Intergenerational Transmission of Education and Early Childhood Outcomes: Evidence from China

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Abstract

In this paper, we study how maternal education affects children's early childhood health outcomes and the development of social and motor skills. We take advantage of the higher education expansion in China, which creates credible exogenous variation in access to colleges that improves educational attainment, to examine the effect through an instrumental variable approach. Our results show that increases in years of schooling and a higher level of education of mothers from rural origin significantly improve children's outcomes. We find the probability of an infant being low birth weight is reduced and the time a child begins speaking, counting, and walking is shortened. In contrast, little impact is found on the child whose mother grew up in urban areas. We investigate several mechanisms that could explain the results and find that mother's schooling is strongly associated with assortative marriage and rural-urban migration.

Keywords: Higher Education Expansion; Maternal Education; Childhood Outcomes; China
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1 Introduction

Extensive research has documented that the early childhood environment is vital for later life outcomes (Almond and Currie, 2011; Currie, 2011). Children's health conditions at birth and during their early childhood are especially important as they could improve educational attainment, income, labor supply, and health status (Behrman and Rosenzweig, 2004; Case, Fertig and Paxson, 2005; Black, Devereux and Salvanes, 2007; Oreopoulos et al., 2008; Smith et al., 2012). Equally important is the early mastery of cognitive and non-cognitive skills, which also significantly affect those outcomes later in life (Heckman, Pinto and Savelyev, 2013). Among various factors that shape children's birth conditions and skills development, maternal education is of special interest to researchers as it plays a major role in determining those early childhood outcomes (Almond, Currie and Duque, 2018). A clear understanding of the impact of maternal education on these outcomes also provides essential policy implications about the intergenerational effects of education, especially for developing countries that usually have a lower level of schooling.

There is a long-lasting discussion related to the intergenerational transmission of human capital that focuses on how parental factors influence children's outcomes. Theoretically, Becker and Tomes (1979, 1986) demonstrate that parental investment in children is crucial to human capital accumulation. Parents' education, especially mother's education, is essential to a child's health and cognitive skills because more educated people are more efficient producers of health. These parents usually have higher socioeconomic status, and therefore, they are more likely to pass better health and other outcomes to the next generation (Grossman, 1997). However, as discussed in Grossman (2006), establishing the causal relationship between parental education and children's outcomes is empirically challenging due to the endogeneity issue from omitted variables that affect both parental education and children's outcomes, which would invalidate the estimates. For example, a third factor, like parents' own health status, could affect their education or earnings, which may lead to poor child health. Meanwhile, poor child health could adversely affect parents' earnings (Currie, 2009), leading the estimate to be biased.

There are two main strands of literature using different methods to address this issue. One strand of the recent studies utilizes family structure to causally identify the effect of parental education on children's outcomes. Behrman and Rosenzweig (2002) use twins sample to isolate nature effect from nurture effect and a few other studies use adoptees to obtain the exogenous variation in parental education (Sacerdote, 2002, 2007; Chen and Li, 2009). Another strand of the literature uses government policy changes that create plausible exogenous variation in educational attainment for affected group of people.[1] However, most of these studies focus on the increases

[1]Recent literature falling into this strand includes, but not limited to, Currie and Moretti (2003); Black, Devereux and Salvanes (2005); Lindeboom, Llena-Nozal and van Der Klaauw (2009); Chou et al. (2010); McCrary and Royer

in the lower level of education induced by policies, such as compulsory education law reforms, and these studies have found mixed results of the impact of intergenerational transmission of education. Only a few studies investigate the impact of higher level of educational attainment on children's health (Currie and Moretti, 2003; Carneiro, Meghir and Parey, 2013).[2] For countries that experienced one educational reform, this may not be an issue since differences among adult educational attainment are likely caused by such reform. However, if there are multiple shocks that affect educational attainment for certain cohorts, the estimate would be biased because those cohorts that are affected by an earlier policy are also likely to be affected by a later reform as well. For instance, China implemented compulsory education reform that mandated nine years of schooling which requires elementary and middle school education and later conducted a higher education expansion that increased people's college attendance, within a short period of time. Therefore, it is challenging to disentangle the effect of improved education due to the earlier reform from the later one.

Our paper studies the impact of maternal education on a comprehensive set of child outcomes in China following the second strand of literature. We take advantage of the higher education expansion, a recent educational reform implemented in 1999 that massively increased access to college, to examine the impact of maternal education on child birth weight, gestational age, health conditions before age one, along with social and motor skills, such as the time the child begins speaking, counting, walking, and self-urinating, which are not widely discussed in the literature, via an instrumental variable approach. To address the endogeneity issue of education and children's outcomes, we utilize the number of colleges in the mother's college-going year and province induced by the expansion as an instrument. It overcomes several empirical challenges in the existing studies. First, the instrument provides ample variation across both location and time. China's college admission system is province-based and we use variations in the number of colleges across different provinces and different college-going years. There is substantial heterogeneity in terms of higher education institutions across provinces in China (Borsi, Valerio Mendoza and Comim, 2022). Second, as previous literature established, national-level educational reforms are unlikely to be correlated with location-specific conditions in many countries (Black, Devereux and Salvanes, 2005; Machin, Salvanes and Pelkonen, 2012). Higher Education Expansion in China is also independent of provincial characteristics (Ding, 2021), which creates credible exogenous variation in educational attainment, and it is unlikely to affect future child outcomes. Third, given that there was a compulsory education reform before the higher education expansion and some cohorts were exposed to both policies, using the most recent reform delivers a more accurate

(2011); Andrabi, Das and Khwaja (2012); Güneş (2015); Keats (2018).

[2]A recent paper by Cowan and Tefft (2020) follows Currie and Moretti (2003) but looks at the impact of college openings on adult health.

estimate of the impact of mother's education on the next generation. We use the China Family Panel Studies (CFPS) 2010 wave as the main data set. Mother's college-going province is defined as her reported province at age 12 since this is the closest year we could get before the college-going year, and migration between age 12 and a typical college-going age of 18 is rare in China. Mother's college-going year is from her self-reported high school graduation year. If she does not attend high school, we use the predicted college-going year. After we match the province-year number of colleges with the mother's college-going year and province, we perform the two-stage least-squares estimation and obtain the causal effect of maternal education on child outcomes.

Results from the Ordinary Least Square (OLS) show that maternal education is negatively correlated with the probability of having an abnormal weight baby and preterm birth, though the low birth weight is less precise. Mother's education is also associated with a higher likelihood of reporting the child having any sickness or hospitalization before age one. In addition, the OLS estimates present a strong negative correlation between maternal education and the time that the child starts to walk independently, speak a full sentence, count from 1–10, and self-urinate. But we do not find similarly statistically-significant effects in IV estimations for the full sample. However, the sub-sample analyses show that, for mothers who originally come from rural areas, a one-year increase in education decreases the probability of having a low birth weight child by two percentage points, and it also shortens the time that the child begins walking independently by 0.3 months, speaking a full sentence by 0.7 months, and counting from one to ten by 1.2 months. We test our results by switching from using regular years of schooling as our independent variable to an alternative measure of years of education after middle school and we find very similar effects. To avoid the potential confounding factor of China's Compulsory Schooling Law, we also perform robustness checks by restricting the sample to mothers born after 1975 who were fully exposed to this reform and then later affected by the higher education expansion reform. The results are both quantitatively and qualitatively similar to our main findings. Further investigation of the potential channels reveals that assortative marriage and rural-urban migration are the driving forces related to the impact of mother's education.

This paper contributes to the literature in three ways. First, to our best knowledge, this study provides the first estimate using a massive higher education expansion in developing countries to examine the effects of maternal education on early childhood outcomes. Unlike most of the literature that uses policies that are more likely to affect people's education in the lower level of the distribution, this paper focuses on a policy that exposed people more to the upper-level of the education distribution. Chevalier and O'Sullivan (2007) and Lindeboom, Llena-Nozal and van Der Klaauw (2009) use changes the minimum school leaving age in the U.K. and find that increases in mother's education year have limited effects on child health. A similar small effect is confirmed in the U.S. by McCrary and Royer (2011) that uses the age at school entry policies in California and

Texas, showing that mother's education has negligible effects on infant birth weight, prematurity, and infant mortality rate. However, other studies in developing countries generally show that maternal education leads to a smaller child mortality rate (Chou et al., 2010; Grépin and Bharadwaj, 2015), reduction in very low birth weight (Güneş, 2015), increased likelihood of having a normal birth weight child, decreased birth defects rate (Huang et al., 2018), and increased completed childhood immunization rate (Özer, Fidrmuc and Eryurt, 2018). Despite the abundant and mixed findings related to policies that improve the lower level of education, limited evidence exists on the impact of mother's education on child outcomes using changes in a higher-level education distribution. Currie and Moretti (2003) show that increases in maternal education induced by new college openings can improve infant health as measured by birth weight and gestational age. Meanwhile, Carneiro, Meghir and Parey (2013) use local market conditions and college tuition as instrumental variables of mother's education, and they find similar improvements in child outcomes associated with maternal education. No current study focuses on the impact of an increase in higher-level education on child outcomes in developing countries. The massive higher education expansion in China provides us an unique opportunity to study the impacts of a policy that induced both more years of schooling and higher attendance in high school and above.

Second, this paper not only focuses on the impact of maternal education on infant health outcomes but also on early childhood development of cognitive skills, which is crucial to later life achievement (Heckman, Pinto and Savelyev, 2013; Campbell et al., 2014). It has been shown that motor skills have positive impact on the development of cognitive skills such as language skills (Gonzalez, Alvarez and Nelson, 2019). Motor skills also affect physical activities (Cliff et al., 2009). Duncan et al. (2007) present that children's early mastery of math concepts and vocabulary have great predictive power to later education achievement. Based on this study, Grissmer et al. (2010) find fine motor skills, in particular, speaking and reading, have positive correlation with children's math and reading scores. Despite the importance of the development of these skills at early stage, little evidence is found on how maternal education could affect them. Carneiro, Meghir and Parey (2013) show that there is no evidence that maternal education improves early childhood motor and social skills development up to 24 months in the U.S. This paper provides the first evidence of maternal education on early childhood motor and social skills development in a Chinese context.

Third, this paper complements existing studies that look at the effects of China's college expansion by providing new evidence of the effects of intergenerational transmission of education, particularly on health and social and motor skills. Recent literature on the expansion mainly examines its impacts on intergenerational education mobility (Guo, Song and Chen, 2019), migration choice (Ding, 2021), and labor market outcomes such as college wage premium (Hu and Bollinger, 2021) and occupational choice (Duan et al., 2022). This paper adds to the literature by providing the effect of the higher education expansion from a different perspective. Using a comprehensive

nationally representative data in 2010, we are able to identify the effect of mothers who were affected ten years after the expansion. Now more than twenty years after China's higher education expansion, it is valuable to understand its impact on the next generation's outcomes through the lens of intergenerational transmission of education.

The rest of this paper is organized as follows. Section 2 describes the background of higher education expansion in 1999. Section 3 presents the data and main variables, including the summary statistics. Section 4 outlines the identification strategy. The results are explained in detail in Section 5, and Section 6 concludes.

2 Higher Education Expansion in China

The formal education timeline in China typically starts with six years of elementary school education. Students can enroll in elementary school once they reach age six but no later than age seven. After completing elementary school, students must attend three years of middle school as required by the Compulsory Schooling Law. Then, if students want to get into higher education institutions, they must attend three years of high school and take the college entrance exam afterwards.

Unlike most developed countries, the central government in China plays an essential role in the development of higher education and its related policies (Che and Zhang, 2018). Since the start of China's sweeping economic reform in 1978, the accompanied state-owned enterprise reform in the 1990s created massive layoffs and the economic condition was worsened by the Asian financial crisis that happened in the same time. In order to reduce the labor market stress, the central government started the Higher Education Expansion (HEE) in 1999 in the hope of making more high school graduates get into college and help the economic development. As suggested by the economist of the Asian Development Bank Mission in China, Ming Tang, the HEE could lead to more education consumption as well as induce more investment in services, construction, and other industries, which could eventually increase the aggregate demand and help the economic growth in the short term. The unexpected HEE was announced in November 1998 and implemented in June 1999 by the central government, and it reflects the government's social and economic development strategy at the national level.

As described in the official document published by the Chinese Ministry of Education - "Action Plan for Education Revitalization in the 21st Century," the central and local governments should gradually increase educational expenditures. The central government should raise the proportion of education spending to total government spending by three percentage points in 2000. The local government's educational expenditure should be increased even more based on their economic

conditions.[3] Under these guidelines, the number of colleges went up simultaneously to support the expansion of higher education. Figure 1 plots the number of colleges in China from 1978 to 2010, and Figure 2 shows the number of colleges in selected provinces during this period. The number of colleges in each province remained almost unchanged before HEE, while it went up rapidly right after HEE.

The central government strictly restricted higher education admission to meet economic development needs. The government allocates admission quotas to different higher education institutions. Before the HEE, college students usually get assigned jobs once they complete their college education. There was also no tuition and fee for college education before the early 1990s, while nearly all higher education institutions started to charge tuition and fees to cover their expense in the mid of 1990s. After HEE, the tuition and fees significantly increased in later years (Wan, 2006). HEE was unanticipated because it was first proposed in November 1998, then approved by the central government in January 1999, and finally implemented in July 1999. The initial plan for the 1999 expansion was to increase college enrollment by 0.23 million compared to 1998; then, this number was finally increased to 0.567 million in the middle of June 1999. Prior to 1999, the average increase in college enrollment rate was about 8%. In 1999, the enrollment rate jumped by 47.4% and kept growing every year.

This expansion has led to millions of students from both urban and rural areas getting into college, and it has also increased educational attainment at various levels because of a higher probability of getting into college after the expansion. As can be seen from Figure 3, new enrollment in high schools jumped dramatically after the higher education expansion. From the 2010 Population Census data, the number of college students per ten thousand increased to 15,467 compared to 8,930 in the 2000 Population Census. We take advantage of the unexpected HEE as an exogenous shock to examine the impacts of maternal education on early childhood outcomes.

One concern regarding HEE-induced education attainment is that the Compulsory Schooling Law (CSL) in 1986, which requires all children to have nine years of education, could potentially confound the estimation of the impact of maternal education. For example, a mother who was born after 1980 should be affected by CSL as well as HEE. Therefore, the sizeable potential impact of maternal education might be attributed to both policies. In this study, we address this concern by utilizing variation both across provinces and years in the number of colleges, which is independent of the previous compulsory educational reform. Further, we restrict our sample to mothers who were fully exposed to the CSL in the robustness checks. The main results are quantitatively and qualitatively similar to our main findings.

[3] See the news report from People's Daily at http://52.34.104.77/renminribao/1999/3/2/11/.

3 The Data and Variables

3.1 Overview of the Data

The main data set we use for this study is the baseline wave of China Family Panel Studies (CFPS) survey data. CFPS is a national representative longitudinal survey conducted by Peking University. The national baseline CFPS survey was conducted in 2010 in 25 provinces of China.[4] These provinces consist of 95 percent of the total population, which can be viewed as a representative sample of China (Xie and Hu, 2014). There are five modules in CFPS, including community, family roster, family, child, and adult. This paper mainly uses survey data from child and adult modules. Child survey questions are answered by the adult family member who is the child's primary caregiver. Children who are aged more than ten years old will answer part of the survey questions by themselves. Adult survey questions are answered by the adults who live in the chosen interviewed family.

The CFPS survey data is ideal for this research because it offers several advantages. First, it has detailed information on the timing and level of adult education, which helps us identify the college-going year for each individual. Second, it tracks an adult's past residence locations at birth, age three, and age 12, which helps us infer the province in the college-going year. We use province at age 12 as college-going province because migration between age 12 and 18 is rare. Combining these two sets of information, we are able to match corresponding provincial level variables to mother, including number of colleges. Third, CFPS asks a wide range of questions related to children's birth outcomes and social and motor skills, which provides an unparalleled advantage in studying the effect of HEE on these important but less-studied outcomes due to lack of data. Fourth, this data set provides rich information on social-economic status and health-related outcomes for mothers who had no exposure to the HEE and mothers who were affected by HEE in the early stage, which allows us to examine the potential channels of the effects of maternal education on the outcomes of child.

The college expansion does not only increase access to college but also induces people to stay longer in school (Xing, 2014). For those mothers who did not finish high school and take the college entrance exam, we follow Ding (2021) to get college-going year information. We use the end year of their education to predict their high school graduation year so that we can match external variables in the college-going year to them. Although CFPS does not have the province information of mother's college-going year, we proxy the location with their reported province at age 12. With these mother's college-going time and location information, we can match it with

[4]The administrative areas that are not in the survey are Hong Kong, Macao, Taiwan, Xinjiang, Tibet, Inner Mongolia, Ningxia, and Hainan.

provincial level macroeconomics variables and control for such aggregate provincial level changes. Provincial-level economics variables data is from China Yearly Statistical Book. We also obtain the number of colleges, college enrollment, and high school graduates for each province and year from the Educational Statistical Book of China.

3.2 The Outcome Variables

In this paper, we mainly study the impact of mother's education on two sets of outcomes: early childhood health outcomes and early childhood social and motor skills.

The first set of health outcomes, following an extensive literature[5], includes a dummy variable of low birth weight (LBW), a dummy variable of very low birth weight (VLBW), a dummy variable of macrosomia, and a dummy variable of gestational age less than 36 weeks.[6] LBW equals one if the infant's birth weight is lower than 2500 grams and zero otherwise. VLBW is defined as one if the infant's birth weight is lower than 1500 grams and zero if it is not. Macrosomia is defined as an infant's birth weight exceeding 4000 grams. We also study whether the child had any sickness before age one and whether the child had any hospitalization in this stage. These two outcomes would give us an indication as whether the child was healthy or not before age one. As for the second set of early childhood outcomes, we focus on four measures that show early childhood social and motor skills development. CFPS asks the child's primary caregiver how many months after birth the child started to perform these skills, including when the child began walking independently, speaking a full sentence, counting from one to ten, and self-urinating.

3.3 The Independent Variables

The variable of interest is maternal education and we focus on two measures of education. The first measure is a continuous variable that records the mother's total years of schooling, and the second is an indicator variable that equals one if the mother has more than nine years of education (some high school or above). The reason that we select the discrete measure is because the HEE not only expanded the enrollment of college students but also increased the number of high school students since they had a higher probability of getting into college after 1999. We do not use the college attainment measure because the HEE had a broader impact in terms of the upper level of schooling (Xing, 2014).

We control for the child mother's ethnicity (an indicator variable equal to one if the mother's ethnicity is Han), the child grandmother's education level (elementary school, middle school, high

[5]See Currie and Moretti (2003); Chou et al. (2010); McCrary and Royer (2011); Güneş (2015)

[6]Since CFPS asks for gestational age in months but not weeks, here we define the variable of gestational age as less than 36 weeks equals one if the infant was reported to be born less than nine months.

school, college, and above), the mother's hukou status (urban or rural) at age 12.[7] We do not control for the father's education since it is highly correlated with the mother's education, and it is a potential channel that could affect children's outcomes (Chou et al., 2010). In addition, we add provincial-level economics variables in the mother's college-going year in all specifications because these variables could be correlated with the number of colleges in that province and also potentially affect the mother's choice of college location.

Furthermore, we include mother's birth year fixed effect, province at age 12 fixed effect, and child province by year of birth fixed effect in the main specifications. The inclusion of mother's childhood province fixed effect accounts for geographical heterogeneity, which captures cultural and social norms that might affect the way a mother raises the child and also child early behaviors. The mother's year of birth fixed effect controls for common shocks at the time dimension, which is likely to improve both educational attainment of mothers and factors that potentially affect future child outcomes. For example, mothers in a younger cohort are more likely to be affected by the one-child policy, which reduces sibling size and encourages parents to spend more resources on them. In addition, the child province by year of birth fixed effect accounts for the time-varying changes in child's birth year and location, which could affect the birth outcomes and early childhood social and motor skills. Meanwhile, there could still be provincial-cohort-specific variables that might be correlated with the number of colleges in that province in a given year and also potentially affect child outcomes. Therefore, we add two provincial-level trends to control for such unobservables. The first is the interaction between mother's year-of-birth dummies and the provincial level college degree population ratio in the 1995 mini Census, and the second is the interaction between mother's year-of-birth dummies and the provincial level college admission rate in 1998.

3.4 Sample Descriptive Statistics

The main sample used in this paper is child survey data matched with their parents' information, both are from CFPS 2010 baseline data. We exclude children with missing values of their mother's education information. We also exclude mothers who were born before 1969.[8] The youngest mother in CFPS 2010 was born in 1994. To eliminate the potential effects of the Compulsory Education Law in 1986 on mother's educational attainment, in the robustness checks part, we

[7]Hukou is the residence registration system in China where only local residents could enjoy certain public benefits within the geographical boundary.

[8]We are aware that mothers born before 1969 might have been highly affected by the Great Famine and therefore tend to be totally different from mothers born in later years. China started the "Later, Longer, Fewer" family planning policy in 1969. After that, China's total fertility rate decreased stably (Chen and Fang, 2021). Therefore, we only focus on the group of mothers who were born after 1969 and are still of child-bearing age in 2010. The excluded mothers sample is around 5% of the matched sample.

further restrict the sample to mothers who were born after 1975.[9]

Table 1 presents the summary statistics of children's birth outcomes, early childhood social and motor skills, and the independent variables. Among the study sample, around 27% of the sample used in this analysis was exposed to HEE. The average number of colleges for the mother's college-going year before HEE is 40, and this number increased to 50 for those mothers exposed to HEE. For mothers who were exposed to HEE, 80% of their college-going year is between 1999 to 2005. Therefore, this number of college increases only reflects changes in the early years after HEE.

Panel A tells us that there are around 5% children have low birth weight and only 0.3% children were in very low weight condition at birth. There are around 4% children who were born overweight and around 4% children whose gestational age is lower than 36 weeks. Comparing the early childhood health outcomes of the two groups of mothers, we do not see much difference. Panel B in Table 1 shows the summary statistics for the four measures of social and motor skills. It is clear that the average number of month a child takes to start walking independently, speaking a full sentence, counting from one to ten, and self-urinating is less for mothers that are exposed to HEE.

4 Empirical Strategy

We are interested in the impact of mother's education on a set of early childhood outcomes, which can be specified in the following equation:

$$y_{ijt} = \beta_0 + \beta_1 Medu_{ipk} + \beta_2 X_i + \beta_3 Z_{pc} + \zeta_p + \zeta_k + \zeta_{jt} + u_{ijt}, \tag{1}$$

where y_{ijt} is the outcome of the child i living in province j who was born in year t, $Medu_{ipk}$ represents the education of child i's mother whose childhood province is p and was born in year k.[10] Throughout this paper, we mainly focus on the continuous measure of years of schooling and a discrete measure of whether the mother's education level is above middle school (i.e., ever attended high school or above). X_i represents a set of variables controlling for maternal characteristics for child i, including mother's ethnicity, maternal grandmother's education level, and mother's hukou status at age 12. Z_{pc} refers to mother's provincial economics variables at their college-going year c including GDP growth rate, employment growth rate, and population growth rate so that

[9]There are only two provinces, Hunan and Gansu, which had the Compulsory Education Law to be effective in 1991, and their first eligible birth cohort is 1976 (Ma, 2017).

[10]We do not use mother's birth province because there could be migration happened during their childhood period. Meanwhile, we can not observe their hukou province in their college-going year. Therefore, we use the most recent observable province information before their college-going year to identify their location information.

we can control for the impact of improved economic conditions on children's health and other outcomes. ζ_p, ζ_k, and ζ_{jt} denote mother's childhood province, birth year, and child's birth province by cohort fixed effects, respectively. We also include mother's cohort-specific trends by interacting the initial year provincial-level college degree population ratio and provincial college admission rate with mother's year of birth to account for potential diverging trends resulted from different initial conditions of higher education and population.

Even though with these fixed effects and cohort trends, we can absorb time-invariant unobserved heterogeneity across different provinces and common shocks across different cohorts, the estimate of β_1 may still be biased due to omitted variables. There might be factors that affect both mother's education and the potential outcome of the child. We employ an instrumental variables (IV) approach to address the endogeneity concerns utilizing the exogenous variation in mothers' education attainment induced by the HEE in China. At the province-year level, we search for instruments that are correlated with mother's education but unlikely to affect the child later outcomes. The instrument we use is the number of colleges in mother's province p in her college-going year c.[11] The identification assumption is that there is no direct impact on these early childhood outcomes under mother's exposure to HEE except through the channel of maternal education. Therefore we are able to estimate a two-stage least squares model with the first-stage regression equation being

$$Medu_{ipk} = \pi_0 + \pi_1 Numcollege_{pc} + \pi_2 X_i + \pi_3 Z_{pc} + \xi_p + \xi_k + \xi_{jt} + \varepsilon_{ipk}. \tag{2}$$

There are several reasons why we use the number of colleges to instrument for mother's education and the exclusion restriction is satisfied. First, there is strong evidence linking college expansion and improved educational attainment in China at various levels (Xing, 2014; Liu and Wan, 2019) and it is unlikely that this swift policy reform was anticipated and endogenously determined by provincial socioeconomic conditions (Feng and Xia, 2022). Ding (2021) also confirms this by a validity test showing that college enrollment is not correlated with provincial-level GDP and employment growth. Second, unlike existing studies focusing on compulsory educational reforms that affected educational attainment in an early stage of an individual, college expansion was more recent. Since those cohorts that were affected by compulsory education laws were also likely to be affected by later educational reforms, previous studies may overestimate the impact of adult education on children's outcomes using the earlier reform. We are able to capture a more accurate relationship between maternal education and children's outcomes by exploiting the variation in educational attainment induced by the number of colleges.

[11]We first calculate the starting year of each education level by using the end year subtracting duration. We assume the mother's college year is the same year when high school is completed for those mothers without college. For those mothers who do not finish high school, we assign eighteen to them, which is the year they become adults.

5 Results

In this section, we present the empirical results of intergenerational transmission of education on children's outcomes. First, we show that the number of colleges has strong predictive power on maternal education in both continuous and discrete measures of educational attainment. Then we proceed with the instrumental variable estimation and find that, on average, there is no significant impact of intergenerational transmission of education on children's birth outcome. However, this is masked by the heterogeneity of mother's urban-rural origin and our sub-sample analyses reveal a strong effect for mothers from rural areas. Next, we test several mechanisms that lead to such result, and we find assortative marriage and rural-urban migration play an important role in understanding the impact of intergenerational transmission of education.

5.1 First-Stage Result of Number of Colleges on Mother's Education

Table 2 summarizes the IV first-stage results following Equation (2). Panel A uses years of schooling as the dependent variable, while panel B uses a discrete variable that equals one if the mother's educational attainment is above nine years, which indicates the mother has at least completed middle school education and attended high school. Column (1) controls for all individual characteristics and fixed effects. Column (2) adds a cohort-specific trend in terms of the college population ratio in the 1995 census. Column (3) additionally adds a cohort-specific trend related to the admission rate prior to the college expansion in 1998 and is the preferred specification. All three specifications reveal similar quantitative results of the impact of access to college. A one-unit increase in the number of colleges would raise 0.05 years of education and the probability of going to high school by one percentage point. Though the coefficients seem to be small, given that the average years of schooling for the sample prior to the expansion is less than seven years, and the average increase in the number of colleges after 1999 is more than 10, translating the impact to 0.5 years, equivalent to a 7% increase. This effect is smaller but consistent with the compulsory education reform literature where Güneş (2015) shows that affected mother's years of education increases by 0.04 years and primary school completion by 1.4-1.7 percentage points. Liu and Wan (2019) find the impact of higher education expansion on years of schooling is around 0.09 years. The impact on the high school-going rate is more pronounced (10 percentage points), approximately 70% compared to the pre-expansion average (14 percent). Therefore, the first stage confirms that there is a strong relationship between college expansion and maternal education and the magnitude is not negligible.

5.2 The Impact of Mother's Education on Child Outcomes

Birth Outcomes Table 3 reports the impact of mother's education on child early childhood health outcomes. Panel A shows the OLS estimates and panel B provides the corresponding IV results. For each column, we examine how years of schooling and high school attendance affect different health measures. An inspection of the first two columns in panel A reveals that there is no significant effect of mother's education on low birth weight, even though the direction of the impact is expected. A one-year increase in schooling will decrease low birth incidence by only 0.2 percentage points and very low birth weight by 0.03 percentage points. Attending high school reduces low birth weight by 0.7 percentage points, and very low birth weight is almost zero and not statistically significant. However, given that the average of very low birth weight children only takes 0.3 percent of the whole sample, it is not a surprising result. We do find years of schooling are correlated with the incidence of reduction of macrosomia, while the high school attendance effect is less precise. Having more education also significantly reduces the chance of the child being born early.[12] There is also a positive correlation between mother's education and reporting the child being sick and hospitalized in the first year after birth. It is likely due to the selection problem that more educated mothers have better care for their children, and they are also more cautious of any illness.

Panel B presents the result from the instrumental variable regression. The F statistics indicate there is a strong power of our first stage estimation as the F statistics exceed ten (Andrews, Stock and Sun, 2019). That the F statistics associated with high school attendance are far larger than those associated with years of education suggests the effect is stronger for people who are marginally affected by the higher education expansion (Ding, 2021). Similar to the literature, we do not find a substantial effect of increased maternal education on infant health at birth or in the first year of birth (Lindeboom, Llena-Nozal and van Der Klaauw, 2009). All IV estimates lack statistical power to make causal inferences.

Social and Motor Skills Table 4 shows the impact of maternal education on early childhood social and motor skills. We focus on how long it takes the child to start walking independently, speaking a full sentence, counting numbers from one to ten, and self-urinating. Coefficients from OLS regressions imply a strong correlation between mother's education and children's social and motor skills. Having one more year of schooling will reduce the time to start walking by 0.137 months, speaking by 0.248 months, counting by 0.79 months, and self-urinating by 0.4 months. The impact of high school attendance is more pronounced. Children born from a mother who at least went to high school will start speaking 1.6 months earlier than children from a less educated

[12] It is worth noting that CFPS does not report gestational age in weeks but in months. The conventional threshold for premature birth is 37 weeks, which is the first week of the 9th month. Here we use 9 months as the cut-off time.

mother, almost 8 percent of the mean effect. The effect for counting numbers is approximately 16 percent and for self-urinating is 10 percent. The IV estimates are consistent with OLS results in terms of direction and magnitude. We still can not claim there is an average effect of mother's education on children's social and motor skills due to the lack of statistical power. However, as we will confirm in the heterogeneity analyses next, we shall not be surprised by the null results found in our IV estimations since we expect that education is more salient for people on the margin affected by the college expansion.

5.3 Heterogeneous Impacts of Mother's Education on Child Outcomes

Rural/Urban Origins Even though there has been rapid urbanization in China over the past decades and economic transformation has improved education access and living conditions in rural areas, there still exists a large gap in terms of both education access and attainment between rural and urban areas, especially among females (Guo, Hu and Ding, 2022). Given the vast differences among educational opportunities across locations, we shall not expect the effect of college expansion to be uniform across all individuals. To investigate the heterogeneous effect of education on children's outcomes, we first look into how rural-urban origins influence infants' health and the forming of social and motor skills in early childhood.

Table 5 shows the IV results for mothers from rural and urban areas separately and the corresponding first stage results are reported in Table B1. For those females whose childhood was in the rural area, one more year of schooling reduces low birth weight incidence by 2.1 percentage points, equivalent to a 36 percent reduction compared to the mean. Completing middle school and attending high school result in an even larger effect of 10.7 percent, almost twice as the mean effect. A similar impact is also found in very low birth weight. We do not find significant impact for other birth outcome measures. Empirical studies have shown that improved education due to college expansion has profound impacts on moving rural people to urban through migration (Ding, 2021), which potentially improves access to health care and other services that deliver better outcomes for infants.

Table 6 presents the results for children's social and motor skills, where we see significant improvements in these outcomes for mothers with more education. Increasing mother's years of schooling slightly reduces the time a child begins to possess those skills and attending high school or above largely decreases the time. Rural children with more educated mothers are seen to have 1.6 months, 4 months, and 7 months earlier than their counterparts with less educated mothers to start walking independently, speaking a full sentence, and counting numbers from one to ten. This set of results shows the important transmission of mother's education to a child's skills in the early stage. More educated mothers possibly pass their increased human capital to

their children by teaching them to perform these activities earlier than others. Although we do not find significant effects from urban mothers, that is possibly due to less variation caused by a smaller sample size.

High/Low Impact Provinces There may also exist differential impacts for provinces with disparate initial access to college. Places with more colleges may have better amenities that are positively correlated with health-related outcomes for those mothers and they pass them on to the next generation. Even though we show that college expansion is independent of provincial economic conditions, preexisting higher education levels could affect the outcomes of affected individuals in a different way.

To test this hypothesis, we split provinces into two categories based on the median of admission rates in 1998, the year prior to the expansion. The high-impact provinces are the first half of all provinces with admission rates above the median in 1998, and the low-impact provinces are the bottom half with admission rates below the median. The effects of mother's education on child birth outcomes are more notable in high-impact provinces while in contrast we do not find such effect in the full sample. One more year of schooling lowers the probability of a child being low birth weight by 4 percentage points and attending high school improves it by 19 percentage points. We also find that mothers from high-impact provinces are more likely to send children to hospitals. However, there is no substantial effect for low-impact provinces.

As can be seen in Table 8, the only significant effect on social and motor skills is the time a child starts counting numbers whose mothers are from high-impact provinces. Children with mothers who have one more year of schooling start counting 3 months ahead of others, and there is almost an 18-month advancement for children whose mother has at least some high school. Other skills are noisier compared to counting and we again find no significant effect for low-impact provinces.

5.4 Robustness Checks

In this section, we perform different specification checks to test if excluding cohort-specific trends and using the restricted sample alter the main results.

First, we do not control the trends that account for differential effects originating from the initial college population ratio and admission rate. If it significantly changes our results, it implies potential selection of college expansion at the province level, which would invalidate our instruments. The results are presented in Table 9. Consistent with what we have found, we do not see the causal effect of intergenerational transmission of mother's education on early childhood health outcomes for the full sample. Only very low birth weight from years of education and the time to start speaking from high school attendance show marginal significant effects and all coefficients estimated are very similar to the magnitude in Tables 3 and 4. Panel B shows the rural

sample test where we confirm our main result is valid since there is no statistical differences from the estimates in panel A Table 5 and 6.

Next, we restrict the sample to those mothers who were born after 1975. The restricted sample helps avoid the confounding impact of the Compulsory Schooling Law (CSL) implemented in 1986. CSL was gradually rolled out across provinces starting in 1986. The earliest eligible birth cohort is mothers who were born in 1970, and the latest eligible birth cohort is the mothers who were born in 1976 (Ma, 2017). All children born after 1975 were fully exposed to CSL. Table 10 reports the IV results using the restricted sample. We find similar results as in Table 3 and Table 4. Maternal education decreases the likelihood of an infant's very low birth weight and improves the development of social and motor skills of mothers with rural hukou at age 12.

Then, we change our main previous variable of interest, maternal education years, to the years of education after middle school. For all the mothers whose education level is elementary school or middle school, their education years after middle school is defined as zero. Table 11 shows the IV results of using mother's education after middle school. Similar to our main results, we do not see maternal education after middle school significantly changing early childhood outcomes. Nonetheless, we do find consistently significant results for rural samples. The magnitudes of these significant estimates are also very close to our main results. This may indicate that there is a positive linear relationship between maternal education and early childhood outcomes in health and social and motor skills.

6 Mechanisms

Our main results show that, on average, there is no meaningful evidence of intergenerational transmission of education on child outcomes through the college expansion, but more educated mothers from rural areas are less likely to have low birth weight children and can better prepare their children's social and motor skills earlier than less educated mothers. In this section, we seek to understand what factors could explain those results by studying several mechanisms. We first examine if the college expansion promotes assortative marriage in China as a common cause found in the literature. Next, we investigate if increased access to education improves labor market outcomes so that mothers have more resources to take care of their children. Then we test if there exists any place-based factors behind these effects. Last, we look into whether access to college changes the health behaviors of affected mothers.

Assortative Marriage Columns (1) and (2) in Table 12 provide evidence of assortative marriage in terms of educational attainment. The full sample analysis shows one more year of schooling increases spousal education by 0.9 years, and the effect is magnified almost 5 times for mothers

from rural areas who at least attended high school. Mother's education is also causally related to the discrete measure of the spouse's education. On average, a one year increase in mother's education leads to 13 percentage points increase in father's attendance of high school, and mothers who have at least some high school are 62 percentage points more likely to marry a similar or higher education level father. These results are driven by the rural sample, which verifies our findings in the heterogeneous effect and is consistent with existing studies (Nie and Xing, 2019).

Labor Market Outcomes Columns (3) and (4) present the results of maternal education on mother's working status and wage income. The full sample estimates show a significant impact of education on employment, while such effect is muted for mothers from rural areas in panel B.

In contrast to the mixed evidence of job status, returns to education have a quantitatively large but noisy effect. One year of schooling increases mother's income by 15.5 percent and 17.8 percent in full and the rural sample, respectively. Attending high school will almost double the income compared to those mothers that are less educated. These estimates are within the range among studies looked into labor market consequences of the high education expansion (Shi and Xing, 2010).

The existence of assortative marriage but no statistically significant impact on labor market outcomes, especially for rural mothers, is not surprising. Literature suggests that mothers tend to spend more time with children and sacrifice labor market outcomes, which in turn could transfer their human capital to the next generation. It is also worth mentioning that mothers in this sample may be selective as we only use women who have children, which would underestimate the effect of education on labor market outcomes.

Location Recent literature suggests place-based factors could affect health outcomes (Deryugina and Molitor, 2021; Finkelstein, Gentzkow and Williams, 2021). As we have confirmed in my previous results, mothers who came from rural areas were more affected by the college expansion and transmitted human capital to the outcomes of the next generation. Most Chinese universities are located in large cities, and attending college requires migrating to those cities (Xing and Zhang, 2017; Cai, Ding and Du, 2022). Is it because they are likely to stay in cities after they receive college education there, so they have better health services that improve children's outcomes? We test if mother's current hukou registration status is affected by her education.

Column (5) in Table 12 shows it is indeed this case. One more year of education on average increases current urban hukou status by 10.8 percentage points, and high school attendance increases having urban hukou by 35 percentage points. These effects are mostly driven by rural mothers, as seen in panel B, where the estimates are larger than those obtained in the full sample.

Adult Health and Risky Behaviors Existing studies have shown that improved access to education, either through compulsory education law or college, likely changes adults' health (Huang, 2015), and risky behaviors such as reducing smoking and drinking (Cowan and Tefft, 2020) which improved their own health conditions. Meanwhile, parents with worse health status may put fewer resources on their children, and therefore, this might be negatively related to health or early social and motor skills development for the next generation.

However, we do not find such channels of effect in the Chinese context. Column (6) presents that there is little impact of mother's own education on her self-reported health as good, although the positive magnitudes are consistent with the literature (Huang, 2015). Columns (7) and (8) show that there is no causal effect of education on health behaviors for mothers. Considering that the average percentage of smoking is only 0.68 percent for the full sample and 0.61 percent for the rural sample, it is not surprising to see the null effect. In addition, the null impact of education on self-reported health and health behaviors is also consistent with the existing findings in Turkey (Cesur, Dursun and Mocan, 2014) and Romania (Malamud, Mitrut and Pop-Eleches, 2021).[13]

7 Conclusion

Although there is a large body of literature examining the intergenerational transmission of education on various outcomes, there are only a few studies focusing on maternal education on early childhood outcomes. Especially, current literature lacks evidence of mother's senior-secondary or above education attainment on child outcomes in their earlier stages. Understanding whether maternal education impacts child outcomes and through which channels these outcomes were affected is extremely important. From the fetal origins hypothesis, helping mothers would be one way to help their children throughout their life course (Almond and Currie, 2011). Making child-bearing age women more educated is a cost-effective way to improve child health (Black et al., 2017).

This paper analyzes the impact of maternal education on early childhood health outcomes and social and motor skills. Using the higher education expansion in China as the exogenous shock to mother's education and applying the IV estimation, this paper finds that, for mothers from rural areas, one year increase in education leads to 2 percentage points decrease in the probability of the child being low birth weight, 0.31 months earlier to start to walk independently, 0.675 months earlier to speak a full sentence, and 1.22 months earlier to count from one to ten. We test several channels through which maternal education could affect child outcomes. The results show that

[13]We also examine whether mother's education has any impact on the probability of a child born in hospital and breastfeeding length. There is no evidence that mother's education leads to any changes to these two outcomes, which could be helpful to early childhood health outcomes.

education leads to assortative marriage and rural-urban migration, which could contribute to the improvement of children's health outcomes and social and motor skills development.

Similar to the findings in studies that examine both higher level education attainment (Currie and Moretti, 2003; Carneiro, Meghir and Parey, 2013) and lower level of educational attainment of the mother (Chou et al., 2010; Güneş, 2015; Huang et al., 2018), results in this paper indicate that senior-secondary or above educational attainment in China has a large impact on infant birth weight and early development of social and motor skills . The mechanism analyses are also consistent with the existing literature on the impact of higher education expansion in China, which vastly improves the socioeconomic status with the increase in education (Li, Whalley and Xing, 2014; Ding, 2021).

As pointed in Black et al. (2017), 250 million children younger than 5 years old who live in low- and middle-income countries (LMIC) have not reached their development potential. Insufficient attention placed on nurturing care during a child's rapid brain development and learning under the age of three is the major concern in many LMICs. A variety of early childhood development programs has been adopted in these countries, while the findings in this paper demonstrate that improving mother's post-compulsory education will be a meaningful way to improve children's early-childhood development and thus further help children's health conditions and human capital accumulation. One thing that needs to be noted is that the sample of mothers we used in the main analysis are mainly from the early cohort who benefited from the higher education expansion, and we show that mothers with high school attendance have seen considerable improvement in the outcome variables of interest. It would be reasonable to believe that college attainment should have an even larger impact on these outcomes, and it deserves further studies in the future.

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8 Figures

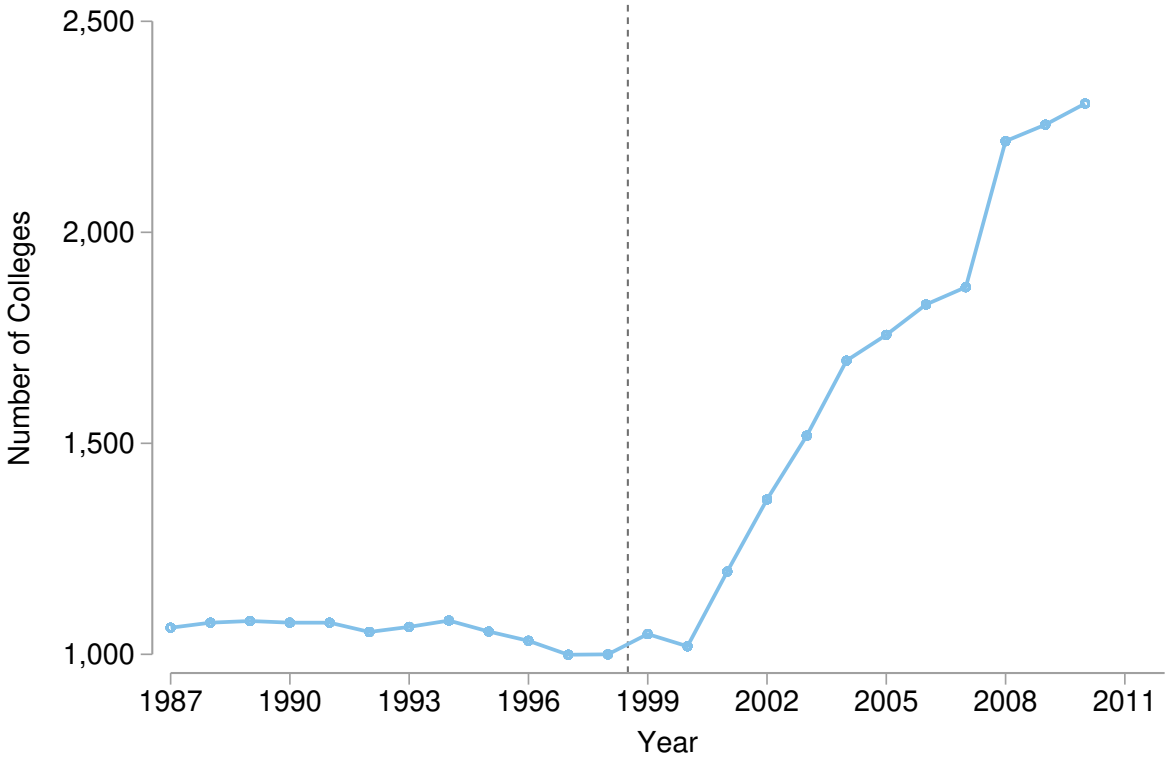


Figure 1: National Number of Colleges

Notes: This figures plots the number of colleges at the national level from year 1987 to 2010. The data is from China Yearly Statistical Book.

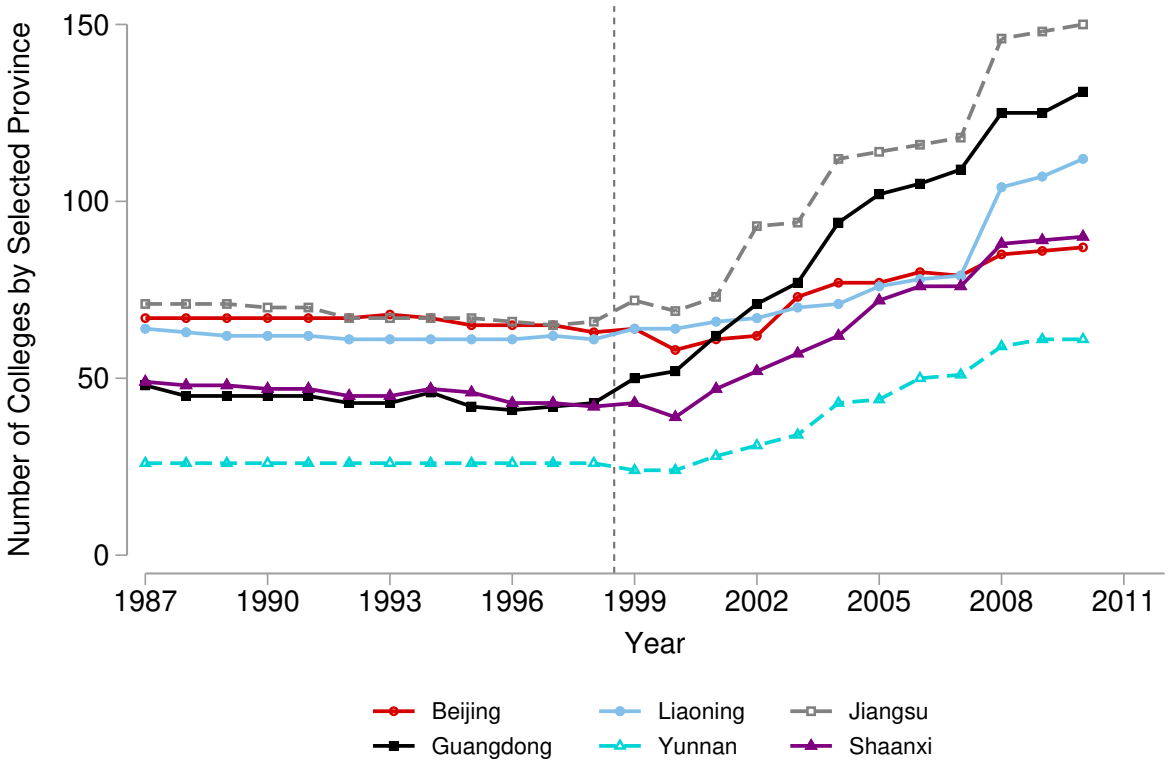


Figure 2: Number of Colleges by Selected Provinces

Notes: This figures plots the number of colleges from year 1987 to 2010 in selected province. The data is from China Yearly Statistical Book and Educational Statistical Book of China. There are six regions in mainland China. Each province presented above is a representative province in different regions.

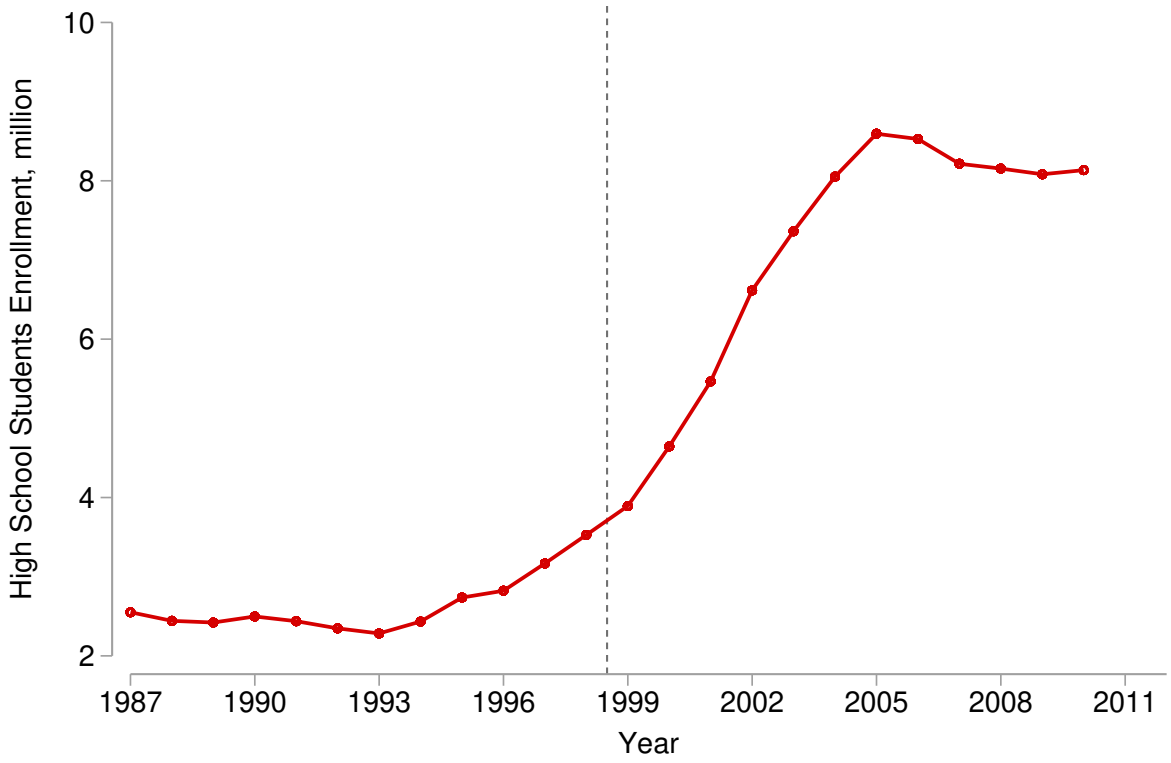


Figure 3: National High School Students New Enrollment

Notes: This figures plots the total number of high school admissions from year 1987 to 2010. The data is from Educational Statistical Book of China.

9 Tables

Table 1: Summary Statistics

	Full sample			Mother's college year before 1999			Mother's college year after 1999		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
A. Health outcomes									
Low birth weight (LBW)	4,638	0.057	0.232	3,371	0.056	0.231	1,267	0.058	0.235
Very low birth weight (VLBW)	4,638	0.003	0.055	3,371	0.004	0.060	1,267	0.002	0.040
Macrosomia	4,638	0.039	0.194	3,371	0.039	0.194	1,267	0.039	0.195
Premature	5,329	0.037	0.189	3,950	0.032	0.175	1,379	0.052	0.223
Any sick	4,574	0.692	0.462	3,449	0.670	0.470	1,125	0.758	0.428
Any hospitalization	4,564	0.610	0.488	3,442	0.585	0.493	1,122	0.687	0.464
B. Social and motor skills									
Walk	4,753	14.328	4.615	3,748	14.509	4.822	1,005	13.653	3.525
Speak	4,490	20.487	8.032	3,651	20.642	8.251	839	19.810	6.926
Count	4,112	34.479	14.858	3,419	35.284	15.212	693	30.508	12.477
Self-urinate	4,262	32.986	13.019	3,506	33.633	13.365	756	29.985	10.726
C. Instrumental variable									
Number of colleges	5,329	42.834	17.326	3,950	39.637	14.443	1,379	51.992	21.205
D. Explanatory variables (mother)									
Han ethnicity	5,329	0.871	0.335	3,950	0.872	0.335	1,379	0.871	0.335
Grandma's education level	5,329	1.194	0.506	3,950	1.143	0.441	1,379	1.341	0.636
Urban Hukou at age 12	5,329	0.098	0.297	3,950	0.090	0.286	1,379	0.120	0.326
Education (high school or above)	5,329	0.179	0.384	3,950	0.138	0.345	1,379	0.297	0.457
Education (years)	5,329	7.062	4.435	3,950	6.594	4.320	1,379	8.403	4.487
Population growth rate	5,329	0.012	0.008	3,950	0.014	0.007	1,379	0.007	0.009
Employment growth rate	5,329	0.027	0.065	3,950	0.029	0.056	1,379	0.020	0.085
GDP growth rate	5,329	0.161	0.079	3,950	0.177	0.081	1,379	0.116	0.052

Notes: This table shows the summary statistics for the outcome variables, instrumental variable and main explanatory variables. Standard deviations are in parentheses. The sample presented in this table is the CFPS 2010 survey data for the main analysis.

Table 2: First Stage-Number of College on Mother's Education

	(1)	(2)	(3)
Panel A: Education years			
Number of College	0.0514***	0.0491***	0.0462***
	(0.0121)	(0.0121)	(0.0121)
	(4)	(5)	(6)
Panel B: High school attendance			
Number of College	0.00987***	0.00982***	0.0100***
	(0.00122)	(0.00122)	(0.00121)
Mother's cohort×college population ratio in 1995		✓	✓
Mother's cohort×admission rate in 1998			✓
Observations	5,329	5,329	5,329

Notes: This table shows the first stage results of the number of colleges on mother's education. The data is from CFPS 2010 and cross-sectional weights are used in the regression. All regressions control for mother's characteristics, including ethnicity, grandmother's education level, and mother's hukou status at age 12. Provincial-level employment rate, GDP growth rate, and population growth rate. In addition, mother's birth year fixed effect, mother's childhood province fixed effect, and child's birth province by year fixed effects are included. Robust standard errors are clustered at the mother's province by cohort level and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: The Impact of Mother's Education on Child Birth Outcomes

	LBW	VLBW	Macrosomia	Premature	Any sick	Any hospitalization
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: OLS						
1. Education years	-0.00223	-0.000355	-0.00191**	0.00017	0.00901***	0.0115***
	(0.00137)	(0.000242)	(0.000851)	(0.00103)	(0.00274)	(0.00269)
2. High school attendance	-0.00781	0.000002	-0.0148	0.00524	0.0289	0.0414
	(0.0111)	(0.00173)	(0.00922)	(0.01121)	(0.0285)	(0.0280)
Panel B: IV						
1. Education years	-0.0131	-0.00199	-0.00372	0.0331	-0.00660	0.00325
	(0.00929)	(0.00121)	(0.00629)	(0.0244)	(0.0272)	(0.0259)
F-statistics	18.79	18.79	18.79	14.46	20.38	20.72
2. High school attendance	-0.0652	-0.00990	-0.0185	0.1525	-0.0332	0.0165
	(0.0471)	(0.00626)	(0.0309)	(0.117)	(0.137)	(0.132)
F-statistics	73.01	73.01	73.01	69.18	76.61	76.23
Observations	4,633	4,633	4,633	5,329	4,566	4,556
Sample mean	0.0568	0.00302	0.0393	0.037	0.692	0.610
Sample SD	0.231	0.0549	0.194	0.189	0.462	0.488

Notes: This table presents the main results of OLS and IV estimations. Dependent variables are shown in the top row. All regressions control follow the specification in column (3) Table 2. Robust standard errors are clustered at the mother's province by cohort level and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: The Impact of Mother's Education on Early Childhood Social and Motor Skills

	Walk (1)	Speak (2)	Count (3)	Self-urinate (4)
Panel A : OLS				
1. Education years	-0.137***	-0.248***	-0.790***	-0.422***
	(0.0234)	(0.0557)	(0.0812)	(0.0690)
2. High school attendance	-0.404**	-1.666***	-5.711***	-3.367***
	(0.183)	(0.432)	(0.705)	(0.696)
Panel B: IV				
1. Education years	-0.00251	-0.481	-0.801	-0.679
	(0.175)	(0.340)	(0.612)	(0.576)
F-statistics	16.88	17.15	20.16	18.72
2. High school attendance	-0.0131	-2.841	-4.918	-4.027
	(0.914)	(1.960)	(3.859)	(3.403)
F-statistics	62.77	50.92	61.78	52.73
Observations	4,748	4,483	4,101	4,253
Sample mean	14.33	20.49	34.51	33.01
Sample SD	4.614	8.035	14.86	13

Notes: This table presents the main results of OLS and IV estimations of the effects of maternal education on child early childhood social and motor skills. The data is from CFPS 2010 and cross-sectional weights are used in the regression. All regressions control follow the specification in column (3) Table 2. Robust standard errors are clustered at mother's province by cohort level, and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: The Impact of Mother's Education on Child Birth Outcomes by Mother's Hukou Origin

	LBW (1)	VLBW (2)	Macrosomia (3)	Premature (4)	Any sick (5)	Any hospitalization (6)
Panel A: Rural						
1. Education years	-0.0210*	-0.00334**	0.00469	0.0420	-0.0178	0.00489
	(0.0117)	(0.0017)	(0.0072)	(0.0327)	(0.0300)	(0.0278)
F-statistics	12.46	12.46	12.46	9.329	14.77	15.03
2. High school attendance	-0.107*	-0.0171**	-0.0185	0.197	-0.0945	0.0262
	(0.0574)	(0.0082)	(0.0309)	(0.1604)	(0.1580)	(0.1490)
F-statistics	47.07	47.07	47.07	44.03	50.93	50.56
Observations	4,116	4,116	4,116	4,803	4,083	4,074
Sample mean	0.0586	0.00316	0.0384	0.036	0.691	0.606
Sample SD	0.235	0.0561	0.192	0.186	0.462	0.489
Panel B: Urban						
1. Education years	-0.0177	-0.00186	-0.0285	-0.0103	-0.0237	-0.0539
	(0.0164)	(0.0031)	(0.0281)	(0.0182)	(0.0558)	(0.0635)
F-statistics	11.7	11.7	11.7	12.01	8.973	8.973
2. High school attendance	-0.157	-0.0189	-0.289	-0.1002	-0.199	-0.452
	(0.1390)	(0.0307)	(0.3060)	(0.1777)	(0.2910)	(0.6290)
F-statistics	5.954	5.954	5.954	6.791	6.887	6.887
Observations	432	432	432	439	396	396
Sample mean	0.0463	0.00231	0.0417	0.045	0.702	0.646
Sample SD	0.21	0.0481	0.2	0.209	0.458	0.479

Notes: This table presents the IV results of maternal education on early childhood health outcomes by mother's urban and rural hukou origin. Mothers with a rural hukou at age 12 are defined as rural hukou origin and mothers with an urban hukou at age 12 are considered as urban hukou origin. All regressions control follow the specification in column (3) Table 2. Robust standard errors are clustered at the mother's province by cohort level and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: The Impact of Mother's Education on Early Childhood Social and Motor Skills by Hukou Origin

	Walk (1)	Speak (2)	Count (3)	Self-urinate (4)
Panel A: Rural				
1. Education years	-0.307**	-0.675*	-1.216*	-0.749
	(0.1500)	(0.4050)	(0.7170)	(0.5590)
F-statistics	11.75	13.17	14.63	13.37
2. High school attendance	-1.676**	-4.093*	-7.266*	-4.445
	(0.8150)	(2.3000)	(4.2340)	(3.2870)
F-statistics	39.32	35.72	50.8	37.9
Observations	4272	4039	3670	3826
Sample mean	14.45	20.6	35.43	33.26
Sample SD	4.714	8.146	14.99	13.1
Panel B: Urban				
1. Education years	0.216	0.976	0.207	0.277
	(0.6100)	(1.0680)	(1.8920)	(1.8930)
F-statistics	6.44	5.28	6.061	6.059
2. High school attendance	2.447	14.13	3.443	3.111
	(7.0120)	(19.6500)	(32.0400)	(21.2200)
F-statistics	8.158	3.492	1.147	8.636
Observations	387	361	348	349
Sample mean	13.14	19.56	27.16	30.99
Sample SD	3.27	6.549	11.01	11.9

Notes: This table presents the IV results of maternal education on early childhood social and motor skills by mother's urban and rural hukou origin. All regressions control follow the specification in column (3) Table 2. Robust standard errors are clustered at the mother's province by cohort level and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: The Impact of Mother's Education on Child Birth Outcomes by High and Low Admission Rates in 1998

	LBW	VLBW	Macrosomia	Premature	Any sick	Any hospitalization
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: High						
1. Education years	-0.0409*	-0.00437	-0.0164	-0.0521	0.0451	0.0619
	(0.0233)	(0.00318)	(0.0154)	(0.0484)	(0.0330)	(0.0388)
F-statistics	5.048	5.048	5.048	3.413	7.740	7.951
2. High school attendance	-0.191**	-0.0204	-0.0765	-0.205	0.231	0.323*
	(0.0954)	(0.0152)	(0.0636)	(0.175)	(0.166)	(0.186)
F-statistics	23.79	23.79	23.79	22.98	29.94	29.58
Observations	2,274	2,274	2,274	2,782	2,109	2,103
Sample mean	0.0616	0.00352	0.0365	0.0331	0.655	0.582
Sample SD	0.240	0.0592	0.188	0.1789	0.476	0.493
Panel B: Low						
1. Education years	-0.000625	-0.00162	0.00266	0.0161	-0.0461	-0.0526
	(0.0112)	(0.00147)	(0.00714)	(0.0268)	(0.0351)	(0.0326)
F-statistics	14.68	14.68	14.68	15.79	14.47	14.21
2. High school attendance	-0.00299	-0.00773	0.0127	0.0815	-0.238	-0.270*
	(0.0538)	(0.00683)	(0.0337)	(0.140)	(0.187)	(0.156)
F-statistics	64.07	64.07	64.07	64.31	53.78	53.80
Observations	2,265	2,265	2,265	2,450	2,369	2,365
Sample mean	0.0521	0.00265	0.0411	0.040	0.726	0.636
Sample SD	0.222	0.0514	0.198	0.197	0.446	0.481

Notes: This table presents the IV results of maternal education on early childhood health outcomes by mother's college province. A mother is defined as from a high college admission rate province if this province's college admission rate in 1998 is higher than the median college admission rate in that year across all provinces. If that province's college admission rate in 1998 is lower than the median, then we define that province as a lower admission rate province.All regressions control follow the specification in column (3) Table 2. Robust standard errors are clustered at the mother's province by cohort level and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: IV-Mother's Education on Early Childhood Social and Motor Skills By High/Low admission rate in 1998

	Walk (1)	Speak (2)	Count (3)	Self-urinate (4)
Panel A: High				
1. Education years	-0.378	-1.445	-3.444*	-0.761
	(0.323)	(1.268)	(1.924)	(1.069)
F-statistics	2.284	2.108	2.516	2.847
2. High school attendance	-1.567	-7.023	-18.39**	-4.075
	(1.293)	(4.911)	(8.248)	(6.108)
F-statistics	15.04	9.702	9.503	10.92
Observations	2,179	2,063	1,902	1,945
Sample mean	14.13	20.40	32.18	32.39
Sample SD	4.778	8.373	14.25	12.86
Panel B: Low				
1. Education years	0.0707	-0.176	0.916	-0.649
	(0.207)	(0.303)	(0.661)	(0.737)
F-statistics	19.49	26.50	35.93	23.68
2. High school attendance	0.420	-1.180	6.371	-4.390
	(1.220)	(2.054)	(4.207)	(4.879)
F-statistics	53.23	57.34	67.84	42.38
Observations	2,482	2,338	2,123	2,227
Sample mean	14.53	20.65	36.66	33.66
Sample SD	4.488	7.762	15.05	13.04

Notes: This table presents the IV results of maternal education on early childhood social and motor skills by mother's college province. All regressions control follow the specification in column (3) Table 2. Robust standard errors are clustered at the mother's province by cohort level and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: IV-Robustness Checks
Mother's Education on Early Childhood Outcomes without Controlling Trends

	(1) LBW	(2) VLBW	(3) Macrosomia	(4) Premature	(5) Any Sick	(6) Any Hospitalization	(7) Walk	(8) Speak	(9) Count	(10) Self-Urinate
Panel A: Full Sample										
1. Education years	-0.0132	-0.00186*	-0.00307	-0.0170	-0.00146	0.00278	-0.0409	-0.482	-0.819	-0.850
	(0.00857)	(0.00110)	(0.00559)	(0.0230)	(0.0240)	(0.0229)	(0.158)	(0.293)	(0.575)	(0.533)
F-statistics	22.91	22.91	22.91	18.13	23.61	23.87	21.05	20.74	22.83	21.26
2. High school attendance	-0.0731	-0.0103	-0.0169	-0.0887	-0.00807	0.0155	-0.238	-3.087*	-5.365	-5.393
	(0.0477)	(0.00624)	(0.0306)	(0.118)	(0.133)	(0.128)	(0.927)	(1.843)	(3.864)	(3.402)
F-statistics	69.57	69.57	69.57	65.93	70.43	70.19	61.71	51.25	62.95	50.24
Observations	4,633	4,633	4,633	5,329	4,566	4,556	4,748	4,483	4,101	4,253
Sample mean	0.0568	0.00302	0.0393	0.037	0.692	0.610	14.33	20.49	34.51	33.01
Sample SD	0.231	0.0549	0.194	0.189	0.462	0.488	4.614	8.035	14.86	13
Panel B: Rural Sample										
1. Education years	-0.0193*	-0.00283*	0.00429	-0.0227	-0.00984	0.00727	-0.302**	-0.693**	-1.268*	-0.921*
	(0.0108)	(0.00148)	(0.00642)	(0.0276)	(0.0257)	(0.0235)	(0.137)	(0.336)	(0.680)	(0.510)
F-statistics	16.46	16.46	16.46	13.05	18.48	18.71	15.32	15.96	16.00	15.45
2. High school attendance	-0.112*	-0.0164*	0.0248	-0.125	-0.0581	0.0433	-1.852**	-4.585**	-8.128*	-5.938*
	(0.0601)	(0.00853)	(0.0364)	(0.145)	(0.151)	(0.140)	(0.905)	(2.111)	(4.282)	(3.286)
F-statistics	48.38	48.38	48.38	45.34	51.32	51.09	40.45	36.68	50.29	36.15
Observations	4,116	4,116	4,116	4,803	4,083	4,074	4,272	4,039	3,670	3,826
Sample mean	0.0586	0.00316	0.0384	0.036	0.691	0.606	14.45	20.60	35.43	33.26
Sample SD	0.235	0.0561	0.192	0.186	0.462	0.489	4.714	8.146	14.99	13.10

Notes: This table presents the IV results of maternal education on early childhood health outcomes and social and motor skills without including two economic variable trends. Independent variables and fixed effects follow Table 3. Robust standard errors are clustered at the mother's province by cohort level and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: IV-Robustness Checks
Mother's Education on Early Childhood Outcomes with Restricted Sample

	(1) LBW	(2) VLBW	(3) Macrosomia	(4) Premature	(5) Any Sick	(6) Any Hospitalization	(7) Walk	(8) Speak	(9) Count	(10) Self-Urinate
Panel A: Full Sample										
1. Education years	-0.0105	-0.00216	-0.00921	-0.0271	-0.0228	0.00315	-0.126	-0.641	-0.645	-0.377
	(0.0116)	(0.00161)	(0.00837)	(0.0323)	(0.0312)	(0.0311)	(0.141)	(0.444)	(0.705)	(0.590)
F-statistics	14.03	14.03	14.03	10.94	15.08	15.55	15.61	12.31	16.16	12.85
2. High school attendance	-0.0476	-0.00982	-0.0419	-0.112	-0.102	0.0143	-0.631	-3.452	-3.627	-2.053
	(0.0525)	(0.00755)	(0.0355)	(0.126)	(0.142)	(0.141)	(0.710)	(2.167)	(3.945)	(3.179)
F-statistics	56.51	56.51	56.51	55.17	60.84	60.70	53.29	38.80	51.97	38.41
Observations	2,956	2,956	2,956	3,287	2,794	2,790	2,760	2,515	2,227	2,358
Sample mean	0.0541	0.00304	0.0389	0.041	0.714	0.635	14.10	20.13	32.79	31.96
Sample SD	0.226	0.0551	0.193	0.198	0.452	0.481	4.352	7.750	13.68	12.06
Panel B: Rual Sample										
1. Education years	-0.0194	-0.00352*	0.00172	-0.0377	-0.0370	0.00549	-0.244*	-0.738	-1.224	-0.563
	(0.0140)	(0.00195)	(0.00831)	(0.0387)	(0.0331)	(0.0319)	(0.142)	(0.488)	(0.777)	(0.587)
F-statistics	10.61	10.61	10.61	8.081	12.14	12.55	13.35	12.05	13.99	12.64
2. High school attendance	-0.0957	-0.0173*	0.00848	-0.167	-0.182	0.0275	-1.342*	-4.304*	-6.959*	-3.253
	(0.0659)	(0.00948)	(0.0409)	(0.153)	(0.163)	(0.159)	(0.751)	(2.568)	(4.129)	(3.295)
F-statistics	37.00	37.00	37.00	36.08	41.02	40.91	35.81	29.91	48.06	31.95
Observations	2,639	2,639	2,639	2,965	2,506	2,503	2,485	2,273	1,992	2,126
Sample mean	0.0553	0.00303	0.0371	0.038	0.709	0.628	14.21	20.17	33.52	32.12
Sample SD	0.229	0.0550	0.189	0.193	0.454	0.483	4.430	7.815	13.88	12.14

Notes: This table presents the IV results of maternal education on early childhood health outcomes and social and motor skills by restricting the sample to mother's who were born after 1975. All regressions control follow the specification in column (3) Table 2. Robust standard errors are clustered at the mother's province by cohort level and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: IV-Robustness Checks
Mother's Education Years after Middle School on Early Childhood Outcomes

Panel A : Full Sample	(1) LBW	(2) VLBW	(3) Macrosomia	(4) Premature	(5) Any Sick	(6) Any Hospitalization	(7) Walk	(8) Speak	(9) Count	(10) Self-Urinate
Education years	-0.0120	-0.00182	-0.00340	0.0279	-0.00607	0.00302	-0.00239	-0.490	-0.851	-0.688
after middle school	(0.00866)	(0.00114)	(0.00568)	(0.0209)	(0.0250)	(0.0240)	(0.166)	(0.336)	(0.659)	(0.578)
F-statistics	75.89	75.89	75.89	71.06	83.99	83.56	62.11	52.63	59.70	57.85
Observations	4,633	4,633	4,633	5,308	4,566	4,556	4,748	4,483	4,101	4,253
Sample mean	0.0568	0.00302	0.0393	0.0373	0.692	0.610	14.33	20.49	34.51	33.01
Sample SD	0.231	0.0549	0.194	0.190	0.462	0.488	4.614	8.035	14.86	13
Panel B: Rural Sample										
Education years	-0.0192*	-0.00306**	0.00430	0.0351	-0.0165	0.00458	-0.297**	-0.708*	-1.304*	-0.751
after middle school	(0.0104)	(0.00147)	(0.00645)	(0.0278)	(0.0276)	(0.0260)	(0.143)	(0.386)	(0.741)	(0.545)
F-statistics	54.05	54.05	54.05	49.81	66.84	66.52	44.61	40.68	46.89	47.48
Observations	4,116	4,116	4,116	4,784	4,083	4,074	4,272	4,039	3,670	3,826
Sample mean	0.0586	0.00316	0.0384	0.0362	0.691	0.606	14.45	20.60	35.43	33.26
Sample SD	0.235	0.0561	0.192	0.187	0.462	0.489	4.714	8.146	14.99	13.10

Notes: This table presents the IV results of maternal education years after middle school on early childhood outcomes. All regressions control follow the specification in column (3) Table 2. Robust standard errors are clustered at the mother's province by cohort level and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

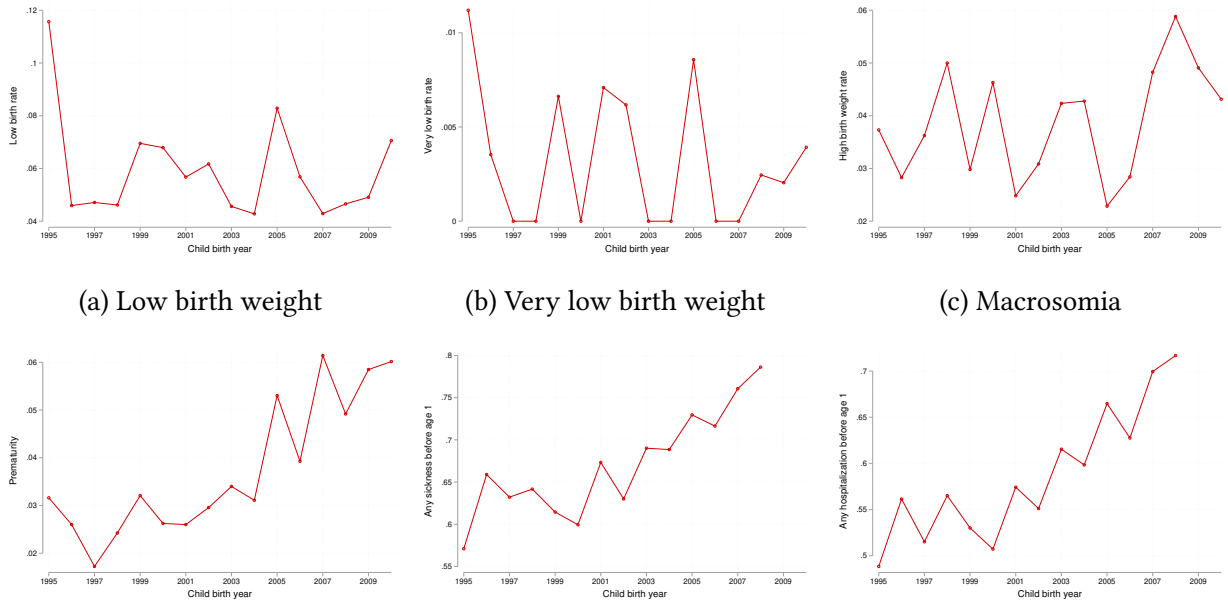
Table 12: The Mechanisms of Mother's Education on Child Outcomes

	(1) Father's education years	(2) Father's high school attendance	(3) Mother Employed	(4) Mother's income if employed	(5) Current urban Hukou	(6) Self-reported good health	(7) Ever smoked	(8) Alcohol often
Panel A : Full Sample								
1. Education years	0.911***	0.133***	0.0660*	0.155	0.108***	0.0157	-0.000588	0.0117
	(0.276)	(0.0442)	(0.0379)	(0.174)	(0.0212)	(0.0111)	(0.00456)	(0.0103)
F-statistics	9.401	9.401	16.32	10.53	23.10	14.46	16.03	14.62
2. High school attendance	4.267***	0.622***	0.321**	0.833	0.348***	0.0722	-0.00277	0.0540
	(1.185)	(0.140)	(0.155)	(0.951)	(0.111)	(0.0499)	(0.0214)	(0.0448)
F-statistics	39.37	39.37	68.93	43.56	69.12	69.17	72.85	69.79
Observations	4,131	4,131	5,145	2,791	5,322	5,329	5,247	5,318
Sample mean	8.231	0.231	0.549	7.334	0.195	0.900	0.00686	0.0216
Sample SD	3.913	0.421	0.498	3.476	0.396	0.300	0.0826	0.145
Panel B: Rural Sample								
1. Education years	1.028***	0.138**	0.0568	0.178	0.0940***	0.0115	0.000119	0.0148
	(0.374)	(0.0549)	(0.0424)	(0.211)	(0.0290)	(0.0136)	(0.00545)	(0.0136)
F-statistics	5.542	5.542	11.32	7.497	9.196	9.329	10.05	9.382
2. High school attendance	4.901***	0.658***	0.286	0.937	0.439***	0.0540	0.000564	0.0694
	(1.567)	(0.169)	(0.183)	(1.132)	(0.136)	(0.0644)	(0.0258)	(0.0582)
F-statistics	23.40	23.40	46.09	33.30	43.97	44.03	46.64	44.37
Observations	3,728	3,728	4,626	2,488	4,798	4,803	4,733	4,792
Sample mean	7.850	0.186	0.546	7.076	0.111	0.898	0.00613	0.0219
Sample SD	3.747	0.389	0.498	3.512	0.314	0.302	0.0780	0.146

Notes: This table presents the IV results of maternal education on various social economics outcomes and adult health-related outcomes. All regressions control follow the specification in column (3) Table 2. Robust standard errors are clustered at the mother's province by cohort level and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendices

A Additional Figures

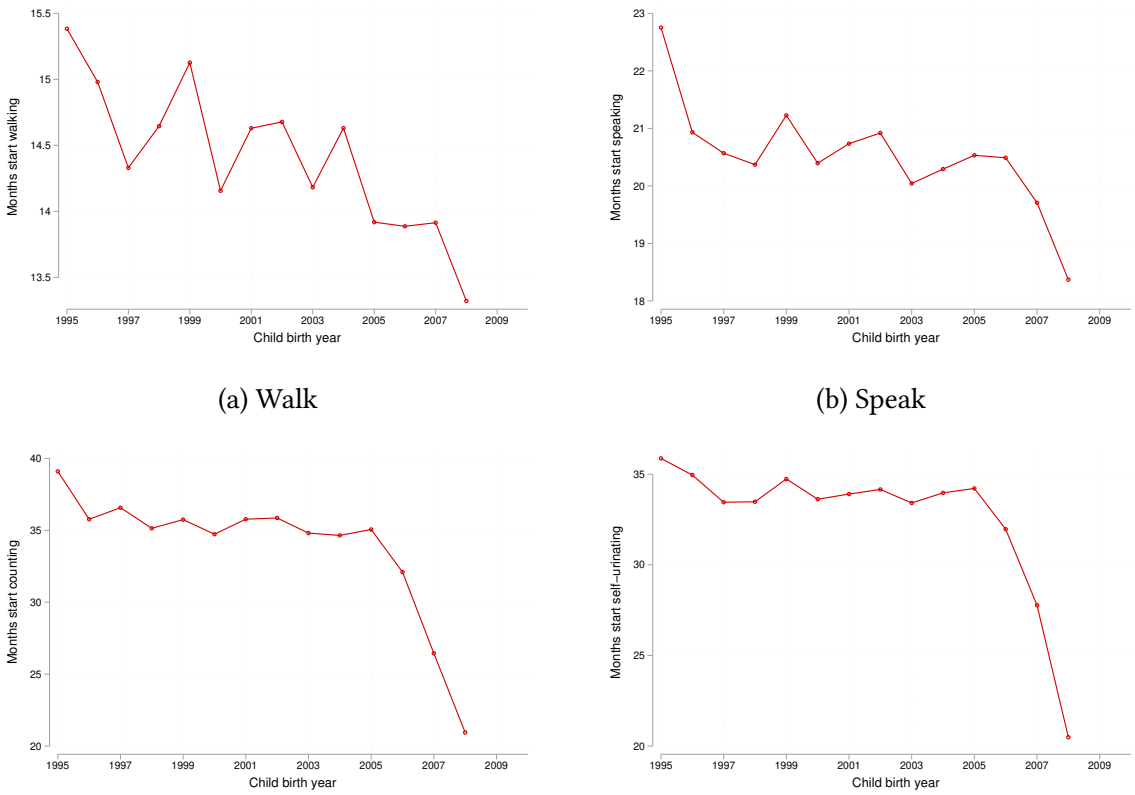


(a) Low birth weight (b) Very low birth weight (c) Macrosomia

(d) Prematurity (e) Any sickness (f) Any hospitalization

Figure A1: Child Health Outcomes

Notes: This figures plots the health outcomes by child birth cohort. Each panel presents a measure of health outcomes for the main sample in this study. The data is from CFPS 2010 child module.



(a) Walk

(b) Speak

(c) Count

(d) Self-urinate

Figure A2: Social and Motor Skills by Child Birth Cohorts

Notes: This figures plots the social and motor skills by child birth cohort. Each panel presents a task in terms of average months to a child takes to begin for the main sample in this study. The data is from CFPS 2010 child module.

B Additional Tables

Table B1: First Stage-Number of College on Mother's Education by Mother's Hukou Status

	Rural			Urban		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Education years						
Number of College	0.0503***	0.0478***	0.0438***	0.0853***	0.0788***	0.0801***
	-0.014	-0.014	-0.0143	(0.0214)	(0.0214)	(0.0230)
Panel B: High school attendance						
Number of College	0.00919***	0.00906***	0.00933***	0.00881***	0.00851**	0.00828***
	(0.00137)	(0.00137)	(0.00140)	(0.00335)	(0.00331)	(0.00316)
Mother's cohort*college population ratio in 1995		✓	✓		✓	✓
Mother's cohort*admission rate in 1998			✓			✓
Observations	4,803	4,803	4,803	439	439	439

Notes: This table shows the first stage results of number of colleges on mother's education by mother's hukou origin. All regressions control follow the specification in column (3) Table 2. Robust standard errors are clustered at mother's province by cohort level, and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$