Understanding the Intergenerational Transmission of Human Capital: Evidence from a Quasi Natural Experiment in China

Dong Zhou[1] **and Aparajita Dasgupta**[2]

Abstract

This paper exploits the closure of senior secondary schools in urban China from 1966 to 1971 to identify the causal intergenerational transmission effects of education. The paper uses the IV approach to examine the intergenerational causality of educational transmission at the senior secondary schooling in urban China. The exogenous variations in parental senior secondary educational attainment both over time and across regions allow us to tackle for selection bias and thus identify the existence and extent of intergenerational transmission effect in education in China. We find evidence of causal intergenerational transmission effects which are stronger for daughters. We also show that our conclusion is robust to alternative identification strategies and data set.

Key Words: Intergenerational Transmission; Human Capital; IVs; Causality; China

JEL codes: I21, J13, J24

1. Introduction

[1] Assistant Professor at Shanghai Jiao Tong University, Minhang District, Shanghai, China

[2] Assistant Professor, Economics, Ashoka University

A robust positive correlation between parental education and children's schooling has been widely documented in literature. Despite the importance of the marginal effects of parental educational attainment on their children's schooling outcomes, the current literature has still not been able to discern the causality and selection effects in this positive correlation[3] which is crucial to distinguish from a policy perspective. First, if children's education attainment is improved by their parents because that better schooling of the parents has shaped their behaviors and personal traits in a certain way, the social benefits of supply of public education might be underestimated. This would be crucial in the sense it can provide insurance for initial conditions to curb lifetime inequality reaching further. Second, understanding the important factors of nurture is also broadly beneficial. It can direct the policies to pay attention to the working lifetime of parents (e.g., unemployment insurance or subsidy with necessary requirements of educational expenditure imposed). Better designed policies can help alleviate parents' current budget constraints, avoid potential ignorance of children's schooling during downturns and improve the outcomes of their children for the sake of long-run development. In this paper, we empirically study the intergenerational effects taking the case of urban China and examine the existence of causality of intergenerational transmission of education with instrument variables. We are also able to detect the patterns of gender heterogeneity in this transmission which are important for policy purpose.

Formal education system was dramatically impacted from 1966 to 1977 by the Cultural Revolution in urban China. The majority of senior secondary schools were shut down between 1966 and 1971. Although the closure was nationwide, the intensity of implementation varied across residential regions. Given the regional and time series variation, we exploit this plausible exogenous shock which is exogenous to parental ability as an Instrumental Variable. Specifically, the interactions between parental age and residential area are used as an instrument for parental senior secondary completion in the empirical model. Both the IV estimates and Difference-in-Difference estimates indicate the existence of causal link between senior secondary attainment of parents and children's senior secondary attendance. Further, estimates consistently indicate that the transmission from parents to daughters is stronger as compared to sons. The results are robust to alternative model specifications, subsamples and data source.

[3]Does the increase in schooling years of parents really make the parents different? Behave differently? Value differently? Or simply do more able parents end up with more able children (selection)?

The primary contribution of this paper is examining the causal relation between parental senior secondary schooling attainment and kids' senior secondary attendance in the largest developing country, China. Most of the existing literature is limited by its focus on reforms at lower levels of education[4]. Second, the policy is involved with a large scale of closure of senior secondary schools and a large affected population, and the empirical section utilize a large sample (China Census 1990). We argue that the implications of this paper can be very informative, especially for developing countries.

This paper is organized as follows. Section 2 reviews the current literature and discusses the historical background. Section 3 describes the data and the empirical strategy. Section 4 presents the empirical results. Robustness and mechanism discussions are provided in this section. Section 5 offers concluding remarks.

2. Background

2.1 Literature

Sorting by the identification strategies, the literature on identifying the intergenerational 'causality' from 'association' can be classified into several types: identical twins, adoptees, and Instrumental Variables (including RDD). Most of the twin-difference estimators show a significant and positive effect of fathers' education on children's schooling achievement (Antonovics and Goldberger, 2005; Behrman and Rosenzweig, 2002; and Pronzato, 2009). But the causal effect of maternal education on children's school outcomes is ambiguous. The adoption strategy also targets at taking out the genetic transmission between parents and biological children and identifying the existence of causality. Due to the absence of genetic transmission in case of adopted children, the difference estimators will capture the causal intergenerational effect from parents' school outcomes onto their children's education outcomes. Bjorklund et al. (2006) and Sacerdote (2000, 2007) present supporting evidence for the causality between paternal education achievement on children's education performance. By contrast, Haegeland et al. (2010) use examination marks as outcome variable and find no causal effect when applied to both twins and adoptees strategies. Besides the inconsistent conclusions, there are two other main concerns for twins and adoptees approaches: sample limitation (e.g., small sample size) and individual specifics (e.g., unobserved differences

[4]For example, reforms for primary schooling.

between twins, unobserved parental characteristics or selective placement of adopted children).

Thirdly, studies utilize education reforms as instruments for parental education and examine the existence of causal effects[5]. Most of the reforms examined are at the lower level of schooling, like primary schooling reforms (Arnaud Chevalier, 2004; Black, Devereux and Salvanes, 2005; Holmlund, Lindahl and Plug, 2010; Oreopoulos et al., 2006). Concerning higher level of schooling, Maurin and McNally (2008) explores the reform of university as an instrument. Additionally, Carneiro, Meghir and Parey (2012) resort to regional economic outcomes as instruments. However, conclusions from these studies vary across regions. For example, Black, Devereux and Salvanes (2005) show insignificant intergenerational causal effect when they study the Norwegian Primary School Reform. Meanwhile Holmlund et al. (2010) obtain positive evidences for the existence of the causal effect of intergenerational transmission in their study of Sweden. Agüero et al. (2010) taking evidence from Zimbabwe finds the presence of causal intergenerational transmission using RDD approach. The above discrepancy might be caused by the satisfactory levels of the instruments and differences of economic environments between developed countries and developing countries. This study will follow the IV approach to examine the intergenerational causality of educational transmission at a relative higher and perhaps more important level for labor market returns in a developing country, precisely looking at the senior secondary schooling in urban China.

2.2 Historical Background: Educational Interruptions

The formal education system in China generally includes 6 years of primary education, 3 years of junior secondary schools, 3 years of senior secondary schools and 4 years of college. After finishing the junior secondary school, individuals can also choose technical secondary school instead of regular senior secondary schools. Also, instead of regular university study, individuals can enter junior college (2-3 years) after graduation from senior secondary schools. However, this common trajectory was interrupted nationally by the Cultural Revolution with the closure of schools (Deng and Treiman, 1997; Li, et al., 2013; Meng and Gregory, 2003; Zhang, et al., 2008; Zhou, et al., 1999).

Marked by May 16th Notification in 1966, the Cultural Revolution formally started (Chandra,

[5] Basic technique is to regress parent's schooling years on the variation of parental exposure to the reform in the first stage estimation and to regress the children's schooling outcome on the predicted value of parental education completion in the second stage.

1987; Deng and Treiman, 1997) and at the very beginning, all levels of schools had been shut-down or stopped offering lectures, especially in urban areas. The primary and junior secondary schools responded to the reopening policy instantly and their closure was temporary (Chandra, 1987; Spence, 2001). The senior high schools were shut down for a longer period in urban areas severely affecting the attainment of senior secondary education among urban population. The prelude to recovery was marked by an official announcement from the central government in September 1971. Consequently, the large-scale interruption to senior secondary schools did not stop until 1972 and it lasted for 6 years (1966-1971). During this period, there was no report of information about senior secondary and higher education. We only observe the number of formal senior secondary school in 1965 was 4112 and was 28029 in 1972 for the whole nation. According to the administrative data, the number of senior secondary schools in cities was only 500 in 1971 and changed to be 4000 in 1972. For town areas, the number of secondary schools was 1100 in 1971 and was 3544 in 1972 (Sources: China Statistics Yearbook, 1949-2009 and China Education Statistics Yearbook: 1971-1998). Figure A-1, A-2 and A-3 in Appendix graphs the supply of formal junior secondary schools and senior secondary schools across three residential areas after 1971. They show that the supplies of secondary schools were pretty consistent over time after 1972 and the number of senior secondary schools gradually increased for urban and town residential[6]. The closure of colleges lasted for a decade. However the fraction of population impacted is small (the proportion of new enrolled college students among the total newly enrolled students) took far less than 1 one percentage in 1965 before the Cultural Revolution. The population with higher education attainment accounted for far less than 1% before 1990. The trends of education attainment at different levels over time (Deng and Treiman, 1997) show that it was the completion of senior secondary schooling severely harmed rather than the other levels by the school closure. Considering the scale of the affected population, this paper focuses on the variations created by the closure of senior secondary schools.

This nationwide closure of senior secondary schools between 1966 and 1971 can serve as a quasi-natural experiment which induces an exogenous shock to individuals' human capital accumulation. Two sources of variations created by the closure of senior secondary schools will be

[6]Generally, there are three residential types: city, town and county (village) in China. The Counties (village or “Xian”) are rural grassroots regions. Towns (Zhen) are regions where county jurisdictions are located and suburban areas, at least 50% of which are non-agricultural population (the 1955 standard). Those who resided in a village or a rural production team were considered rural. Broadly speaking both town residential and city residential were considered urban.

utilized in our empirical identification: the variations over birth cohorts (based on the regular ages to begin senior high schools) and the variations across city and town residents among different provinces. In general, town and city are geographically neighboring and with similar economic environments. Given the spirit of the Cultural Revolution of 'equalization' (Meng, 2003; Treiman, 1997; and Zhang, 2011), the town regions were less likely to be impacted than the city areas. Overall, town and city residents experienced similar educational interruptions during 1966-1977 except for the intensity[7].

3. Data, Identification Strategy and Empirical Model

3.1 Data and Empirical Sample Selection

The main data source used is the China Population Census of 1990.[8] It contains important individual information and household variables which include birth year, region of residence, province of birth, sex, relationship to the head of the household, location of biological parents, education attainment by level, ethnicity, number of kids born for female, family size, occupation types, and dwelling of individuals (residential areas: city, town and rural).Two methods are utilized to match parents with children.[9] The first one is based on the relationship to household head. The survey coded relationship to the household heads within households. We link their spouses to the household heads and separate them into samples of mothers and fathers. Further we match the children to their parents at household level. The second way uses the individuals' self-reported code of parents within household to match the children to their biological parents[10]. We match individuals with their biological parents according to the self-reported unique code of their biological parents. We obtain similar results using both of these ways. The results of the second way of data matching-individual based- are presented. In this way, rule for linking parent is not only based on

[7]There was an expansion of secondary schools after 1972 in rural areas and later decline after 1978 (Zhang, 2013). Thinking about the potential contaminations from the expansions of the secondary schools in rural counties at the second half of the Cultural Revolution, it is better to rule out the rural residents.

[8]This census has been considered national efforts, mobilizing millions of census takers and hundreds of millions of participants. It used household as the unit of census and all members within households were asked a series of demographic Information. It was conducted under the direct leadership of China's State Council, which forms a special leadership group composed of high level officials from relevant governmental ministries and organizations. These organizations include statistics, public security, economic planning, family planning, civil affairs, ethnic affairs, education, finance, labor, and others. The actual design, implementation, and processing of census data are carried out by China's State Statistical Bureau (SSB, also known as the National Bureau of Statistics).

[9]For empirical sample, we also adjust to the age gaps between parents and children and drop the unreasonable samples，dropping samples with age gap under 16 and over 45.

[10] For each individual, they have unique code within the household and are asked the code for their biological parents within the households.

link to household head or spouse of household head but also biological link to each family members which also allows a larger sample size.

The common ages to start formal schooling were 7 to 9 years during the Cultural Revolution. Individuals attended senior high schools at ages of 16 to 18 years and were around 19 to 21 years when they completed the senior high education. Since most of senior secondary schools were closed in 1966, parents older than 20 years in 1966, ideally should have had completed senior secondary schools and their senior high attainments have not had been affected by the closure of secondary schools. By contrast, individuals younger than 19 and older than 12 in 1966 were affected, for they were about to attend or were attending secondary schools before most of the secondary schools reopened formally in 1972. Therefore, the parents sample of analysis is restricted to parents at age 12-26 in 1966 (year of birth: 1940-1953; age in 1990: 37-50) born in residential of town and city. Secondly, the central relationship to gauge in this study is the effect of senior secondary attainments of parents on senior secondary attendance of their children. We only consider their children at ages over 16 if they were attending senior high schools in 1990 or had completed the senior secondary schooling already before 1990: children at ages of 16 to 22 in 1990 (year of birth: 1964-1974). Additionally, we also study a clear restricted sample: parents at ages of 22-26 years (control group) and at ages of 14-18 years in 1966 (treated group). All years of birth are adjusted by school calendar.

Descriptive statistics for the empirical sample are presented in Table 1_A and Table 1_B. In addition, for better illustrating the effects of the school closure, we also present statistics for group comparisons between a clear control group (parents at ages of 22-26 in 1966) and treated group (parents at ages of 14-18 in 1966). Overall, our empirical sample includes 231891 observations for mother-to-child sample and 169716 for father-to-child sample. The treated parents are younger than the control group and have lower proportions of senior secondary completion. Correspondingly, observations of the younger parents with kids at ages 16 to 22 are less than the older parents. For the children sample, those in the treated group are around 1.5 to 2 years younger than those born by parents in the control group. Similarly, the proportion of attending senior secondary schools as well as junior secondary completion for children of affected parents was lower than the kids of unaffected parents in 1990. Female children account for similar proportions in different sample groups. It exhibits similar quarter patterns across groups.

3.2 Identification Strategy

As discussed above, cohort and regional variation will be used to identify the exposed parents and test the causal intergenerational relationship: time variation (unaffected parents at ages of 20-26 years in 1990; exposed parents at ages of 12-19 years in 1990) and regional variation (parents in city areas: high exposure; parents in town residential: low exposure). Earlier entry, delay school entry or grade repetition might cause the cut-off age to become imperfectly accurate and lead to bias. Hence, we will allow flexibility to the cut-off ages and utilize interactions of residential dummy, province dummies and age dummies as instruments for parents' senior secondary completion.

To visually illustrate these variations, we graph the proportions of senior secondary education attainment against age cohorts for female and male samples from towns (low exposure) and cities (high exposure) respectively in Figure 1. For the birth cohorts at ages older than 20 years as well as at ages younger than 12 years in 1966, the trends of senior high attainment are slightly increasing over years of birth, both for female and male samples. We can observe two parallel trends for the education attainment of old cohorts. However, the birth cohorts at ages of 12-19 years in 1966, who experienced their senior schooling ages during the school closure, were impacted by the closure of secondary schools and their senior high completion rates declined dramatically in city areas. Placebo test of junior secondary completion across regions and birth cohort is also presented. Parallel trends with small fluctuations imply that there do not exist similar intensive impacts on junior secondary completion.

Furthermore, to show the validity of the identification strategy, we regress maternal and paternal senior secondary educational attainments on dummies of ages of parents, the dummy of parents' residential regions and the interaction terms of age dummies with regional dummy controlling for province fixed effect, quarter pattern and ethnicity fixed effects. In case of no education interruptions, the interaction coefficients in regressions are insignificant or close to 0 controlling for the dummies of age and the dummy of residential to capture intrinsic differences across regions and cohorts. If the closure of senior secondary schools were fully and firmly only enforced in city areas while residents in towns didn't encounter any interruptions at all, the coefficients of interaction terms for unaffected cohorts group should be close to zero or insignificant and the coefficients of interactions for the affected cohorts should be significantly negative which are corroborated by our findings.

Regression results are summarized in Table 2. Same regressions have been applied to different control and treated groups. All age dummies represent the parental ages in 1966. The reference group is the birth cohort at age of 26 years in 1966. As expected, most of the coefficients of interactions representing exposed parents from city (parents aged below 20 years in 1966 in city areas) are negative and significantly different from 0 while for the parents of the control cohorts, the estimates of interactions are insignificant or close to 0 (see Table 2). Tests are done to check joint significance of coefficients of the interactions for the treated group and the potential unaffected group. It strongly rejects the null hypothesis that the estimates of interactions are jointly insignificantly different from 0 for the exposed mothers, but the coefficients of interactions are jointly insignificant for the older mothers (potentially unaffected age cohorts). Same conclusions are also obtained for the sample of male, sample of mother-son, sample of mother-daughter, sample of father-son, and father-daughter. The coefficients of interactions from various groups are plotted in Figure 2[11].

3.3 Empirical Models

Three empirical models are applied for checking the robustness of the results. They are summarized by the following two stages regressions equations:

The First Stage Regression

$$ED^P = a_0 + a_1 Age^k + a_2 Girl^k + a_3 Age^p + a_4 \Pr ovince^p + a_5 Ethncn^p + a_6 City^p + a_7 \Pr ovince^k + a_8 Ethncn^k + dX + \sum Age^p * City^p + \upsilon \qquad Strategy\text{-}1$$

Alternatives

$$ED^P = a_0 + a_1 Age^k + a_2 Girl^k + a_3 Age^p + a_4 \Pr ovince^p + a_5 Ethncn^p + a_6 City^p + a_7 \Pr ovince^k + a_8 Ethncn^k + dX + \sum Age^p * City^p * \Pr ovince^p + \upsilon \qquad Strategy\text{-}2$$

$$ED^P = a_0 + a_1 Age^k + a_2 Girl^k + a_3 Age^p + a_4 \Pr ovince^p + a_5 Ethncn^p + a_6 City^p + a_7 \Pr ovince^k + a_8 Ethncn^k + dX + \sum Treated^p * City^p + \upsilon \qquad Strategy\text{-}3$$

[11]Placebo regressions of parents' junior secondary completion on the same group of independent variables are examined and there are no similar patterns as the impacts on parental senior secondary attainments. Most estimators of the interactions are insignificant. Please see Appendix B for the results. Comparisons between regressions of parental senior and junior high completion support the fitness of our instruments.

The Second Stage Regression

$$ED^k = \beta_0 + \beta_1 \tilde{ED}^P + \beta_2 Age^k + \beta_3 Girl^k + \beta_4 Age^p + \beta_5 \Pr ovince^p + \beta_6 Ethncn^p + \beta_7 City^p + \beta_8 \Pr ovince^k + \beta_9 Ethncn^k + \delta X + \varepsilon$$

The superscript "p" denotes parent (we examine mother-child and father-child transmission relationship separately) and "k" represents kids in all cases. ED is the educational attainment and it is measured by the dummy indicating whether the parent has completed the senior secondary education or not. For children, it indicates whether the child is attending (or has attended) senior secondary school or not.

Age refers to a full set of indicators of ages in 1966 for parents and kids' age in 1990, *Province* is a full set of birth provincial indicators, and *Ethncn* is a full set of the ethnicity indicators. $City^p$ is the residential indicator (city or town) for parents; X is a vector of independent variables controlling for other individual specifics: the number of kids born to the mother, family size, the marriage status of the parent and birth quarter fixed effects.

In the second stage, the senior completion of parents will be replaced by the predicted value from the first stage regression. We apply three different identification strategies to instrument ED^P. In the first two, we have a group of interaction terms, $\sum Age^p * City^p$ or $\sum Age^p * City^p * Province^p$, serve as instrumental variables for parental senior secondary completion[12]. In other words, the interactions of age dummies in 1966 for parents and the residential indicator (city or town) as well as the interactions of age dummies, parental birth province dummies and the residential indicator are used as IVs to capture the exogenous variation of parental education attainment caused by the policy interruptions. There are 30 provinces including 3 municipalities, 2 residential areas and 15 age cohorts. Considering the number of the instruments, we test for over identification restrictions. Over-identifying restrictions are not rejected. Our instruments are valid in strategy 2 and strategy 1 when by requesting heteroscedasticity-robust standard errors.

Advantages of strategy 1 and 2: we can avoid bias as the results of one simple binary instrument:

[12]Statistics for the Durbin and Wu-hausman tests of endogeneity significantly rejected the null hypothesis (parental education attainment is exogenous) and the P values are 0.0002 when robust standard errors are adjusted for 15 clusters in ages. Linear probability models are applied for both stages[12] and clustered robust standard errors are computed. Probit probability models are applied. For robustness, model specifications excluding the provincial and age fixed effects for children or including a time trend are also tested (as Black, Devereux and Salvanes, 2005). Consistent conclusions are found.

inaccurate identifications of the cutting-off age. Also cohort-invariant differences across regions as well as the time-varying differences across cohorts can be differenced out by the comparisons across regions and across cohorts. For robustness, we also test the third specification, the simple binary instrument which indicates whether one born in city residential was affected by the school closure or not (younger treated group at ages younger than 19 years in 1966). No matter using which strategy, consistent estimations can be achieved as long as the unobserved characteristics v is uncorrelated with the implementation of the closure of schools. Significantly positive estimates of ED^{P} will prove the existence of causal effects of the parental schooling outcome on their offsprings' schooling outcomes.

4. Results and Robustness Checks

4.1 Differences-in-Difference Estimates

Before presenting the estimation results, we first compute simple difference-in-difference tables showing the intuition behind the IV approach based on the sample of the clear control and treated groups. Table 3-A is for the sample of mothers-and-children and Table 3-B is for sample of fathers-and-children. In general, city residents obtained more education than town residents because of regional differences and parents born in the treated cohorts obtained less education because of policy interruptions. The difference in the difference estimators show that causal negative effects on urban parents' senior high completion in treated group and thereby their children were less likely to attend senior secondary schools (-0.108 for fathers' senior high attainment; and -0.098 for children's senior secondary attendance; -0.105 for mothers' senior high attainment; and -0.082 for children's senior secondary attendance).

Given the above evidence, we can calculate the Wald estimates (a simple-but imprecise-instrumental variables estimator) of the effects of parents' education attainment on children's schooling outcome. They are the ratios of these two difference-in-difference estimates. The marginal effect of mothers' senior education attainment can contribute to enhancing their children's secondary attendance by-0.082/-0.105=0.781 (Table 3_A). The intergenerational effect from fathers' senior secondary completion to children's senior attendance is -0.098/-0.108=0.907 (Table 3_B). It suggests that the marginal effect of the completion of senior secondary education of parents increases the probability of their children to attend senior secondary by 78 to 91%. Before controlling for the provincial fixed effects and age fixed effects, these simple estimators can firstly provide suggestive evidences for the existence of the causal transmission between parents' education attainment and children's education outcome.

4.2 OLS and IV Estimates

The main estimation results of the empirical sample are presented in Table 4 and 5. Results for the main empirical model, strategy one, are shown in Table 4. Column (1) and (3) show the positive transmission of parents' senior secondary completion and children's senior secondary attendance in 1990 with OLS regressions for various relationships separately. All the estimates consistently point out significantly positive effects ranging from 0.30 to 0.34.

Column (2) and (4) present the estimates with the IV approach. All the IV estimates again are significantly positive at level of 1% and the magnitudes of the interested estimates are consistent with the Wald estimates. The completion of senior secondary schools for mothers enhances the probability of children to attend senior secondary schools by 80% controlling for kinds of fixed effects and related factors. The IV estimators are larger than the OLS estimates because the closure of schools negatively impacted the parents' education attainment and lowered the linear correlation. If fathers obtain senior secondary education, the marginal effect is to increase their children's senior secondary attendance by 71 percent. These evidences prove the existence of causality for the intergenerational transmission of human capital. The instrumented results also weakly support that there is gender difference effect: the transmissions from parents-to-daughter are stronger than parents-to-sons although the results of OLS show not much of a difference. The mother-to-daughter transmission effect exhibits to be stronger under the TSLS methodology (mother-to-son 0.659; mother-to-daughter 0.882). Similarly, for daughters, the marginal effect of fathers' education attainment on their senior attendance is 0.749 which is stronger than the effect on sons (0.640). Strategy 2 and 3 are implemented in Table 5. Consistent results are found.

4.3 Robustness Checks

4.3.1 *Various Treatment and Control Groups*

For robustness checks, we first examine different samples of various age-spans. Table 6 presents the regression estimates for two subsamples: 1. parents of ages 12-26 in 1966 with children of age 16-20; 2. parents at ages of 14-18and 22-26 in 1966 with children of age 16-22. The variables of interest are still the indicator showing whether mothers or fathers have obtained senior secondary schooling or not and the indicator representing whether the children have attended or were attending senior secondary schools in 1990. Overall, the OLS estimates are consistent across different subsamples (around 0.30-0.34) which are similar with results of Table 4 and 5. Consistently, the IV approach again indicates significantly stronger intergenerational transmission and the existence of causality. Also, we find that the parents-to-daughter relationship is weakly stronger than the parents-to-son. In addition, other subsamples with different treatment and control groups are also tested: 1. parents at ages of 17-24 in 1966 with children of age 16-20; 2. parent at ages of 17-24 in 1966 with children of age 16-24 in 1990; 3. parents at ages of 13-26 in 1966 with children of age 16-20 as well as 18-24; 4. parents at ages of 13-26 in 1966 with children of age 16-26. Consistent conclusions are found. Second, we examine a different schooling outcome of children: the junior secondary completion. As shown in Table 7, significantly causal effects of intergenerational transmissions are found again, no matter for the mother-to-children relation or father-to-children relation. And the marginal effects of parents' senior high attainments on daughters' schooling outcomes are stronger than the parents-to-sons side. We also include younger children (children at age of 13-16 in 1990 for parents at age 13-26 in 1966) and gauge the intergenerational transmission using different schooling outcome of children (junior and senior secondary attendance).

Additionally, alternative model specifications, for example excluding children's birth places, age cohort effects and ethnicities, or considering time trend, are also tested. For example independent variables, such as age indicators of children are excluded for the possible existed endogenous problem of timing of childbearing; the regression models are weighted by the cohort population size; inclusion and exclusion of other related variables, for example marriage status of parents, are tested; the probit probability models are also explored for the second stage to check the nonlinear intergenerational effects.

4.3.2 Other Data Source

We further apply the identification strategy 1 to another data source: the Chinese Household Income Project Survey (CHIPS) 2002. As a result of the design of the survey, we only can explore two other residential: the rural areas and cities. However, we can use both schooling years as well as senior secondary completion to measure the educational attainment for children and parents. The selected sample included mothers and fathers who were at ages of 15-25 in 1966 and their children within the households in 2002[13]. For father-to-children relation, there are 1123 pairs of urban fathers and children and 3103 pairs of rural fathers and children. For father-to-children relation, there are 917 pairs of urban mothers and children and 2068 pairs of rural mothers and children. As shown in Table 8, most of the OLS and IV estimates are significantly positive and these estimates of interest consistently confirm the existence of causal effect of parent's educational attainment on their children's schooling outcomes.

4.3.3 Concerns and Robustness

For the concerns with sex selection of children, we regress the ratio of number of male children to total number of children born for each female sample on the interactions, age dummies, quarter fixed effect and province fixed effect (see Table 2). All the coefficients of interactions are close to 0. The second concern is whether the timing of childbearing has been impacted obviously. We examine the average age of children by parents' birth cohorts. As the smoothly increasing trends in both residential locations show, the closure of schools has not caused obvious discontinuity in mothers' decision to choose the timing of giving births in both residential locations (See Appendix D).

The last concern is that we are not able to follow those adult children having moved out the households (around 30% of the sample). The reason for attrition is mainly related with the facts that the adult kids get married and establish new households. Patterns of the attrition are checked (see graphs in Appendix D). Families with older parents are more likely to have children move out, especially for female children. The patterns are consistent across town residents and city residents. With the assumption that the moved out children follow the same structure and determinants are consistent across regions, the sample bias can be alleviated after taking the difference in difference across regions and age cohorts. When our identification strategy is applied, the potential estimation bias is alleviated. If we can have a unique data matching the population, the estimate of interest is perfectly estimated.

Statistics show that younger parents (the treated group) have less kids moving out and the urban areas have more kids move out, the attrition dummy is negative related with the IVs and negative related with parents' senior high attainment (see Appendix D). According to bounds of instruments

[13]The exclusion of younger parents is because that the rural areas (Zhang, 2013) have experienced expansion of secondary school construction during 1972 to 1978 and the younger age cohorts in rural areas could have benefited from this temporary expansion which contaminated the nature of the instruments. These results are only presented for reference and one source of robustness checks, considering all the existing policy differences in rural areas and the attrition problem of adult children in 2002.

proposed by Nevo, Aviv and Adam M. Rosen (2008), if the unobserved specifics (u) are negatively correlated with the instruments (z) and negatively correlated with the interested endogenous variable (x), we can bound the real estimate between the OLS estimate and the IV estimate while the instruments are negatively correlated with the endogenous variable. Therefore, the real estimates can be bounded between the OLS estimate and the IV estimate which the intergenerational transmission coefficients are significantly positive. We can summarize as follows:

The OLS estimator can be formulated as $\beta^{ols} = \beta + \frac{\sigma_{ux}}{\sigma_{x^2}}$ and the IV estimator is $\beta^{iv} = \beta + \frac{\sigma_{uz}}{\sigma_{xz}}$. When $\sigma_{ux} < 0$, $\sigma_{uz} < 0$ and $\sigma_{xz} < 0$, we can conclude that the real estimator is bounded as $\beta^{ols} < \beta < \beta^{iv}$.

5. Concluding Remarks

Using the exogenous variation of parental senior secondary schooling induced by the closure of senior secondary schools from 1966 to 1971 in urban China, we are able to estimate the causal intergenerational effects based the IV approach (2SLS). The 1990 China census shares considerable information allowing one to match the parents with their children and identify a large exposure sample which makes the empirical results more convincing.

We find that the completion of senior secondary schools for mothers enhances the probability of children to attend senior secondary schools by 80% controlling for unobserved heterogeneity related factors. We find the marginal effect of fathers' attainment of senior secondary education increase their children's senior secondary attendance by 71 percent. The instrumented results also weakly support that there is gender difference effect: the transmissions from parents-to-daughter are stronger than parents-to-sons (mother-to-son being 65 percent; mother-to-daughter being 88.2 percent. Similarly, for daughters, the marginal effect of fathers' education attainment on their senior attendance is stronger.

The significant IV estimators consistently indicate that there exists a causal relationship between the parents' and children's educational attainment. The relative stronger persistent effect for girls brings out interesting dynamics of education mobility in face of shocks and calls out for better targeted education policies that can address this gender difference in the long term.

References

Acemoglu, D., and Angrist, J. (2000). How Large Are Human-Capital Externalities? Evidence from Compulsory Attendance Laws. *NBER Macroeconomic Annual*, No. 15 (2002). 9-59.

Angrist, D.J., and Imbens, W. G. (1995). *Two-Stage Least Squares Estimation of Average Causal Effects in Models with Variable Treatment Intensity*. Journal of the American Statistical Association, 90(430): 431-442.

Agüero, M. J., and Ramachandran M. (2013). The Intergenerational Transmission of Schooling: Evidence from Zimbabwe. *Working Paper*.

Antonovics, L.K., and Goldberger, S.A. (2005). Does Increasing Women's Schooling Raise the Schooling of the Next Generation? Comment. *American Economic Review*, 95(5): 1738-1744.

Haveman, R., and Barbara Wolfe, B. (1995). The Determinants of Children Attainments: A Review of Methods and Findings. *Journal of Economic Literature*, 33(4): 1829-1878.

Ashenfelter, O. and Krueger, B. A. (1994). Estimates of the Returns to Schooling from a New Sample of Twins. *American Economic Review*, 84(5): 1157-1173.

Ashenfelter, O. and Rouse, C. (1998). Income, Schooling, and Ability: Evidence from a New Sample of Identical Twins. *Quarterly Journal of Economics*, 113(1): 253-284.

Behrman, R. J., and Rosenzweig, R. M. 2002. Does Increasing Women's Schooling Raise the Schooling of the Next Generation?. *American Economic Review*, 92(1): 323-334.

Behrman, R. J., and Rosenzweig, R. M. 2005. Does Increasing Women's Schooling Raise the Schooling of the Next Generation? Reply. American Economic Review, 95(5): 1745-1751.

Björklund, A., Lindahl, M. and Plug, E. (2004). Intergenerational Effects in Sweden: What Can We Learn from Adoption Data?. IZA DP 1194.

Björklund, A., Lindahl, M. and Plug, E. (2006). The Origins of Intergenerational Associations: Lessons from Swedish Adoption Data. *Quarterly Journal of Economics*, 121(3): 999-1028.

Black, E. S., Paul J. Devereux, J. P. and Salvanes, G. K. (2005). Why the Apple Doesn't Fall Far: Understanding Intergenerational Transmission of Human Capital. *American Economic Review,* 95(1): 437-449.

Carneiro, P., Meghir, C. And Parey, M. (2012). Maternal Education, Home Environments and the Development of Children and Adolescents. *Journal of the European Economic Association*, 2013(11): 123-160.

Chevalier, A. (2004). Parental Education and Child's Education: A Natural Experiment, *IZA discussion paper No. 1153.*

Haveman, R., and Barbara Wolfe, B. (1995). The Determinants of Children Attainments: A Review of Methods and Findings. *Journal of Economic Literature*, 33(4): 1829-1878.

Hageland, T., Kirkebøen, J. L., Raaum, O. and Salvanes, G. K. (2010). Why Children of College Graduates Outperform their Schoolmates: A study of Cousins and Adoptees. *Discussion Papers 628*, Research Department of Statistics Norway.

Holmlund, H. (2007). A Researcher's Guide to the Swedish Compulsory Schooling Reform. *Working Paper 9/2007*, Swedish Institute for Social Research.

Holmlund, H., Lindahl, M. and Plug, E. (2010). The Causal Effect of Parent's Schooling on Children's Schooling: A Comparison of Estimation Methods. *Journal of Economic Literature*, 49(3): 615-51.

Imbens, G., and Joshua Angrist, J. (1994). Identification and Estimation of Local Average Treatment Effects. *Econometrica*, 62(2): 467-476.

Maurin, E. and McNally, S. (2008). Educational Effect of Widening Access to the Academic Track: A Natural Experiment. *CEE Discussion Papers 0085*, Centre for the Economics of Education, LSE.

Meng X., and Gregory, R. (2003). The Impact of Interrupted Education on Subsequent Educational Attainment–a Cost of the Chinese Cultural Revolution. *Economic Development and Cultural Change*, 50(4): 935-959.

Oreopoulos, P. (2006). Estimating Average and Local Average Treatment Effects of Education when Compulsory School Laws Really Matter. *American Economic Review*, 96(1): 152-175.

Oreopoulos, P., Page, M. and Stevens, H. A. (2006). The Intergenerational Effects of Compulsory Schooling. *Journal of Labor Economics*, 24(4): 729-760.

Plug, E. (2004). Estimating the Effect of Mother's Schooling on Children's Schooling Using a Sample of Adoptees. *American Economic Review*, 94(1): 358-368.

Plug, E., and Vijverberg, W. (2003). Schooling, Family Background, and Adoption: Is it Nature or is it Nurture?. *Journal of Political Economics*, 111(3): 611-641.

Pronzato, C. (2009). An Examination of Paternal and Maternal Intergenerational Transmission of Schooling. *Journal of Population Economics*, 25(2): 591-608.

Sacerdote, B. (2002). The Nature and Nurture of Economic Outcomes. *American Economic Review (Papers and Proceedings)*, 92(2): 344-348.

Sacerdote, B. (2007). How Large are the Effects from Changes in Family Environment? A Study of Korean American Adoptees. *Quarterly Journal of Economics*, 121(1): 119-158.

Schultz, T. P. (2002). Why Governments Should Invest More to Educate Girls. World Development, 30(2): 207-225.

Singer, Martin. (1971). Educated Youth and the Cultural Revolution in China. University of Michigan, Center for Chinese Studies: 10, Ann Arbor, Mich.

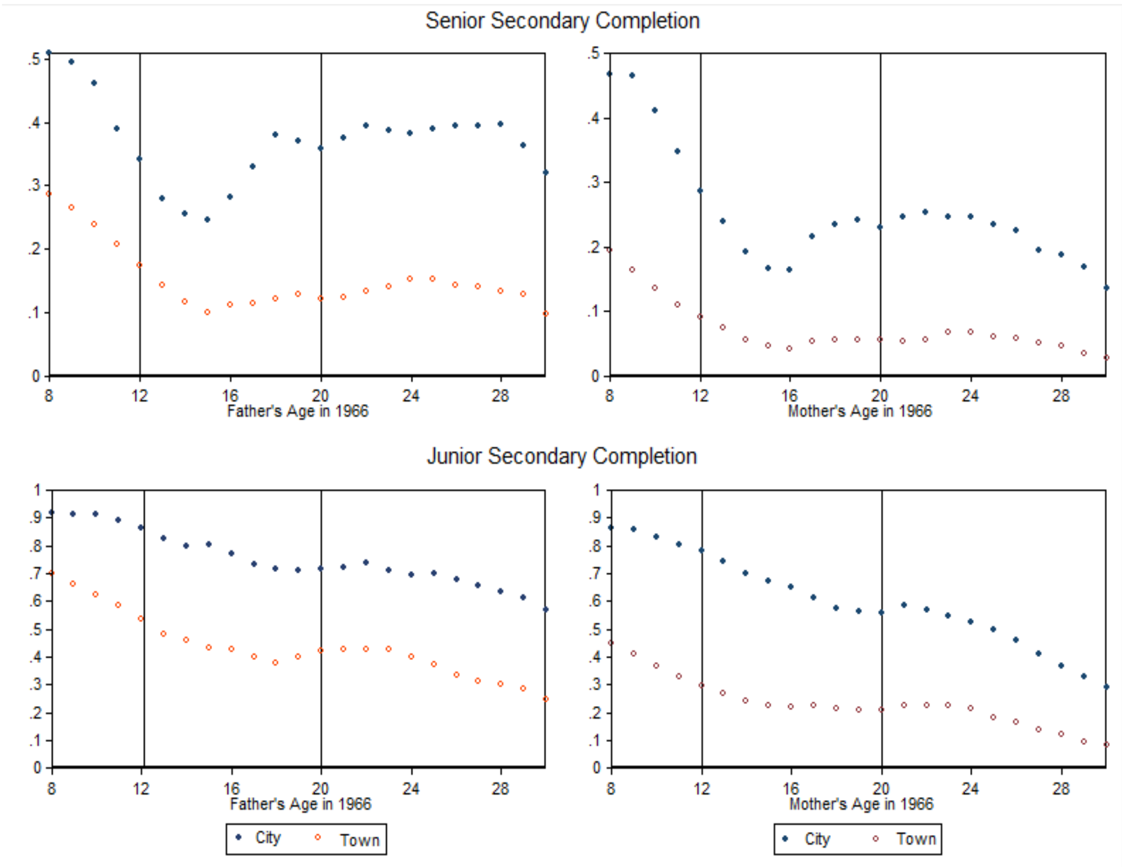
Treiman, J. D., and Deng, Z. (1997). The Impact of the Cultural Revolution on Trends in Educational Attainment in the People's Republic of China. *American Journal of Sociology*, 103(2):391-428.

Xie, Y., Jiang, Y., and Greenman, E. (2008). Did Send-Down experience Benefit Youth? A Reevaluation of the Social Consequences of Forced Urban-Rural Migration during China's Cultural Revolution. *Social Science Research*, 37:686-700.

Zhang, J. S., Liu P.K., and Yung, L. (2007). The Cultural Revolution and Returns to Schooling in China: Estimates based on Twins. *Journal of Development Economics*, 84(2): 631-639.

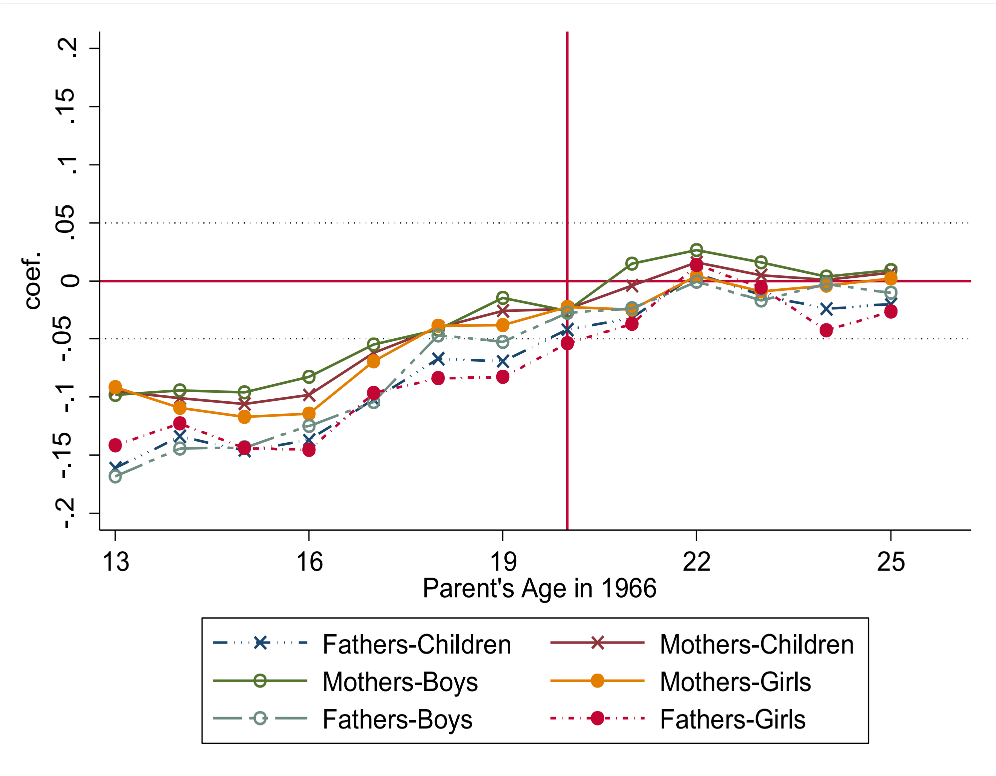
Zhou, X. G. and Hou, L. R. (1999). Children of the Cultural Revolution: the State and the Life Course in the People's Republic of China. *American Sociological Review,* 64(1): 12-36.

Figure 1: Secondary Education Attainment, by Residential and Gender



Note: the proportions of junior and senior secondary completions against parents' ages in 1966 are graphed in Figure 1 for all female and male samples separately. In all graphs, the red hollow circle lines represent the town areas and the blue dots represent observations from city areas. The left two graphs are for male samples while the right two ones are for female observations.

Figure 2: The Impacts on Parents' Senior High Educational Attainment



Note: scatters in Figure 2 are the coefficients of the interaction of age indicator and the residential dummy in the regressions of parents' senior secondary completion on interactions, age indicators, residential indicators, ethnicity indicators, birth quarters fixed effects, and fixed effect of provinces.

Table 1-A: Statistics Summary

Panel A	Mean	Std. Dev.	Control Cohorts (22-26)	Treated Cohorts (14-18)
		Mother's Characteristics		
Age	43.735	3.537	47.351	39.988
Senior Secondary Attainment	0.106	0.308	0.152	0.052
Marriage Status	0.968	0.177	0.957	0.978
Numbers of Children	2.686	1.076	2.602	2.778
Number of Children Born	3.273	1.239	3.639	2.954
Family Size	4.966	1.464	4.953	4.994
Han	0.939	0.239	0.936	0.938
Obs.	*231891*		*90117*	*70210*
Quarter One	*56547*		*20502*	*18045*
Quarter Two	*53279*		*21042*	*16031*
Quarter Three	*57479*		*22545*	*17412*
Quarter Four	*64586*		*26028*	*18722*
		Child's Characteristics		
Age	18.517	1.888	19.12	17.83
Girl	0.478	0.500	0.476	0.479
Senior Secondary Attendance	0.315	0.465	0.373	0.243
Junior Secondary Completion	0.663	0.473	0.722	0.585
Han	0.939	0.239	0.936	0.938
Obs.	*231891*		*90117*	*70210*
Quarter One	*59470*		*22737*	*18402*
Quarter Two	*55210*		*21146*	*16851*
Quarter Three	*52337*		*21568*	*14878*
Quarter Four	*64874*		*24666*	*20079*

Note: 1. Sample: mothers at ages of 12-26 in 1966 with kids aged 16-22 in 1990; 2. marriage status is a dummy representing whether were married with spouse. The comparisons between a clear control group at ages of 22-26 in 1966 and a clear treated group at ages of 14-18 in 1966 are presented

Table 1-B: Statistics Summary

Panel A	Mean	Std. Dev.	Control Cohorts (22-26)	Treated Cohorts (14-18)
		Father's Characteristics		
Age	45.168	3.344	47.884	40.494
Senior Secondary Attainment	0.201	0.401	0.251	0.114
Marriage Status	0.980	0.141	0.982	0.978
Numbers of Children	2.709	1.064	2.644	2.857
Family Size	5.032	1.415	4.985	5.162
Han	0.937	0.242	0.938	0.934
Obs.	*169716*		*87378*	*34646*
Quarter One	*41385*		*21097*	8,316
Quarter Two	*36753*		*19441*	7,099
Quarter Three	*41299*		*21407*	8,380
Quarter Four	*50279*		*25433*	10,851
		Child's Characteristics		
Age	18.331	1.840	18.796	17.507
Girl	0.478	0.500	0.476	0.481
Senior Secondary Attendance	0.301	0.459	0.358	0.186
Junior Secondary Completion	0.643	0.479	0.701	0.520
Han	0.930	0.254	0.927	0.931
Obs.	*169716*		*87378*	*34646*
Quarter One	*43792*		*22737*	*18402*
Quarter Two	*40740*		*21146*	*16851*
Quarter Three	*37666*		*21568*	*14878*
Quarter Four	*47518*		*24666*	*20079*

Note: 1. Sample: fathers at ages of 12-26 in 1966 with kids aged 16-22 in 1990; 2. marriage status is a dummy representing whether were married with spouse. The comparisons between a clear control group at ages of 22-26 in 1966 and a clear treated group at ages of 14-18 in 1966 are presented

Table 2: Evaluating the Effects of School Closure

Dependent Variables		Mother's Senior Secondary Completion		Father's Senior Secondary Completion		Ratio of No. of Male Children to Total No. of Children
Interactions		Sample 1	Sample 2	Sample 1	Sample 2	All females
δ_{12}	City*age_12	-0.101*** (0.017)	--	-0.152*** (0.038)	--	-0.0003*** 0.0005
δ_{13}	City*age_13	-0.122*** (0.013)	--	-0.178*** (0.028)	--	0.0187 *** 0.0003
δ_{14}	City*age_14	-0.129*** (0.010)	-0.128*** (0.009)	-0.154*** (0.021)	-0.154*** (0.020)	0.0133 *** 0.0003
δ_{15}	City*age_15	-0.133*** (0.008)	-0.132*** (0.008)	-0.162*** (0.017)	-0.161*** (0.016)	0.0051*** 0.0003
δ_{16}	City*age_16	-0.125*** (0.007)	-0.123*** (0.007)	-0.151*** (0.013)	-0.150*** (0.013)	0.0040*** 0.0003
δ_{17}	City*age_17	-0.087*** (0.007)	-0.086*** (0.008)	-0.116*** (0.011)	-0.115*** (0.011)	0.0018*** 0.0003
δ_{18}	City*age_18	-0.065*** (0.006)	-0.064*** (0.007)	-0.082*** (0.010)	-0.082*** (0.011)	-0.0019*** 0.0003
δ_{19}	City*age_19	-0.049*** (0.006)	--	-0.084*** (0.009)	--	-0.0029*** 0.0003
δ_{20}	City*age_20	-0.044*** (0.006)	--	-0.054*** (0.009)	--	0.0084 *** 0.0003
δ_{21}	City*age_21	-0.018*** (0.006)	--	-0.041*** (0.009)	--	0.0007 *** 0.0004
δ_{22}	City*age_22	0.007 (0.006)	0.007 (0.006)	-0.002 (0.008)	-0.002 (0.010)	-0.0042 *** 0.0002
δ_{23}	City*age_23	-0.001 (0.006)	-0.0005 (0.008)	-0.017** (0.008)	-0.017* (0.009)	-0.0016 *** 0.0003
δ_{24}	City*age_24	-0.001 (0.006)	-0.0003 (0.008)	-0.026*** (0.008)	-0.026*** (0.010)	0.0082 *** 0.0002
δ_{25}	City*age_25	0.007 (0.006)	0.008 (0.008)	-0.017** (0.008)	-0.017* (0.010)	0.0087 *** 0.0002
Obs.		231891	160327	169716	122024	294355
R-squared		0.11	0.12	0.11	0.12	0.01
Wald-Test						

i	87.55	124.44	34.07	42.00	---
ii	91.90	82.89	54.47	52.26	---
iii	0.93	0.56	3.61	3.61	---

i: the null hypothesis: $\delta_{12}=\delta_{13}=\delta_{14}=\delta_{15}=...=\delta_{24}=\delta_{25}=0$

ii: the null hypothesis: $\delta_{12}=\delta_{13}=\delta_{14}=\delta_{15}=\delta_{16}=\delta_{17}=\delta_{18}=\delta_{19}=0$

iii: the null hypothesis: $\delta_{21}=\delta_{22}=\delta_{23}=\delta_{24}=\delta_{25}=\delta_{26}=0$

Note: 1. Empirical sample includes parents' aged 12-26 in 1966 adjusted for school calendar with children aged 16-22 in 1990; 2. The reference cohort is the group for parents aged 26 born in towns in 1966; 3. Other controls: age cohort dummies, residential dummy, province fixed effects, ethnicity fixed effects and quarter fixed patterns for parents. 4. *** represents significance at 1%,* *represents significance at 5% and * represents significance at 10%; 5. Sample 1 includes parents at ages of 12-26 in 1966 with children at ages of 16-22 in 1990. Sample 2 includes parents at ages of 14-18 and 22-26 in 1966 with children at ages of 16-22 in 1990.

Table 3-A: Difference-in-Difference (Mothers-and-Children)

Panel A:	**Senior Secondary Completion of Mothers**		
	Treated Group (age 14-18 in 1966)	Control Group (age 22-26 in 1966)	Difference
City	0.120	0.268	-0.147*** (0.003)
Town	0.024	0.066	-0.042*** (0.001)
Difference	0.096*** (0.002)	0.202 *** (0.002)	-0.105*** (0.003)
Panel B:	**Senior Secondary Attendance of Children**		
	Treated Group (age 14-18 in 1966)	Control Group (age 22-26 in 1966)	Difference
City	0.445	0.583	-0.138*** (0.004)
Town	0.162	0.218	-0.055*** (0.002)
Difference	0.283*** (0.003)	0.365*** (0.003)	-0.082*** (0.005)

Table 3-B: Difference-in-Difference (Fathers-and-Children)

Panel A:	**Senior Secondary Completion of Fathers**		
	Treated Group (age 14-18 in 1966)	Control Group (age 22-26 in 1966)	Difference
City	0.226	0.398	-0.171*** (0.006)
Town	0.083	0.146	-0.063*** (0.002)
Difference	0.143*** (0.004)	0.251*** (0.003)	-0.108*** (0.006)
Panel B:	**Senior Secondary Attendance of Children**		

	Treated Group (age 14-18 in 1966)	Control Group (age 22-26 in 1966)	Difference
City	0.390	0.566	-0.176***
			(0.006)
Town	0.130	0.209	-0.078***
			(0.003)
Difference	0.260***	0.358***	-0.098***
	(0.005)	(0.003)	(0.007)

Note: standard errors are reported in the parenthesis. We also apply the difference in difference approach for the whole empirical sample and obtained robust results. Please see the Appendix C.

Table 4: Intergenerational Transmission of Senior Secondary Education

Dependent Variable	**Senior Secondary Attendance of Children**				
	(1)	**(2)**		**(3)**	**(4)**
	OLS	**IV**		**OLS**	**IV**
Mother-All	0.337***	0.788***	**Father-All**	0.310***	0.709***
	(0.07)	(0.07)		(0.03)	(0.076)
R-Square	0.24	0.16	R-Square	0.26	0.20
Obs.	231891	231891	Obs.	169716	169716
F-statistics of the First Stage		216.47			173.52
Mother-Daughter	0.336***	0.882***	**Father-Daughter**	0.304***	0.749***
	(0.07)	(0.087)		(0.025)	(0.057)
R-Square	0.26	0.14	R-Square	0.285	0.22
Obs.	110891	110891	Obs.	81185	81185
F-statistics of the First Stage		105.76			86.87
Mother-Son	0.337***	0.659***	**Father-Son**	0.316***	0.640***
	(0.07)	(0.082)		(0.035)	(0.102)
R-Square	0.21	0.175	R-Square	0.24	0.176
Obs.	121000	121000	Obs.	88531	88531
F-statistics of the First Stage		123.52			99.42

Note: 1.Other independent variables include family-size, marital status of parents, number of kids own by the parent in household, kids' age cohort dummies, parents' age cohort dummies (adjusted by school calendar), a residential region dummy, ethnicity fixed effects for parents and children, birth province fixed effects for parents and children, and quarter fixed effects for parents and children. Only the estimates of interest, the coefficients of parents' senior high completion, are presented and each estimator represents result from one single regression in the table; 2. Robust standard errors are reported in brackets. *** represents significance at 1%,* *represents significance at 5% and * represents significance at 10%.

Table 5: Examination with Various Identification Strategies

Dependent Variable	Senior Secondary Attendance of Children								
IV Estimates	**Strategy 3**		**Strategy 2**			**Strategy 3**		**Strategy 2**	
Mothers-	Sample 1	Sample 2	Sample 1	Sample 2	**Fathers-**	Sample 1	Sample 2	Sample 1	Sample 2
All	0.768***	0.761***	0.656***	0.646***	**All**	0.784***	0.850***	0.556***	0.529***
	(0.049)	(0.081)	(0.032)	(0.039)		(0.10)	(0.06)	(0.035)	(0.047)
R-Square	0.19	0.20	0.20	0.20	R-Square	0.19	0.20	0.22	0.24
Obs.	231891	160327	231891	160327	Obs.	169716	122024	169716	122024
F-statistics (First Stage)	233.35	188.31	61.78	64.28		195.23	162.99	48.19	50.70
Daughter	0.870***	0.879***	0.599***	0.608***	**Daughter**	0.790***	0.860***	0.508***	0.483***
	(0.11)	(0.12)	(0.041)	(0.04)		(0.086)	(0.07)	(0.038)	(0.052)
R-Square	0.22	0.23	0.24	0.24	R-Square	0.21	0.22	0.22	0.27
Obs.	110891	76557	110891	76557	Obs.	81185	58208	81185	58208
F-statistics (First Stage)	114.54	92.76	30.10	31.48		99.47	82.84	24.12	24.83
Son	0.670***	0.648***	0.593***	0.590***	**Son**	0.733***	0.839***	0.469***	0.425***
	(0.11)	(0.11)	0.040	0.049		(0.13)	(0.09)	0.038	(0.050)
R-Square	0.17	0.17	0.19	0.19	R-Square	0.17	0.18	0.23	0.24
Obs.	121000	83770	121000	83770	Obs.	88531	63816	88531	63816
F-statistics (First Stage)	135.59	106.34	34.48	35.78		111.87	93.25	27.59	28.86

Note: 1.Other independent variables include family-size, marital status of parents, number of kids own by the parent in the household, kids' age cohort dummies, parents' age cohort dummies (adjusted by school calendar), a residential region dummy, ethnicity fixed effects for parents and children, birth province fixed effects for parents and children, and quarter fixed effects for parents and children. Only the estimates of interest, the coefficients of parents' senior high completion, are presented and each coefficient represents one single regression in the table; 2. Robust clustered standard errors are reported in brackets and adjusted by clustering in ages. *** represents significance at 1%, **represents significance at 5% and * represents significance at 10% (same as all the rest of the tables); 3. Sample 1 includes parents at ages of 12-26 in 1966 with children at ages of 16-22 in 1990. Sample 2 includes parents at ages of 14-18 and 22-26 in 1966 with children at ages of 16-22 in 1990.

Table 6: Examination within Samples of Different Age-Spans

Dependent Variable	Senior Secondary Attendance of Children							
Variable of Interest	**Mothers' Senior Secondary Completion**				**Fathers' Senior Secondary Completion**			
Sample of Parents	12-26 in 1966		14-18&22-26 in 1966		12-26 in 1966		14-18&22-26 in 1966	
Sample of Children	Age 16-20 in 1990		Age 16-22 in 1990		Age 16-20 in 1990		Age 16-22 in 1990	
	(1) OLS	**(1) IV**	**(2) OLS**	**(2) IV**	**(1)OLS**	**(1)IV**	**(2)OLS**	**(2)IV**
Parent-All	0.337***	0.801***	0.339***	0.793***	0.308***	0.651***	0.311***	0.736***
	(0.070)	(0.089)	(0.060)	(0.073)	(0.027)	(0.087)	(0.071)	(0.098)
R-Square	0.24	0.17	0.24	0.16	0.26	0.20	0.27	0.20
Obs.	188156	188156	160327	160327	143098	143098	122024	122024
F-statistic at first stage		187.46		182.01		154.52		147.54
Parent-Daughter	0.339***	0.870***	0.335***	0.874***	0.304***	0.753***	0.304***	0.736***
	(0.070)	(0.081)	(0.050)	(0.092)	(0.02)	(0.054)	(0.022)	(0.064)
R-Square	0.28	0.156	0.27	0.13	0.29	0.23	0.29	0.23
Obs.	92070	92070	76557	76557	69892	69892	58208	58208
F-statistic at first stage		93.40		89.90		78.46		73.84
Parent-Son	0.336***	0.628***	0.344***	0.686***	0.312***	0.534***	0.317***	0.709***
	(0.070)	(0.078)	(0.080)	(0.083)	(0.033)	(0.095)	(0.032)	(0..131)
R-Square	0.22	0.188	0.22	0.14	0.25	0.18	0.25	0.103
Obs.	96086	96086	83770	83770	73206	73206	63816	63816
F-statistic at first stage		106.26		102.11		87.66		84.67

Note: 1.Other independent variables include family-size, marital status of parents, number of kids own by the parent in household, kids' age cohort dummies, parents' age cohort dummies (adjusted by school calendar), a residential region dummy, ethnicity fixed effects for parents and children, birth province fixed effects for parents and children, and quarter fixed effects for parents and children; 2. Each estimate is from a single regression. (1) and (2) represent different samples as indicated. R-squared at the first stage ranges from 0.11 to 0.16.

Table 7: Examination with Different Outcome Variable

Dependent Variable	**Junior Secondary Completion of Children**							
Variable of Interest	**Mothers' Senior Secondary Completion**				**Fathers' Senior Secondary Completion**			
Sample of Parents	12-26 in 1966		14-18&22-26 in 1966		12-26 in 1966		14-18&22-26 in 1966	
Sample of Children	Age 16-22 in 1990		Age 16-22 in 1990		Age 16-22 in 1990		Age 16-22 in 1990	
	(1) OLS	**(1) IV**	**(2) OLS**	**(2) IV**	**(1) OLS**	**(1) IV**	**(2) OLS**	**(2) IV**
Parent-All	0.135***	0.230***	0.130***	0.264***	0.158***	0.280***	0.156***	0.303***
	(0.003)	(0.05)	(0.004)	(0.075)	(0.004)	(0.049)	(0.004)	(0.061)
R-Square	0.23	0.22	0.23	0.16	0.24	0.20	0.25	0.23
Obs.	231891	231891	160327	160327	169716	169716	122024	122024
F-statistic at first stage		217.47		182.01		173.52		147.54
Parent-Daughter	0.131***	0.175***	0.127***	0.150***	0.155***	0.184***	0.154***	0.197**
	(0.004)	(0.059)	(0.005)	(0.059)	(0.005)	(0.072)	(0.006)	(0.082)
R-Square	0.25	0.25	0.26	0.26	0.33	0.26	0.28	0.26
Obs.	110891	110891	76557	76557	81185	81185	58208	58208
F-statistic at first stage		105.76		89.90		83.21		73.84
Parent-Son	0.139***	0.238***	0.134***	0.256***	0.161***	0.379***	0.159***	0.403***
	(0.004)	(0.063)	(0.005)	(0.071)	(0.004)	(0.084)	(0.005)	(0.109)
R-Square	0.20	0.20	0.21	0.20	0.22	0.20	0.22	0.21
Obs.	121000	121000	83770	83770	88531	88531	63816	63816
F-statistic at first stage		123.52		102.11		99.42		84.67

Note: 1.Other independent variables include family-size, marital status of parents, number of kids own by parents in household, kids' age cohort dummies, parents' age cohort dummies (adjusted by school calendar), a residential region dummy, ethnicity fixed effects for parents and children, birth province fixed effects for parents and children, and quarter fixed effects for parents and children.; 2. Each estimate is from a single regression. (1) and (2) represent different samples.

Table 8: Intergenerational Transmission based on CHIPS 2002

Dependent Variable		**Senior Secondary Attainment of Children**			
Independent Variable: Senior Secondary Completion of Parents					
	OLS	**IV**		**OLS**	**IV**
Mother-Children	0.165***	0.312*	**Father-Children**	0.198***	0.390**
	(0.02)	(0.16)		(0.02)	(0.14)
R-Square	0.35	0.34	R-Square	0.36	0.34
Obs.	2983	2983	Obs.	4225	4225
R-Squared of the First Stage		0.22			0.34
F-Statistics of the First Stage		14.58			20.92
Dependent Variable		**Schooling Years of Children**			
Independent Variable: Schooling years of Parents					
Mother- Children	0.231***	0.376	**Father- Children**	0.249***	0.470***
	(0.02)	(0.26)		(0.02)	(0.19)
R-Square	0.42	0.40	R-Square	0.45	0.505
Obs.	2720	2720	Obs.	4125	4125
R-Squared of the First Stage		0.36			0.33
F-Statistics of the First Stage		25.42			33.18

Note: 1. Other independent variables include kids' gender, kids' age cohort dummies, parents' age cohort dummies, a residential region dummy (urban and rural areas), ethnicity fixed effects, and birth province fixed effects. Only the estimates of interest, the coefficients of parents' senior high completion or schooling years, are presented and each coefficient represents one single regression; 2. Robust standard errors are reported in brackets. *** represents significance at 1%,* *represents significance at 5% and * represents significance at 10%; 3. Interaction terms of the residential indicator and ages indicators are utilized as instruments which is the same identification strategy as the strategy 1.

Appendix A: the Educational Policy Changes

Figure A-1 shows the variations of senior secondary schools across city and town residential between 1971 and 1972 and an obvious increase in the number of senior secondary schools in city areas.

Figure A-1: The Supply of Senior Secondary Schools between 1971 and 1972

Figure A-2: Number of Senior Secondary Schools, by Region

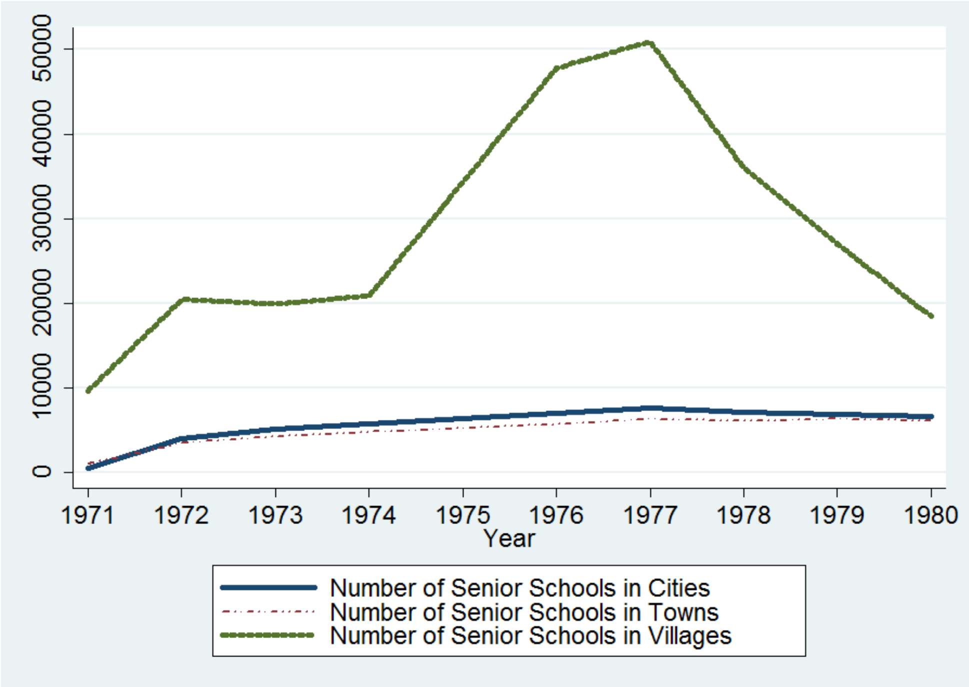
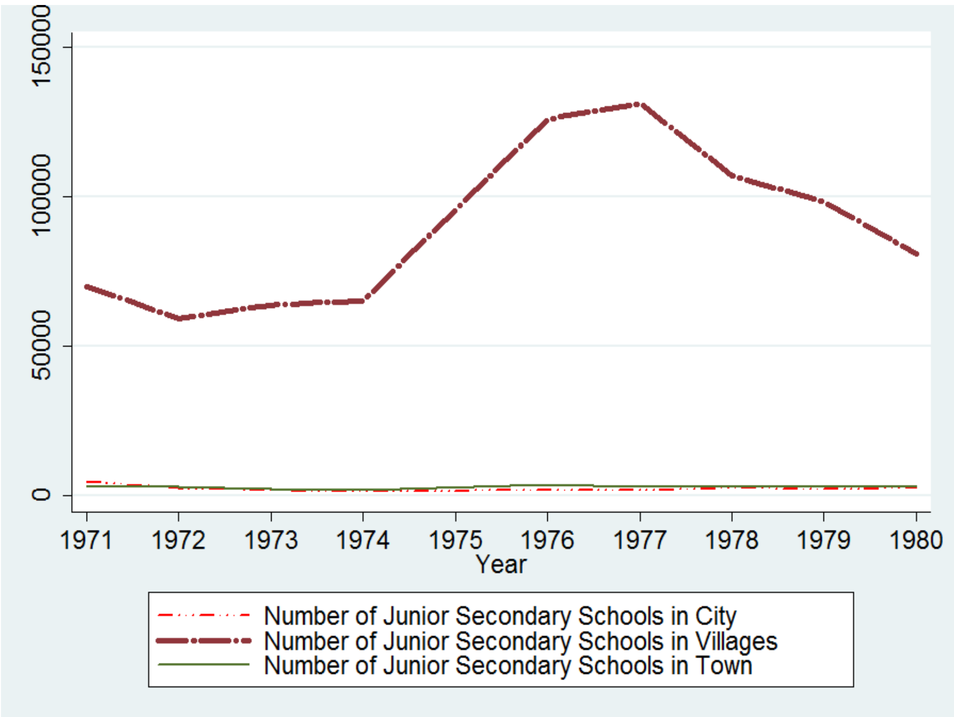


Figure A-3: Number of Junior Secondary Schools, by Region



According to Figure A-2 and A-3, the rural (villages) and urban (cities) areas exhibit quite different experience during the second half of the Cultural Revolution. We can observe the expansions in junior and senior secondary schools in rural areas which down grade the validity of controlling the rural areas as control groups. Limited by administrative statistics during the Cultural Revolution and before the Cultural Revolution, we only obtain the number of senior high schools in rural area was 20,000 in 1972. We only consider the residents in city and town residential. Table A shows the number of senior secondary schools in town and city residential. In both areas, the numbers of schools exhibit consistent patterns.

Table A-1: the Number of Senior Secondary Schools across City and Town

Year	City	Town	Year	City	Town
1971	550	1100	1981	6069	5951
1972	4000	3544	1982	5559	5743
1973	5139	4301	1984	5431	5725
1974	5848	4833	1985	5458	5926
1976	7008	5734	1986	5467	6154
1977	7610	6377	1987	5328	5969
1978	7106	6106	1988	5227	5904
1979	6893	6375	1989	5207	5851
1980	6676	6149	1990	5028	5828

Appendix B: Placebo Tests of the Junior Secondary High Completion

Table B-1: Evaluating the Effects of School Closure

		Maternal Education Attainment		Paternal Education Attainment	
Residential*	**Age in 1966**	**Senior High**	**Junior High**	**Senior High**	**Junior High**
δ_{12}	City*age_12	-0.101*** (0.017)	0.061** (0.025)	-0.152*** (0.038)	0.040 (0.047)
δ_{13}	City*age_13	-0.122*** (0.013)	0.046** (0.019)	-0.178*** (0.028)	-0.074** (0.035)
δ_{14}	City*age_14	-0.129*** (0.010)	-0.001 (0.014)	-0.154*** (0.021)	-0.086*** (0.026)
δ_{15}	City*age_15	-0.133*** (0.008)	0.021 (0.012)	-0.162*** (0.017)	-0.075*** (0.021)
δ_{16}	City*age_16	-0.125*** (0.007)	0.011 (0.011)	-0.151*** (0.013)	-0.112*** (0.016)
δ_{17}	City*age_17	-0.087*** (0.007)	0.002 (0.010)	-0.116*** (0.011)	-0.083*** (0.013)
δ_{18}	City*age_18	-0.065*** (0.006)	-0.001 (0.009)	-0.082*** (0.010)	-0.056*** (0.012)
δ_{19}	City*age_19	-0.049*** (0.006)	0.007 (0.009)	-0.084*** (0.009)	-0.063*** (0.011)
δ_{20}	City*age_20	-0.044*** (0.006)	0.019 (0.009)	-0.054*** (0.009)	-0.066*** (0.11)
δ_{21}	City*age_21	-0.018*** (0.006)	0.028*** (0.009)	-0.041*** (0.009)	-0.071*** (0.011)

δ_{22}	City*age_22	0.007 (0.006)	0.023** (0.009)	-0.002 (0.008)	-0.039*** (0.010)
δ_{23}	City*age_23	-0.001 (0.006)	0.020** (0.009)	-0.017** (0.008)	-0.062*** (0.010)
δ_{24}	City*age_24	-0.001 (0.006)	-0.010 (0.009)	-0.026*** (0.008)	-0.056*** (0.010)
δ_{25}	City*age_25	0.007 (0.006)	0.009 (0.009)	-0.017** (0.008)	-0.027*** (0.010)
Obs.		231891	231891	169716	169716
R-squared		0.11	0.12	0.11	0.12
F-Statistic※					
Wald-Test①		87.55	3.27|3.27※	34.07	8.23|4.41※
Wald-Test②		91.90	0.99|1.13※	54.47	15.79|2.68※
Wald-Test③		0.93(P=0.44)	4.74|5.67※	3.61	12.00|5.15※

①The null hypothesis: $\delta_{12}=\delta_{13}=\delta_{14}=\delta_{15}=...=\delta_{24}=\delta_{25}=0$

②The null hypothesis: $\delta_{14}=\delta_{15}=\delta_{16}=\delta_{17}=\delta_{18}=0$

③The null hypothesis: $\delta_{22}=\delta_{23}=\delta_{24}=\delta_{25}=0$

※ For the regressions of junior secondary completion, F-statistics are also presented for the following null hypothesis: $\delta_{12}=\delta_{13}=\delta_{14}=\delta_{15}=...=\delta_{24}=\delta_{25}$; $\delta_{14}=\delta_{15}=\delta_{16}=\delta_{17}=\delta_{18}$; $\delta_{22}=\delta_{23}=\delta_{24}=\delta_{25}$.

Note: 1. Empirical sample includes parents' aged 12-26 in 1966 adjusted for school calendar with children aged 16-22 in 1990; 2. The reference cohort is the group for parents aged 26 born in towns in 1966; 3. Other controls: age cohort dummies, residential dummy, province fixed effects, ethnicity fixed effects and quarter fixed patterns for parents. 4. *** represents significance at 1%,* *represents significance at 5% and * represents significance at 10%.

Regressions same as the Table B-2 in the main context are applied using the junior secondary completion as the dependent variable for the empirical samples. As shown in Table B-1 and B-2, the coefficients of interactions and F-statistics for the joint significant tests are consistently supporting the validity of our identification strategy.

Table B-2: Evaluating the Effects of School Closure for Restricted Sample

		Maternal Education Attainment		**Paternal Education Attainment**	
Residential*	**Age in 1966**	**Senior High**	**Junior High**	**Senior High**	**Junior High**
δ_{14}	City*age_14	-0.128*** (0.009)	-0.001 (0.015)	-0.154*** (0.020)	-0.086*** (0.025)
δ_{15}	City*age_15	-0.132*** (0.008)	0.021 (0.013)	-0.161*** (0.016)	-0.074*** (0.021)
δ_{16}	City*age_16	-0.123*** (0.007)	0.011 (0.011)	-0.150*** (0.013)	-0.111*** (0.016)
δ_{17}	City*age_17	-0.086*** (0.008)	0.003 (0.010)	-0.115*** (0.011)	-0.083*** (0.013)
δ_{18}	City*age_18	-0.064*** (0.007)	-0.001 (0.009)	-0.082*** (0.011)	-0.056*** (0.012)
δ_{22}	City*age_22	0.007 (0.006)	0.023** (0.010)	-0.002 (0.010)	-0.039*** (0.010)
δ_{23}	City*age_23	-0.0005 (0.008)	0.020** (0.010)	-0.017* (0.009)	-0.062*** (0.010)

δ_{24}	City*age_24	-0.0003 (0.008)	-0.011 (0.010)	-0.026*** (0.010)	-0.056*** (0.010)
δ_{25}	City*age_25	0.008 (0.008)	0.009 (0.010)	-0.017* (0.010)	-0.028*** (0.010)
Obs.		160327	160327	122024	122024
R-squared | F-statistic		0.11|244.8	0.16| 361.48	0.11|184.3	0.12|203.88
F-Statistic※					
Wald-Test[1]		124.44	2.42|2.57※	42.00	10.63 |5.83※
Wald-Test[2]		82.89	0.88|0.99※	52.26	15.88|2.61※
Wald-Test[3]		0.56(P=0.69)	4.33|5.17※	3.61	12.59|5.41※

[1]The null hypothesis: $\delta_{14} = \delta_{15} = ... = \delta_{24} = \delta_{25} = 0$

[2]The null hypothesis: $\delta_{14} = \delta_{15} = \delta_{16} = \delta_{17} = \delta_{18} = 0$

[3]The null hypothesis: $\delta_{22} = \delta_{23} = \delta_{24} = \delta_{25} = 0$

※ For the regressions of junior secondary completion, F-statistics are also presented for the following null hypothesis: $\delta_{12} = \delta_{13} = \delta_{14} = \delta_{15} = ... = \delta_{24} = \delta_{25}$; $\delta_{14} = \delta_{15} = \delta_{16} = \delta_{17} = \delta_{18}$; $\delta_{22} = \delta_{23} = \delta_{24} = \delta_{25}$.

Note: 1. Empirical sample includes parents' aged 14-18 and 22-26 in 1966 adjusted for school calendar with children aged 16-22 in 1990; 2. The reference cohort is the group for parents aged 26 born in towns in 1966; 3. Other controls: age cohort dummies, residential dummy, province fixed effects, ethnicity fixed effects and quarter fixed patterns for parents. 4. *** represents significance at 1%,* *represents significance at 5% and * represents significance at 10%.

Appendix C: Difference-in-Difference Tables

Table C-1: Difference-in-Difference (Fathers-and-Children)

Panel A:	Senior Secondary Completion of Fathers		
	Treated Group (age 13-19 in 1966)	Control Group (age 20-26 in 1966)	Difference
City	0.242	0.37	-0.128*** (0.005)
Town	0.088	0.135	-0.047*** (0.002)
Difference	0.154*** (0.003)	0.235*** (0.002)	-0.081*** (0.005)
Panel B:	**Senior Secondary Attendance of Children**		
	Treated Group (age 13-19 in 1966)	Control Group (age 20-26 in 1966)	Difference
City	0.418	0.550	-0.132*** (0.005)
Town	0.140	0.206	-0.066*** (0.003)
Difference	0.278*** (0.004)	0.344*** (0.002)	-0.066*** (0.005)

Table C-2: Difference-in-Difference (Mothers-and-Children)

Panel A:	Senior Secondary Completion of Mothers		
	Treated Group (age 13-19 in 1966)	Control Group (age 20-26 in 1966)	Difference
City	0.138	0.231	-0.093***
			(0.003)
Town	0.028	0.057	-0.029***
			(0.001)
Difference	0.11***	0.173***	-0.064***
	(0.002)	(0.001)	(0.003)
Panel B:	Senior Secondary Attendance of Children		
	Treated Group (age 13-19 in 1966)	Control Group (age 20-26 in 1966)	Difference
City	0.465	0.570	-0.106***
			(0.003)
Town	0.168	0.218	-0.051***
			(0.002)
Difference	0.297***	0.352***	-0.055***
	(0.003)	(0.002)	(0.004)

Appendix D: Concerns for Data

The first concern is whether the timing of childbearing has been impacted obviously. We examine the average age of children by parents' birth cohorts. As the smoothly increasing trends in both residential locations show, the closure of schools has not caused obvious discontinuity in mothers' decision to choose the timing of giving births in both residential locations (See Figure D-1). Secondly, sex selection of children is considered. We gauge the proportion of boy children born and graphed them against mothers' age cohorts in Figure D-2. The flat curves indicate that there is no obvious gender selection over time and no significant difference exists between town residents and city residents. We also regress the ratio of number of male children to total number of children born for each female sample on the interactions, age indicators, quarter fixed effect and province fixed effect (see Table D-3). All the coefficients of interactions are close to 0.

The last concern is that we are not able to follow those adult children having moved out the households (around 30% of the sample). The reason for attrition is mainly related with the facts that the adult kids get married and establish new households. To better understand the problem of attrition, we computed the total number of children missed, the number of girls and boys missed within the households at the level of mothers' age cohort. The results are graphed in Figure D-3. Based on the statistics, the missing children are majorly children of parents in control group. They are probably with more education attainment, or it is also possible that more able children are more likely to move out the households and become independent. If they are the case, our estimates might underestimate the effects and constitute lower bounds for the intergenerational transmission.

Figure D-3 is for city households and Figure D-4 is for town residents. Both graphs show that families with older parents are more likely to have children move out. On average, for birth cohorts who were older than 22 in 1966 (control group), one of their children has left and lost tracking in cities. Meanwhile, there are more children, around 1.5, losing tracking for the town households. For younger cohorts, the number of children having moved out is below 0.5, on average. Hence, most of the children for the younger mothers were still living within the households in 1990. The analysis of the composition shows that most of the children are girls and in the control group, around one girl has left her parents. By contrast, the proportions of boys moving out were less both in city and town areas. Compared boys and girls, overall most of the boys are still living within the households. Combining both graphs, the probability of missing is more likely a function of their own ages, less likely depends on parents' education attainment and probably is not correlated with the unobserved ability of parents as well as children's education attainment. Also, all the curves show that the moving out patterns of children are similar and consistent across residential regions as well as across genders over time series. With the assumption that the moved out children follow the same structure and determinants are consistent across regions, the sample bias can be alleviated after taking the difference in difference across regions and age cohorts. Therefore, our estimates are sufficient for consistency. The patterns are consistent across town residents and city residents and when the identification strategy is applied, the potential estimation bias is alleviated. If we can have a unique data matching the population, the estimate of interest is perfectly estimated.

Our inability to solve the problem of attrition which might bias the estimators if the pattern of missing is a function of parent's education and correlated with the unobserved specifics. To further explore the correlation, correlations between variables of interest are studied and presented in Table C-1 and Table C-2 based on the empirical data. We also apply the regressions of the first stage to explore the missing kids problem (see Table C-3). How the attrition problem can bias our estimator? The younger parents have less kids moving out and the urban areas have more kids move out. Attrition problem is negative related with the IV and negative related with parents' senior high attainment.

Table D-1 Correlation Matrix

Correlation	U	X	Y
Indicator of Attrition (U)	1		
Maternal Senior High Completion(X)	-0.077	1	
Children Senior Attendancy(Y)	-0.0686	0.3302	1

Table D-2 Correlation between the Instruments and the Indicator of Attrition

IVs	City*age_12	City*age_13	City*age_14	City*age_15	City*age_16	City*age_17	City*age_18
U	-0.0257	-0.0365	-0.0496	-0.0594	-0.0705	-0.0798	-0.08
City*age_19	City*age_20	City*age_21	City*age_22	City*age_23	City*age_24	City*age_25	City*age_26
-0.0821	-0.0644	-0.043	-0.0139	0.0082	0.0352	0.0588	0.0817

Figure D-1: Children's Age by Parent's Age in 1966

(Sample: 1990 China Census)

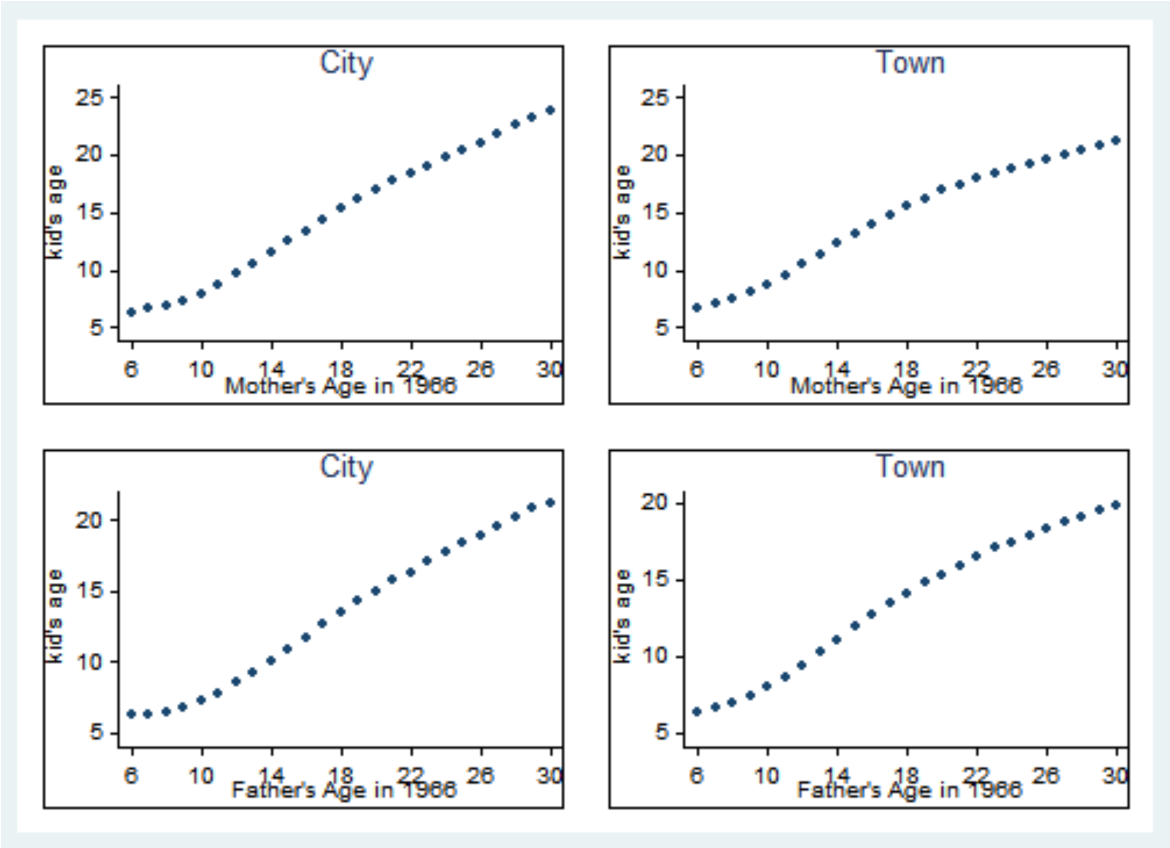


Figure D-2: The Proportion of Boy's Births by Mother's Cohort

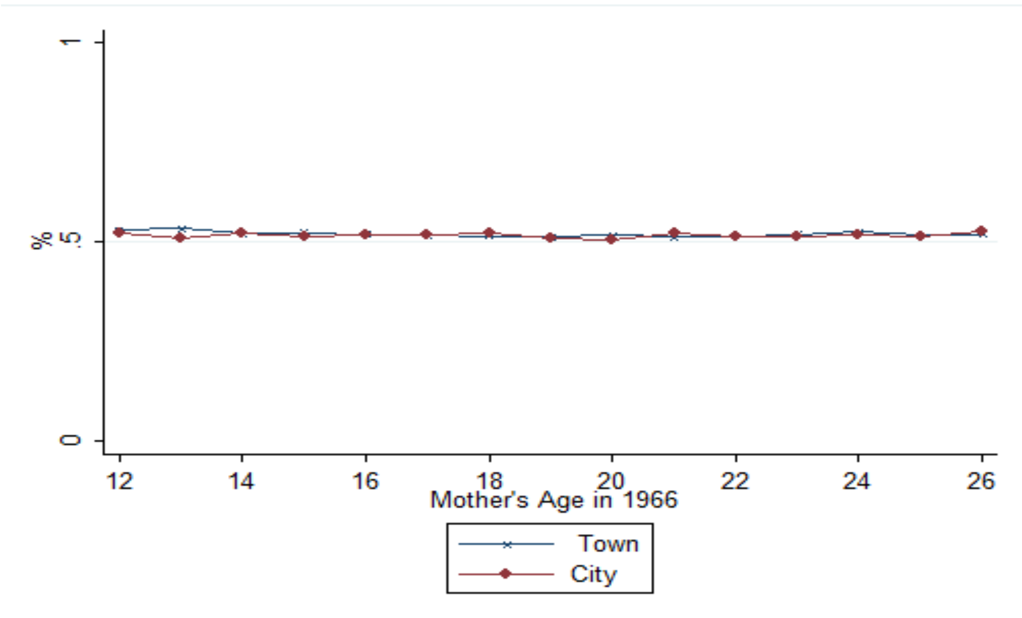


Figure D-3: the Children Missed for Households in Cities

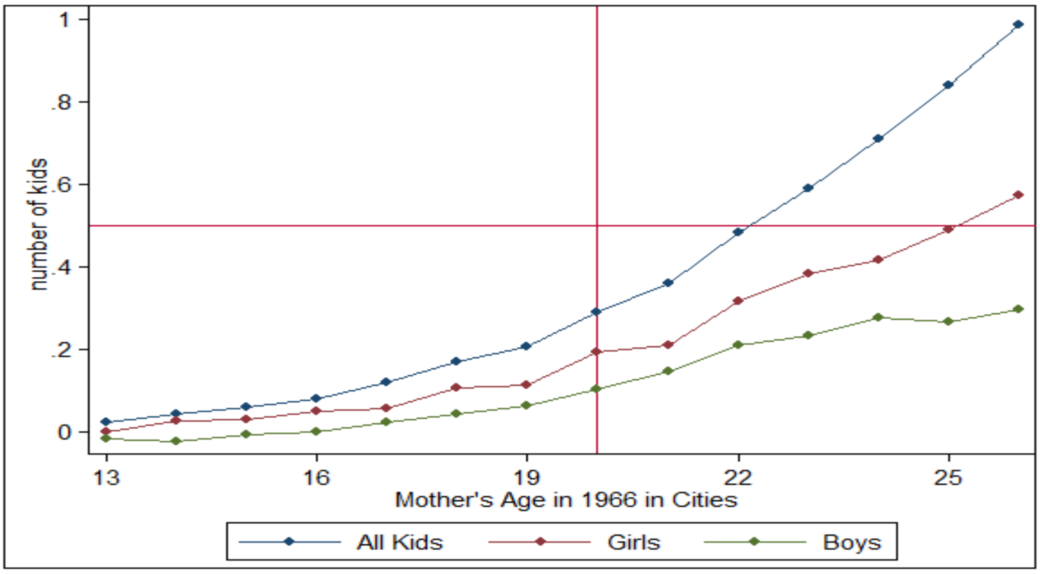


Figure D-4: the Children Missed for Households in Towns