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Abstract

This paper has three objectives. First, we present the mobility pattern for intergenerational education persistence. Second, we estimate the effect of parental education on children education by using instruments generated by the Chinese Cultural Revolution, and further explore the mechanisms of this causal relationship. Third, this study aims to investigate the impact of two education reforms on intergenerational transmission of education, including the Compulsory Education Law and college expansion reform. Although mobility seems increasing for the newer generation, the lowest mobility is found in rural areas for the lowest-educated group. Fathers' education has a significant impact on children education through the nurture effect, which is almost entirely driven by father's income. Finally, we find that popularizing compulsory education did not have a expected effect on increasing mobility. Moreover, the college expansion policy indeed reduces the intergenerational education mobility in urban areas, but this effect is not found in rural areas.

Keywords: intergenerational education mobility, nurture effect, education reforms, China.

JEL Classification: H5, I2, O1.

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1. Introduction

Intergenerational mobility in income has received much attention in the economics literature in the past few decades (Solon, 1999; Black and Devereux, 2011). This issue is particularly important in a developing country such as China where income inequality increased dramatically in the past several decades with the transition from a planned economy to a market-oriented economy (Meng et al., 2005; Benjamin et al., 2011; Song, 2013). Specifically, the nation-wide Gini coefficient of individuals' annual income increased from 0.371 in 1997 to 0.462 in 2015.[2]

Several studies have identified an important role of parental education in the transmission of economic status from parents to children (Gong et al., 2012; Yuan and Lin, 2013; Magnani and Zhu, 2015). Education is particularly important in China's context because China has experienced dramatic changes in the labor market from the mid-1990s. Since then, job-seekers have become free to choose jobs, and employers have more flexibility to make decisions on hiring and firing compared to the pre-reform period when jobs were largely assigned to individuals by universities, communities, or local governments (Dong and Xu, 2009; Fields and Song, 2013; Song, 2016). As a consequence of these market-oriented reforms, the education level has become an important determinant of income, and the return to schooling has risen sharply since the 1990s in China, and is now comparable to western economies. In addition, education inequality explains the largest proportion in total income inequality, as suggested by recent literature (Song and Ma, 2016), making it urgent to better understand how educational inequality would transmit from one generation to the next.

In this paper, we use the newly-released CHIP 2013 dataset to carefully investigate education inequality from the perspective of intergenerational education mobility and the policy consequences of two important education policies: compulsory education law (CEL) and college expansion policy (CEP). A major contribution of this paper is to provide a comprehensive analysis of the intergenerational education mobility in China, including presenting a complete education mobility profile, estimating the nurture effect using instruments generated by the Chinese Cultural Revolution, conducting a comprehensive heterogeneity analysis to investigate the heterogeneity in intergenerational transmission of education, empirically testing the mechanisms through which the nurture effect works, and exploring the policy consequences of two important public education policies such as the Compulsory Education Law and college expansion policy.

Several important findings appear from our empirical analyses. First, the intergenerational education mobility is lower in urban than rural China. This may

[2]The Gini coefficients for inequality are from the National Bureau of Statistics, available at http://www.stats.gov.cn/tjsj/zxfb/201601/t20160119_1306083.html.

occur because urban areas have more good schools and educational resources, which enable people to accumulate their advantage over generations. Second, more intergenerational persistence in education tends to occur for higher level of education in urban areas but for both lowest and highest levels of education in rural areas. The highest persistence found in rural areas for the lowest education group might be some evidence for educational poverty traps in that parents can pass their low education to their children which may create persistent poverty in income over generations. Third, the results show that fathers' education has a significant impact on children education through the nurture effect, but mothers' impact is mainly through the nature effect. A deeper investigation of the mechanism behind this nurture effect informs us that the nurture effect would disappear after adding father's income as a control variable, suggesting that the nurture effect for paternal education is almost entirely driven by father's income.

Finally, We found that popularizing compulsory education did not have an expected effect on increasing mobility due to poor targeting and insufficient enforcement. In addition, the college expansion policy indeed reduces the intergenerational education mobility in urban areas, but this effect is not found in rural areas. Reasons why rural children did not benefit significantly from the college expansion policy may be because they cannot afford higher education or a large proportion of rural children did not finish the high school education, which is a prerequisite for higher education in China. Therefore, the policy at the college level indeed is beyond the reach of many rural students and thus has a small impact on them. Given these results, we suggest offering poor families educational subsidies to help them afford higher-level education, and investing more resources in high school in rural areas. Meanwhile, policies such as creating more equal education opportunities would be desirable to prevent rich households accumulating their advantages over generations through education.

The remainder of this paper is organized as follows. Section 2 discusses previous relevant research and specifies our contributions, and Section 3 describes the dataset and presents some descriptive statistics. Section 4 shows the intergenerational education mobility profile by looking at the transition matrixes in different dimensions. Section 5 demonstrates the OLS and IV regression results to disentangle the nurture effect from the nature effect and explores the mechanisms behind these effects. Section 6 investigates the policy consequences of two important education policies, and Section 7 concludes.

2. Past relevant research

Numerous studies have examined the intergenerational correlation of education in different countries. Hertz et al. (2007) calculates the intergenerational education correlation in 42 countries, with an average 0.39 and the highest correlation (0.66) in

Peru. Two commonly recognized mechanisms behind this intergenerational transmission are nature and nurture effects. The nature effect refers to the intergenerational education transmission related to inherent abilities that parents pass to their children through genes, while the nurture effect refers to a causal effect of parental education on children's schooling through educational investment, better home environment, and so on. In econometrics terms, the nurture effect is interpreted as the causal relationship while the nature effect results in the potential endogeneity problem.

2.1 Nature vs. nurture effect

Existing studies on this topic mainly focus on disentangling the nurture effect from the nature effect through three identification strategies. The first is to use twin parents. Behrman and Rosenzweig (2002) is one of the first studies that implement this strategy using the children of monozygotic twin mothers and fathers, which can difference out genetic factors that influence children's education. A more recent paper using this method is Bingley et al. (2009). They use unique Danish administrative data for identical and fraternal twin parents and their children to estimate both short-run and long-run intergenerational education effects.

The second is to use data from adopted children. Under the assumption that adopted children are randomly assigned to families as infants and treated exactly the same as biological children, comparing adopted children and natural children can identify the effect of environmental factors on the intergenerational transmission of education. Sacerdote (2002) and Plug (2004) use this method and find father's education has significant influence on children's education. As the data and information on adopted children is limited, the fact that some children in the data are adopted by biological parents would bias the results. Thus, large registry datasets of adopted children were employed by recent literature. For example, Björklund et al. (2006) finds both adoptive and biological parents' education play an important role in their children's education.

The third is to employ the IV approach, which isolates the effect of parents' education on children outcomes using instrumental variables, such as some important education reforms. For example, Chevalier (2004) uses a change in the compulsory schooling requirement that took place in Britain in 1957 as the instrumental variable to identify the effect of parental education on their children's educational attainment. Black et al. (2005) utilizes the Norwegian schooling reforms during 1959–1973 and find weak causal effects of parental education on children's education attainment. More recent papers such as Oreopoulos et al.(2006), Holmlund et al. (2011) and Stella(2013) also use compulsory school law changes to study the intergenerational correlation of education.

However, compulsory school reform is rarely used as the instrumental variable in

China.[3] The reason is that the compulsory school reform was implemented in 1986. Accordingly, most of people who experienced that education reform don't have children or their children are too young to finish schooling. In addition, we should be aware of an important limitation to use the compulsory schooling law as the instrument to estimate the nurture effect. The laws only affected the bottom of educational attainment distribution, and hence most of the literature using this IV to identify the nurture effect focuses on the effect for the lowly educated groups, which may not be applicable for other groups.

In response to the issues mentioned in the paragraph above, several attempts have tried to use the Chinese Cultural Revolution (CR) as the instrument, such as Meng and Gregory (2002) and Meng and Zhao (2013). However, these studies only focused on urban China and used the datasets in early time periods when the children whose parents were affected by CR had not yet finished schooling.

2.2 Heterogeneity analysis

Although heterogeneity in educational transmission has been recognized as an important dimension of educational inequality (Harmon et al., 2003; Heckman and Li, 2004; Koop and Tobias, 2004; Henderson et al., 2011), very few studies have explicitly addressed this aspect of intergenerational education transmission (Bauer and Riphahn, 2007). We summarize the existing heterogeneity studies by several dimensions as shown below.

The most discussed heterogeneity is the differential effect between fathers and mothers. For example, Behrman and Rosenzweig (2002) finds a positive and large effect of the father's schooling but no effect for the mother's schooling. Chevalier (2004) finds large effects of mother's education on children's educational attainment, but does not find statistically significant effects of father's education. Stella (2013) also shows that maternal education is more important than paternal education for the next generation.

The second comparison is also the gender difference -- the differing effect of parents' education on sons' and daughters' education. Bruck and Esenaliev (2013) finds that daughters tend to experience lower intergenerational mobility than sons in Kyrgyzstan using data from three household surveys collected in 1993, 1998 and 2011. Pastore and Roccisano (2015) does the same job but extends it to eight developing countries. Magnani and Zhu (2015) uses the Census data in China and finds that the effects of paternal education transmission on sons' education attainments are larger than those of maternal transmission, while the paternal and maternal transmission has similar impacts on daughters' education.

[3] One exception is Song (2012) which identifies the causal effect of popularizing compulsory schooling on poverty reduction in China.

The third is to investigate changes in intergenerational education correlation over time for different age cohorts. Bruck and Esenaliev (2013) discovers that the younger cohorts in Kyrgyzstan, who were exposed to the transition during their school years, experienced a rapid decline in educational mobility. Magejo et al. (2014) identifies a decrease in intergenerational transmission of education for 1954-1993 birth cohorts.

The final comparison is between urban and rural population. Golley and Kong (2013) investigates the difference in intergenerational education correlation between urban and rural China. They point out that the higher mobility observed in rural and migrant populations stems from the fact that the majority of these children complete only junior high school, with some children in the youngest cohorts moving down the education ladder relative to their parents. In contrast, urban children seem to at least maintain their parents' education level.

2.3 Mechanism analysis

A lot of literature have estimated the nurture effect in different countries and for different cohorts, but the specific mechanism is largely unknown to us. Black and Devereux (2010) proposed three possible mechanism of intergenerational transmission of education. The first is the income channel. That is the higher educated parents tend to have higher income and higher income leads to higher education attainment of their children. The second is that parental education may affect parental time allocation and the productivity of the parent in child-enhancing activities. The third is about the bargaining power, which would be influenced by parents' education. However, empirical tests of each of three channels are still in infancy.

2.4 The impact of public education

Public education is an important policy tool that may significantly influence education mobility. Unfortunately, very few studies have examined the effect of education policies on intergenerational transmission of education. To the authors' knowledge, the only policy tested by existing research is the abortion of tuition fees in primary schools. Al-Samarrai and Zaman (2007) finds that the abolition of tuition fees in Malawi leads to an increase in enrollment rates of primary education and more importantly these gains are identified to be higher for the poor population. Similar results are found by Tinker et al. (2013) for seven Sub-Saharan African countries, which indicate that the removal of fees can improve the intergenerational mobility of education.

2.5 Our contributions

Beyond the studies reviewed in previous sub-sections, this paper contributes to the literature on intergenerational transmission of education in at least five main aspects.

First, this paper presents a complete education mobility profile by investigating the pattern of intergenerational transmission of education in different dimensions, such as urban and rural, different age cohorts, and so on. Specifically, we will make use of transition matrixes between parents' education and children education to enrich our understanding of various mobility pattern masked by a single regression coefficient estimated by most of previous studies.

Second, this paper will employ the Chinese Cultural Revolution (CR) as the instrument to disentangle the nurture effect from the nature effect using the nation-wide dataset (CHIP 2013). As mentioned above, although Meng and Gregory (2002) and Meng and Zhao (2013) have tried to do this job using earlier datasets, these studies only focused on urban China and used the datasets in early time periods when the children whose parents were affected by CR had not yet finished schooling. In contrast, since the CR affects in urban and rural China differently, our paper will employ separate sets of instruments for urban and rural areas - a revised version from Chen (2010) who studied the effect of parental education on children health.

Third, this paper will conduct a comprehensive heterogeneity analysis to investigate the heterogeneity in different dimensions, father versus mother, son versus daughter, urban versus rural, high-educated parents versus low-educated parents, etc. More importantly, we will combine these heterogeneity results with the distinction between nature and nurture effect. Although previous studies reviewed above have examined various heterogeneities, they mainly use the OLS regressions and rarely consider the heterogeneous nurture effect. Our paper will fill in this gap by running IV estimations in different dimensions.

Fourth, this paper will utilize father's income to test to what extent the income channel can explain the intergenerational education mobility in both nature and nurture effect. As mentioned above, although several studies have argued that parents' education can affect children education through higher parental income (Holmlund, 2008; Black and Devereux, 2010), few studies have ever tested this claim empirically, especially within nurture effect.

Fifth, our paper will innovatively examine the effects of two policies in the field of public education on intergenerational education persistence, including compulsory education law (CEL) and college expansion policy (CEP). Many studies proposed policy suggestions to increase education mobility (i.e., reduce intergenerational education correlation), but rarely test the quantitative policy effects. Several earlier attempts only examined the effect of removing tuition fees for primary education on intergenerational education mobility. However, these policies may be outdated and have few policy insights for now in countries like China (especially in urban China) where most people have completed primary education. In this paper, in addition to testing the effect of primary education policies in China, we will also investigate the effect of college expansion policy on intergenerational transmission of education in China's context. To our knowledge, this is the first attempt to examine consequences

of higher education reform on education mobility.

3. Data description

We use the CHIP 2013 (China Household Income Project) survey data to investigate the impact of parental education on children education. CHIP is a study designed by a team of Chinese and Western economists and is among the best available national survey data on household income, expenditures, education, and program participation (for more details about the design and methodology of the CHIP study, see Gao, Yang, & Li, 2013). CHIP particularly suits the analytical needs of this study because it includes the completed years of schooling for both children and their parents as well as various demographic and socioeconomic characteristics. This differs from several other well-known datasets in China such as CGSS (China General Social Survey) and CFPS (China Family Panel Studies) which only provide the level of education (e.g., primary school, middle school, high school, and college) and do not tell us whether the person quitted in the middle of each level of schooling. As a result, we are not able to know the exact years of schooling using other datasets. Another advantage of the CHIP dataset is that it includes father's income which is very useful in the mechanism analysis.

Samples of the CHIP study were drawn from larger National Bureau of Statistics (NBS) samples using a multistage stratified probability sampling method. To generate a nationally representative sample, CHIP includes sample provinces from eastern, central, and western regions of China. The survey has been conducted in five waves including CHIP 1988, CHIP 1995, CHIP 2002, CHIP 2007, and CHIP 2013, and the data we use for this paper (CHIP 2013) is the most recent one, in which the children of those who experienced the Cultural Revolution have completed their schooling. The CHIP 2013 is conducted in 15 provinces including Beijing, Shanxi, Liaoning, Jiangsu, Anhui, Guangdong, Henan, Hubei, Sichuan, Chongqi, Yunnan, Gansu, Shandong, Hunan, and Xinjiang. The sample includes 6866 households in urban China and 10,759 households in rural China.

The Chinese Cultural Revolution (CR) occurred between 1966 and 1976. It was a political movement that disrupted everyone's life during that period. However, in terms of education, only those who should be in school during the CR experienced school interruption. In addition, the degree of school interruption during the CR was quite different across years (as detailed below in the next section). This generated an exogenous variation of educational attainment, which is irrelevant to individuals' innate abilities.

In order to capture the effect of CR and make use of it as an instrument, we impose some birth year restrictions on our sample. According to Meng and Gregory (2002) and Chen (2010), people born in the period of 1947-1961 experienced different

degree of school interruption. Thus, we include people whose parents were born during this time period as the treatment group. For comparison, we include people whose parents were born in 1942-1946 and 1962-1966 as the control group. These parents were not directly affected by CR in terms of interrupted education, but all experienced CR and the Mao era and thus have similar characteristics with the treatment group. In addition, the reason for excluding parents who were born before 1942 is that those parents obtained their education mainly under the pre-communist system, which may differ from the system that operated after 1949, and part of their education may have also been interrupted by World War II and the Civil War. The reason for excluding parents who were born after 1966 is mainly to make sure that their children would have finished schools at the time of the survey implemented in 2014. Furthermore, we exclude children who were born in 1961 or before to guarantee that children themselves were not affected by CR directly. Finally, we require that all the children should have completed their education at the time of the survey.

In summary, the reason we restrict parental and children's birth cohorts to these ranges is to ensure the instrument we are using is valid. By restricting the sample to the birth cohorts who experienced the CR but their children did not, school interruption during the CR provides a valuable chance to identify the nurture effect in intergenerational education mobility.

The final sample includes 5,850 children with their parents information, and 1,052 of them are in urban areas, whereas the remaining 4,798 are in rural China. The summary statistics of the key variables are shown in Table 1.

Table 1 Descriptive Statistics of Key Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Sc	5850	11.02	3.34	0	22
Sf	5850	7.70	3.09	0	20
Sm	5850	6.37	3.52	0	19
Age	5850	30.73	5.30	23	51
Urban hukou	5850	0.18	0.38	0	1
Male	5850	0.71	0.45	0	1
Minority	5850	0.07	0.25	0	1

Note: Sc, Sf, and Sm denote the years of schooling for children, fathers, and mothers, respectively. The other variables are self-explanatory.

As can be seen, children in this sample on average receive 11 years of schooling, with the standard deviation equal to 3 years. In China, the formal education typically consists of 6 year primary school, 3 year middle school, 3 year high school, 3 or 4 year college and above. That is, children in our sample on average reached high school level and aged 30 in the survey year. According to the Compulsory Education Law implemented in 1986, people whose age were below 16 should complete 9 years

of compulsory schooling (including 6 year primary school and 3 year middle school). Thus, most children have completed 9 year compulsory schooling while their parents only have 6-7 years of schooling.

Given the survey structure, most people are rural residents and thus have rural hukou (household registration status). 71% of the children sample are male, and only 7 percent belongs to minority group. Since there is a very large rural–urban gap in terms of education levels as documented in previous literature (Song, 2012), we separate our sample by urban and rural division and show the descriptive statistics in the table below.

Table 2 Descriptive Statistics for Urban and Rural Residents

Panel A: Urban					
Variable	Obs	Mean	Std. Dev.	Min	Max
Sc	1052	13.71	2.88	0	22
Sf	1052	10.07	3.17	0	20
Sm	1052	9.33	3.36	0	19
Age	1052	30.12	4.90	23	50
Male	1052	0.61	0.49	0	1
Minority	1052	0.06	0.23	0	1
Panel B: Rural					
Variable	Obs	Mean	Std. Dev.	Min	Max
Sc	4798	10.44	3.14	0	21
Sf	4798	7.18	2.82	0	18
Sm	4798	5.72	3.21	0	16
Age	4798	30.86	5.37	23	51
Male	4798	0.74	0.44	0	1
Minority	4798	0.07	0.25	0	1

Note: Sc, Sf, and Sm denote the years of schooling for children, fathers, and mothers, respectively. The other variables are self-explanatory.

Table 2 verifies the large educational inequality between urban and rural China. Urban residents on average receive 3 more years of education than rural residents do, including both children and their parents. An average urban child in our sample has received 13 years of formal schooling meaning that the average group has completed high school. Notably, given the mean value and standard deviation of the children education in rural areas, we can infer that a large proportion of children still have not completed 9 years of compulsory schooling.

To further understand whether Compulsory Education Law implemented in 1986 have contributed to popularizing primary and middle schooling, we split our sample by children's birth cohort, and present the results in Table 3.

Table 3 Descriptive Statistics by Birth Cohorts

Birth cohort of child	Share %	Sc				Sf				Sm			
		Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
1965-1969	0.8	7.87	3.24	0	16	5.53	3.43	0	15	3.57	3.56	0	15
1970-1974	4.27	8.51	2.92	0	17	5.50	3.12	0	15	3.82	3.00	0	15
1975-1979	9.66	9.68	3.02	0	19	6.58	3.40	0	18	4.60	3.62	0	18
1980-1984	21.01	10.45	3.18	0	21	7.31	3.10	0	17	5.93	3.50	0	17
1985-1989	42.65	11.52	3.32	0	22	8.12	2.89	0	19	6.90	3.32	0	18
1990-1994	21.61	11.82	3.15	0	19	8.28	2.91	0	20	7.15	3.37	0	19

As can be seen, the average years of schooling increase with children's age. People who were born after 1985 have received nearly 12 years of education. It is noteworthy that although people born in the 1970s were affected by the Compulsory Education Law, many of them still have not completed 9-year compulsory schooling. For instance, the average years of schooling for the 1970-1974 age cohort is only 8.51, indicating that the law is not strictly enforced as stated (Song, 2012).

4. Intergenerational education mobility profile

This section presents a complete intergenerational education mobility profile in different dimensions. We first examine the pattern of intergenerational education mobility by looking at the transition matrix. The left column denotes parents' education (whoever has more years of schooling) and the upper row denotes children education. Table 4 displays the probability of being in each quintile for children's years of schooling conditional on starting in a given quintile for their parents' education. Such a quintile mobility matrix displays the extent of movement across the five quintiles across the two generations.

Table 4 Quintile Transition Matrix for Intergenerational Education Mobility

Schooling of Parent % (the higher one)	Lowest Quintile	Quintile 2	Quintile 3	Quintile 4	Highest Quintile
Lowest Quintile	41.07	34.38	14.9	7.28	2.37
Quintile 2	23.57	31.89	22.82	14.85	6.88
Quintile 3	9.15	35.47	26.57	17.17	11.64
Quintile 4	11.76	16.86	27.84	26.27	17.25
Highest Quintile	4.82	11.28	22.31	32.04	29.54

We see two main patterns. First, conditional on starting in a given parents' education quintile, the likelihood of remaining there varies from 26% to 32% for the four higher quintiles and is equal to 41% for the lowest quintile. That is, we do see much intergenerational mobility in education although the lowest quintile exhibit the highest level of intergenerational persistence. Second, most of these changes were from one quintile to an adjacent one, but there were those who changed quite a lot. For example, 2.37 percent of people whose parents belong to the lowest quintile in education

climbed up through the education ladder and reached the highest quintile. Another interesting pattern is that for each quintile except the lowest one, more than 50% of children moved down along the education quintiles compared to their parents.

We should be aware of the fact that since the average years of schooling have increase significantly from father's generation to children's generation, the quintile transition matrix may well mask the real movements between different education levels. Thus, we re-draw the transition matrix by five education levels in Table 5 and show the share of each education level for both parents and children.

Table 5 Quintile Transition Matrix by Education Level

Schooling of Parent % (the higher one)	Schooling of Children %					Total	
	Not Educated	Primary	Middle	High	College & Graduate	%	Number
Not Educated	2.99	51.5	29.34	11.98	4.19	2.85	167
Primary	0.6	28.1	34.89	20.19	16.22	51.64	3,021
Middle	0.27	9.33	33.51	28.18	28.71	25.66	1,501
High	0.11	5.57	14.3	26.97	53.06	15.66	916
College &Graduate	0	1.63	5.31	8.98	84.08	4.19	245
Total	0.48	19.32	29.91	22.6	27.69	5,850	
	28	1130	1,750	1322	1,620		

It turns out that the share of people who completed nine-year compulsory education (including primary and middle school) has increased from less than a half for fathers' generation to nearly 80% for children's generation. However, the other side of this story is that 20% of children did not finish middle school who were mostly affected by the *Compulsory Education Law*, indicating that the law may not be very well enforced. In addition, due to the college expansion policy started from 1999, 27% of children's generation have completed college education compared to only 4.19% for fathers' generation.

As is seen, the finding from Table 4 that most of mobility changes were from one quintile to an adjacent one remains true in Table 5. [4]However, we observe very high persistence in education for children whose parents completed college education. That is, as long as you have one of the parents who completed college in our sample, you would be very likely (84%) to complete college education as well.

Given the fact that there is a large education gap between urban and rural China (Song, 2012), we further divide our sample into urban and rural based on the location of residence. Table 6 presents these results.

[4] Compared to Table 4 in which many children moved down the education ladder relative to their parents, we see in Table 5 that the absolute education levels have risen for children's generation.

Table 6 Quintile Transition Matrix in Urban and Rural Areas

Panel A: Urban

Schooling of Parent % (the higher one)	Schooling of Children %					Total	
	Not Educated	Primary	Middle	High	College & Graduate	%	Number
Not Educated	0	30	20	40	10	0.95	10
Primary	0.89	11.11	19.11	34.67	34.22	21.39	225
Middle	0.36	1.46	14.23	33.94	50	26.05	274
High	0.28	1.1	2.76	22.93	72.93	34.41	362
College &Graduate	0	0	3.87	7.73	88.4	17.21	181
Total	0.38 4	3.42 36	9.6 101	25.86 272	60.74 639	1,052	

Panel B: Rural

Schooling of Parent % (the higher one)	Schooling of Children %					Total	
	Not Educated	Primary	Middle	High	College & Graduate	%	Number
Not Educated	3.18	52.87	29.94	10.19	3.82	3.27	157
Primary	0.57	29.47	36.16	19.03		58.27	2,796
Middle	0.24	11.08	37.82	26.89	23.96	25.57	1,227
High	0	8.48	21.84	29.6	40.07	11.55	554
College &Graduate	0	6.25	9.38	12.5	71.88	1.33	64
Total	0.5 24	22.8 1,094	34.37 1,649	21.88 1,050	20.45 981	4,798	

We show again the large educational gap between urban and rural areas from at least two pieces of evidence. First, for children's generation, more than 95% of people completed middle school in urban areas, compared to less than 77% in rural areas, partly reinforce the finding from Song (2012) that the *Compulsory Education Law* was poorly enforced in rural China. Second, 60% of children completed college in urban China compared to only 20% in rural areas.

In terms of the mobility pattern, we do observe an interesting difference between urban and rural China. For urban areas, we find larger mobility at lower education levels but smaller mobility at higher education levels. For example, if your parent completed only primary education, the probability for you to have the same education level is only 11%, and you would have a chance of 34% to complete college education. In contrast, if your parent completed college, the probability for you to also complete college is 88.4%. This large probability implies the high intergenerational persistence in terms of education for high-educated urban residents.

Nonetheless, rural China exhibits the opposite pattern characterizing lower mobility at lower education levels but larger mobility at higher education levels. Let us show the

same example for rural areas. If your parent completed only primary education[5], the probability for you to have the same education level is 29%, and you would have only a chance of 14% to complete college education. In contrast, if your parent completed college, the probability for you to also complete college is 71%, which is smaller than the urban counterpart (88%). These comparisons mean that the high persistence occurs at lower education levels in poorer rural China, which has important policy implications. It may imply a poverty trap in education across generations which might further generate a poverty trap in income over generations. In this case, anti-poverty policies towards low-educated people are very much needed to help them escape from the poverty trap. We will further reinforce these patterns through regression analyses in the next section.

The last table in Section 4 divides the entire sample into three sub-groups based on children's birth cohort, including those born in the 1970s, 1980s, and 1990s, respectively. In this way, we aim to examine the change in mobility pattern over time for different birth cohorts, and the results are presented in Table 7.

Table 7 Quintile Transition Matrix by Children's Birth Cohorts

Children's birth cohort	Schooling of Parent % (the higher one)	Schooling of Children %				
		Not Educated	Primary	Middle	High	College & Graduate
70 generation	Not Educated	4.92	63.93	19.67	9.84	1.64
	Primary	1.14	37.5	40.72	16.48	4.17
	Middle	0	21.58	37.41	30.94	10.07
	High	0	11.29	22.58	29.03	37.1
	College &Graduate	0	0	8	12	80
80 generation	Not Educated	1.18	49.41	31.76	12.94	4.71
	Primary	0.54	27.02	35.25	19.6	17.6
	Middle	0.2	8.91	34.97	27.91	28.01
	High	0	5.92	15.36	26.24	52.48
	College &Graduate	0	2.05	3.42	6.85	87.67
90 generation	Not Educated	0	23.53	52.94	11.76	11.76
	Primary	0.33	21.34	29.15	25.9	23.29
	Middle	0.6	5.37	27.16	27.76	39.1
	High	0.44	2.22	9.33	28.44	59.56
	College &Graduate	0	1.37	8.22	12.33	78.08

We observe an optimistic pattern that the intergenerational mobility in education becomes larger over time especially at lower education levels. For children whose parents are not educated, the probability to climb up through education ladder and reach the college level increases from 1.64% for the 1970s birth cohort to 4.71% for the 1980s and to 11.76% for the 1990s. Similarly, for children whose parents are

[5] We can also see this point for people who are not educated. Since the percentage of these people is too small, we choose to use primary education as an example for lower education levels.

primary school graduates, the probability to reach the college level increases from 4.17% for the 1970s birth cohort to 17.6% for the 1980s and to 23.29% for the 1990s.

5. Regression results of intergenerational education mobility

5.1 OLS estimations

We first use the following standard linear model to estimate the marginal effects of paternal years of education on the education attainment of the next generation. The estimation equation is as follows.

$$Edu_i^C = \alpha_0 + \alpha_1 Edu_i^P + X_i'\beta + \varepsilon_i \quad (1),$$

where the superscripts c and p index the child and the parent (either mother or father), respectively; Edu denotes years of formal schooling; X is a vector of control variables for the child including male, minority dummy, birth cohort dummies, and residential province dummy variables. This model captures the overall effect of parental education on children education after controlling for covariates. The main results are displayed in Table 8.

Table 8 OLS Regression Results by Region

OLS	(1) Father-Child	(2) Mother-Child	(3) Father-Son	(4) Father-Daughter	(5) Mother-Son	(6) Mother-Daughter
Panel A: Urban Residents						
Sf	0.371***		0.386***	0.333***		
	(0.0257)		(0.0344)	(0.0395)		
Sm		0.364***			0.405***	0.277***
		(0.0247)			(0.0318)	(0.0403)
Male	-0.588***	-0.649***				
	(0.163)	(0.162)				
Minority	0.692*	0.660*	1.004*	0.298	0.913*	0.297
	(0.353)	(0.352)	(0.524)	(0.469)	(0.511)	(0.481)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Birth Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,052	1,052	638	414	638	414
R-squared	0.264	0.270	0.276	0.206	0.310	0.162
Panel B: Rural Residents						

OLS	(1) Father-Child	(2) Mother-Child	(3) Father-Son	(4) Father-Daughter	(5) Mother-Son	(6) Mother-Daughter
Sf	0.281***		0.267***	0.317***		
	(0.0151)		(0.0167)	(0.0342)		
Sm		0.238***			0.213***	0.316***
		(0.0139)			(0.0155)	(0.0305)
Male	-0.804***	-0.762***				
	(0.0933)	(0.0938)				
Minority	-0.489***	-0.525***	-0.302	-0.740*	-0.277	-0.875**
	(0.187)	(0.188)	(0.214)	(0.395)	(0.216)	(0.391)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Birth Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,798	4,798	3,531	1,267	3,531	1,267
R-squared	0.218	0.211	0.196	0.219	0.181	0.232

Note: Birth cohorts are defined by five-year interval as displayed in Table 3. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Several interesting results stand out from the table above. First, on average, the regression coefficients on parental education are larger in cities than in rural areas, suggesting a lower intergenerational education mobility in urban China. This may occur for two reasons. On the one hand, rural parents on average receive significantly less education than urban parents, which makes more room for intergenerational mobility. On the other hand, urban areas have more good schools and educational resources, which enable people to accumulate their advantage over generations.

Second, if we compare the mobility between sons and daughters, we find that the regression coefficient is larger for sons in cities, but smaller for them in rural areas. As we know, the OLS results incorporate both the nature and nurture effects since we cannot control for unobserved inherent capabilities. However, the difference between sons and daughters in terms of the mobility pattern in different geographic areas is hard to explain by the nature effect. It is very likely that parents tend to allocate more educational resources to sons in both urban and rural areas, so we see more persistence in education for sons in urban areas where enough education resources are available. In contrast, more persistence occurs for girls in rural areas where education resources are scarce and thus low-level education is easier to transmit for daughters.

Another notable finding is that the coefficient on male is negative, suggesting that girls on average receive more education than sons. This may reflect the feedback effect meaning that girls receive more education in response to gender-based labor market discrimination in China found in many previous studies (Song and Ma, 2016).

We further run OLS regressions for fathers with different levels of education given the different mobility pattern along with the education level we observed in the previous section. As it turns out in Table 9, more persistence tends to occur for higher level of education in urban areas but for both lowest and highest levels of education in rural areas. That is, high educated people tend to accumulate their advantages over time by transmitting more education to the next generation. Besides, this persistence is indeed even larger in urban areas since the regression coefficient for the highest education level is 0.09 which is much larger than 0.04 for the rural counterpart.

Table 9 OLS Regression Results by Education Level

OLS	(1) Primary & Below	(2) Middle	(3) High	(4) College & Graduate
Panel A: Urban Residents				
Sf	-0.0963	0.00542	0.0238*	0.0906***
	(0.197)	(0.0100)	(0.0132)	(0.0153)
Male	-1.451	0.0189	-0.0789	-0.135
	(1.574)	(0.0679)	(0.0721)	(0.0894)
Minority	-1.600	-0.0315	0.216	0.198
	(2.865)	(0.170)	(0.173)	(0.185)
Province dummies	Yes	Yes	Yes	Yes
Birth Cohort dummies	Yes	Yes	Yes	Yes
Observations	40	101	272	639
R-squared	0.380	0.434	0.077	0.110
Panel B: Rural Residents				
Sf	0.0938***	0.00224	-0.000649	0.0421***
	(0.0176)	(0.00205)	(0.00658)	(0.0119)
Male	0.366***	-0.0228*	-0.0792**	-0.186***
	(0.121)	(0.0128)	(0.0365)	(0.0653)
Minority	-0.0437	-0.0151	-0.0693	0.177
	(0.216)	(0.0231)	(0.0795)	(0.161)
Province dummies	Yes	Yes	Yes	Yes
Birth Cohort dummies	Yes	Yes	Yes	Yes
Observations	1,118	1,649	1,050	981
R-squared	0.178	0.066	0.072	0.113

Note: Birth cohorts are defined by five-year interval as displayed in Table 3. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

The highest persistence found in rural areas for the lowest education group is an important finding for policy purposes. This might be some evidence for educational poverty traps in that parents can pass their low education to their children which may create persistent poverty in income over generations. The last noteworthy finding in Table 9 is that although the coefficients on male are mostly negative, there is one exception happening for the lowest education group in rural areas. That is, girls suffer more from low-educated parents than boys in rural China.[6]

5.2 Instrumental variable estimations

This section aims to disentangle the nurture effect from the nature effect in intergenerational transmission of education. Estimating the nurture effect is important, because it can tell us the extent to which public policy can reduce education inequality in the current generation and subsequent generations, and hence can affect income inequality. As mentioned in previous sections, we will make use of the instrument generated by the CR event since people born in different years were affected by this political movement differently.

Several existing studies have summarized school interruption during the CR in terms of the impact on missed years of schooling for different age cohorts (Meng and Gregory, 2002; Chen, 2010; Meng and Zhao, 2013). These impacts on different birth cohorts in urban and rural areas are clearly displayed by Table A1 and A2, respectively, which is a revised version from Chen (2010).[7] Since historical background has been detailed in these above-mentioned papers, we briefly summarize the key components here for simplicity.

5.2.1 School interruptions in urban areas

According to the historical documents and several existing studies (Pepper, 1996; Chen, 2010), the large scale school interruption in urban China can be divided into the following four periods: (1) 1966-68. Education at all levels was stopped; no teaching was carried out and no new students were admitted. (2) 1968-71. Primary and middle schools were reopened. Children aged 7-9 could begin primary school and students who would have completed primary school in 1966-68 were allowed to attend middle school. However, at the same time, in the reopened middle schools, the original national standardized curriculum and teaching materials were completely abolished. Not until 1971 were recovered curricula made available. That is, although middle schools reopened in principle, most of children mainly took excursions to countryside to work rather than learning. Later, most of these students, the so-called “educated-

6 Girls in poor rural families usually quit the school early and help parents do farming or housework.

7 Chen (2010) first proposed a set of instruments in both urban and rural areas according to historical documents he collected. However, the instruments he used were not exactly consistent with the text. In this paper, we double checked some historical materials and made up our revised instruments, which are slightly different from Chen's paper.

youths" were sent to the rural areas to be "re-educated by peasants" due to the lack of employment opportunities in cities. Thus, in our analysis, we assume that middle schools were actually closed in this period. At the mean time, the original 6-3-3 schooling system (i.e. six years of primary, three years of middle school and three years of high school) was cut to be 5-2-2, which continued until 1976. (3) 1971-1976. High schools resumed the admission of new graduates directly from middle schools but had been cut to 2 years. Middle school curriculum was recovered during this time. (4) 1976-1981. After the Cultural Revolution officially ended in 1976, the original 6-3-3 schooling system was recovered. National College Entrance Examinations were resumed in 1977, and everyone who had missed their chances of college education because of the Cultural Revolution (e.g., "educated-youths") were permitted to take the exams.

Based on the events introduced above, Table A1 summarizes the expected interruptions encountered by urban individuals born in different years, assuming they had the potential to complete high school had the Cultural Revolution not occurred. The last column estimates the expected total years of interruptions encountered by an urban individual.[8] We will use this column as the instrument to estimate the nurture effect in intergenerational education mobility.

We take the 1956 birth cohort as an example to explain the appendix table A1. If these people started primary school on time at seven years of age, then they had completed three years of primary education when the CR began. Because all schools were closed between 1966 and 1968, their primary education was cut short by two years. In 1968, these students went back to the primary school and completed their primary education. In 1969, these students entered middle school even though they missed two-year primary education. However, as we claimed previously, middle school students in this period mainly took excursions to countryside to work rather than learning, and hence they missed another three years of middle school education. In 1971, they started to attend high schools and missed another year of high school education compared to earlier cohorts since high school has been cut to 2 years. Hence, this cohort missed two years in primary school, three years in middle school, and one year in high school during the CR.

5.2.2 School interruptions in rural areas

Indeed, popularizing education in rural China was on Chinese Communist Party (CCP)'s political agenda in the Maoist era. The effort to boost rural enrollment was made as early as in the Great Leap Forward (GLF) movement in 1958-1961, whose education component was known as "the Cultural Revolution in 1958" (Pepper, 1996).

[8] Note that Table A1 lists the *expected*, as opposed to the *actual*, education interruptions encountered by these individuals. Without further information, it is difficult to estimate the *actual* education interruptions they encountered since the schooling system may be slightly different across regions. The same is true for Table A2.

The major practice of the 1958 Cultural Revolution was the establishment of a large number of collectively-run agricultural primary and middle schools in 1958-1961. However, many middle schools in rural areas were closed in 1961-63 due to the economic crisis that followed immediately after the GLF, but revived in 1964-65. In 1965, there were more than 60,000 agricultural middle schools nationwide, almost tripling the number in 1958 (22,579).

Considered as a product of "Bourgeois ideology", however, all agricultural middle schools built in the late 1950s as well as many primary schools were closed during the initial stage of the Chinese Cultural Revolution (1966-69) (Pepper, 1996). Things started to change in 1969, when the government decided to implement a radical education reform in rural China. The central government in 1969 required that every village-level collective should build its own complete primary school and that each commune should build its own combined middle/high school.[9] Despite the limited funding resources available from the state, most local governments managed to complete these tasks, an important reason being that many of these commune-run secondary schools were built on the foundation of the previously closed middle schools.[10] The national number of rural secondary schools soared from 604 in 1965 to 11,819 in 1971, and continued to grow to 50,916 in 1977.

In retrospect, rapid expansion of rural schools seems to represent the general theme of China's rural education system in the Maoist era. Both the "Cultural Revolution in 1958" and rural education reform in 1969 aimed to achieve universal secondary school enrollment in rural China. The initial phase of the Chinese Cultural Revolution in 1966-69, along with the GLF crisis in 1961-63, however, broke the continuity of these two campaigns to expand rural school systems, and thus represented the major interruptions.[11] Table A2 summarizes the expected education interruptions experienced by the cohorts at school age around the Cultural Revolution years for rural residents. It lists the expected years of education interruptions encountered by rural individuals born in different years, assuming the "counterfactual" of China's rural education system was that the peak years of rapid school expansion extended from 1958 and uninterrupted to the early 1970s. It is noteworthy that the interruptions in rural areas were generated by both the CR and post-GLP crisis, which is different from interruptions in urban China solely generated by the CR.

5.2.3 Identification strategy

The comparison in terms of formal years of schooling between cohort groups who encountered CR (the *treatment* groups) and those who did *not* encounter these shocks (the *control* groups) provides exogenous variation in individuals' educational attainment. Control groups should be chosen in a way that they are similar to the

[9] Refer to People's Daily on May 12, 1969.
[10] See Chen (2010) for more details.
[11] We keep the assumption made by Chen (2010) that the interruption started in early 1961 and ended in late 1963, so the 1961-1963 period is corresponding to a three-year interruption.

treatment groups in all aspects, except that they did not encounter education interruptions.

There are two appropriate control groups: (1) the group of individuals born in 1962-66 (the After-CR group), and (2) the group of individuals born in 1942-46 (the Before-CR group). The After-CR group consists of those whose education was not interrupted, even though they were born before the Cultural Revolution and were attending school during the Cultural Revolution. For urban residents, these individuals started their primary education after schools were reopened (in 1968) and finished their secondary school education after colleges and universities resumed normal recruitment (in 1977). The Before-CR group is the group of individuals who had completed their high school education just before the outbreak of the Cultural Revolution. This group would have entered universities by 1965 before the Cultural Revolution. The reason to restrict the Before-CR group to individuals born after 1942 is that those parents obtained their education mainly under the pre-communist system, which may differ from the system that operated after 1949, and part of their education may have also been interrupted by World War II and the Civil War.

For rural residents, the Before-CR and After-CR are also suitable control groups, although with somewhat different reasons. The After-CR group consists of those who were fully exposed to the radical education reform of 1969, entering primary school after 1969 and entering secondary schools in the peak years of school expansion. The Before-CR group consists of individuals whose middle school education was exposed to the peak years of another school expansion campaign, i.e. the "Cultural Revolution in 1958". These two cohorts represented those who were exposed to the peak years of rapid school expansion at their school age.

5.2.4 Results of IV estimations

In what follows, we make use of the total expected years interrupted provided by the two appendix tables as instruments for parental education. The first-stage results are provided in Appendix Table A3. As is seen, the exposure to the CR indeed leads a reduction in parental years of schooling in both urban and rural areas. Females tend to be affected by the CR to a larger extent, especially in rural areas.

Since the instrumental variable approach employed exogenous instruments for parental education which are not correlated with parents' inherent abilities, it captures

[12] Several existing studies have found that the effect tends to be larger in magnitude when using the IV estimation (Meng and Zhao, 2013; Song et al., 2016). When the nurture effect is heterogeneous, the IV estimate could be lower or higher than the OLS estimate as it is a weighted Local Average Treatment Effect (LATE), which captures the effect for the particular group the instruments identify. That is to say that it identifies an effect for a subgroup of individuals whose (parental) treatment status is changed by the random shock identified by the instrument. The degree to which the LATE is applicable to the whole population depends on how `local' the estimate is and how heterogeneous the population is.

the nurture effect. The results estimated by the 2SLS are provided in Table 10. We discover that the nurture effect works only for fathers, but not for mothers especially in urban areas. That is, fathers' education has a significant impact on children education through nurture effect, but mothers' impact is mainly through the nature effect. Specifically, the empirical results suggest that a one year decrease in father's schooling because of school interruption during the CR leads to a 0.611 and 0.566 year decrease in the child's schooling for urban and rural areas, respectively.[12] We will further examine the specific channels through which fathers' nurture effect is working.

Table 10 Instrumental Variable Estimations

2SLS	(1) Father-Child	(2) Mother-Child	(3) Father-Son	(4) Father-Daughter	(5) Mother-Son	(6) Mother-Daughter
Panel A: Urban Residents						
Sf	0.612***		0.702**	0.495*		
	(0.218)		(0.337)	(0.271)		
Sm		0.0286			0.150	-0.173
		(0.227)			(0.308)	(0.349)
Male	-0.465**	-0.768***				
	(0.201)	(0.191)				
Minority	0.818**	0.512	1.107**	0.396	0.892*	-0.0279
	(0.380)	(0.390)	(0.559)	(0.493)	(0.528)	(0.593)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Birth Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,052	1,052	638	414	638	414
R-squared	0.201	0.139	0.176	0.171	0.237	-0.104
Panel B: Rural Residents						
Sf	0.534***		0.529***	0.494*		
	(0.118)		(0.126)	(0.280)		
Sm		0.172**			0.178*	0.181
		(0.0754)			(0.0909)	(0.131)
Male	-0.758***	-0.788***				
	(0.0980)	(0.0981)				
Minority	-0.467**	-0.522***	-0.335	-0.671	-0.275	-0.870**
	(0.192)	(0.188)	(0.221)	(0.409)	(0.215)	(0.390)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Birth Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,798	4,798	3,531	1,267	3,531	1,267

2SLS	(1) Father-Child	(2) Mother-Child	(3) Father-Son	(4) Father-Daughter	(5) Mother-Son	(6) Mother-Daughter
R-squared	0.172	0.207	0.139	0.202	0.180	0.220

Note: Birth cohorts are defined by five-year interval as displayed in Table 3. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Moreover, several previous findings from the OLS regressions remain true. For example, the regression coefficients on parental education are larger in urban than in rural areas. This further indicates that the reason behind this result is not that urban parents pass more inherent abilities to their children through genes than rural parents, but due to a larger nurture effect in urban areas. The rationale might be that urban areas have more good schools and educational resources, which enable people to accumulate their advantage over generations. Lastly, we find that the regression coefficient is much larger for sons than for daughters in cities, suggesting the son preference in terms of allocating educational resources.

5.3 Possible mechanisms

We know from the last section that fathers' education significantly affects children education through the nurture effect, but the specific mechanism is unknown. Fortunately, we have the information for fathers' annual income in the CHIP dataset, which enables us to test the income channel proposed by previous literature (Black and Devereux; 2010). Table 11 and 12 report the OLS and IV regression results after controlling for father's annual income, respectively.

Table 11 OLS Estimations Controlling for Father's Income

OLS	(1) Father-Child	(2) Mother-Child	(3) Father-Son	(4) Father-Daughter	(5) Mother-Son	(6) Mother-Daughter
Panel A: Urban Residents						
Sf	0.319***		0.342***	0.280***		
	(0.0340)		(0.0449)	(0.0538)		
Sm		0.319***			0.371***	0.234***
		(0.0309)			(0.0407)	(0.0494)
Father's income	0.00789**	0.0108***	0.0119**	0.00309	0.0138***	0.00769
	(0.00386)	(0.00369)	(0.00536)	(0.00561)	(0.00509)	(0.00534)
Male	-0.547***	-0.591***				
	(0.190)	(0.187)				
Minority	0.167	0.169	0.477	-0.148	0.379	-0.108
	(0.405)	(0.400)	(0.629)	(0.515)	(0.613)	(0.518)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes

OLS	(1) Father-Child	(2) Mother-Child	(3) Father-Son	(4) Father-Daughter	(5) Mother-Son	(6) Mother-Daughter
Birth Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	720	720	432	288	432	288
R-squared	0.256	0.274	0.280	0.181	0.317	0.168
Panel B: Rural Residents						
Sf	0.288***		0.302***	0.243***		
	(0.0218)		(0.0250)	(0.0443)		
Sm		0.221***			0.207***	0.266***
		(0.0194)			(0.0221)	(0.0401)
Father's income	0.0213***	0.0212***	0.0193***	0.0262***	0.0194***	0.0246***
	(0.00293)	(0.00297)	(0.00350)	(0.00544)	(0.00357)	(0.00540)
Male	-1.014***	-0.966***				
	(0.120)	(0.121)				
Minority	-0.778***	-0.780***	-0.636**	-0.915*	-0.586*	-0.986*
	(0.264)	(0.266)	(0.309)	(0.525)	(0.313)	(0.521)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Birth Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,705	2,705	1,929	776	1,929	776
R-squared	0.222	0.209	0.196	0.209	0.173	0.222

Note: Birth cohorts are defined by five-year interval as displayed in Table 3. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 12 IV Estimations Controlling for Father's Income

2SLS	(1) Father-Child	(2) Mother-Child	(3) Father-Son	(4) Father-Daughter	(5) Mother-Son	(6) Mother-Daughter
Panel A: Urban Residents						
Sf	0.434		0.277	0.599		
	(0.413)		(0.562)	(0.525)		
Sm		-0.0929			0.0410	-0.440
		(0.504)			(0.486)	(1.868)
Father's income	0.00293	0.0247	0.0143	-0.0127	0.0235	0.0342
	(0.0181)	(0.0174)	(0.0218)	(0.0264)	(0.0153)	(0.0737)
Male	-0.507**	-0.676***				
	(0.236)	(0.231)				
Minority	0.106	0.384	0.517	-0.327	0.650	0.227
	(0.456)	(0.512)	(0.699)	(0.604)	(0.754)	(1.132)

2SLS	(1) Father-Child	(2) Mother-Child	(3) Father-Son	(4) Father-Daughter	(5) Mother-Son	(6) Mother-Daughter
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Birth Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	720	720	432	288	432	288
R-squared	0.243	0.087	0.276	0.073	0.206	-0.410
Panel B: Rural Residents						
Sf	0.165		0.365*	-0.442		
	(0.193)		(0.204)	(0.505)		
Sm		0.123			0.220	-0.0601
		(0.115)			(0.136)	(0.205)
Father's income	0.0240***	0.0241***	0.0180***	0.0423***	0.0191***	0.0335***
	(0.00515)	(0.00443)	(0.00544)	(0.0133)	(0.00530)	(0.00778)
Male	-1.021***	-0.995***				
	(0.120)	(0.125)				
Minority	-0.807***	-0.809***	-0.624**	-1.009*	-0.580*	-0.940*
	(0.267)	(0.267)	(0.309)	(0.596)	(0.319)	(0.534)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Birth Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,705	2,705	1,929	776	1,929	776
R-squared	0.212	0.202	0.194	-0.045	0.173	0.154

Note: Birth cohorts are defined by five-year interval as displayed in Table 3. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

The OLS coefficients become smaller when controlling for fathers' income, suggesting a potential channel through which fathers' education affects children education. More strikingly, Table 12 informs us that the nurture effect would disappear after adding father's income as a control variable, suggesting that the nurture effect for paternal education is almost entirely driven by father's income. Specifically, better-educated fathers earn higher income which offers children more educational resources, making their children more educated. In contrast, low-educated fathers earn less income and can offer fewer educational resources, making their children less educated.

To the authors' knowledge, this paper is the first attempt to empirically test the income channel in the literature on intergenerational education persistence. The finding has important policy implications in that it may imply a poverty trap in education across generations which might further generate a poverty trap in income

over generations. In this case, creating more equal educational opportunities and offer low-income family educational subsidies would reduce intergenerational education persistence and lower inequality.

6. Effect of education policies on intergenerational education persistence

In this section, we examine the effects of two important nation-wide education policies on intergenerational education persistence, including the *Compulsory Education Law (CEL)* implemented in 1986, and the college expansion policy started from 1999. The reason we select these two policies is that they are probably the only two nation-wide policies that can significantly affect people's years of schooling. We briefly introduce the background of the two policies below, and then present the regression results.

6.1 Policy background

In order to provide 9 years of compulsory education to children and to help youths to achieve literacy, the *Compulsory Education Law (CEL)* was promulgated and implemented in China on 1 July 1986. Since then, children aged from 6 to 15 years old were required to receive 9 years of compulsory education (Zhang and Zhao, 2006). The compulsory schooling includes 6 years of primary school and 3 years of middle school (lower-level secondary school). According to the law, if you were older than 15 years old in 1986, you would not have been affected by the law. Thus, we generate a variable called "CEL" equal to 1 if you were born after 1971, and 0 otherwise.

Another important education policy is the college expansion policy (CEP) started from the late 1990s. In 1999, the Chinese central government started to expand college enrollments by building more colleges in provinces with fewer colleges and increasing the enrollments in existing colleges. In fact, college enrollment rates stayed very stable at a low level (between 20% to 40%) during the 1980s and 1990s. The purposes of implementing college expansion policy include to universalize higher education, to promote the development of human resources, and to alleviate the problem of urban unemployment. Places with lower college availability before the expansion were expanded more.

The difference between the *CEP* and *CEL* introduced in the previous part is that it was implemented gradually with increasing enrollments each year. For instance, college enrollments increased from 1 million to 1.08 million from 1997-1998 before the expansion policy started. The year of 1999 witnessed a dramatic increase in college enrollments from 1.08 million to 1.6 million. Since the start of the new century, the enrollments increased gradually from 2.21 million in 2000 to 7 million in

2015. The evolution in total enrollments and enrollments rates from 1977-2015 is displayed in Figure 1 below.

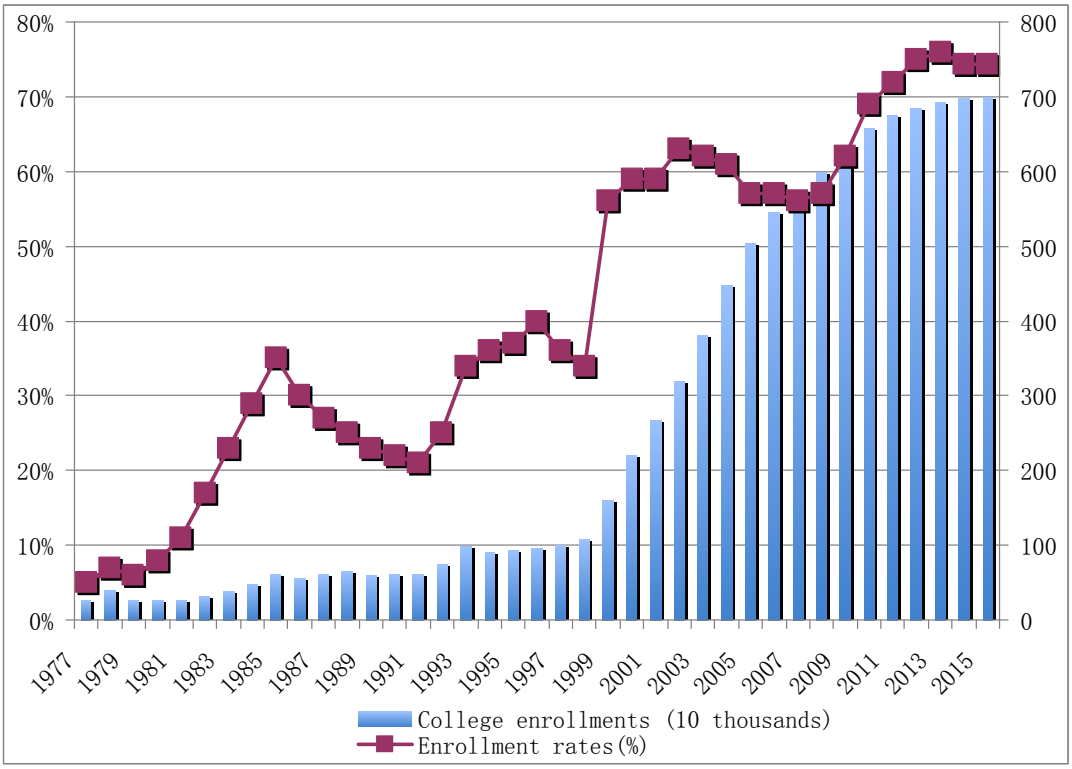

Figure 1 The Evolution of College Enrollments since 1977

Given the gradual nature of the college expansion policy (CEP), we design a variable named "CEP" equal to years of exposure to the college expansion policy. We assume that students start their college at age 18. In this case, we can calculate years of exposure to the college expansion policy according to people's age. The larger this variable is, the more likely the students attend the college. A specific variable definition for the two policies is provided in the Appendix Table A4.

6.2 Estimation results

The effects of the two education policies introduced below will be investigated separately in two regressions. For each policy, we extend the estimation equation (1) by adding a term denoting the policy itself and an interaction term between the policy and parents' education. The coefficients on the interaction terms can tell us how each policy affected the intergenerational education mobility. The estimation results for *Compulsory Education Law (CEL)* are provided in Table 13.

Table 13 Impact of Compulsory Education Law on Education Mobility

CEL	(1)	(2)	(3)	(4)
	Urban		Rural	

Sf	0.212		0.246**	
	(0.178)		(0.0981)	
Sf * CEL	0.160		0.0354	
	(0.179)		(0.0992)	
Sm		0.388**		0.299***
		(0.152)		(0.0989)
Sm * CEL		-0.0256		-0.0618
		(0.153)		(0.0997)
CEL	0.393	1.354	-0.535	-0.248
	(1.704)	(1.511)	(0.685)	(0.542)
Male	-0.587***	-0.644***	-0.803***	-0.762***
	(0.163)	(0.162)	(0.0933)	(0.0938)
Minority	0.691*	0.673*	-0.490***	-0.525***
	(0.354)	(0.352)	(0.187)	(0.188)
Province dummies	Yes	Yes	Yes	Yes
Birth Cohort dummies	Yes	Yes	Yes	Yes
Observations	1,052	1,052	4,798	4,798
R-squared	0.265	0.271	0.218	0.211

Note: "CEL" is a dummy variable representing whether the child is affected by the Compulsory Education Law. A detailed definition can be found in Appendix Table A4. Birth cohorts are defined by five-year interval as displayed in Table 3. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

The coefficients on interaction terms in Table 13 are insignificant, indicating that the *Compulsory Education Law* did not play a role in reducing intergenerational education persistence.[13] This may occur for two reasons. In urban areas, the nine-year compulsory education has almost been popularized even before the law was implemented. Thus, it has no further effect on people's years of schooling and thus no significant effect on intergenerational mobility. In our sample, only 40 urban children did not complete 9-year compulsory education. In contrast, in rural areas, the law was not strictly enforced as stated (Song, 2012). Remember from Table 3 that although people born in the 1970s were affected by the Compulsory Education Law, many of them still have not completed 9-year compulsory schooling. For instance, the average years of schooling for the 1970-1974 age cohort is only 8.51. Indeed, 30 percent of rural children did not complete nine-year education.

As can be seen, popularizing compulsory education would not automatically translate to larger mobility as several international literature found (Tinker et al., 2013). The targeting and enforcement of these policies would also affect the policy outcomes.

We then report the results for the college expansion policy in Table 14. It tells us that

[13] As a robustness check, we also use an alternative measure for the CEL by calculating years of exposure to the CEL policy based on people's age. The results are very similar to what we presented in Table 13, and are available upon request from the authors.

the college expansion policy indeed increases the intergenerational education mobility in urban areas, but this effect is not found in rural areas. In contrast, the college expansion policy unexpectedly reduces the education mobility over generations. Specifically, in urban areas, the college expansion policy lowers the regression coefficient by 0.0187 and 0.0150 on father's education and mother's education, respectively.

Table 14 Impact of College Expansion Policy on Education Mobility

CEP	(1)	(2)	(3)	(4)
	Urban		Rural	
Sf	0.466***		0.233***	
	(0.0415)		(0.0236)	
Sf * yrCEP	-0.0187***		0.00912**	
	(0.00634)		(0.00393)	
Sm		0.441***		0.225***
		(0.0395)		(0.0223)
Sm * yrCEP		-0.0150**		0.00186
		(0.00595)		(0.00351)
yrCEP	0.215**	0.179**	0.133***	0.191***
	(0.0946)	(0.0894)	(0.0453)	(0.0411)
Male	-0.564***	-0.625***	-0.777***	-0.738***
	(0.163)	(0.162)	(0.0930)	(0.0936)
Minority	0.767**	0.689**	-0.459**	-0.505***
	(0.353)	(0.351)	(0.187)	(0.188)
Province dummies	Yes	Yes	Yes	Yes
Birth Cohort dummies	Yes	Yes	Yes	Yes
Observations	1,052	1,052	4,798	4,798
R-squared	0.270	0.275	0.224	0.216

Note: " yrCEP " stands for years exposed to the college expansion policy. A detailed definition can be found in Appendix Table A4. Birth cohorts are defined by five-year interval as displayed in Table 3. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

There might be two reasons why the rural children did not benefit significantly from the college expansion policy. First, the expansion policy is on education demand side, but the supply side reform is needy. That is, some rural families may not have enough money to send their children to college even though they are admitted (Guo and Chen, 2015). Also, poor families face a larger opportunity cost of attending post-secondary schools. Many students have to choose to work in order to earn enough money for their family and thus drop out of the college. These factors may make richer households in rural areas benefit from the policy, in that the children from these families face a larger probability of being admitted by colleges and they can also afford the higher education. This may explain why the intergenerational education persistence is reinforced by the policy. Second, a large proportion of rural children did not finish the high school education. In fact, high school education is almost a

prerequisite for higher education in China. Students who completed their high school can take the National College Entrance Examination (NCEE), the national standard exam as an entrance to higher education institutions. Enrollments are on province level and the total score in NCEE is the main criterion for admission to colleges. Therefore, the policy at the college level indeed is beyond the reach of many rural students and thus has a small impact on them.

7. Conclusion

In this paper, we used the newly-released CHIP 2013 dataset to carefully investigate the intergenerational education mobility and the policy consequences of two important education policies. We do see much intergenerational mobility in education although the lowest quintile exhibit the highest level of intergenerational persistence.

Several important findings stand out from our empirical analyses. First, on average, the regression coefficients on parental education are larger in cities than in rural areas, suggesting a lower intergenerational education mobility in urban China. This may occur because urban areas have more good schools and educational resources, which enable people to accumulate their advantage over generations. Second, more intergenerational persistence in education tends to occur for higher level of education in urban areas but for both lowest and highest levels of education in rural areas. The highest persistence found in rural areas for the lowest education group might be some evidence for educational poverty traps in that parents can pass their low education to their children which may create persistent poverty in income over generations.

We further estimate the nurture effect using instruments provided by the Cultural Revolution in China. The results show that the nurture effect works only for fathers. That is, fathers' education has a significant impact on children education through nurture effect, but mothers' impact is mainly through the nature effect. Specifically, the empirical results suggest that a one year decrease in father's schooling because of school interruption during the CR leads to a 0.611 and 0.566 year decrease in the child's schooling for urban and rural areas, respectively. A deeper investigation of the mechanism behind this nurture effect informs us that the nurture effect would disappear after adding father's income as a control variable, suggesting that the nurture effect for paternal education is almost entirely driven by father's income. Specifically, better-educated fathers earn higher income which offers children more educational resources, making their children more educated.

Finally, we examined the effects of two important education policies on intergenerational education mobility, including the *Compulsory Education Law (CEL)* implemented in 1986, and the college expansion policy started from 1999. We found that popularizing compulsory education did not have an expected effect on increasing mobility due to poor targeting and enforcement. In addition, the college expansion

policy indeed reduces the intergenerational education mobility in urban areas, but this effect is not found in rural areas. One reason why rural children did not benefit significantly from the college expansion policy may be because a large proportion of rural children did not finish the high school education, which is a prerequisite for higher education in China. Therefore, the policy at the college level indeed is beyond the reach of many rural students and thus has a small impact on them. Another possibility is that rural families cannot afford college even though rural children got admitted by the colleges.

In summary, offering more education opportunities may not automatically translate to larger mobility. The targeting and enforcement of these policies would also affect the outcomes and should be promoted in order to increase mobility and reduce education inequality. Poor enforcement of the Compulsory Education Law can and did downplay the role in narrowing educational inequality. Moreover, more attention need to be paid to the educational poverty traps in rural areas meaning that parents can pass their low education to their children which may create persistent poverty in income over generations. Efforts may include ensuring adequate financial resources for primary education in poor areas and improving school quality in rural China, and increasing the affordability of higher education by offering education subsidies or loans to poor families.

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Appendix

Table A1 Expected Education Interruptions: Urban Residents Born in 1947-1961

Treatment groups	(1) Birth year	(2) Primary school starting year	(3) Middle school starting year	(4) High school starting year	(5) Expected years of delayed enrollment	(6) Expected years interrupted in primary school	(7) Expected years interrupted in middle school	(8) Expected years interrupted in high school	(9) Expected years interrupted = (5) + (6) + (7) + (8)
Interrupted high school	1948	1955	1961	1964				1	1
	1949	1956	1962	1965				2	2
	1950	1957	1963	1966				3	3
Interrupted middle and high school	1951	1958	1964	1967			1	3	4
	1952	1959	1965	1968			2	3	5
	1953	1960	1968	1970			3	3	6
	1954	1961	1968	1970		1	3	3	7
	1955	1962	1968	1970		2	3	3	8
	1956	1963	1969	1971		3	3	1	7
	1957	1964	1970	1972		3	2	1	6
	1958	1965	1971	1973		3	1	1	5
Interrupted primary education	1959	1968	1973	1976	2	1			3
	1960	1968	1973	1976	1	1			2
	1961	1968	1973	1976		1			1

Note: This table assumes (1) an urban child started schooling at age 7; and (2) every child had the potential to attend senior high school. The number of years interrupted in Column (9) is calculated as the horizontal sum of the numbers in columns (5)-(8).

Table A2 Expected Education Interruptions: Rural Residents Born in 1947-1961

Treatment groups	(1) Birth year	(2) Primary school starting year	(3) Middle school starting year	(4) Interrupted primary school	(5) Interrupted middle school	(6) Expected years of interruption = (4) + (5)
CR1: post-GLF crisis at middle school	1947	1954	1960		2	2
	1948	1955	1961		3	3
	1949	1956	1962	2	2	4
	1950	1957	1963	3	1	4
CR2: post-GLF crisis at primary school; middle school closure in 1966-1968	1951	1958	1964	3	1	4
	1952	1959	1965	3	2	5
CR3: post-GLF crisis at primary school; middle school closure in 1966-1968	1953	1960	1966	3	3	6
	1954	1961	1967	3	2	5
	1955	1962	1968	3	1	4
CR4: primary education interrupted in 1966-68; 1969 Education Reform at middle school	1956	1963	1969	3		3
	1957	1964	1969	3		3
	1958	1965	1970	3		3
CR5: primary education interrupted in 1966-68; 1969 Education Reform at primary level	1959	1966	1971	3		3
	1960	1967	1972	2		2
	1961	1968	1973	1		1

Note: This table assumes (1) a rural child started schooling at age 7; (2) every child had the potential to attend middle school. The variable "expected years of interruption" includes years during the post-GLF crisis in 1961-63 and years exposed the chaotic years in 1966-68.

Table A3 The Results of First Stage Regression

First stage	Sf			Sm		
	All	Urban	Rural	All	Urban	Rural
CRf	-0.176***	-0.182***	-0.257***			
	(0.0186)	(0.0364)	(0.0204)			
CRm				-0.307***	-0.146***	-0.459***
				(0.0213)	(0.0398)	(0.0225)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,850	920	4,930	5,850	844	5,006
R-squared	0.015	0.027	0.031	0.034	0.016	0.077

Note: The dependent variable is the actual years of parental schooling. CRf and CRm denote the expected years of interruption due to Cultural Revolution for fathers and mothers, respectively. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table A4 Definitions for Policy Variables

Birth year	CEL affected	Years of Exposure to CEP
1965-1970	0	0
1971-1980	1	0
1981	1	1
1982	1	2
1983	1	3
1984	1	4
1985	1	5
1986	1	6
1987	1	7
1988	1	8
1989	1	9
1990	1	10
1991	1	11
1992	1	12
1993	1	13

Note: CEL denotes the Compulsory Education Law, and CEP stands for the College Expansion Policy.