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The effect of number of siblings and birth order on educational attainment: Empirical Evidence from Chinese General Social Survey

Feng Xiong[a], Leizhen Zang[b,c,*], Ling Zhou[d], Fei Liu[e]

[a] Jinhe Center for Economic Research, Xi'an Jiaotong University, Xi'an, People's Republic of China
[b] The College of Humanities and Development Studies, China Agricultural University, No.2 Yuanmingyuan West Road, 100193, Beijing, People's Republic of China
[c] Institute of State Governance, Peking University, 100871, Beijing, People's Republic of China
[d] Jinjiang College, Sichuan University, 620860, Meishan, People's Republic of China
[e] Center for Economics, Finance and Management Studies, Hunan University, 410006, Changsha, People's Republic of China

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ABSTRACT

Data from China demonstrate that the effect of the number of siblings on education is restricted by many factors, such as children's gender, urban or rural household registration, whether there is only one child, the birth order of children within the family, and parents' status. Chinese families have significant preferences for the eldest son and the youngest son. Moreover, research based on the natural experiment and instrumental variable approach suggests that market-oriented reform of education has increased the cost of family education expenditures since China's reform and opening up, which further aggravates the negative impact on education of having many siblings in an urban setting.

1. Introduction

The education level of the youngest generation is related to the future development of a country. Policy makers and researchers need to fully understand the factors that affect education in order to achieve a better promotion policy, which works with either developing countries or developed countries. However, in developing countries, there are generally lower public and private financial expenditures on education. Especially in developing countries with large populations and serious imbalances in regional development, the education access of their children has become scarcer and more precious.

From the perspective of factors within family, extant research has found that the number of siblings and birth order have different effects on the educational attainment of each child from various countries in different time periods (Barclay, 2018; Booth & Kee, 2009). Why do factors within family affect children's education? Both the resource dilution theory and the limited resource distribution theory emphasize that parents need to make choices for different children's education expenditures to achieve better return on family education investment. However, according to the quantity-quality balance approach, there is a more complex relationship between the number of siblings and their education quality (Mogstad & Wiswall, 2016; Zhong, 2017).

From the perspective of factors beyond family, regional development differences and macro government policies also affect children's educational opportunities. For example, the economic growth brought about by China's reform and opening-up (known in the West as the Opening of China) in 1978 and the family planning policy implemented in the 1980s have changed the size of Chinese families (Wang, 2012). So it's necessary for us to assess how the macro policies affect individual behaviour choices. As a manufacturing power with the largest population in the world, China's next generation education level is of great value to the promotion and innovation of productivity level in China and the world.

In the research, it is urgent to find the influence of different factors within and beyond families on children's education through rigorous empirical analysis on the national level, rather than observe their local characteristics just from regional analyses of some provinces and cities to achieve the integration of the Chinese experience into global research. To better reply to these questions, data from the Chinese General Social Survey (CGSS 2008) were used in this paper to systematically analyse the complex relationship between children and education. In this paper, a more robust result is given by natural experiment and an instrumental variable model. The second section below presents a literature review. The third section explains the data and research methods, while the fourth section presents the results, followed by a conclusion in the fifth section, and a discussion in the

* Corresponding author at: The College of Humanities and Development Studies, China Agricultural University, No.2 Yuanmingyuan West Road, 100193, Beijing, China.
E-mail addresses: colinxf@stu.xjtu.edu.cn (F. Xiong), zangleizhen@cau.edu.cn (L. Zang), chowyuxiu@163.com (L. Zhou), 598974662@qq.com (F. Liu).

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sixth and final section.

2. Literature review

2.1. The perspective of influencing factors within family

Factors within family obviously have an important impact on children's educational opportunities. Apart from parents' social-economic status, family size and the number of siblings are the first focus of scholars' attention. Anastasi (1956) suggested that an increase in the number of siblings and shorter birth intervals would reduce the resources that parents can allocate to each child. This is known as the "siblings resource dilution hypothesis", which explains why having more siblings limits family resources such as parents' care, parents' energy and family income, which leads to reduced opportunities for each child (Downey, 2001). Jæger (2009); Strohschein et al. (2008) also put forward and examined the resource dilution hypothesis. They were concerned about the negative relationship among family resources, parental resource allocations and children's outcomes. Based on evidence from the United States, the number of siblings also has a strong negative effect on tests measuring verbal ability and years of schooling (Blake, 1989). In such studies, the negative correlation between the number of siblings and education attainment is considered inarguable and virtually unequivocal (Steelman et al., 2002).

The second factor is the birth order. Hauser and Sewell (1985) found that birth order played a vital role in educational level, and generally, children born earlier are better educated because they have a better family context than those born later. The similar impact of birth order on educational attainment has also been found in the UK, based on data from the British Household Panel Survey (Booth & Kee, 2009).

The third factor is the gender of the child. The gender structure of the siblings also has an important effect on individual educational level. Scholars such as Oliveira (2019) studied the effect of gender by controlling for the size of the family and found that a daughter's level of schooling decreases with the number of younger siblings, while a son's schooling increases with the number of younger siblings. So girls' educational choices have been negatively affected by their siblings' gender composition. Specifically, having brothers would be bad news for girls because it would decrease the latter's educational level (Lei et al., 2017). On the other hand, older female siblings can improve younger siblings' educational attainment.

However, the theoretical explanation for the influencing factors within family is based on the static perspective. For instance, the siblings resource dilution hypothesis, based on a static economic level to assess the impact of family resources on children's education, ignores the impact when the family is dynamically in a state of abundance (Nkurunziza et al., 2017). Becker et al. (2018) discussed the family resources distribution process from the perspective of the efficiency hypothesis. Specifically, the family resources are tilted toward the children with higher returns on investment. In some developing countries, such as China, compared with women, men work longer wage-earning hours and have certain advantages in the process of employment (Chi & Li, 2014). Therefore, the educational return of men is higher than that of women, and family resources will naturally be inclined toward boys in these countries.

Another explanation for the influence of the number of siblings to the distribution of educational resources comes from Becker and Lewis (1973), who considered the trade-off between the quantity and quality of children, also known as the "quantity-quality trade-off hypothesis". They stated that parents should make a choice between quantity and quality in light of limited family resources. Other scholars through numerous empirical studies have also found a negative correlation between children's educational achievement and family size (Angrist et al., 2010; Hanushek, 1992). As the number of children increases, investments in home education are unlikely to increase. Families must make a trade-off between quantity and quality of educational opportunities. With technology and economic development, when women have higher incomes and wider participation in socio-economic activities, quality rather than quantity will become more pronounced. Black et al. (2005) found a negative correlation between family size and children's education based on the Norway data set; however, when they considered the birth order or used twin births as an instrument, family-size effects became negligible. Dang and Rogers (2015) studied the situation in Vietnam and found their fertility rate had fallen sharply at the same time that their educational attainment had rapidly risen. This result in Vietnam is consistent with the quantity-quality trade-off hypothesis in child education.

In addition, studies that explain family size and children's educational opportunities also include the confluence hypothesis, which suggests that the intellectual milieu of families is lowered with additional children, and the admixture ("no effect") hypothesis, which suggests that the negative relationship between family size and achievement is an artefact of cross-sectional research resulting from unobserved heterogeneity (Sandberg & Rafail, 2014). But we did not consider these due to the limited space in the paper.

2.2. The perspective of influencing factors beyond family

However, the results of empirical studies on the above theories are also very different. Children can also help each other, which is beneficial to their growth, thus raising these children's education level (Knodel et al., 1990). Moreover, some conclusions are not consistent within a single country based on different data and methods used. The conclusions on the influence of children's birth order are also inconsistent in the extant literature. Some studies have found a positive effect of children's birth order on education, holding that the younger children will have an advantage over the older (Mechoulan & Wolff, 2015). However, other studies have suggested that the effect of children's birth order on education does not appear from the start, but gradually emerges when the number of children has reached a certain level (Kantarevic & Mechoulan, 2006).

This is mainly because factors beyond family also have an important impact on children's education. Firstly, macro-government policies often play a crucial role in individual development. Argys and Averett (2019) discovered that the one-child policy (OCP) in China saliently reduced fertility, and then they examined how the OCP affected the education of Chinese migrants to the USA.

Secondly, unequal wage policies and household type (rural or urban household) also bring about the differential choice of family education. Women and men in China have different returns of education investment in the job market. Studies have shown that China's urban and rural household create serious educational inequality (Knight & Shi, 1996; Wu, 2011).

Finally, unbalanced regional development and historical and cultural traditions also have a major impact on children's educational opportunities. Family preference also plays a part. In particular, traditionally Chinese people have a preference for having sons, so family resources will lean toward boys. Lin (2018) used son preference as an instrumental variable to generate exogenous variations in the number of siblings in Taiwanese families and revealed that a larger number of siblings resulted in lower educational attainment. Earlier studies showed that due to the huge developmental inequality between rural and urban areas (Qian & Smyth, 2008), children who lived in urban areas were less affected by the number of siblings in terms of their access to education than were those who lived in rural areas.

2.3. Empirical research on siblings and educational access in China

The relationship between siblings and educational opportunities in China has always been the focus of scholars' attention. The influencing factors of Chinese children's access to education include both factors within and beyond families.

First of all, the number of siblings and the gender preference for sons in Chinese families affect children's education. And gender discrimination in terms of work rewards also remains a problem. Thus, many families, especially those with severe resource constraints, may sacrifice their girls' quality of education to improve the quality for boys in the allocation of educational resources. Under the influence of the OCP and the reform, the gender preference phenomenon further affects family size. Rosenzweig and Zhang (2009), using the twin utility test, found that a significant substitution relationship links the quality and quantity of Chinese children, and the impact of the Chinese OCP on capital development is moderate. Lei et al. (2017) revealed that the effect of quantity disappeared after controlling the gender composition and birth order, indicating that the structure of the compatriots rather than the quantity is what mainly affected the educational level.

Secondly, there is still a serious imbalance in terms of economic development across China. A considerable number of researchers have shown that urban and rural factors and family socio-economic status (occupational status and education level of parents) have significant effects on gender differences in educational attainment (Hannum et al., 2009; Knight & Shi, 1996). Gender inequality is more serious in rural areas than in urban areas, and the lower the socio-economic status of the group, the greater the gender inequality. This is because these groups have lower incomes and family resources. However, using the OCP as an instrumental variable, Qian (2009) found that having a second child in rural China increased the enrolment rate of the first child. However, the choice of twins or the policy as instrumental variables largely solved endogenous problems. This finding was only effective for families that had twins, and there was a lack of external effectiveness for families without twins. Yet the proportion of twin families in the general population is very small. In addition, these studies ignored the increase in education expenditures for citizens because of education marketization reforms, in spite of the increase in economic growth and people's income due to the reform and opening up. And the studies were devoid of further empirical analysis on how such macro-policies affect Chinese family education.

Thirdly, the influence of macro-policy in China should not be ignored. According to the theoretical model that children's education level is a function of the sum of family education investment and government education investment (Mayer & Lopoo, 2008), when government invests more in educational resources, families can invest fewer resources in children's education, so that the effect of siblings on educational level decreases accordingly. Especially since the reform and opening up, with economic growth, the government investment in education has continued to increase. Therefore, it is necessary to examine the effects of sibling attainment on educational resources in different periods, before and after the reform and opening up. Lu and Treiman (2008) found that under national policies during different periods in China, the effects of the quantity of children on education level were different, which means that the national policy can alleviate the adverse effects of family resource shortages.

2.4. Hypothesis development

According to the resource dilution theory, a family's resources, both material and immaterial, are limited. Having many children means having fewer resources for each child. In other words, a child with more siblings will get relatively fewer family resources, such as parental care and the family's financial support, which will reduce the opportunities for individual educational attainment. Therefore, the number of siblings influences children's educational attainment. So we proposed our first hypothesis as follows:

H1 : Ceteris paribus, the effect of the number of siblings on educational attainment is significantly negative in China.

Due to family's limited resources, parents are often compelled to make a trade-off between the quality and quantity of their children's education (Yilmaz, 2018). In pursuing maximum family income, parents prefer to invest resources in those children who offer a higher rate of return on investment. The educational return rate of men is higher than that of women (Kim & Sakamoto, 2017). Furthermore, in Chinese traditional culture, people always have the idea of "raising [their] son for old age" and a natural preference for boys (Zhang, 2015). This will lead to the household's resources being inclined toward boys. Thus, there exists a noteworthy educational gap between girls and boys (Hannum et al., 2009).

H2 : Ceteris paribus, the effect of the number of siblings on educational attainment is significantly different between genders in China.

As a developing country, gaps between rural and urban areas resulting from extremely unbalanced development may reside in all aspects of life in China. The cost of general education for urban children is significantly higher than it is in rural areas. Therefore, one more child means a heavier burden on urban families in education. Thus, the quantity of children in urban areas has a significantly greater negative effect on years of schooling. The third hypothesis is thus given as follows:

H3 : Ceteris paribus, children in Chinese urban areas suffer a much greater negative effect on their educational attainment from having more siblings than do those in rural areas.

Since China's reforms and opening up in 1978, China has transformed from a planned economy into a market economy. A large-scale marketization reform has been carried out, both in higher education and in basic education. Many private schools were set up after 1978, which resulted in significant increases in the education costs for urban homes under the market-oriented reform. Simultaneously, equality between men and women has always been emphasized, since the OCP was introduced in 1982, and the social status and social equality of men and women have been improved. Therefore, taking into account the above factors, the fourth hypothesis is presented below:

H4 : Ceteris paribus, compared to the situation before the reform and opening up, having a greater number of siblings has had a greater negative effect on education length since the reform and opening up. But the effect is significantly weakened in regard to gender difference, that is, gender discrimination has been controlled or weakened.

3. Methods

3.1. Model construction

To further examine our previously stated hypotheses and to explore the impact mechanism between the number of siblings and educational attainment, we established the following multiple linear regression model:

$$Edu_i = \alpha_0 + \alpha_1 Sibling_i + \gamma X_i + \varepsilon_i \quad (1)$$

$$\varepsilon_i \sim N(0, \delta^2) i = 1,2, \ldots, N$$

where, a is the regression coefficient; N denotes the number of samples; and ε_i represents residuals that follow a normal distribution. This paper uses the maximum likelihood estimator (MLE) to estimate these regression coefficients.

In the research, the dependent variable is a finite value with a range from 1 to 24. Taking this data characteristic into account, the traditional OLS method is not the perfect way to estimate the regression coefficient. To analyse the data precisely, the paper used the Tobit model created by the Nobel Economics Prize laureate James Tobin. Tobit models are used to account for models whose dependent variables are restricted to limited values and ranges. In this paper, the Tobit model helped in obtaining a more accurate and steadier average partial effect (APE).

The Tobit model demonstrates precisely the regression characteristics of dependent variables on constraint conditions. The model-specific embodiment is presented as follows. The level of education attainment (Edu_i) is the dependent variable, and the number of siblings is

the main independent variable. The other independent variables are shown in the vector of X_i. Based on the Tobit model theory, Edu_i^* is the latent variable of Edu_i.

$$Edu_i^* = \alpha_0 + \alpha_1 Sibling_i + \gamma X_i + \varepsilon_i \quad (2)$$

$$Edu_i^* = \begin{cases} infEdu_i < inf \\ Edu_i inf \leq Edu_i \leq sup \\ supEdu_i \geq sup \end{cases} \quad (3)$$

The Tobit model should satisfy the assumption of the general regression model in equation 1 as well as normality and homoscedasticity. In equation (3), the estimated value α_1 is the APE of the independent variable on the latent variable Edu_i. To acquire α_1, an adjustment factor should be multiplied. Then the adjusted estimated value can be compared with the OLS regression result.

$$\text{Adjustment} = n^{-1}\sum_{i=1}^{n} (\hat{\alpha_1} Sibling_i + \hat{\gamma} X_i)/\sigma \quad (4)$$

3.2. Data

The data in this paper are from the CGSS2008 (Chinese General Social Survey), the first national, comprehensive and biennially academic social survey in China since 2003. The CGSS systematically collects data on society, communities, families and individuals. It summarizes the trends of social development, promotes the opening and sharing of Chinese social science empirical research, and provides data for international comparative research. The CGSS adopts a multistage stratified sampling method and obtains a nationally representative sample (Bian & Li, 2012). The CGSS is widely used in the academic field due to its rigorous survey method and high data quality (Oshio et al., 2011).

Based on the CGSS database, the number of siblings is the independent variable, and education attainment is the dependent variable. In order to further study the structural effect of the number of siblings on education attainment in a family, the number of siblings is divided into four variables: 'birth order', 'only child', 'the eldest child', and 'the youngest child'. Then a discussion on the effect of the number of siblings on the education length is undertaken in these four variables, with the intention of verifying whether there is a sequential relationship between a family's limited resource allocation and either an eldest child preference or a youngest child preference.

In addition, many other factors are also linked to children's educational attainment in Chinese families. In order to improve the explanatory power of the model, the authors selected the other variables related to child education attainment using the random forest method. The variables are defined in detail as follows. For instance, different ethnic groups have different educational habits. China is a multi-ethnic country with a total of 57 ethnic groups, of which the Han ethnicity accounts for more than 90% of the national population. An existing social survey shows that Han parents put a high value on education (Postiglione, 2013). Thus, ethnic property (Han) in the paper is set as a dummy variable. When this is equal to 1, the respondent is of Han ethnicity; otherwise, the respondent is of an ethnic minority. Scholars have also found that gender egalitarianism in terms of education is a challenge in China. In particular, girls in rural areas are faced with more severe problems in obtaining educational resources (Li & Tsang, 2003; Shu, 2004). So, the gender of the respondent was chosen as a control variable, which is also a dummy variable (0 = male, 1 = female). In addition, the education of the next generation is largely influenced by the parents' socio-economic status (Brown & Park, 2002; Tsui & Rich, 2002; Zhou et al., 2014). Thus, the discussion in the paper considers whether parents work in the city or in a public institution, whether parents are educated, and whether they are CPC members, which is an important resource and status symbol in China. In the questionnaire, a certain proportion of the answers are about children whose parents passed away before the children reached the age of 14. In order to avoid self-selection bias in the sample, a sample of fatherless or motherless respondents was also taken into account, namely the two control variables: 'fatherless child' and 'motherless child'.

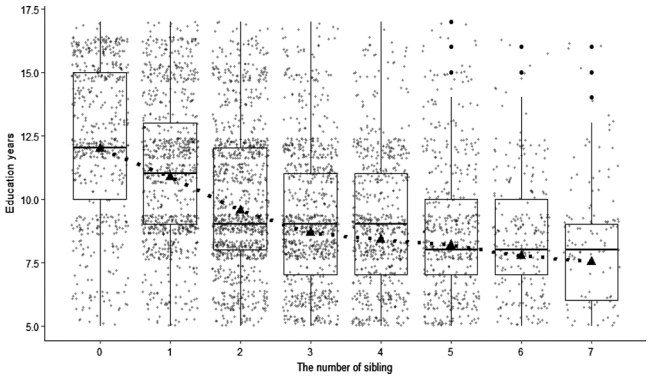

Fig. 1. Boxplot of education attainment years by number of siblings.

In the robustness test, the level of education was used as an alternative variable to the number of educational years. The final academic level was classified into seven levels, namely non-educational experience, primary school level, culture of junior secondary school, secondary school, college, undergraduate degree, and master or PhD degrees, indicated as 0 to 6, respectively. Table A1 in the appendix describes the statistical information for each variable, while a histogram of the main independent and dependent variables is presented in Figure A1.

Fig. 1 clearly shows the statistical distribution of education years by the number of siblings, increasing one by one. The boxplot shows that the number of education attainment years decreased as the number of siblings increased. In terms of years of education, from one child in the family to four siblings, the years of education attained by the respondents were reduced by 10% for each additional sibling.

Table A2 in the appendix shows the correlations of different kinds of variables. It is clear that the number of siblings is significantly related to the respondents' number of educational years, and the effect is negative. The number of the mother's and father's educational years is positively related to their children's educational level. The death of a mother or father significantly reduced the children's number of educational years. Males had more educational years. Moreover, respondents from urban areas had significantly more educational years. To better support the results, a regression analysis based on the DID (difference-in-difference) model was followed.

4. Empirical Results

4.1. Baseline regression

Table A3 in the appendix shows that the variables used in the paper do not exist in multicollinearity. Table 1 indicates that the number of siblings often significantly reduced an individual's number of years of education. Model 1 is a simple linear regression with one variable, the number of siblings, which is the main explanatory variable. Models 2 – 5 gradually expand Model 1 by adding more control variables, such as the dummy variables of Han ethnicity, gender, and so on. Therefore, we can also clearly see that the children of Han ethnicity had more education experience. And males had many more educational years than females. Parents' CPC memberships had a similar effect on their children's educational years. Furthermore, mothers' working in public institutions had a bigger effect on children's educational years than father's. Hence, to some extent, in China, the main responsibility for children's education still rests on the mother; that is, the influence of the mother on her children's education is much greater.

To avoid the self-selection bias from the sample mentioned above,

Table 1
The basic regression results.

Education attainment years	Model 1 OLS	Model 2 OLS	Model 3 OLS	Model 4 OLS	Model 5 Tobit	Model 6 IV
The number of siblings	−0.6270***	−0.2971***	−0.3429***	−0.3078***	−0.3088***	−1.7467***
	(0.02)	(0.03)	(0.02)	(0.03)	(0.03)	(0.19)
Race property (Han)		0.3750*	0.3755*	0.4324*	0.4290*	−0.0092
		(0.19)	(0.17)	(0.19)	(0.19)	(0.26)
Gender		0.7142***	0.6875***	0.7199***	0.7192***	0.5661***
		(0.09)	(0.09)	(0.10)	(0.10)	(0.13)
The type of household		0.8944***	1.1073***	0.8751***	0.8798***	0.5926*
		(0.14)	(0.15)	(0.17)	(0.17)	(0.23)
Final academic level of father		0.9754***	0.9389***	0.9470***	0.9493***	0.3072**
		(0.05)	(0.04)	(0.05)	(0.05)	(0.11)
Father is a CPC member		0.2536	0.2773*	0.2754	0.2754	0.9187***
		(0.14)	(0.13)	(0.15)	(0.15)	(0.21)
Mother is a CPC member		0.4397	0.6812**	0.4804	0.4804	
		(0.27)	(0.26)	(0.28)	(0.28)	
Fatherless child (14 years old)		−1.0397***				
		(0.22)				
Motherless child (14 years old)			−0.7689**			
			(0.25)			
Father works in a public institution			0.7930***	0.0382	0.0417	0.1359
			(0.15)	(0.19)	(0.19)	(0.25)
Mother works in a public institution		1.3957***		1.3792***	1.3764***	0.2222
		(0.16)		(0.19)	(0.19)	(0.29)
Constant	11.1634***	7.4988***	7.6611***	7.5024***	7.5024***	13.3137***
	(134.82)	(34.47)	(37.77)	(0.22)	(33.42)	(17.52)
Observations	5491	4108	4663	3760	3760	3752
R-square	0.108	0.348	0.330	0.346	–	–
Overidentification test Sargan statistic						0.566
Endogenous test Durbin-Wu-Hausman statistic						123.553***

Note: *, ** and *** mean 10%, 5% and 1%, respectively. The standard deviation of the corresponding explanatory variable is shown (Same as below). In Model 6, mother is a CPC member and mother's highest academic degree are set as instrumental variables.

two variables were added to models, models 2 'fatherless child' (under 14 years old) and model 3 'motherless child' (under 14 years old), respectively. Models 2 and 3 show that being fatherless or motherless had significant negative effects on the children's educational attainment years. And the number of siblings in a family also significantly reduced the years of education. Thus, this consistent finding verifies hypothesis 1.

The results of the Tobit model in Model 5 are in line with the results of Model 4. In econometrics, endogeneity broadly refers to situations in which an explanatory variable is correlated with the error term. The distinction between endogenous and exogenous variables originated in simultaneous equation models, where one separates variables whose values are determined by the model from variables that are predetermined. Ignoring simultaneity in the estimation leads to biased estimates as it violates the exogeneity assumption of the Gauss–Markov theorem. The problem of endogeneity is unfortunately often ignored by researchers conducting non-experimental research, and doing so precludes making policy recommendations. Instrumental variable techniques are commonly used to address this problem. Durbin (1954) first proposed the endogeneity test in a regression estimated via instrumental variables by the Stata program "ivendog". The null hypothesis states that an ordinary least squares (OLS) estimator of the same equation would yield consistent estimates; that is, any endogeneity among the regressors would not have deleterious effects on OLS estimates. A rejection of the null hypothesis indicates that endogenous regressors' effects on the estimates are meaningful, and instrumental variable techniques are required.

As Table A4 shows, mothers' CPC membership and highest academic level added as instrumental variables. Through the correlation coefficient test, the correlation coefficient between mother as a CPC member and the number of siblings is -0.065, while the coefficient between mother's highest academic level and the number of siblings is -0.385. Both coefficients had a significant negative correlation. So the number of siblings in a family was greatly influenced by the mother, whose socio-economic characteristic variables are exogenous and are determined before the birth of the child. Thus, mothers' CPC membership and her highest academic attainment, both of which have a high correlation with the number of siblings, are highly exogenous and meet the requirements of instrumental variables. And in the analysis of the empirical results, Model 6 significantly passes the Durbin-Wu-Hausman test, which means that the number of siblings exists in endogeneity and requires instrumental variables. Meanwhile, the Sargan statistic in Model 6 was not significant, so all of the instrument variables are exogenous and valid. Models 1 – 6 clearly exhibited the consistent finding that having a greater number of siblings had a significantly negative effect on education attainment. Thus, the empirical results above are robust and consistent.

In order to further study differences among different sibling structures, the number of siblings was divided into four variables, namely 'only child', 'birth order', 'eldest child' and 'youngest child'. After introducing these four variables to replace the explanatory variable, the number of siblings, the results obtained are shown in Table 2. The authors obtained a fitted value of the number of siblings by regression, explaining the jointly influence of the number of siblings by other variables, such as gender preference, family social & economic status, household type and other variables. Model 1 including fitted value of the number of siblings by regression the number of siblings, shows that the number of siblings significantly reduced an individual's number of years of education. So the issue of cause-effect is further proved based on the method of instrumental variable in Table 1. Model 2 shows that only children clearly had more years of education. Model 3 reveals that the younger the child is in birth order, the lower the attainment of education and allocation of educational resources the respondent had as a child. Models 4 and 5 verify that the allocation of educational resources favoured the eldest and the youngest; that is, the eldest and the youngest had more educational resources. Moreover, in Model 6, with the addition of two variables, 'eldest child' and 'youngest child', the results show that the category of 'youngest child' has many more

Table 2
Further analysis based on the structure of siblings in families

	Model 1	Model 2	Model 3	Model (4)	Model (5)	Model (6)
Only child		1.4257***				
		(0.17)				
Birth order			−0.0827**			
			(0.03)			
Eldest child				0.3391***		0.5319***
				(0.11)		(0.11)
Youngest child					1.0724***	1.1599***
					(0.10)	(0.11)
Number of siblings	−0.3051***					
	(0.03)					
Fitted value of the number of siblings by regression	−2.2726***					
	(0.07)					
Race property (Han)		0.4738**	0.5222**	0.5153**	0.5028**	0.4856**
		(0.19)	(0.20)	(0.20)	(0.19)	(0.19)
Gender		0.7104***	0.7530***	0.7495***	0.6840***	0.6705***
		(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Type of household		0.9084***	0.9320***	0.9430***	0.8865***	0.8967***
		(0.18)	(0.18)	(0.18)	(0.17)	(0.17)
Highest academic level of father		1.0274***	1.0671***	1.0684***	1.0324***	1.0006***
		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Father works in a public institution		0.0574	0.0099	0.0135	0.0410	0.0438
		(0.19)	(0.19)	(0.19)	(0.19)	(0.19)
Mother works in a public institution		1.3557***	1.5962***	1.5735***	1.5014***	1.3895***
		(0.19)	(0.19)	(0.19)	(0.19)	(0.19)
Father is a CPC member		0.2142	0.1663	0.1596	0.2099	0.2291
		(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
Mother is a CPC member		0.5410*	0.4643	0.4847*	0.5080*	0.5545**
		(0.28)	(0.28)	(0.28)	(0.28)	(0.28)
Constant	16.6465***	6.3496***	6.4572***	6.2246***	6.0686***	5.9291***
	(0.19)	(0.20)	(0.21)	(0.20)	(0.20)	(0.20)
Observations	3760	3760	3760	3760	3760	3760
R-square	0.325	0.336	0.325	0.326	0.342	0.347

significant effects in the number of years of education than has the 'eldest child' category. This finding means that families are more likely to increase the number of years of education for the youngest child. Another explanation for the finding is that because older brothers and sisters have already completed their education when the youngest child is being educated, the younger children will no longer be subject to limited family resources.

4.2. Cross-analysis between gender and years of education

In order to assist visualization of the effects of respondents' gender difference on years of education, Fig. 2 presents the difference under the conditions of different sibling situations. Overall, male respondents had more years of education than had female respondents. However, both female and male respondents showed a gradual decline in the number of years of education as the number of siblings increased, but years of education decreased significantly more rapidly among females than among males. Specifically, with every additional sibling among the female respondents, the females' years of education decreased by 15 percent, while for male respondents, the decrease was only by 10 percent.

To strengthen the results of the above visual presentation, Table 3 demonstrates in detail the different effects of siblings on educational years between males and females. Model 1 shows the results of the interactive term of the number of siblings and the gender of the children: the education years decreased significantly when the next child was female. Model 2 shows that eldest females who had many brothers were associated with fewer opportunities of education, which further verifies the existence of gender discrimination in the allocation of family resources in China. Models 3 and 4 indicate the effect of the number of siblings on years of educational attainment in the different gender groups. The results show that compared to the females, the males experienced a less negative effect from the number of siblings on the years of education. Therefore, hypothesis 2 has been confirmed.

We believe there are two reasons for this finding: firstly, in China, because of the traditional idea of boy preference, families pay more attention to their boys' education; secondly, families in China believe that the education of boys can bring more family return and contribution.

4.3. Cross-analysis between areas and years of education

Fig. 3 shows the boxplot distribution of sibling numbers and years of education from two different regions, both in rural and urban areas. Overall, urban respondents had a significantly higher number of educational attainment years than had rural respondents. However, in both urban and rural areas, as the number of respondents' siblings increased, their years of education showed a gradual decline, but compared with rural areas, the number of years of education among urban respondents (with an increased number of siblings) fell faster. Specifically, for each additional sibling in rural areas, the respondents' number of years of education was reduced by 0.8 years, while that of urban respondents correspondingly decreased by 1.2 years.

The regression results in Table 4 show the impact of different living locations. Model 1 in Table 4 shows that the number of siblings in rural areas actually reduced the children's educational attainment years. For Model 2, the authors created a product of gender, household type (rural, and the number of siblings). Regression coefficients show that these variables had significant constraints on the number of years of education. The significantly negative effect of the interactive term indicates that the number of siblings in rural areas actually had a much more negative effect on female children's years of educational attainment. Comparing the results of Models 3 and 4, we can see that the number of siblings for children in rural areas had a lower negative impact on the number of years of education than it had in urban areas. Thus hypothesis 3 is verified.

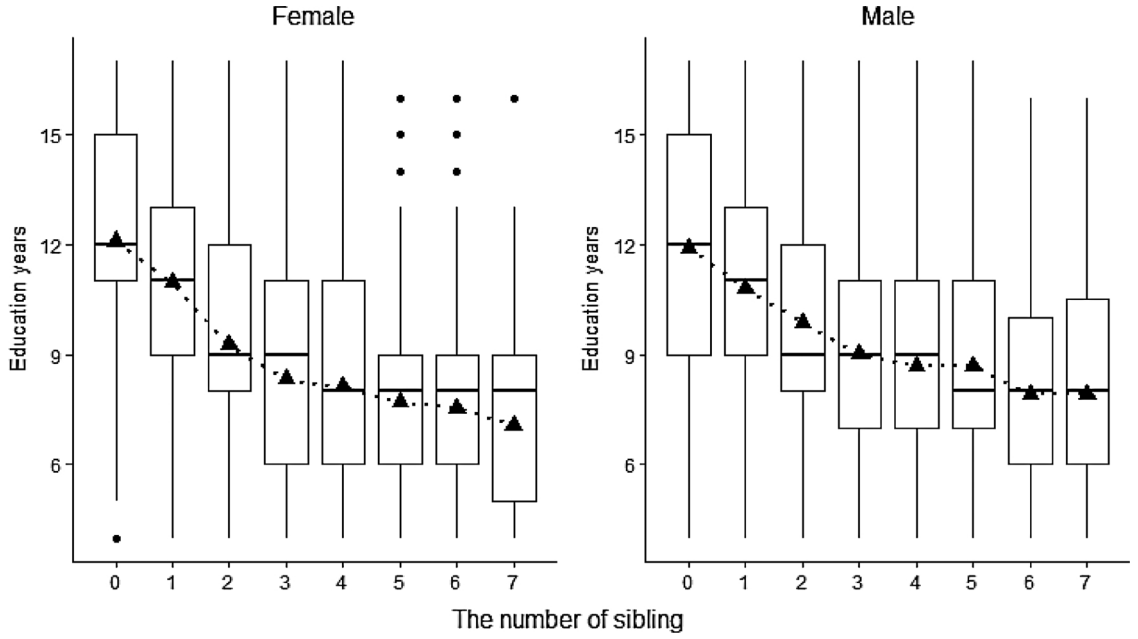

Fig. 2. Boxplot of the number of siblings and years of education.

Table 3
The difference between males and females

Education attainment years	Model 1	Model 2	Model 3	Model 4
	All data	All data	Female	Male
Number of siblings	−0.3844***	−0.3766***	−0.3502***	−0.2745***
	(0.04)	(0.04)	(0.04)	(0.04)
Number of siblings*Gender (= 1)	0.1491***	0.1408***		
	(0.05)	(0.05)		
Number of siblings *eldest daughter (= 1)		−0.1470***		
		(0.06)		
Gender	0.2997*	0.2324		
	(0.17)	(0.17)		
Race property (Han)	0.4301**	0.4113**	0.3141	0.5700**
	(0.19)	(0.19)	(0.26)	(0.29)
Type of household	0.8730***	0.8701***	0.6979***	1.0063***
	(0.17)	(0.17)	(0.24)	(0.25)
Highest academic level of father	0.9463***	0.9442***	0.9871***	0.9180***
	(0.05)	(0.05)	(0.07)	(0.07)
Father works in a public institution	0.0446	0.0467	0.0560	0.0514
	(0.19)	(0.19)	(0.26)	(0.27)
Mother works in a public institution	1.3838***	1.3846***	1.9572***	0.7969***
	(0.19)	(0.19)	(0.25)	(0.27)
Father is a CPC member	0.2680*	0.2702*	0.1095	0.4113*
	(0.15)	(0.15)	(0.21)	(0.22)
Mother is a CPC member	0.5004*	0.4994*	0.5009	0.4939
	(0.28)	(0.28)	(0.39)	(0.40)
Constant	7.7214***	7.8102***	7.6143***	8.1089***
	(0.24)	(0.24)	(0.30)	(0.32)
Observations	3760	3760	1879	1881
R-square	0.347	0.348	0.394	0.296

The reasons for the verification are twofold. First, although the per capita income of Chinese urban residents is higher than that of rural residents, the urban education expenditure in China is greater, which affects the distribution of family resources. Second, the number of educational years of children in rural areas, where the effect of the number of siblings on years of education is relatively smaller, is lower than it is in urban areas.

4.4. Natural experiment based on reform

The reform and opening up in 1978 was an important turning point in Chinese history. It not only led to changes in the economy, society and politics, but also greatly affected the lives of the Chinese people. Given that the age of admission to primary school is six-years old, and the data used in this paper indicate that the average education period of the respondents was 9.3988 years (see Table A1), some of the respondents must have received their primary education more than 16 years ago (1978-16 = 1962). In other words, respondents who were born before 1962 obtained the lowest academic qualifications before the reform and opening up; otherwise, after 1962, the highest academic qualification was obtained after the reform and opening up. Therefore, the year 1962 is taken as the key timeline. Respondents were divided into two groups: before and after the reform, so as to test the effects of the reform on the number of siblings and the number of years of education. Fig. 4 clearly shows that before the reform, due to China's planned economic system and unimplemented OCP, schooling years per capita were very short. And, of course, the number of siblings did not significantly affect the respondents' number of educational years. But after the reform, China shifted from a planned economy to a market economy, and governments invested limited resources in economic development, which drastically reduced public finance expenditures on public education and compulsory education, and thus personal education expenditure rose significantly. Economic growth led to the increase of respondents' overall education years, but when the number of siblings increased, the respondents' number of educational years significantly decreased.

To strengthen the above phenomenon, the regression results in Table 5 provide more reliable empirical results. Model 1 in Table 5 shows that as time went on, the respondents' number of educational years significantly increased.

In Model 2, the interactive term (The number of siblings*Gender*Period (= 1)) is used in detail to test the superimposed effect based on the DID model. The significantly negative regression coefficient indicates that the number of siblings after the

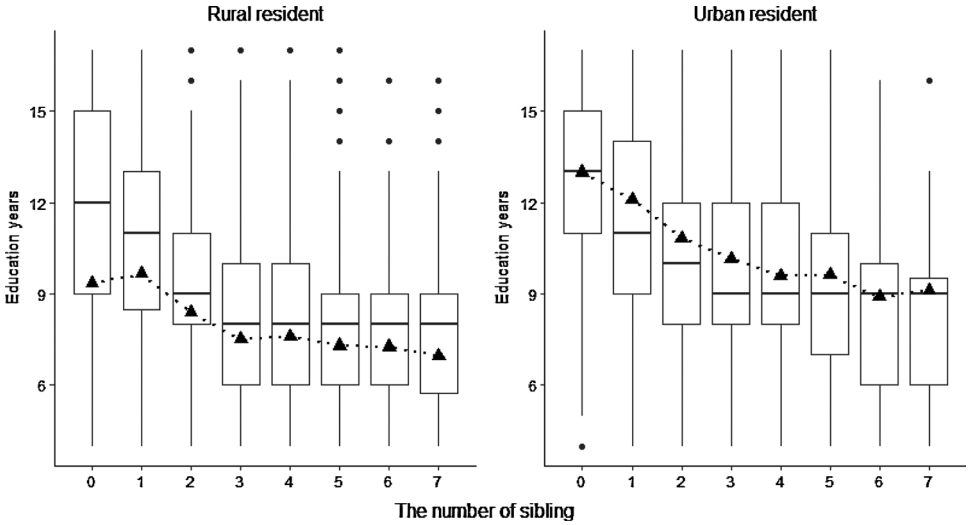

Fig. 3. Boxplot of number of siblings in rural and urban areas and years of education.

reform actually had a much more negative effect on the children's number of educational years. Since the reform, the number of educational attainment years significantly increased. Family income is no longer dependent on the number of children, but on the quality of the children's return on investment. Further comparison of Models 3 and 4 are also true for this result. Thus hypothesis 4 is confirmed.

4.5. Robustness test

The parents' highest academic level represents the status of children's educational background, so it can describe children's educational attainment and replace the variable of educational years to check the robustness of the regression results. As Table A5 shows, the results are almost identical to those in Table 1. Therefore, the number of siblings has a robust effect on children's educational attainment.

5. Conclusion

Based on the analysis of CGSS data, the paper reports on the effects of the number of siblings on the number of a person's educational years in China. The study found that consistently stable conclusions can be drawn in different models. First, the number of siblings in China can have a significantly negatively effect in terms of restricted educational opportunities and a reduced number of years of education. Second, although both male and female respondents were faced with fewer educational years with the increasing number of siblings, females were more negatively affected than were men. Third, in considering whether the respondents were an only child in a family and the child order in the family (i.e. whether they were the eldest or youngest child), the authors also found that there is a strong eldest son preference and youngest child preference in China. Respondents' order of siblings in the family had a significant effect on their number of educational years. Fourth,

Table 4
The difference between urban and rural areas

Educational attainment years Residential characteristics	Model 1 All residents	Model 2 All residents	Model 3 Rural residents	Model 4 Urban residents
Number of siblings	−0.2774***	−0.3929***	−0.2561***	−0.4411***
	(0.03)	(0.05)	(0.03)	(0.05)
Number of siblings* Rural(= 1)	0.1102*	0.1805***		
	(0.06)	(0.06)		
Number of siblings* Female(= 1)* Rural(= 1)		−0.1306***		
		(0.04)		
Rural(= 1)	−1.1930***	−1.2084***		
	(0.24)	(0.24)		
Female(= 1)	−0.7127***	−0.4452***	−0.9509***	−0.3535**
	(0.24)	(0.13)	(0.13)	(0.15)
Race property (Han)	0.4408***	0.4437**	0.5776**	0.0546
	(0.19)	(0.19)	(0.23)	(0.36)
Highest academic level of father	0.9358***	0.9367***	1.1813***	0.7293***
	(0.05)	(0.05)	(0.08)	(0.07)
Father works in a public institution	0.0462	0.0456	0.0039	−0.1086
	(0.19)	(0.19)	(0.26)	(0.27)
Mother works in a public institution	1.3080***	1.2987***	0.9326*	1.5094***
	(0.19)	(0.19)	(0.54)	(0.20)
Father is a CPC member	0.2766**	0.2746*	0.5011***	0.2017
	(0.15)	(0.15)	(0.23)	(0.19)
Mother is a CPC member	0.4901**	0.4939*	1.2476*	0.4432
	(0.28)	(0.28)	(0.66)	(0.29)
Constant	8.4063***	9.1955***	6.8697***	9.6782***
	(0.23)	(0.30)	(0.27)	(0.45)
Observations	3760	3760	2393	1367
R-square	0.346	0.348	0.163	0.303

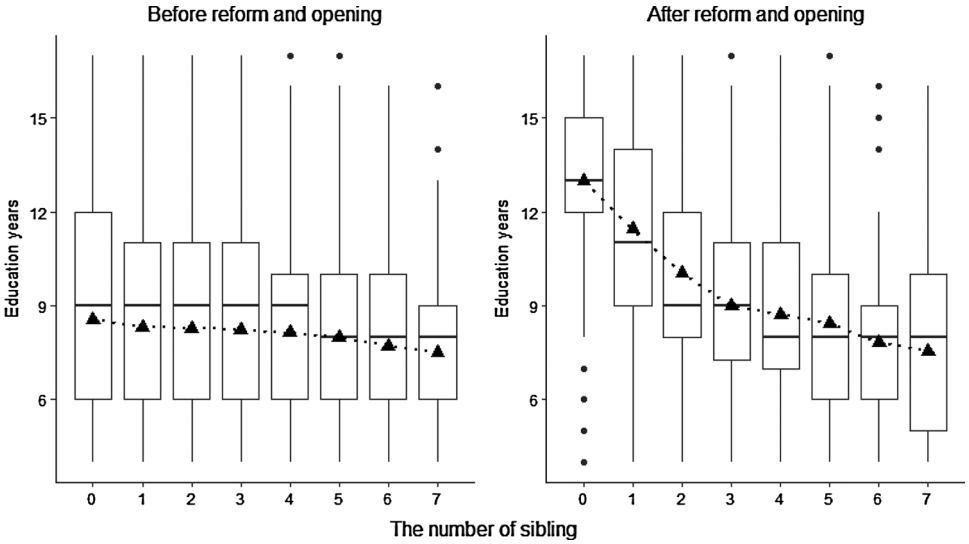

Fig. 4. Boxplot of educational years by the number of siblings before and after the reform.

the negative effect of the number of siblings on the number of years of education in urban areas was higher than it was in rural areas. Fifth, based on the experimental method, this paper found that since the reform and opening up, the number of siblings has had a greater negative effect on the number of the respondents' educational years. Overall, the gender difference has been shrinking, and the study did not support the results of similar scholars. For example, Lu and Treiman (2008) found that the effect of the number of siblings on educational level was different in different national policies during different periods in China, meaning that national policies can alleviate the adverse effects of insufficient household resources.

6. Discussion

Since the population is the main predictive indicator of a country's prospects, the quality and quantity of the population are related to the country's future development. The research in this paper helps to summarize the driving force of long-term economic growth since the reform and opening up, and also helps to predict the future development potential in China, as well as equal society potential. On the theoretical level, compared to existing studies (Blaabæk et al., 2019; Lu & Treiman, 2008), this paper found that the relationship between the number of siblings and the educational attainment in China is very complicated. It is not only affected by factors within families, such as

Table 5
. Difference between before and after the reform and opening up

Period	Model 1 All data	Model 2 All data	Model 3 Before reform and opening up	Model 4 After reform and opening up (= 1)
The number of siblings	−0.0176	−0.3264***	−0.0087	−0.4266***
	(0.04)	(0.04)	(0.04)	(0.04)
Period	2.2373***	1.2220***		
	(0.21)	(0.14)		
The number of siblings*Period	−0.3916***			
	(0.06)			
The number of siblings*Gender		0.2211***		
		(0.05)		
(The number of siblings*Gender) * Period (= 1)		−0.1409***		
		(0.05)		
Race property (Han)	0.5036***	0.5127***	0.1861	0.6269***
	(0.19)	(0.19)	(0.34)	(0.23)
Gender	0.7581***	0.3829*	0.9607***	0.6897***
	(0.10)	(0.17)	(0.16)	(0.12)
Type of household	0.8967***	0.9110***	1.4414***	0.6558***
	(0.17)	(0.17)	(0.31)	(0.21)
Highest academic level of father	0.7811***	0.8104***	0.7168***	0.7988***
	(0.05)	(0.05)	(0.10)	(0.06)
Father works in a public institution	0.0420	0.0450	0.1651	−0.0330
	(0.18)	(0.18)	(0.33)	(0.22)
Mother works in a public institution	1.3792***	1.4779***	1.2090***	1.4584***
	(0.18)	(0.18)	(0.32)	(0.23)
Father is a CPC member	0.3210**	0.2858	0.2187	0.3651**
	(0.15)	(0.15)	(0.27)	(0.18)
Mother is a CPC member	0.6278**	0.5921**	1.0420**	0.4599
	(0.27)	(0.28)	(0.49)	(0.33)
Constant	5.9353***	6.7624***	5.9642***	8.2073***
	(0.26)	(0.26)	(0.38)	(0.28)
Observations	3760	3760	1303	2457
R-square	0.367	0.362	0.251	0.351

the gender structure of children's birth order, eldest daughter and the social-economic status of parents, but also by national macro-policies and background regional economic development. Also, in different stages of social and economic development, the contributions of different influencing factors vary (Galor & Moav, 2002). Therefore, the quantity-quality trade-off analysis perspective has its limitations in different stages of economic development in China. At the same time, the resource dilution hypothesis is weakened under the influence of macro policies and regional development imbalances. At the policy level, the results of this paper show that the education marketization policy in China's reform and opening up needs to pay more attention to urban poor families' children's education access and reduce the cost of private education expenditures in urban and rural areas while improving the education level of the whole society. For example, in the future, the government can increase investment in public schools by issuing education vouchers.

In addition, since the reform and opening up, the difference in educational years between male and female respondents has been significantly reduced. Specifically, after the reform, the cost of education afforded by the government during the planned economy period was transferred to the family. In the case of families with limited resources, if the first child was a daughter, with every increase in the number of siblings, her educational years were shortened more than they were for boys. Compared with the situation before the reform and opening up, the phenomenon of gender discrimination in education has gradually been weakening. However, this weakening may also be caused by China's implementation of the OCP in 1982, but further analysis is still necessary. And further work is needed to understand how the effects of family size on educational attainment vary between different contexts, over time, by gender, etc.

Research data for this article

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CRediT authorship contribution statement

Feng Xiong: Conceptualization, Methodology, Data curation, Visualization. **Leizhen Zang:** Data curation, Writing - original draft, Investigation, Supervision. **Ling Zhou:** Writing - review & editing. **Fei Liu:** Writing - review & editing.

Declaration of Competing Interest

The authors report no declarations of interest

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ijedudev.2020.102270.

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