td>(0.118)</td>
<td>(0.159)</td>
</tr>
<tr>
<td>After8_{j=7}</td>
<td>0.327***</td>
<td>0.326**</td>
</tr>
<tr>
<td></td>
<td>(0.124)</td>
<td>(0.148)</td>
</tr>
<tr>
<td>After8_{j=8}</td>
<td>0.199</td>
<td>0.198</td>
</tr>
<tr>
<td></td>
<td>(0.126)</td>
<td>(0.163)</td>
</tr>
<tr>
<td>After8_{j=9}</td>
<td>0.157</td>
<td>0.156</td>
</tr>
<tr>
<td></td>
<td>(0.117)</td>
<td>(0.141)</td>
</tr>
<tr>
<td>After8_{j=10}</td>
<td>0.249*</td>
<td>0.248*</td>
</tr>
<tr>
<td></td>
<td>(0.112)</td>
<td>(0.134)</td>
</tr>
<tr>
<td>After8_{j=11}</td>
<td>0.146</td>
<td>0.145</td>
</tr>
<tr>
<td></td>
<td>(0.144)</td>
<td>(0.152)</td>
</tr>
<tr>
<td>After8_{j=12}</td>
<td>0.238</td>
<td>0.238</td>
</tr>
<tr>
<td></td>
<td>(0.177)</td>
<td>(0.193)</td>
</tr>
<tr>
<td>Mean of above</td>
<td>0.218</td>
<td>0.217</td>
</tr>
<tr>
<td>Birth year*after8</td>
<td>0.000133</td>
<td>(0.0124)</td>
</tr>
<tr>
<td>Other controls</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Constant</td>
<td>7.349***</td>
<td>7.349***</td>
</tr>
<tr>
<td></td>
<td>(0.0886)</td>
<td>(0.0880)</td>
</tr>
<tr>
<td>Observations</td>
<td>5581</td>
<td>5581</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.160</td>
<td>0.160</td>
</tr>
</tbody>
</table>

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. j is age when CEL was implemented.

Table. A3
First Stage Estimation Results using Gansu Survey.

| Expected school entry age | 1.036*** |
|                          | (0.0542) |
| Gender                   | Y        |
| Mother's education level | Y        |
| Father's education level | Y        |
| Birth year               | Y        |
| Township                 | Y        |
| Constant                 | 0.175    |
|                          | (0.485)  |
| Mean of DV               | 7.853    |
| Cragg-Donald Wald F statistic | 285.728 |
| Kleibergen-Paap rk Wald F statistic | 330.462 |
| Observations             | 1882     |
| R-squared                | 0.286    |

Note: Standard errors in parentheses are clustered by village. *** p<0.01, ** p<0.05, * p<0.1.

Since all the observations are born in younger cohorts, we use expected school entry age as IV for actual school entry age. Expected school entry age= 7+(9-bmonth)/12 if birth month is between Jan to Aug. Expected school entry age= 8+(9-bmonth)/12 if birth month is between Sep to Dec.

Hukou status is not controlled because all the observations are from rural Gansu.


Fredriksson, Peter, Ockert, Bjorn, 2013. Life-cycle effects of age at school start. Econ J. 124.579, 977–1004.


