Maternal Education and Early Childhood Outcomes in China*

Xiaozhou Ding†
South Dakota State University

Yaxiang Song‡
Creighton University

May 2024

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 mothers' educational attainment, to examine these effects through an instrumental variable approach. Our results show that increases in years of schooling beyond the nine-year compulsory education level significantly improve children's outcomes. We find the probability of an infant having low birth weight is reduced and the time it takes for a child to start speaking, counting, and walking is shortened. We investigate several mechanisms that could explain these results and find that mothers' schooling is strongly associated with assortative marriage and rural-urban migration. Suggestive evidence also shows mothers with more schooling are likely more aware of how to effectively invest in their children.

Keywords: Higher Education Expansion, Maternal Education, Childhood Outcomes
JEL Classification Codes: I21, J13, O15

*We are grateful for the helpful comments from Shamma Alam, Alicia Atwood, Susan Averett, Charles Courtemanche, Xiaoting Huang, Melanie Guldi, Esra Kose, Sara LaLumia, Jianjun Li, Steve Lugauer, Olga Malkova, Vivek Moorthy, Siobhan O'Keefe, Peter Orazem, Dan Su, Teresa Waters, Jin Yang, and seminar and conference participants at Creighton University, Peking University, Southwestern University of Finance and Economics, Bucknell University, Southern Economic Association Annual Meeting, Midwest Economics Association Annual Meeting, Liberal Arts College Public and Labor Conference, ASHEcon Annual Meeting, and Asian Meeting of the Econometric Society.

†Ness School of Management and Economics, South Dakota State University. Email: xiaozhou.ding@sdstate.edu.
‡Heider College of Business, Creighton University. Email: yaxiangsong@creighton.edu.

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 can positively impact 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, particularly maternal education, is essential for 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.

Two distinct strands of literature employ different methodologies to address this issue of parental education's influence on children's outcomes. In recent studies, one strand utilizes family structure to causally identify the effect of parental education. For example, Behrman and Rosenzweig (2002) employ a twin sample to disentangle the nature effect from the nurture effect, while others, such as Sacerdote (2002), Sacerdote (2007), and Chen and Li (2009), use adoptees to obtain the exogenous variation in parental education. Another strand of the literature leverages government policy changes, which create plausible exogenous variation in educational attainment for specific groups of individuals.[1] However, a significant portion of these studies predominantly

[1]Recent studies falling into this strand, but not limited to, include Currie and Moretti (2003), Black, Devereux,

focuses on the increase in lower levels of education induced by policies, such as compulsory education law reforms, yielding mixed results regarding the impact of intergenerational transmission of education. Only a few studies investigate the effects of higher levels of educational attainment on children's health (Currie and Moretti, 2003; Carneiro, Meghir, and Parey, 2013).[2] Moreover, in countries that experienced multiple educational reforms, examining the impact of improved education becomes challenging. When several policies affect educational attainment for specific cohorts, disentangling the the effect of enhanced education due to earlier reforms from later ones becomes a complex task. The interplay of these policies complicates the attribution of outcomes solely to one particular reform.

In this paper, we embrace the challenges of estimating the causal effect of maternal education on children's early childhood outcomes following the second strand of literature. Our paper differs from the aforementioned studies by looking at a policy reform that specifically targeted the higher margins of educational attainment and occurred after the well-studied compulsory education.[3] We study the impact of maternal education on a comprehensive set of child outcomes in China through the lens of higher education expansion, a recent educational reform implemented in 1999 that massively increased access to college. This expansion, in turn, raised the likelihood of mothers continuing their education beyond compulsory schooling.

Our empirical work looks into the conventional measures of the health status of children, including child birth weight, gestational age, and health conditions before age one. Additionally, we investigate important indicators of social and motor skills, such as the time a child takes to begin speaking, counting, walking, and self-urinating – a set of variables that have received limited attention in existing literature. To address the endogeneity issue of education and children's outcomes, we employ an instrumental variable approach that utilizes 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 given 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),[4]

and Salvanes (2005), Lindeboom, Llena-Nozal, and van Der Klaauw (2009), Chou et al. (2010), McCrary and Royer (2011), Andrabi, Das, and Khwaja (2012), Güneş (2015), and Keats (2018).

[2] Cowan and Tefft (2020) follows Currie and Moretti (2003) but looks at the impact of college openings on adult health. In a recent paper, Malamud, Mitrut, and Pop-Eleches (2023) also examines how schooling expansion in Romania affects health and mortality for adults, with a focus on the lower margins of educational attainment.

[3] For the studies on China's compulsory education law reform on children's health, see Huang et al. (2018).

[4] Ding (2021) shows higher education expansion in China is independent of provincial characteristics.

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 estimate of the impact of mothers' education on the next generation.

We use the China Family Panel Studies (CFPS) 2010 wave as the main data set. It has important information that helps us identify mothers' childhood location and college-going year. We focus on mothers from rural areas because they constitute a large percent of the sample[5] and also have larger variations in educational attainment. We define the mother's college-going province as her self-reported province at age 12 since this is the closest year we could get before the typical college-going year (age 18), and migration between age 12 and college-going age is rare in China given hukou restrictions during that time. Mother's college-going year is obtained from her self-reported high school graduation year. If she does not attend high school, we use the end of the education 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 Squares (OLS) show that maternal years of schooling above compulsory education level are negatively correlated with the probability of having an abnormal weight baby and are positively correlated to a child's gestational age. Mother's education is also associated with a higher probability 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 the child starts to walk independently, speak a full sentence, count from one to ten, and self-urinate. The IV estimations show consistent results that an extra year of education beyond compulsory schooling reduces the probability of having a low birth weight child by two percentage points. It also accelerates the time it takes a child to start walking independently by 0.2 months, speaking a full sentence by 0.7 months, counting from one to ten by 1.6 months, and self-urinating by 1.1 months. We test our results by switching our independent variable to an alternative measure of years of education – maternal total years of education, and we find very similar effects. To avoid the potential confounding effect 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 earlier reform and then later affected by the higher education expansion reform. The results are both quantitatively and qualitatively similar to our main findings. Further examination of potential mechanisms reveals that assortative marriage and rural-urban migration explain the impact of mothers' education and more educated mothers

[5]Mothers with a rural hukou make up more than 90% of the CFPS 2010 children sample after excluding observations with missing values in essential variables. More details about the sample information can be found in Section 3.

care more about children's education and communication skills. Additionally, households with more educated mothers invest more in children, which contributes to improvements in social and motor skills.

To assess the long-term cost-benefit implications of maternal education on children's outcomes, we draw upon estimates from prior research and perform a back-of-the-envelopment calculation. Our findings indicate that the long-term increase in permanent income resulting from improved birth weights exceeds the costs associated with the construction of new colleges. This provides preliminary evidence suggesting the cost-effectiveness of expanding higher education.

This paper makes three significant contributions to the existing literature. First, to our best knowledge, this study provides the first estimate of the effects of maternal education on early childhood outcomes in a developing country, utilizing a substantial higher education expansion as the policy context. Unlike most previous research, which predominantly focuses on policies affecting the lower margins of education spectrum, our study examines a policy that significantly impacted individuals at the higher levels of the education distribution. Prior studies such as Chevalier and O'Sullivan (2007) and Lindeboom, Llena-Nozal, and van Der Klaauw (2009) use changes in the minimum school leaving age in the UK and find that increases in mother's education year have limited effects on child health. A similar small effect is confirmed in the US by McCrary and Royer (2011), which 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 rich but mixed evidence related to policies targeting lower levels of education, limited research has explored the impact of maternal education on child outcomes within the context of higher level education system changes. Currie and Moretti (2003) show that increases in maternal education induced by new college openings can improve infant health in the U.S. 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 mothers' 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 a unique opportunity to investigate the effects of a policy that extended schooling beyond the compulsory education level on child outcomes.

Second, this paper not only focuses on the impact of maternal education on infant health outcomes but also on the early childhood development of cognitive skills. Established research

has demonstrated that early childhood development of cognitive skills is crucial to later life achievement, as indicated by Heckman, Pinto, and Savelyev (2013) and Campbell et al. (2014).[6] Nevertheless, there is limited evidence about how maternal education may affect children's skill development during their toddler years. Evidence has shown that the development of motor skills in toddlers has a positive impact on the development of cognitive skills such as language skills (Gonzalez, Alvarez, and Nelson, 2019). In addition, motor skills are also vital to physical activities (Cliff et al., 2009). Duncan et al. (2007) show that children's early mastery of math concepts and vocabulary have great predictive power to later education achievement. Based on Duncan et al. (2007)'s study, Grissmer et al. (2010) find that fine motor skills, in particular, speaking and reading, have positive correlation with children's math and reading scores. Carneiro, Crawford, and Goodman (2007) also show that children's early development of walking alone and speaking has extremely important impact on their social and cognitive skills during later childhood stage. Despite the importance of developing these skills in early childhood, only a few work has specifically examined how maternal education may influence them. Carneiro, Meghir, and Parey (2013) presents findings indicating that there is no evidence that maternal education improves early childhood motor and social skills development up to 24 months in the U.S. In this paper, we provide the first evidence of the substantial effects of maternal education on early childhood motor and social skills development in a developing country context. Additionally, our paper also contributes to a broader literature that examines the "cash puzzle" in which cash transfers to mothers do not effectively improve children's outcomes (Macours, Schady, and Vakis, 2012; Field and Maffioli, 2021; Premand and Barry, 2022). We find that although increased maternal education, driven by expanded college access, does not necessarily lead to improved labor market outcomes for these mothers, it does prompt them to invest more time in their children, which can yield significant benefits without requiring additional cash transfers.

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 focusing on improved maternal education on the next generation's early childhood health and social and motor skills development. Recent literature on the higher education expansion mainly examines its impacts on intergenerational education mobility (Guo, Song, and Chen, 2019), household savings (Bollinger, Ding, and Lugauer, 2022), 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

[6]Another strand of literature focuses on non-cognitive skills. For example, a recent study looks at maternal education and non-cognitive skills in rural China (Leight and Liu, 2020). Carneiro, Crawford, and Goodman (2007) summarizes the impact of both cognitive and non-cognitive skills on later outcomes.

able to identify the effect of mothers who were affected ten years after the expansion. Given that many countries are considering expanding their higher education access, including the US, it is important to understand the impact of education 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 the discussion of mechanisms is in Section 6. Section 7 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 six years of 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 afterward.

Unlike most developed countries, the central government in China plays an essential role in the development of higher education and its related policies. 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 at 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 helping 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.[7] 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 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 which may potentially increase mother's education 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 sizable 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.

[7] 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 survey conducted by Peking University. The baseline CFPS survey was conducted in 2010 in 25 provinces of China.[8] 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 (Ding, 2021).[9] Combining these two sets of information, we are able to match corresponding provincial-level variables to mothers, 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 maternal education on these important but less-studied outcomes due to a lack of data. Fourth, this data set provides rich information on the 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 obtain college-going year information. We use the end year of their education as college-going year so that we can match external variables in that year to these respondents. 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 provincial-level macroeconomics variables and control for such aggregate provincial-level changes. Provincial-

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

[9]Using the census 2010 data, we find that the 5-year migration rate is 1.57% for school children aged from 12 to 17.

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 study the impact of mother's education on two main sets of outcomes: early childhood health outcomes and social and motor skills.

The first set of health outcomes, following an extensive literature, includes a dummy variable of low birth weight (LBW), a dummy variable of very low birth weight (VLBW), a dummy variable of macrosomia, and gestational age. 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 been reported by the parents to have any sickness before age one and whether the child had been hospitalized in this stage. Though these two outcomes could imply the health status of children, they could also serve as an indication of whether the parents were aware of the health conditions of the child before age one since the response is retrospectively self-reported without describing the exact symptoms. As for the second set of early childhood outcomes, we focus on four measures that demonstrate 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. These skills are considered to have strong predictive power to later educational achievements, such as reading, math, and attention skills (Duncan et al., 2007).

3.3 The Independent Variables

The variable of interest is maternal education. In the main specification, we construct a measure of maternal education as years of schooling above the 9th grade. We adopt this measure for two reasons. First, China's compulsory education law mandates nine years of formal education since 1986, which has been studied extensively. The cohorts who were exposed to this reform potentially have less variation in educational attainment. Second, as pointed out by Xing (2014), the expansion of the higher education system likely induced students to stay longer in school due to the increased college opportunities. We do use the regular continuous measure of years of education in the robustness check to verify our result is not sensitive to the choice of education variable. The comparison of these two results could also provide informative evidence about the health and cognitive skills return to different levels of maternal education. We discuss this issue

later. For those individuals who only completed compulsory education, their years above grade 9 are coded zero. Otherwise, we use the reported years of schooling subtracting 9 to obtain the years of education.

We control for the child's mother's ethnicity (an indicator variable equal to one if the mother's ethnicity is Han), the child's maternal grandmother's education level (elementary school, middle school, high school, and college and above). 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; Güneş, 2015). 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, accounting for cultural and social norms that could influence a mother's child-rearing practices and a child's early behavioral development. 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 the 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, the year before higher education expansion.

3.4 Sample Descriptive Statistics

The main sample used in this paper is child survey data matched with their parents' information, both are from the CFPS 2010 baseline data. We select mothers who had rural hukou at age 12 because they consists of the largest share of the sample[10]. We exclude children with missing values

[10]Hukou is the residence registration system in China where only local residents could have certain public benefits within the geographical administration

of their mother's education information. We also exclude mothers who were born before 1969.[11] 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 check, we further restrict the sample to mothers who were born after 1975.[12]

Table 1 presents the summary statistics of major variables in our empirical study. We present these information in two ways. We break the variables by four categories, including child birth outcomes, early childhood social and motor skills, our instrumental variable (number of colleges at province-year level), key explanatory variables related to maternal characteristics, and provincial economic conditions of those mothers. We also present the summary statistics for the full sample, mothers whose college year before 1999, and mothers whose college year after 1999. Among the study sample, around 25% 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 39, and this number increased to 51 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, our focus in this paper is more on the early years of higher education expansion.

Panel B tells us that there are around 5.8% of children have low birth weight and only 0.3% children were in very low weight condition at birth. There are around 3.8% children who were born overweight and the sample children's gestational age is around 9.3 months. Comparing the early childhood health outcomes of the two groups of mothers, we do see large differences among very low birth weight and gestational age. Younger mothers who were exposed to HEE reduced the incidence of very low birth weight by almost 50% but also decreased the gestational age around 0.5 month. Around 70% of children were reported to had been sick before age one and mothers whose college years are after the expansion are more likely to report a higher incidence. A similar pattern is also found on hospitalization where the average is 60% and college expansion affected mothers reported 67%.[13]

Panel C shows the four measures of social and motor skills. The average number of months for a child to start walking is 14.4 and for a child to start speaking is 20.5, both slightly decreased for mothers who were affected by college expansion. Children take longer time to know how to count (36.2 months) and self-urinate (33.9 months). It is clear that the length is shorter for children

[11]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. In addition, 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.

[12]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).

[13]We plot the average of these child birth and health outcomes by mother's college-going year in Figure A1 and the associated trends are noisy potentially due to the low probability nature of low and very low birth weight. Figure A3 presents the similar trend but at child birth cohort level.

whose mothers that were exposed to HEE.[14]

Panel D presents the characteristics of mothers. On average, mothers in our sample have 6.6 years of education and 0.5 years of above grade 9 education. The mean years of schooling increases to 7.7 for mothers whose college year is after 1999 and their average education years above grade 9 are almost doubled the sample average. There is no noticeable differences for ethnicity and maternal grandmother's education.

In Panel E, we also show the characteristics in terms of the mother's childhood provinces, which we will control in our empirical specifications to account for the impact of economic development on mother's educational choice and child health outcomes.

4 Empirical Strategy

4.1 Instrumental Variables

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 born in province j year t, $Medu_{ipk}$ represents the education of child i's mother whose childhood province is p and was born in year k.[15] Throughout this paper, we mainly focus on the continuous measure of years of schooling above grade 9. X_i represents a set of variables controlling for maternal characteristics for child i, including mother's ethnicity and maternal grandmother's education level. Z_{pc} refers to mother's provincial economic variables at their college-going year c, including GDP growth rate, employment growth rate, and population growth rate so that 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 enrollment rate with mother's year of birth to account for potential diverging trends resulted from different initial conditions of higher education and population.

[14]The cohort trend confirms this pattern. Figure A2 plots four graphs that show the overall decline of time children use to master these skills, which roughly match the college expansion time in 1999. Figure A4 shows more apparent improvement in these skills of children who were born after 2003, around the time when the first cohort of mothers who were affected by HEE gave birth.

[15]We do not use mother's birth province because there could be migration 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.

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 are unlikely to affect the child's later outcomes. The instrument we use is the number of colleges in mother's childhood province p in her college-going year c.[16] 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

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

and the second-stage equation as

$$y_{ijt} = \beta_0 + \beta_1 \widehat{Medu}_{ipk} + \beta_2 X_i + \beta_3 Z_{pc} + \zeta_p + \zeta_k + \zeta_{jt} + u_{ijt}. \tag{3}$$

Existing studies focusing on compulsory educational reforms that affected educational attainment in an early stage of an individual, college expansion was more recent educational reform which affects higher level education attainment. Since those cohorts that were affected by compulsory education laws were also likely to be affected by later higher education reform, previous studies may overestimate the impact of adult education on children's outcomes using the earlier reform. We believe using the recent higher education expansion could 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.

4.2 The Validity of the Instrument

The 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 above grade 9 as the dependent variable, while in panel B we switch to the commonly used educational attainment variable that measures total years of education. Column (1) controls for all individual characteristics and fixed effects. Column (2) adds a cohort-specific trend in terms of the college

[16] 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 the end year of education as college-going year.

population ratio in the 1995 census. Column (3) additionally adds a cohort-specific trend related to the enrollment 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 0.052 years of education beyond middle school level and 0.044 years of education on the regular basis. 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 around 12, translating the impact to 0.6 years, equivalent to a 9.7% increase.[17] Güneş (2015) shows that mothers affected by compulsory education reform in Turkey increases years of schooling 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 in China. Our estimate is within the range of the literature that finds a positive impact of educational reforms on educational attainment. Therefore, the first stage confirms that there is a strong relationship between college expansion and maternal education and the magnitude is not negligible.

Placebo Test of Validity To further verify the validity of our instruments, we conduct a series of tests that randomly assign mother's college-going provinces and college-going years. This placebo test helps justify our variation in the number of colleges is random and causally affects maternal education. The results are in Table B2 and more details are discussed after the main regression analysis.

4.3 Threats to Identification

Even though 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),[18] concerns still arise as to whether the expansion of college is correlated with other preexisting conditions at the province level. For instance, do places that lag behind in health care receive more investment in higher education out of the hope of bringing more construction to improve health facilities as well? On the other hand, there could be some contemporaneous shocks at the province-year level that may not be absorbed by our fixed effects of mother's province and cohort, leading to the biased estimates of the effect of maternal education on child outcomes.

[17] In Table 1 we show that the number of colleges before expansion is 39.2 and the number of colleges after expansion is 51.4. $0.05 \times 12/6.166 \approx 9.7\%$.

[18] Ding (2021) also confirms this by a validity test showing that college enrollment is not correlated with provincial-level GDP and employment growth. Cai, Ding, and Du (2024) shows that both in-province enrollment and out-province enrollment in the early years of the expansion are not related to economic conditions at the province level.

In this section, we address those potential threats to identification in two ways. First, we show that the concern of reverse causality, or the selection of college expansion policy to improve future generation's healthcare resources, is not strong. Then we combine data from other sources around major economic reforms at the same time to ease the worry that other confounding factors rather than the expansion of higher education leads to the improvement in child outcomes.

4.3.1 Selection in Healthcare Resources

To alleviate the concern of reverse causality that college expansion could target provinces accompanied by an increasing needs for improving health conditions, we conduct a pre-trend test. Specifically, we collect data on the number of health care facilities HC_j in 1995 and 1998 and the number of colleges $NumCollege$ in 1998 and 2005. We regress the change in number of colleges post the expansion and change in health care facilities prior to the expansion:

$$NumCollege_j^{2005} - NumCollege_j^{1998} = \gamma_0 + \gamma_1 \left(HC_j^{1998} - HC_j^{1995}\right) + v_j, \tag{4}$$

The corresponding scatter plot is in Figure 4. The estimated coefficient γ_1 is -0.46 and statistically insignificant. If anything, it provides suggestive evidence that the expansion was not selecting provinces that experience large changes in health care facilities.

4.3.2 Contemporaneous Reforms and Shocks

We recognize that our identification strategy could be compromised by contemporaneous province-year level effects correlated with college expansion, particularly during the late 1990s–a period marked by significant economic reforms in China. These reforms, potentially influencing human capital investment and educational attainment, necessitate careful consideration in our analysis. Although our focus is on individuals from rural areas–who may be less directly impacted by urban-centered reforms–we still undertake tests to examine any correlation between these reforms and maternal education, and to assess their potential effects.

Trade Policies China's early 2000s WTO accession not only enhanced firm performance and innovation (Brandt et al., 2017; Ma, 2023) but also increased Chinese families' income and wealth, leading to more children pursuing higher education in the U.S. (Khanna et al., 2023). Conversely, a recent study suggests that the 1980s and 1990s open door policy negatively impacted female education (Jiang, Kennedy, and Zhong, 2023), as employment opportunities enticed women to terminate their schooling prematurely. Lin and Long (2020) presents mixed findings regarding the WTO accession's impact on Chinese students' educational attainment. We incorporate this aspect into our quantitative analysis to test the correlation between college expansion and trade

volumes. Our results, shown in Table B1 column (1), indicate a one percent increase in export is correlated with 1.4 colleges and not statistically insignificant.

State-Owned Enterprise Reform There might also be concerns centered around the reforms on state-owned enterprises as the breaking of "iron rice bowl" could influence the labor market and household finance (He et al., 2018), hence changes the decision for educational investment. We follow our previous analysis and examine if there exists a relationship between the two reforms at the province level. The second column in Table B1 reveals no significant correlation; only 0.024 additional college construction correlates with an increase of 10,000 workers at the provincial level.

Housing Reform Initiated in the late 1990s, the shift towards a market-oriented housing system from a predominantly state-allocated one (Man, 2011) led to substantial urban housing price surges, significantly influencing household saving and consumption patterns (Chen, Yang, and Zhong, 2020). For rural families, these increases could directly make urban living–and thereby, access to urban educational resource–more costly. Indirectly, the thriving urban housing market might have drawn investments and savings from rural areas, potentially diverting resources from education. Our findings suggest that a one percent increase in residential housing sales value correlates with a mere 0.016 college, a negligible effect amidst the post-1998 housing market boom.

***Hukou* Reform** The *hukou* (household registration) system has long been a major barrier to rural-urban migration in China, impacting rural migrants' access to public services, including education, in urban locales. *Hukou* reforms, especially those easing rural-urban migration restrictions, could significantly affect educational attainment by allowing more rural residents to access urban educational resources (Huang et al., 2022). Given the varied implementation and impact of these reforms across provinces, we investigate the intensity of *hukou* reforms at the provincial level to test their correlation with college expansion. The findings, presented in the last column of Table B1, do not indicate a strong correlation between higher education expansion and the intensity of *hukou* reforms.

5 The Main Empirical Results

In this section, we present the empirical results of maternal education on children's outcomes. First, we show that the number of colleges has a strong predictive power on maternal education. Then we proceed with the instrumental variable estimation and find that, on average, there is a significant effect of mother's education on children's birth outcomes, especially for low and

very low birth weight. We also find meaningful improvements in the time a child takes to start speaking, counting, and self-urinating. Next, we conduct robustness checks and placebo tests to provide further supportive evidence that our main result is causal. Last, we investigate the heterogeneous impacts of maternal education on male and female children's outcomes as well as the impact on children of different birth order.

5.1 The Impact of Mother's Education on Child Outcomes

We present our main results of IV estimations on birth and health outcomes as well as social and motor skills in Table 3. Panel A shows the OLS estimates and Panel B reports the corresponding IV results.

Birth and Health Outcomes Table 3 columns (1) to (6) report the impact of mother's education on child birth outcomes and health outcomes before age one. We examine how years of schooling above grade 9 affect different birth outcomes and present the results using alternative measures of education in the robustness checks. 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 after grade 9 will decrease low birth incidence by only 0.18 percentage points and very low birth weight by 0.02 percentage points. However, given that the average of very low birth weight children is only 0.3 percent of the whole sample, it is not a surprising result. Our OLS result does not find years of schooling are correlated with the incidence of reduction of macrosomia but having more education also significantly reduces the chance of the child being born early by increasing gestational age by 0.017 months.[19] There is also a positive correlation between mother's education and the probability reporting the child being sick or 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 estimation. The F statistics indicate there is a strong power of our first stage estimation as they exceed 10 (Andrews, Stock, and Sun, 2019). One more year of schooling after grade 9 reduces low birth weight incidence by 1.92 percentage points, equivalent to a 32 percent reduction compared to the mean. A similar impact is also found in very low birth weight. We do not find a significant impact on 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

[19] 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.

for infants and will be discussed later. 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).

Social and Motor Skills Columns (7) through (10) in Table 3 show 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 Panel A imply a strong correlation between mother's education and children's social and motor skills. Having one more year of schooling after grade 9 will reduce the time to start walking by 0.11 months, speaking by 0.36 months, counting by 1.35 months, and self-urinating by 0.9 months. The IV estimates are consistent with the OLS results but differ in magnitude. We find the impact on time a child takes to walk and speak are larger than the OLS, which reduces 0.3 and 0.7 months for the two skills respectively, equivalent to a 2 and 3 percent drop for one year of mother's education above grade 9. Children with more educated mothers also take less time to count and learn how to self-urinate though the latter effect is noisier. This set of results shows the important transmission of mother's education to a child's skills in the early stage, which is also found in a recent work by Priyanka and Sara (2023) where they find Bangladesh women's early exposures to educational programs improved motor skills for their children. More educated mothers possibly pass their increased human capital to their children by teaching them to perform these activities earlier than others. We show this correlation in the mechanism analysis.

Long-Run Effects of Birth Weight While the fact that we find positive impacts of maternal education and child outcomes is not a surprise, it is less clear about the benefits for children in the long run and how they are compared to the costs of college expansion. The literature has identified long run benefits associated with social programs that improve children's health in the U.S. (Aizer, Hoynes, and Lleras-Muney, 2022). Less is known in the context of a developing country. Borrowing from existing studies that look into the returns to birth weight, we conduct a back-of-the-envelope calculation to estimate the net benefits of the expansion in terms of health outcomes.[20]

We follow the estimate from Bharadwaj, Lundborg, and Rooth (2018) that moving from the normal birth weight threshold (2500 grams) to low birth weight will reduce permanent income by

[20] Eriksson, Pan, and Qin (2014) use Danish administrative data to look at the returns to birth weight and find no strong long-run outcomes such as test scores. This is potentially through parental investment in children with less healthy conditions at birth and therefore the gap is mediated over the longer period. Bharadwaj, Lundborg, and Rooth (2018) confirms the weaker effect of birth weight on health outcomes in the long run, but labor market outcomes remain stable. Additionally, Gertler et al. (2014) use an experiment in Jamaica and find earnings increase by 25 percent for children who were given psychosocial stimulation to growth-stunted children.

2.5 percent. Figure A5 plots the cross-sectional age-earnings profiles for all working adults in 2010, which is consistent with Figure 1 in Fang and Qiu (Forthcoming). We estimate the accumulative permanent income between 35 and 45 is 141,740 yuan, multiplying 2.5% which is equivalent to 3,544 yuan. Figure A6 shows the trend of infrastructure spending per student in China where we collect the data from China's Yearbook of Education Statistics. All values are adjusted by inflation and normalized to the year 2010. Apparently, the estimated income effect exceeds the cost of construction of colleges and universities, given that the average expense between 1999 and 2010 is only 1,933 yuan. Considering that we are only using the estimate for the age between 35 and 45, the total benefit on permanent income could be even higher.

5.2 Specification Checks

In this section, we perform several specification checks to test if our main result is robust to using alternative measures of mother's education and different samples. We also test if our instrumental variable estimation provides plausible causal effect by a set of placebo checks.

First, we replace our key variable of mother's education years above grade 9 with the commonly used total years of schooling. The result is presented in Table 4 Panel A. Similar to our main results, we do not see using maternal education across all levels significantly changes our estimates. Nonetheless, we do find consistently significant results for low birth and cognitive skills of walking, speaking, and counting. 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 as the return to one year of maternal education is stable over different levels.

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. Panel B in Table 4 reports the IV results using the restricted sample. We find similar results as in Table 3. Maternal education after compulsory education stage decreases the likelihood of an infant's very low birth weight and improves the development of social and motor skills of mothers.

In Panel C, we conduct a placebo test by only using sample with mothers whose college-going year is before 1999 to conduct our empirical analysis. The idea is that number of colleges at the province-year level experiences the largest variation after 1999 and should be driving the result. Essentially, those earlier cohorts of mothers serve as a placebo group because the access to colleges was quite limited and the educational attainment was low. We should not expect the impact of

college expansion to have an meaningful impact on these mothers and affect child outcomes. The results confirm our hypothesis. All coefficients are insignificant and the first stage F statistics are smaller compared to the main sample.

As we briefly discussed earlier, to further verify if our instrument is valid, we conduct a series of placebo tests by randomizing mother's college-going provinces and years. Specifically, we randomly assign childhood province to mothers and move the college going year backward and forward up to 2 years. As can be seen from Table B2, throughout all the results there is only one outcome showing statistical significance, suggesting what we find in the main result is causal.

5.3 Heterogeneous Impacts of Mother's Education on Child Outcomes

Child Gender We do not control child gender in our main IV specification because it is not reasonable to believe child gender will reversely affect mother's education. However, given there still exists a large gender gap in both education and labor market outcome in China (Hu, Guo, and Ding, 2022), it is natural to examine if maternal education affects birth and health outcomes as well as social and motor skills differently for male and female children. We split our sample into sons and daughters and conduct our IV estimation for these two groups separately.

Table 5 shows the corresponding results. Sons have lower probability of being low birth weight and daughters have lower probability of being very low birth weight with more educated mothers. In contrast to our main results, mothers with one more year of above compulsory education tends to report sons having sickness by 5.5 percentage points and hospitalization before age one by 9 percentage points. We do not find such effect on daughters with more educated mothers. This discrepancy in behaviors of mothers in response to child health conditions may potentially contribute to the diverging future health outcomes of children, especially considering the impact is larger on sons with mothers having more years of schooling. However, daughters are likely to be macrosomia if their mothers have more education. Columns (7) to (10) show a less significant impact of maternal education on the differences of social and motor skills within each gender group, but their magnitudes are close to our main estimates.

Birth Order The lack of statistical power in the previous results by gender may stem from the smaller sample size or there is another source of variation that leads to the significant impact in the main result but not in the subsample. Rural mothers in our sample are likely to be affected by the one-child policy but may still be allowed to have a second child if the first is a girl in some provinces. Given that child rearing is a learning process and birth order could also interact with maternal education to differentially affect child outcomes, we investigate if this is indeed the case.

Table 6 reports the estimation results for the first-born and second-born or above child separately. Panel A shows the impact of mother's years of schooling above grade 9 on the first-born

child. One more year of education reduces low birth weight by 2.5 percentage points, very low birth weight by 0.35 percentage points, and both are statistically significant. The first born children also different in their social and motor skills if mothers have different education years. One year of maternal education shortens the time of starting to walk by 0.4 months, speak by 0.9 months, and count by 1.1 months. All three skills have similar results compared to the main estimates, and we do not find statistically significant results for higher parity children. What we find shows that it is the first born children who are driving the main result. In addition, we find gestational age slightly decreases for a higher birth order child. However, the second or above birth order children are 17.7 percentage points less likely to report have any sickness before age one and this effect is statistically significant.

This set of results has important implications in terms of understanding the impact of maternal education on child outcomes. While extensive literature has focused on birth and health outcomes, which we also identify in this paper, we uncover the heterogeneous effects in birth outcomes and cognitive skills across birth order. The nontrivial effects for first-born children from mothers with different educational attainment suggest that children born from households with more educated mothers have the advantage of getting better social and motor skills, but adults do learn from their first child and could potentially reduce the cognitive gaps for later children. The large decrease (25 percent) in the probability of reporting having any illness for higher birth order kids also shows that mothers may know more about how to take care of their children through the learning process of the first child. Our finding is also consistent with the recent study that shows negative birth order effects on parenting behaviors for adolescents in contemporary China (Kim and Wang, 2023).

6 Mechanisms

6.1 Maternal Education and Mother's Outcomes

Our main results show that, on average, there is meaningful evidence of intergenerational transmission of education on child outcomes through the college expansion, and 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 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 exist 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 7 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. 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 12 percentage points increase in father's attendance of high school. These results are consistent with existing studies that find assortative marriage in China (Nie and Xing, 2019).

Labor Market Outcomes Columns (3) and (4) present the results of maternal education on mothers' working status and wage income. The full sample estimates show a large but not statistically significant impact of education on these outcomes. One more year of education increases mother's employment probability by 5 percentage points and income by 17.2 percent. 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, 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 our previous results, mothers who came from rural areas were largely 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, 2024). Is it because they are likely to stay in cities after they receive a college education, 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 7 shows it is indeed this case. One more year of education, on average, increases the probability of currently having urban hukou status by 7.87 percentage points.

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 the 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 0.6 percent for the full 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, 2023).[21]

6.2 The Impact of Maternal Education and Child Care

The previous section has identified two causal channels through assortative marriage and rural-urban migration of more educated mothers that lead to the improved early childhood outcomes. In this section, we seek to utilize several questions related to how parents care about child development and their investment in children to provide suggestive evidence of why increased educational attainment of mothers may lead to the better cognitive skills development.

Observer's Perceptions CFPS survey observers are asked to report how they perceive the degree that adults care about the educational achievement and communication skills during the interview. The OLS results are listed in the first two columns in Table 8. Mothers with one more year of schooling above grade 9 is 4.2 percentage points more likely to be rated by the observer that the adults in the households care about child education and 3.4 percentage points more likely to be perceived as care about child communication skills.

Even though the observer is randomly assigned and is independent from the educational attainment of the mother, we cannot rule out other possibilities that could potentially correlate the perception and maternal education since the education background was available to the observer during the interview. Nonetheless, this still provides informative evidence of how a more educated mother invests differentially in her children.

Child Investment Why do we find the main results that children with more educated mothers have shorter time to obtain social and motor skills? It could be that these households invest

[21]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.

more in children by various early childhood activities such as reading and playing, which would provide important policy implications to early childhood development. CFPS asks parents if they frequently read for children, buy books, play out with children, and use toys to teach children as well as taking kids to training courses. Even though we do not know the exact timing of this information as they are only asked for parents with children age between 3 and 5 at the survey time, they still provide insights about how more educated mothers invest in children.

The results are presented in columns (3) through (10) in Table 8. Apparently, one more year of education above grade 9 leads parents 6 percentage points more likely to read for children, 7 percentage points more likely to buy books, and 6 percentage points more likely to play frequently with children. Households with more educated mothers are more likely to use toys to improve children's cognitive skills, though this could be correlated with more resources as well. But we do not find significant differences in attending training courses, which serves as a good argument that financial constraint may not play an important role in this context, especially considering the fact that we also do not find significant differences in labor market outcomes.

Furthermore, the mixed findings on the impact of cash transfers to mothers on children's health are puzzles to economists. Field and Maffioli (2021) observed that cash transfers alone did not lead to improvements in children's nutrition and reduction of stunting, but effective social behavior communication significantly reduced stunting. Priyanka and Sara (2023) show that education-specific cash transfers, however, yield long-term spillover benefits in the improvement of the next generation. In our study, we find that despite the fact that women with higher levels of education do not necessarily experience better labor market outcomes, they tend to possess a greater understanding of how to make effective investments in their children.

7 Conclusion

Although there is a large body of literature examining the impact of maternal education on various outcomes, there are only a few studies focusing on early childhood outcomes in developing countries. Especially, current literature lacks evidence of mothers' senior-secondary or above education attainment on child outcomes in children's earlier lifetime. Understanding whether maternal education impacts child outcomes and through which channels these outcomes are affected is extremely important. From the fetal origins hypothesis, helping mothers would be one important 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 beyond the compulsory schooling level, 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, 0.3 percentage points reduction in the incidence of very low birth weight, 0.3 months earlier to walk independently, 0.7 months earlier to speak a full sentence, and 1.3 months earlier to count from one to ten. Our heterogeneous results indicate that these effects are likely driven by the first-born children. We test several channels through which maternal education could affect child outcomes. The results show that 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. More educated mothers are also perceived by survey observer as pay more attention to children's education and communication skills. These mothers are also more likely to invest in other activities with children.

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 education above the compulsory level 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).

In addition, our paper examines the cost-effectiveness of higher education expansion and its potential long-term benefits for children. We estimate the increase in permanent income for children associated with improved birth weights and compare it with per-student infrastructure expenditure. Our calculations indicate that the benefits associated with birth weight alone surpass the costs, suggesting even greater long-term benefits when factoring in cognitive skills improvement.

As pointed out in Black et al. (2017), 250 million children younger than 5 years old who live in low- and middle-income countries (LMICs) 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 mothers' 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 is mainly from the early cohort who benefited from the higher education expansion. 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 more significant impact on these outcomes, and it deserves further

studies in the future.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT 4 in order to proofread the manuscript. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

References

Aizer, Anna, Hilary Hoynes, and Adriana Lleras-Muney. 2022. "Children and the US Social Safety Net: Balancing Disincentives for Adults and Benefits for Children." *Journal of Economic Perspectives*, 36(2): 149–174.

Almond, Douglas, and Janet Currie. 2011. "Killing Me Softly: The Fetal Origins Hypothesis." *Journal of Economic Perspectives*, 25(3): 153–72.

Almond, Douglas, Janet Currie, and Valentina Duque. 2018. "Childhood Circumstances and Adult Outcomes: Act II." *Journal of Economic Literature*, 56(4): 1360–1446.

Andrabi, Tahir, Jishnu Das, and Asim Ijaz Khwaja. 2012. "What Did you Do All Day? Maternal Education and Child Outcomes." *Journal of Human Resources*, 47(4): 873–912.

Andrews, Isaiah, James H Stock, and Liyang Sun. 2019. "Weak Instruments in Instrumental Variables Regression: Theory and Practice." *Annual Review of Economics*, 11(1): 727–753.

Becker, Gary S, and Nigel Tomes. 1979. "An Equilibrium Theory of the Distribution of Income and Intergenerational Mobility." *Journal of Political Economy*, 87(6): 1153–1189.

Becker, Gary S, and Nigel Tomes. 1986. "Human Capital and the Rise and Fall of Families." *Journal of Labor Economics*, 4(3, Part 2): S1–S39.

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

Behrman, Jere R, and Mark R Rosenzweig. 2004. "Returns to Birthweight." *Review of Economics and Statistics*, 86(2): 586–601.

Bharadwaj, Prashant, Petter Lundborg, and Dan-Olof Rooth. 2018. "Birth Weight in the Long Run." *Journal of Human Resources*, 53(1): 189–231.

Black, Maureen M, Susan P Walker, Lia CH Fernald, Christopher T Andersen, Ann M DiGirolamo, Chunling Lu, Dana C McCoy, Günther Fink, Yusra R Shawar, Jeremy Shiffman, et al. 2017. "Early Childhood Development Coming of Age: Science through the Life Course." *The Lancet*, 389(10064): 77–90.

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

Black, Sandra E., Paul J. Devereux, and Kjell G. Salvanes. 2007. "From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes." *The Quarterly Journal of Economics*, 122(1): 409–439.

Bollinger, Christopher, Xiaozhou Ding, and Steven Lugauer. 2022. "The Expansion of Higher Education and Household Saving in China." *China Economic Review*, 71: 101736.

Borsi, Mihály Tamás, Octasiano Miguel Valerio Mendoza, and Flavio Comim. 2022. "Measuring the Provincial Supply of Higher Education Institutions in China." *China Economic Review*, 71: 101724.

Brandt, Loren, Johannes Van Biesebroeck, Luhang Wang, and Yifan Zhang. 2017. "WTO Accession and Performance of Chinese Manufacturing Firms." *The American Economic Review*, 107(9): 2784–2820.

Cai, Shu, Xiaozhou Ding, and Rui Du. 2024. "College Education, Enrollment Location, and the Geographical Mobility of Young Adults." *Unpublished Manuscript*.

Campbell, Frances, Gabriella Conti, James J Heckman, Seong Hyeok Moon, Rodrigo Pinto, Elizabeth Pungello, and Yi Pan. 2014. "Early Childhood Investments Substantially Boost Adult Health." *Science*, 343(6178): 1478–1485.

Carneiro, Pedro, Claire Crawford, and Alissa Goodman. 2007. "The Impact of Early Cognitive and Non-Cognitive Skills on Later Outcomes." Centre for the Economics of Education, LSE 0092.

Carneiro, Pedro, Costas Meghir, and Matthias Parey. 2013. "Maternal Education, Home Environments, and the Development of Children and Adolescents." *Journal of the European Economic Association*, 11(suppl_1): 123–160.

Case, Anne, Angela Fertig, and Christina Paxson. 2005. "The Lasting Impact of Childhood Health and Circumstance." *Journal of Health Economics*, 24(2): 365–389.

Cesur, Resul, Bahadir Dursun, and Naci Mocan. 2014. "The Impact of Education on Health and Health Behavior in a Middle-Income, Low-Education Country." National Bureau of Economic Research.

Chen, Binkai, Xi Yang, and Ninghua Zhong. 2020. "Housing Demand and Household Saving Rates in China: Evidence from a Housing Reform." *Journal of Housing Economics*, 49: 101693.

Chen, Yi, and Hanming Fang. 2021. "The Long-Term Consequences of China's "Later, Longer, Fewer" Campaign in Old Age." *Journal of Development Economics*, 151: 102664.

Chen, Yuyu, and Hongbin Li. 2009. "Mother's Education and Child Health: Is There a Nurturing Effect?" *Journal of Health Economics*, 28(2): 413–426.

Chevalier, Arnaud, and Vincent O'Sullivan. 2007. "Mother's Education and Birth Weight." *Available at SSRN 970232*.

Chou, Shin-Yi, Jin-Tan Liu, Michael Grossman, and Ted Joyce. 2010. "Parental Education and Child Health: Evidence from a Natural Experiment in Taiwan." *American economic Journal: Applied Economics*, 2(1): 63–91.

Cliff, Dylan P, Anthony D Okely, Leif M Smith, and Kim McKeen. 2009. "Relationships between Fundamental Movement Skills and Objectively Measured Physical Activity in Preschool Children." *Pediatric Exercise Science*, 21(4): 436–449.

Cowan, Benjamin W., and Nathan Tefft. 2020. "College Access and Adult Health." *NBER Working Paper*, No. 26685.

Currie, Janet. 2009. "Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development." *Journal of Economic Literature*, 47(1): 87–122.

Currie, Janet. 2011. "Inequality at Birth: Some Causes and Consequences." *American Economic Review*, 101(3): 1–22.

Currie, Janet, and Enrico Moretti. 2003. "Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings." *The Quarterly Journal of Economics*, 118(4): 1495–1532.

Deryugina, Tatyana, and David Molitor. 2021. "The Causal Effects of Place on Health and Longevity." *The Journal of Economic Perspectives*, 35(4): 147–170.

Ding, Xiaozhou. 2021. "College Education and Internal Migration in China." *China Economic Review*, 69: 101649.

Duan, Yide, Haotian Zhang, Wenfu Wang, and Xiaoyan Ao. 2022. "The Effects of China's Higher Education Expansion on Urban and Rural Intergenerational Mobility." *China Economic Review*, 73: 101793.

Duncan, Greg J, Chantelle J Dowsett, Amy Claessens, Katherine Magnuson, Aletha C Huston, Pamela Klebanov, Linda S Pagani, Leon Feinstein, Mimi Engel, Jeanne Brooks-Gunn, et al. 2007. "School Readiness and Later Achievement." *Developmental Psychology*, 43(6): 1428.

Eriksson, Tor, Jay Pan, and Xuezheng Qin. 2014. "The Intergenerational Inequality of Health in China." *China Economic Review*, 31: 392–409.

Fang, Hanming, and Xincheng Qiu. Forthcoming. ""Golden Ages": A Tale of the Labor Markets in China and the United States." *Journal of Political Economy Macroeconomics*.

Fan, Jingting. 2019. "Internal Geography, Labor Mobility, and the Distributional Impacts of Trade." *American Economic Journal: Macroeconomics*, 11(3): 252–288.

Feng, Shuaizhang, and Xiaoyu Xia. 2022. "Heterogeneous Firm Responses to Increases in High-Skilled Workers: Evidence from China's College Enrollment Expansion." *China Economic Review*, 73: 101791.

Field, Erica M, and Elisa M Maffioli. 2021. "Are Behavioral Change Interventions Needed to Make Cash Transfer Programs Work for Children? Experimental Evidence from Myanmar." National Bureau of Economic Research 28443.

Finkelstein, Amy, Matthew Gentzkow, and Heidi Williams. 2021. "Place-Based Drivers of Mortality: Evidence from Migration." *American Economic Review*, 111(8): 2697–2735.

Gertler, Paul, James Heckman, Rodrigo Pinto, Arianna Zanolini, Christel Vermeersch, Susan Walker, Susan M Chang, and Sally Grantham-McGregor. 2014. "Labor Market Returns to An Early Childhood Stimulation Intervention in Jamaica." *Science*, 344(6187): 998–1001.

Gonzalez, Sandy L, Veronica Alvarez, and Eliza L Nelson. 2019. "Do Gross and Fine Motor Skills Differentially Contribute to Language Outcomes? A Systematic Review." *Frontiers in Psychology*, 10: 2670.

Grépin, Karen A, and Prashant Bharadwaj. 2015. "Maternal Education and Child Mortality in Zimbabwe." *Journal of Health Economics*, 44: 97–117.

Grissmer, David, Kevin J Grimm, Sophie M Aiyer, William M Murrah, and Joel S Steele. 2010. "Fine Motor Skills and Early Comprehension of the World: Two New School Readiness Indicators." *Developmental Psychology*, 46(5): 1008.

Grossman, Michael. 1997. "Effect of Education on Health." *The Social Benefits of Education*.

Grossman, Michael. 2006. "Education and Nonmarket Outcomes." *Handbook of the Economics of Education*, 1: 577–633.

Güneş, Pinar Mine. 2015. "The Role of Maternal Education in Child Health: Evidence from a Compulsory Schooling Law." *Economics of Education Review*, 47: 1–16.

Guo, Yumei, Yang Song, and Qianmiao Chen. 2019. "Impacts of Education Policies on Intergenerational Education Mobility in China." *China Economic Review*, 55: 124–142.

Heckman, James, Rodrigo Pinto, and Peter Savelyev. 2013. "Understanding the Mechanisms through Which an Influential Early Childhood Program Boosted Adult Outcomes." *American Economic Review*, 103(6): 2052–86.

He, Hui, Feng Huang, Zheng Liu, and Dongming Zhu. 2018. "Breaking the "Iron Rice Bowl:" Evidence of Precautionary Savings from the Chinese State-Owned Enterprises Reform." *Journal of Monetary Economics*, 94: 94–113.

Huang, Bin, Massimiliano Tani, Yi Wei, and Yu Zhu. 2022. "Returns to Education in China: Evidence from the Great Higher Education Expansion." *China Economic Review*, 74: 101804.

Huang, Wei. 2015. "Understanding the Effects of Education on Health: Evidence from China." *IZA Discussion Paper*.

Huang, Wei, Xiaoyan Lei, Guangjun Shen, and Ang Sun. 2018. "Neither Nature nor Nurture: The Impact of Maternal Education on Child Health." Unpublished Manuscript.

Hu, Chenxu, and Christopher Bollinger. 2021. "Effects of Cohort Size on College Premium: Evidence from China's Higher Education Expansion." *China Economic Review*, 70: 101700.

Hu, Chenxu, Hao Guo, and Xiaozhou Ding. 2022. "Son Preference, Intrahousehold Discrimination, and the Gender Gap in Education in China." *International Review of Economics & Finance*, 79: 324–339.

Jiang, Xuan, Kendall Kennedy, and Jiatong Zhong. 2023. "When Opportunity Knocks: China's Open Door Policy and Declining Educational Attainment." *Labour Economics*, 81: 102312.

Keats, Anthony. 2018. "Women's Schooling, Fertility, and Child Health Outcomes: Evidence from Uganda's Free Primary Education Program." *Journal of Development Economics*, 135: 142–159.

Khanna, Gaurav, Kevin Shih, Ariel Weinberger, Mingzhi Xu, and Miaojie Yu. 2023. "Trade Liberalization and Chinese Students in U.S. Higher Education." *The Review of Economics and Statistics*, 1–46.

Kim, Jun Hyung, and Shaoda Wang. 2023. "Birth Order Effects and Parenting Behaviors." *China Economic Review*, 79: 101950.

Leight, Jessica, and Elaine M Liu. 2020. "Maternal Education, Parental Investment, and Noncognitive Characteristics in Rural China." *Economic Development and Cultural Change*, 69(1): 213–251.

Lindeboom, Maarten, Ana Llena-Nozal, and Bas van Der Klaauw. 2009. "Parental Education and Child Health: Evidence from a Schooling Reform." *Journal of Health Economics*, 28(1): 109–131.

Lin, Faqin, and Cheryl X Long. 2020. "The Impact of Globalization on Youth Education: Empirical Evidence from China's WTO Accession." *Journal of Economic Behavior & Organization*, 178: 820–839.

Li, Shi, John Whalley, and Chunbing Xing. 2014. "China's Higher Education Expansion and Unemployment of College Graduates." *China Economic Review*, 30: 567–582.

Liu, Ling, and Qian Wan. 2019. "The Effect of Education Expansion on Intergenerational Transmission of Education: Evidence from China." *China Economic Review*, 57(July): 101327.

Machin, Stephen, Kjell G Salvanes, and Panu Pelkonen. 2012. "Education and Mobility." *Journal of the European Economic Association*, 10(2): 417–450.

Macours, Karen, Norbert Schady, and Renos Vakis. 2012. "Cash Transfers, Behavioral Changes, and Cognitive Development in Early Childhood: Evidence from a Randomized Experiment." *American Economic Journal: Applied Economics*, 4(2): 247–273.

Malamud, Ofer, Andreea Mitrut, and Cristian Pop-Eleches. 2023. "The Effect of Education on Mortality and Health." *The Journal of Human Resources*, 58(2): 561–592.

Ma, Mingming. 2017. "Does Children's Education Matter for Parents' Health and Cognition in Old Age? Evidence from China." *Evidence from China (November 7, 2017)*.

Man, Joyce Yanyun, ed. 2011. *China's Housing Reform and Outcomes*. The Lincoln Institute of Land Policy.

Ma, Xiao. 2023. "College Expansion, Trade, and Innovation: Evidence from China." *International Economic Review*.

McCrary, Justin, and Heather Royer. 2011. "The Effect of Female Education on Fertility and Infant Health: Evidence from School Entry Policies Using Exact Date of Birth." *American Economic Review*, 101(1): 158–95.

Nie, Haifeng, and Chunbing Xing. 2019. "Education Expansion, Assortative Marriage, and Income Inequality in China." *China Economic Review*, 55: 37–51.

Oreopoulos, Philip, Mark Stabile, Randy Walld, and Leslie L Roos. 2008. "Short-, Medium-, and Long-Term Consequences of Poor Infant Health: An Analysis Using Siblings and Twins." *Journal of Human Resources*, 43(1): 88–138.

Özer, Mustafa, Jan Fidrmuc, and Mehmet Ali Eryurt. 2018. "Maternal Education and Childhood Immunization in Turkey." *Health Economics*, 27(8): 1218–1229.

Premand, Patrick, and Oumar Barry. 2022. "Behavioral Change Promotion, Cash Transfers and Early Childhood Development: Experimental Evidence from a Government Program in a Low-Income Setting." *Journal of Development Economics*, 158: 102921.

Priyanka, Sadia, and Raisa Sara. 2023. "Intergenerational Effects of an Education Stipend Program on Child Development: Evidence from Bangladesh." *Working Paper*.

Sacerdote, Bruce. 2002. "The Nature and Nurture of Economic Outcomes." *American Economic Review*, 92(2): 344–348.

Sacerdote, Bruce. 2007. "How Large Are the Effects from Changes in Family Environment? A Study of Korean American Adoptees." *The Quarterly Journal of Economics*, 122(1): 119–157.

Shi, Li, and Chunbing Xing. 2010. "China's Higher Education Expansion and Its Labor Market Consequences." *IZA Discussion Paper*.

Smith, James P, Yan Shen, John Strauss, Yang Zhe, and Yaohui Zhao. 2012. "The Effects of Childhood Health on Adult Health and SES in China." *Economic Development and Cultural Change*, 61(1): 127–156.

Wan, Yinmei. 2006. "Expansion of Chinese Higher Education Since 1998: Its Causes and Outcomes." *Asia Pacific Education Review*, 7(1): 19–32.

Xie, Yu, and Jingwei Hu. 2014. "An Introduction to the China Family Panel Studies (CFPS)." *Chinese Sociological Review*, 47(1): 3–29.

Xing, Chunbing. 2014. "Education Expansion, Migration and Rural-Urban Education Gap: A Case Study on the Effect of University Expansion." *China Economic Quarterly*, 13(1): 207–232.

Xing, Chunbing, and Junfu Zhang. 2017. "The Preference for Larger Cities in China: Evidence from Rural-Urban Migrants." *China Economic Review*, 43: 72–90.

8 Figures

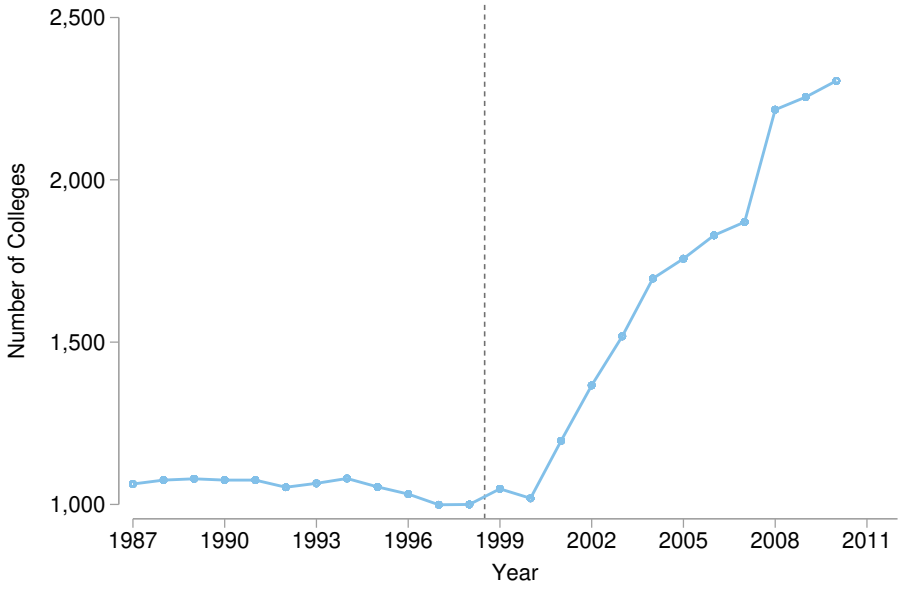


Figure 1: National Number of Colleges

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

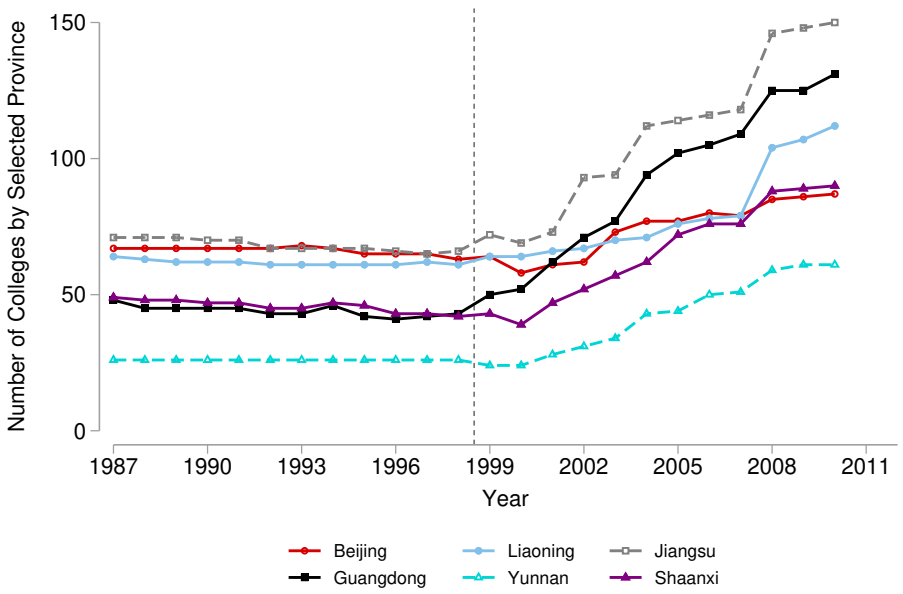


Figure 2: Number of Colleges by Selected Provinces

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.

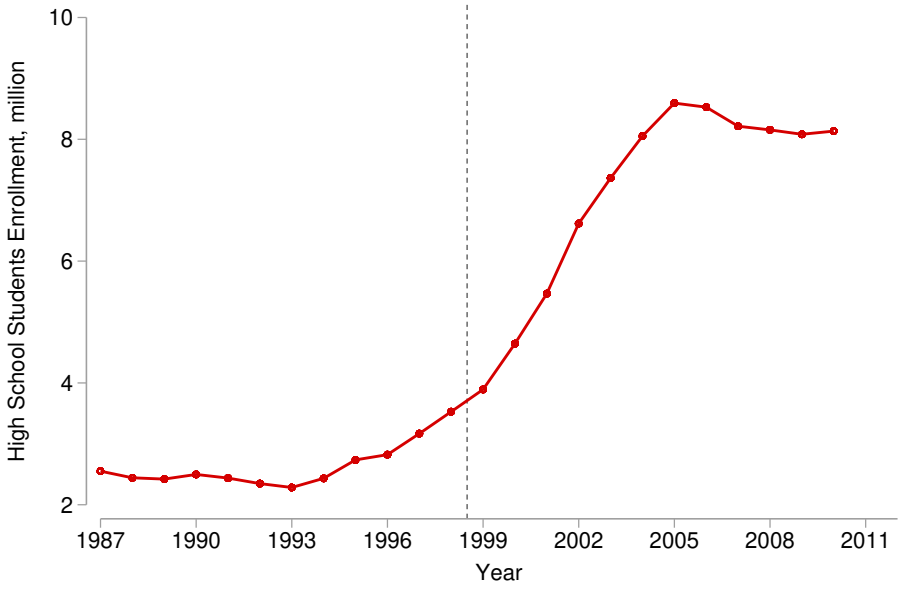


Figure 3: National High School Students New Enrollment

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.

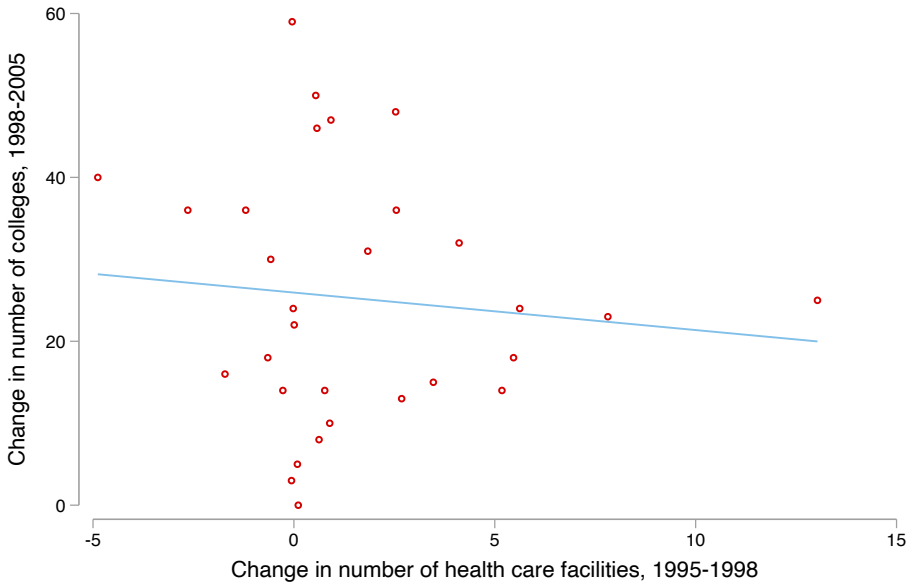


Figure 4: Pre-Trend Test of Number of Colleges and Number of Health Care Facilities

Notes: This figures plots the change in number of colleges from year 1998 to 2005 against the change in the number of health care facilities between 1995 and 1998. The estimated coefficient of Equation (4) is -0.46 with p-value 0.351.

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. Instrumental variable									
Number of colleges	4,803	42.254	17.376	3,590	39.154	14.604	1,213	51.426	21.260
B. Child birth and health outcomes									
Low birth weight (LBW)	4,120	0.058	0.235	3,017	0.058	0.233	1,103	0.061	0.239
Very low birth weight (VLBW)	4,120	0.003	0.056	3,017	0.004	0.060	1,103	0.002	0.043
Macrosomia	4,120	0.038	0.192	3,017	0.038	0.192	1,103	0.039	0.194
Gestage	4,784	9.288	0.580	3,573	9.300	0.576	1,211	9.252	0.592
Any sickness	4,093	0.691	0.462	3,115	0.672	0.469	978	0.751	0.433
Any Hospitalization	4,084	0.606	0.489	3,109	0.583	0.493	975	0.677	0.468
C. Social and motor skills									
Walk	4,275	14.448	4.714	3,407	14.609	4.905	868	13.815	3.815
Speak	4,045	20.592	8.143	3,314	20.765	8.354	731	19.806	7.057
Count	3,682	35.384	14.992	3,093	36.158	15.270	589	31.323	12.694
Self-Urinate	3,834	33.228	13.108	3,177	33.871	13.421	657	30.120	10.963
D. Explanatory variables									
Mother education years	4,803	6.536	4.202	3,590	6.127	4.102	1,213	7.745	4.263
Mother education years above grade 9	4,803	0.518	1.502	3,590	0.370	1.278	1,213	0.957	1.961
Mother ethnicity as Han	4,803	0.865	0.342	3,590	0.865	0.341	1,213	0.864	0.343
Grandma education level	4,803	1.135	0.415	3,590	1.096	0.351	1,213	1.250	0.548
E. Mother childhood province characteristics									
Population growth rate	4,803	0.012	0.008	3,590	0.014	0.008	1,213	0.007	0.009
Employment growth rate	4,803	0.028	0.066	3,590	0.030	0.058	1,213	0.021	0.086
GDP growth rate	4,803	0.162	0.080	3,590	0.178	0.081	1,213	0.117	0.053

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 Result: The Impact of Number of Colleges on Mother's Education

	(1)	(2)	(3)
Panel A: Education Years above 9th Grade			
Number of College	0.0517***	0.0511***	0.0520***
	(0.00738)	(0.00745)	(0.00742)
Panel B: Education Years			
Number of College	0.0503***	0.0478***	0.0438***
	(0.0140)	(0.0140)	(0.0143)
Mother's cohort×College population ratio in 1995		✓	✓
Mother's cohort×Enrollment rate in 1998			✓
Observations	4,803	4,803	4,803

Notes: This table shows the first stage results of the number of colleges on mother's education years after grade 9. 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 Outcomes

	LBW	VLBW	Macrosomia	Gestage	Any sickness	Any hospitalization	Walk	Speak	Count	Self-urinate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A. OLS										
Medu	-0.0018	-0.0002	-0.0026	0.0168**	0.0122*	0.0154**	-0.1116***	-0.3606***	-1.3503***	-0.9153***
	(0.0031)	(0.0003)	(0.0021)	(0.0074)	(0.0063)	(0.0062)	(0.0420)	(0.1036)	(0.1682)	(0.1605)
Observations	4,116	4,116	4,116	4,784	4,083	4,074	4,272	4,039	3,670	3,826
B. IV										
Medu	-0.0192*	-0.00306**	0.0043	-0.00404	-0.0165	0.00458	-0.297**	-0.708*	-1.304*	-0.751
	(0.0104)	(0.00147)	(0.00645)	(0.0483)	(0.0276)	(0.0260)	(0.143)	(0.386)	(0.741)	(0.545)
Kleibergen-Paap F	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	9.288	0.691	0.606	14.45	20.60	35.43	33.26
Sample SD	0.235	0.0561	0.192	0.580	0.462	0.489	4.714	8.146	14.99	13.10

Notes: This table presents the main results of OLS and IV estimations. Dependent variables are shown in the top row. All regression controls 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: Specification Checks

	LBW	VLBW	Macrosomia	Gestage	Any sickness	Any hospitalization	Walk	Speak	Count	Self-urinate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A. Total education years										
Total education years	-0.0210*	-0.00334**	0.00469	-0.00478	-0.0178	0.00489	-0.307**	-0.675*	-1.216*	-0.749
	(0.0117)	(0.00165)	(0.00719)	(0.0570)	(0.0300)	(0.0278)	(0.150)	(0.405)	(0.717)	(0.559)
Kleibergen-Paap F	12.46	12.46	12.46	9.493	14.77	15.03	11.75	13.17	14.63	13.37
Observations	4,116	4,116	4,116	4,784	4,083	4,074	4,272	4,039	3,670	3,826
B. Restricted Sample (born after 1975)										
Medu	-0.0173	-0.00312*	0.00153	-0.00132	-0.0324	0.00488	-0.244*	-0.757*	-1.293*	-0.555
	(0.0120)	(0.00171)	(0.00737)	(0.0538)	(0.0288)	(0.0282)	(0.137)	(0.442)	(0.762)	(0.558)
Kleibergen-Paap F	45.80	45.80	45.80	43.27	59.48	59.42	42.85	35.32	44.21	42.26
Observations	2,639	2,639	2,639	2,960	2,506	2,503	2,485	2,273	1,992	2,126
C. Restricted sample (mother's college-going year before 1999)										
Medu	0.177	0.053	-0.0823	-0.188	0.0402	0.0143	0.00981	2.58	-0.356	-2.383
	(0.120)	(0.035)	(0.060)	(0.174)	(0.102)	(0.103)	(0.938)	(2.125)	(4.891)	(2.917)
Kleibergen-Paap F	3.989	3.989	3.989	5.283	6.078	6.07	7.239	7.768	6.517	6.992
Observations	2,990	2,990	2,990	3,550	3,085	3,079	3,382	3,296	3,075	3,160

Notes: This table presents the robustness checks of our main IV estimations. Panel A uses total years of mother's education as key independent variable. Panel B restricts the sample to mothers who were born after 1975. Other 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 5: The Heterogeneous Impact of Maternal Education by Child Gender

	LBW	VLBW	Macrosomia	Gestage	Any sickness	Any hospitalization	Walk	Speak	Count	Self-urinate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A. Sons										
Medu	-0.0271*	-0.00203	0.00879	0.0497	0.0553*	0.0917**	-0.319	-0.291	-0.793	-1.268*
	(0.0159)	(0.00229)	(0.0108)	(0.0388)	(0.0295)	(0.0381)	(0.287)	(0.507)	(0.838)	(0.734)
Kleibergen-Paap F	26.48	26.48	26.48	23.67	31.50	31.41	22.45	21.70	25.67	21.70
Observations	2,136	2,136	2,136	2,465	2,108	2,101	2,198	2,075	1,868	1,954
Sample Mean	0.0515	0.00140	0.0454	9.284	0.689	0.615	14.49	20.86	35.94	33.40
Sample SD	0.221	0.0375	0.208	0.580	0.463	0.487	4.807	8.242	15.05	12.94
B. Daughters										
Medu	-0.0175	-0.00439*	0.0178**	-0.0579	-0.0337	0.00794	-0.231	-0.191	-0.775	0.228
	(0.0167)	(0.00265)	(0.00905)	(0.0672)	(0.0310)	(0.0282)	(0.219)	(0.435)	(0.886)	(0.709)
Kleibergen-Paap F	54.14	54.14	54.14	50.29	49.45	48.19	41.20	42.55	48.30	51.28
Observations	1,891	1,891	1,891	2,231	1,883	1,881	1,987	1,886	1,726	1,791
Sample Mean	0.0693	0.00529	0.0317	9.291	0.692	0.592	14.44	20.38	35	33.11
Sample SD	0.254	0.0725	0.175	0.581	0.462	0.492	4.602	8.004	14.98	13.21

Notes: This table presents the IV results of maternal education on early childhood health outcomes and social and motor skills by child gender. 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 Heterogeneous Impact of Maternal Education by Birth Order

	LBW	VLBW	Macrosomia	Gestage	Any sickness	Any hospitalization	Walk	Speak	Count	Self-urinate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A. First Child										
Medu	-0.0250*	-0.00350*	-0.00288	0.00458	-0.00146	0.00673	-0.419**	-0.896*	-1.141*	-0.681
	(0.013)	(0.002)	(0.008)	(0.045)	(0.027)	(0.024)	(0.175)	(0.480)	(0.683)	(0.596)
Kleibergen-Paap F	44.73	44.73	44.73	45.17	62.23	62.21	38.17	36.1	41.41	41.08
Observations	2,898	2,898	2,898	3,292	2,828	2,821	3,015	2,870	2,705	2,753
Sample Mean	0.0559	0.00345	0.0366	9.291	0.687	0.603	14.32	20.33	34.57	33.24
Sample SD	0.23	0.0587	0.188	0.583	0.464	0.489	4.684	8.087	15.01	13.26
B. Second Child or Above										
Medu	-0.0535	-0.00441	0.0437	-0.136*	-0.177**	-0.101	-0.22	-0.615	-1.427	-1.399
	(0.036)	(0.006)	(0.029)	(0.081)	(0.078)	(0.065)	(0.713)	(1.440)	(2.083)	(1.480)
Kleibergen-Paap F	19.24	19.24	19.24	13.57	10.02	10.05	5.801	5.963	5.186	6.559
Observations	1,140	1,140	1,140	1,421	1,188	1,186	1,186	1,097	900	1,004
Sample Mean	0.0649	0.00263	0.043	9.279	0.698	0.61	14.85	21.39	38.04	33.39
Sample SD	0.246	0.0513	0.203	0.57	0.459	0.488	4.849	8.297	14.59	12.41

Notes: This table presents the IV results of maternal education years after middle school on early childhood outcomes by child birth order. 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: Mechanisms

	Father education years (1)	Father education years>9 (2)	Mother employed (3)	Mother's income if employed (4)	Current urban hukou (5)	Self-reported good health (6)	Ever smoked (7)	Alcohol often (8)
Medu	0.899***	0.121***	0.0514	0.172	0.0787***	0.00969	0.000102	0.0124
	(0.270)	(0.0293)	(0.0335)	(0.207)	(0.0228)	(0.0115)	(0.00467)	(0.0105)
Kleibergen-Paap F	25.38	25.38	50.55	30.55	49.01	49.03	50.82	49.36
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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

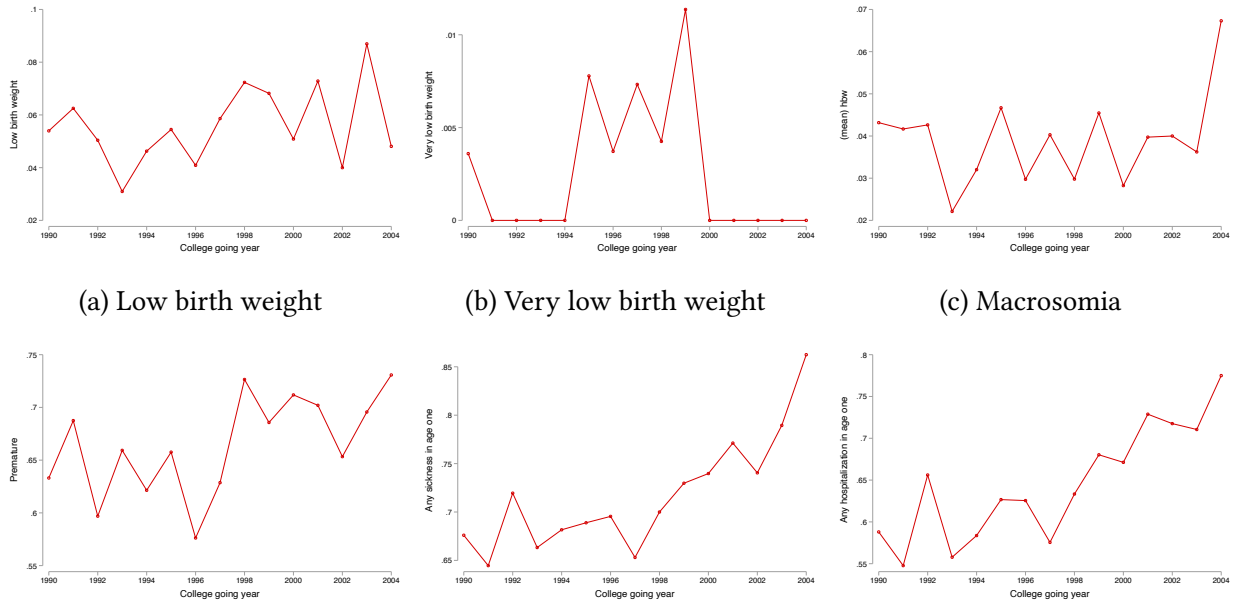
Table 8: The Correlation between Maternal Education and Child Care

	Observer's report if adults care about		Whether parents frequently							
	Education	Communication	Read	Buy book	Play out	Use toys to count	Use toys to tell color	Use toys to tell shape	Use toys to read	Ask kids attend training courses
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Medu	0.0422***	0.0336***	0.0608***	0.0716***	0.0612***	0.0591***	0.0494**	0.0313*	0.0282**	0.0116
	(0.00601)	(0.00552)	(0.0120)	(0.0146)	(0.0112)	(0.0153)	(0.0206)	(0.0184)	(0.0116)	(0.00812)
R^2	0.183	0.188	0.311	0.365	0.352	0.390	0.339	0.322	0.311	0.321
Observations	4,801	4,801	927	926	927	757	757	757	927	927

Notes: This table presents the OLS results of two sets of relationship between maternal education and child care. Columns (1) and (2) use survey observer's reported responses in terms of how much the household adults care about children's education and communication skills. Columns (3) to (10) use responses to questions as whether parents frequently do those activities with children and these questions are only asked for households with children age between 3 and 5 at survey time. 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

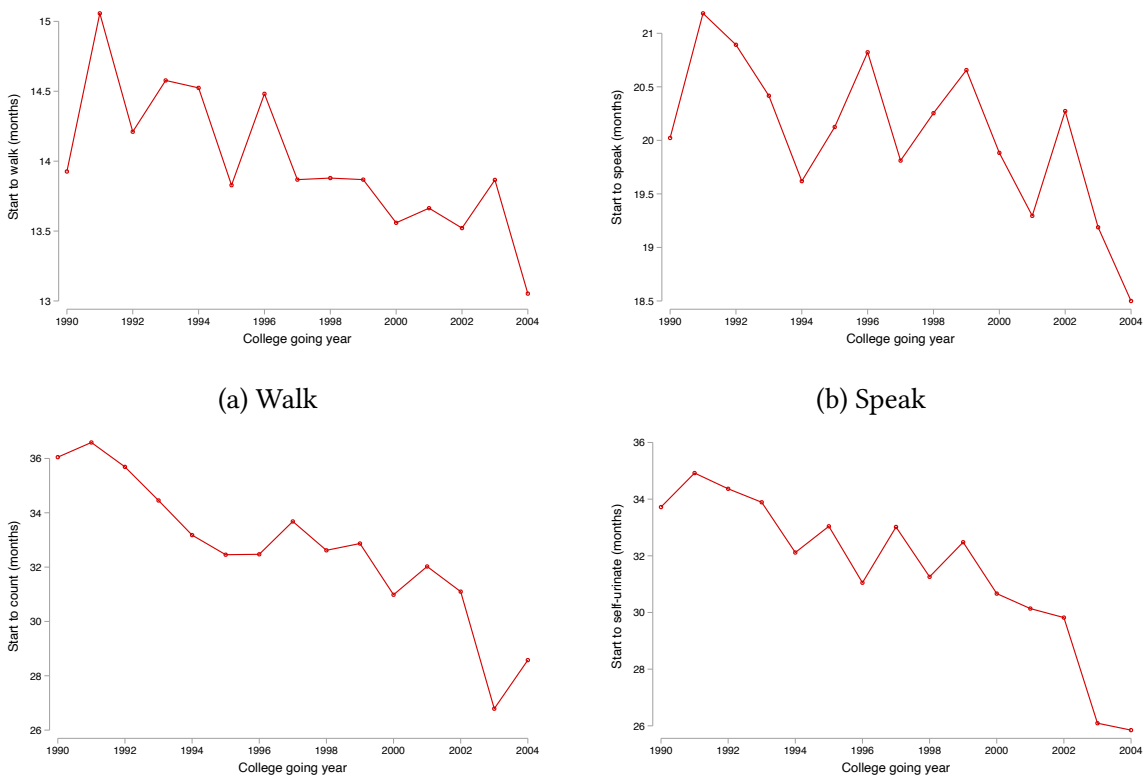


(a) Low birth weight (b) Very low birth weight (c) Macrosomia

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

Figure A1: Child Birth and Health Outcomes by Mother's College-Going Year

Notes: This figures plots the child birth and health outcome variables by mother's college-going year. Data is compiled from CFPS 2010 and we collapse the average of each outcome variable by mother's college-going year.



(a) Walk

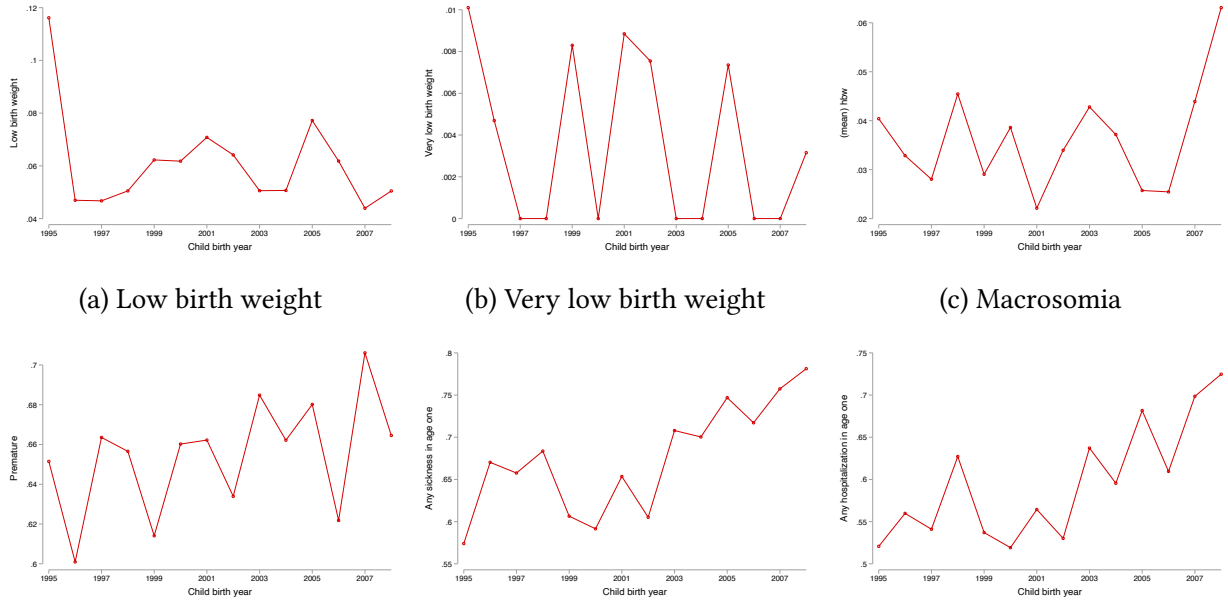
(b) Speak

(c) Count

(d) Self-urinate

Figure A2: Early Childhood Social and Motor Skills by Mother's College-Going Year

Notes: This figures plots the cognitive skills outcome variables by mother's college-going year. Data is compiled from CFPS 2010 and we collapse the average of each outcome variable by mother's college-going year.

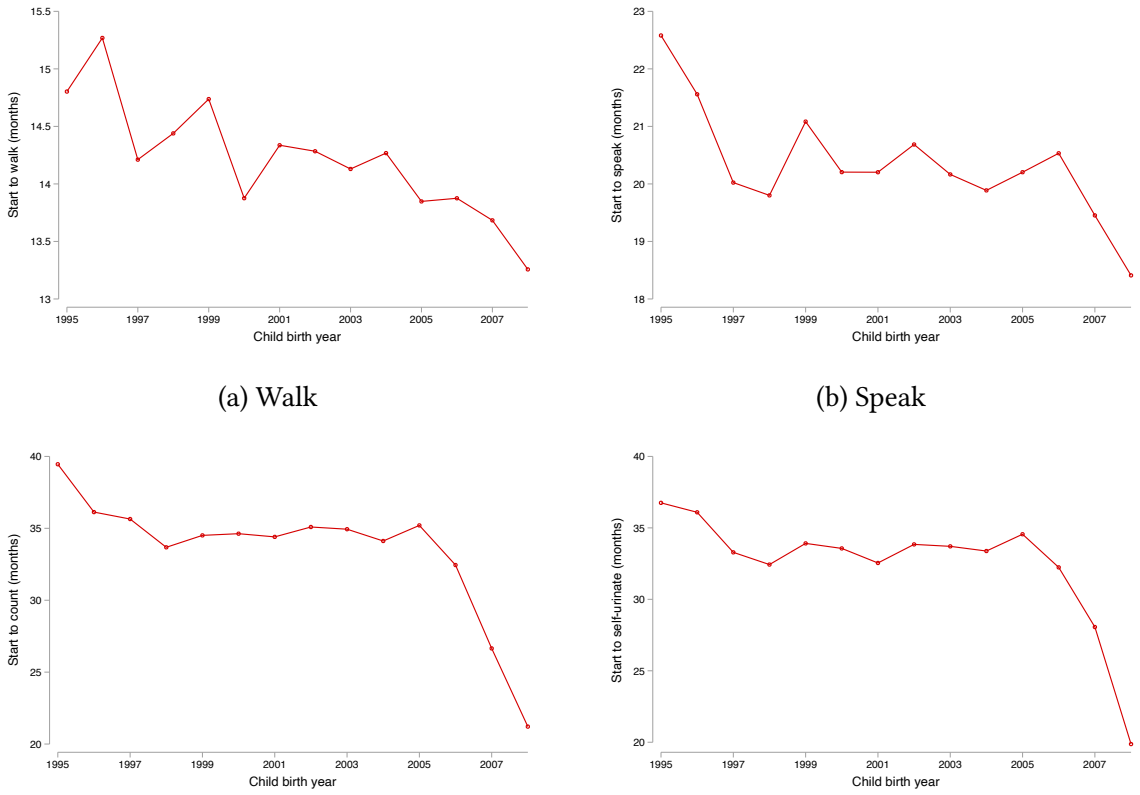


(a) Low birth weight (b) Very low birth weight (c) Macrosomia

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

Figure A3: Child Health Outcomes by Child Birth Cohorts

Notes: This figures plots the health outcomes by child birth cohorts. 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 A4: Social and Motor Skills by Child Birth Cohorts

Notes: This figures plots the social and motor skills by child birth cohorts. 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.

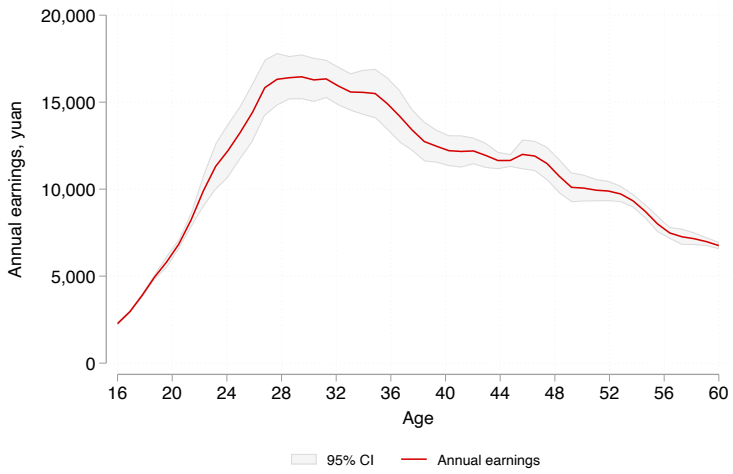


Figure A5: Cross-Sectional Age-Earnings Profiles in 2010

Notes: The solid lines are kernel smoothed values and the gray shaded areas are the 95% confidence intervals.

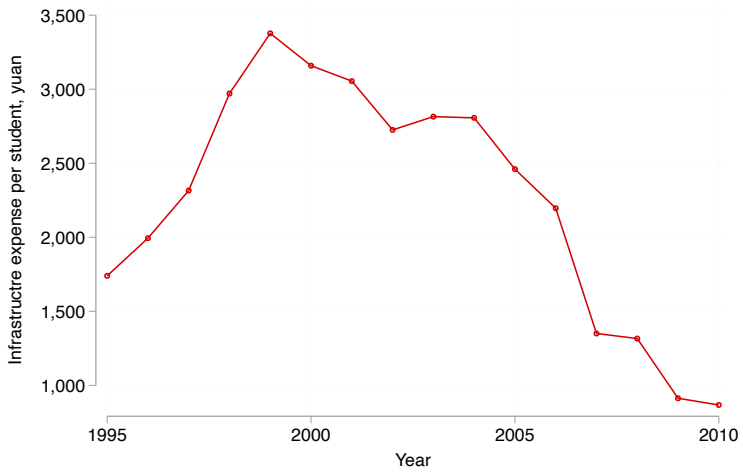


Figure A6: China's Higher Education Infrastructure Expense per Student

Notes: This figure shows the per student spending on infrastructure. Data is from China's Yearbook of Education Statistics. All expenditure values are adjusted by CPI and normalized to year 2010.

B Additional Tables

Table B1: Validity Tests of the Instrument: The Impact of Contemporaneous Reforms and Shocks on the Number of Colleges

	(1)	(2)	(3)	(4)
	Log Export Volume (10,000 US dollars)	Number of SOE Workers (10,000 person)	Log Residential Housing Sales Value (billions)	Hukou Reform Index
Number of colleges	1.469	0.024	0.016	-0.060
	(1.015)	(0.017)	(1.469)	(0.372)
R^2	0.519	0.531	0.424	0.510
Observations	300	300	150	240

Notes: This table presents the results of the validity tests of our instrument. We examine the the impacts of contemporaneous reforms and shocks on the number of colleges. Note the first row presents our independent variables which are the first differences of corresponding variables between the year of 1995 and 2005. The dependent variable is the first difference of the number of colleges at the province level between 1995 and 2005. The sample period is restricted from 1995-2005 as this period showed large changes in both the number of colleges and other reforms and shocks. The export volume, number of SOE workers, and residential housing sales data for each province were obtained from China's National Bureau of Statistics, and the residential housing sales data is available starting from the year 2000. The hukou reform index data is from Fan (2019) and averaged at the province level. All the regressions include provincial-level employment growth rate, GDP growth rate, population growth rate, and province and year fixed effects with robust standard errors. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B2: Placebo Check with Random Province and College-Going Year

	LBW	VLBW	Macrosomia	Gestage	Any sickness	Any hospitalization	Walk	Speak	Count	Self-urinate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A. -2 Years										
Medu	-0.0140	0.000113	-0.0194	-0.0189	0.0255	-0.0253	0.208	0.369	-0.458	0.569
	(0.0186)	(0.00300)	(0.0170)	(0.0594)	(0.0452)	(0.0379)	(0.349)	(0.842)	(1.372)	(1.383)
Observations	3,817	3,817	3,817	4,427	3,771	3,763	3,925	3,706	3,361	3,503
B. -1 Year										
Medu	-0.0230	-0.00599*	-0.00162	-0.0151	0.0151	-0.0147	-0.0961	0.333	-0.508	-0.682
	(0.0157)	(0.00343)	(0.0126)	(0.0497)	(0.0341)	(0.0294)	(0.294)	(0.577)	(1.089)	(0.884)
Observations	3,590	3,590	3,590	4,124	3,515	3,508	3,622	3,407	3,075	3,212
C. +1 Year										
	-0.00833	-0.00260	0.00166	0.00775	-0.0222	0.00522	-0.0523	-0.303	-1.509**	0.229
	(0.0146)	(0.00236)	(0.00890)	(0.0397)	(0.0303)	(0.0302)	(0.263)	(0.458)	(0.702)	(0.651)
Observations	3,959	3,959	3,959	4,605	3,932	3,924	4,121	3,902	3,552	3,698
D. +2 Years										
	-0.00978	-0.00260	0.00163	0.0390	-0.0124	0.00443	-0.226	-0.379	-0.812	0.316
	(0.0127)	(0.00215)	(0.00853)	(0.0327)	(0.0305)	(0.0303)	(0.220)	(0.403)	(0.640)	(0.596)
Observations	3,918	3,918	3,918	4,559	3,897	3,889	4,099	3,886	3,538	3,686

Notes: This table shows the placebo IV regressions. We randomly assign childhood province to mothers and move the college going year backward and forward up to 2 years. 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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$