J Popul Econ (2017) 30:569–590
DOI 10.1007/s00148-016-0614-z

ORIGINAL PAPER

Sibling gender composition's effect on education: evidence from China

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Received: 2 February 2015 / Accepted: 23 August 2016 / Published online: 10 September 2016
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Abstract We use a population survey of the Chinese adult population—2010 Chinese Family Panel Studies (CFPS) modeled after the Panel Study of Income Dynamics. We find that being the oldest child gives an education benefit to male and not female children who are often assigned supervisory roles for younger siblings. Most importantly, an increase in the fraction of female siblings leads to a significant increase in education of Chinese men and to a lesser extent Chinese women. This effect is concentrated among those with rural Hukou. In China, male children absorbed more education resources so that in a credit constrained family, increases in fraction of siblings who are sisters frees up resources for educating boys. This is less so for girls since their education was lower and additional resources would not be used for them.

Keywords Education · Siblings · China · Gender composition

JEL Classification I20 · I25 · J16 · J24

1 Introduction

Using a full adult-age population survey of Chinese residents, the China Family Panel Studies (CFPS), this paper examines the effect of family structure, in particular sibling gender composition, on education accomplishments of men and women. We also explore for both genders how this effect differs before and after the One Child Policy

Responsible editor: Junsen Zhang

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(OCP) and between urban and rural Hukou respondents who were differentially affected by the OCP.

Family characteristics, such as parental education, number of siblings, and sibling composition may play an important role in children's development and educational attainment. In recent years, researchers have studied the relationship between sibling gender composition and children's educational attainment (Butcher and Case 1994; Kaestner 1997). Sibling sex composition may affect children's educational attainment through various pathways (Becker and Lewis 1973; Butcher and Case 1994). One view is that having more brothers may be beneficial to one's educational outcomes than having more sisters in a son-preference society (Conley 2000). Having more brothers may impel the family to put more resources into education so that girls may benefit more from a better educational environment. In addition, a family with more male children may have male-role expectations socialized into all the children regardless of their actual gender.

Another view implies that if an individual is a minority with respect to her/his siblings' gender, she/he will have a special status and this special status will be beneficial to her/his educational achievement (Rosenberg 1965). The third view, based on the sibling rivalry theory, states that families tend to devote more resources to the preferred gender if they face credit constraints (Garg and Morduch 1998; Morduch 2000).

Most of the empirical literature uses data from developed countries like the USA, where gender preference affects the childbearing decision and family structure modestly (Ben-Porath and Welch 1976). Therefore, our study about China may contribute to the literature in the following perspectives. First, son preference is more widespread, implying possibly larger potential effects on fertility behavior and family structure. Second, the implementation of OCP in China has produced a dramatic and heterogenous transform of fertility choice and family structure. Third, there is some evidence that OCP may exacerbate son preferences in China (Merli and Smith 2002; Smith et al. 2014), which may reinforce the effect of sibling sex composition on investment in children's education. Fourth, over the past three decades, China has experienced rapid economic growth, generating large heterogeneities in family resources that can be allocated to children's education. As a result, China has provided an opportunity to study how sibling gender composition affects the educational attainment in a developing country under unique economic and demographic transitions.

Using a full adult-age population of Chinese residents, we find a strong negative effect of number of siblings on education. We also find that being the oldest child enjoys an education benefit. Whether we control for number of siblings or not, an increase in the fraction of siblings who are girls leads to a significant increase in education of Chinese men, and to a lesser extent Chinese women.

We also find very heterogeneous effects between those who have urban Hukou and those with rural Hukou. The education attainment of the rural residents is much lower than that of the urban residents. Men generally have higher education than women, but the gender gap is narrowed for the younger group, especially for rural residents. We also find that the percent of girls as siblings has larger positive impacts on the education of those with rural Hukou, especially for men and for the younger group.

This paper is divided into five sections. The next section reviews the relevant literature on this subject while Sect. 3 explains the main data that will be used in the analysis in this paper—the 2010 national baseline of the CFPS. Section 4 summarizes the principal empirical findings of the research. The final section highlights our main conclusions.

2 Literature Review

Several important studies have shown consistent evidence of male bias both in developed and developing countries. For instance, Das Gupta (1987) examined sex bias in Punjab society in India, and the data support the hypothesis that sex bias is focused on higher birth-order girls. Furthermore, fertility decline heightens such selective discrimination, and women's education faces stronger discrimination against higher birth-order girls. The reason for this strong preference for sons lies on the women's structural marginalization in their culture.

Deuchler (1992) studied the Confucian transformation in Korea. This book compared the traditional society of Korea with that of China in order to examine their similarities and differences about their Confucian culture transformation. One important point in this book is that Korean traditional society is based on a bilineal kindred system, while China society has the notion of a lineage system. Furthermore, matrilineal characters are more conspicuous in Korean society than in China in many aspects. For example, matrilineal kin are treated more generously in mourning and funeral rites. Second, newly married bridegrooms often have to stay for a long time at their bride's parents' house. Third, maternal family was equally important in determining the status of offspring as patrilineal family.

Classical papers on sibling rivalry also reveal sex bias. Garg and Morduch (1998) point out that if pro-male bias exists, sibling rivalries can yield gains for those who have relatively more sisters than brothers. They use rich survey data from Ghana to examine sibling's gender composition on their health and find that those children having all sisters would do 25–40 % better on measured health indicators than those having all brothers. Morduch (2000) uses data on young teenagers from South Africa and Tanzania to investigate sibling composition's effect on education attainment. From the data of Tanzania, completed years of school is increased by 0.44 years when moving from an all-brothers to all-sisters scenario, while the data of South Africa shows insignificant effects of sibling composition.

Rose (2000) tries to explore the impact of a child's gender on Indian rural households' time allocation for the 5-year period subsequent to a child's birth. The findings indicate that women work less subsequent to the birth of a son relative to a daughter, and this effect differs substantially due to binding credit constraints in these households. Lundberg and Rose (2002) use the Panel Study of Income Dynamics (PSID) sample to examine the effects of children and different gender of children on men's labor supply and hourly wage rates. They find that births of children, especially births of sons, have a significantly positive impact on father's labor supply and hourly wage rates.

Ananat and Michaels (2008) exploit the variation that having a female firstborn child increases the probability that a woman's first marriage breaks up, to measure divorce's impact on economic outcomes. Their results show that divorce widens the income distribution. Dahl and Moretti (2008) explored parental preferences for sons from aspects of divorce, child custody, marriage, shotgun marriage when the gender of the child is known before birth, and fertility decision. They show that preference for sons is prevalent in the USA and largely driven by fathers. However, these effects for the USA are much smaller than developing countries such as China.

Recent evidence from some developing countries, like China, India, and Taiwan, also indicate some kinds of sex bias. Wei and Zhang (2011) try to explain the high and rising household savings rate in China by proposing a new competitive saving motive. They use cross-regional and household-level data to prove that Chinese parents with a son increase their savings in order to raise their son's relative competence for marriage, as the sex ratio rises. Jayachandran and Kuziemko (2011) try to explain why mothers breastfeed girls less than boys through data from India. They find the following results: breastfeeding duration increases with birth order, and is lowest for daughters and children without older brothers, and exhibits the largest gender gap near target family size. Under this situation, child survival exhibits similar patterns as breastfeeding.

From the literature above, we find that boy preference is common both in developed and developing countries. The gender bias could affect decisions on fertility, childcare, child education, parents' labor supply, marriage, etc. This paper investigates sibling gender composition's impact on child education in China, where son preference has a long history under the Confucian cultural background and may become stronger with the implementation of the OCP.

Sibling sex composition's effect on educational attainment is a branch of literature about sibship size's effect. Powell and Steelman (1990) explore the effects of sibling density and sex composition on educational outcomes. Using High School and Beyond data, they find a strong negative effect of the number of siblings closely spaced on education of those children. Butcher and Case (1994) investigate the impact of sibling sex composition on the education of men and women born in America between 1920 and 1965. After controlling for household size, they find that women raised only with brothers received significantly more education than women with any sisters on average, an impact that has decreased over time. In contrast, male education was not affected by the sex composition of his siblings.

Butcher and Case's (1994) paper has drawn much attention with many scholars replicating or revising their methods to explore the relationship between sibling gender composition and educational attainment. For example, Kaestner (1997) examined the relationship between sibling gender composition and educational attainment using data from the National Longitudinal Survey of Youth (NLSY). While this study replicates in many ways (Butcher and Case 1994), it finds that sibling sex composition has no effects on educational attainment of white males or females, while having sisters has positive effects on the educational attainment of black adults. Hauser and Kuo (1998) use data from the Occupational Changes in a Generation Survey, the Survey of Income and Program Participation, and the National Survey of Families and Households to analyze effects of sibling gender composition on educational attainment among different cohorts of women. They find little evidence that the presence of sisters or the percentage of sisters in the sibship affected women's schooling in the USA during this century, a conclusion obviously quite different from that of Butcher and Case (1994) and Kaestner (1997).

Conley (2000) using data from the 1989 wave of the PSID concludes that the increased number of siblings of the opposite gender is harmful to respondents' educational attainment no matter what respondents' gender is. The reason is that gender-minority children's specific needs are unable to be met. Yu and Su (2006) examine various sibship characteristics' (including family size, sibship density, birth-order rank, and sibship gender composition) influence on educational attainment in Taiwan. Through the analysis of a sibling sample of 12,715 observations drawn from a national survey, they find that first-born sons have privilege while first-born daughters do not, the harm of sibship density receives little support in Taiwan, and girls benefit from being the minority gender in the sibship.

Black et al. (2005) examined effects of family size and birth order on children's education attainment using a rich dataset from Norway. After using instrumental variables for family size, its negative impact on education becomes negligible. In contrast, birth order has a significantly negative effect on children's education. In addition, birth order also has significant associations with adult earnings, employment, and teenage childbearing, especially among women. Similarly, Chen et al. (2014) use 0.8 million Taiwanese first-born data to investigate the male siblings' impact on first-born children's education. Having a brother might have two channels affecting first-born children's education: the direct one due to human capital investment difference, and the indirect one due to decreasing sibsize. The results show neither has a significant effect on first-born boys' education. For first-born girls, both pathways are important in explaining their education but go in opposite directions. The total effect results in nearly zero.

In summary, conclusions about the relationship between sibling gender composition and educational attainment from the literature vary based on different theories and data used in the empirical work. Furthermore, most of the empirical work is drawn from an investigation in developed countries/regions. In this paper, we will use China Family Panel Studies data to study this important issue in present-day China to make contributions in the following aspects. First, we employ national representative data from China to test which theory plays a leading role in the largest developing country. Second, China faced a fertility transition with the implementation of OCP in the past decades, so we compare effects in different birth cohorts as this could reveal this relationship under changing family structure and son preference atmosphere. Third, China has been relaxing its birth control policy in recent years and now all couples are allowed to have two children. Therefore studying the impact of sibling gender composition effect on education may reveal some policy implications for the future.

3 Data Description—CFPS 2010

For our analysis, we will use data from the 2010 national baseline of the CFPS. Since it is designed following the PSID, CFPS is often called the Chinese PSID. CFPS, collected by the Institute of Social Science Survey at Peking University, is a biennial survey with the first wave conducted in 2010. Since CFPS collects data on different levels of aggregation—communities, households, and individuals—it makes it possible to study social and economic issues in China over the full age range of the adult Chinese population. Its questionnaire covers demographics, socioeconomic conditions, education, and health of respondents, facilitating research in China on a variety of topics.

The national baseline of CFPS was conducted in 2010 in 25 provinces[1] covering 95 % of the Chinese population, which makes it close to nationally representative. CFPS adopts a multistage stratification with probability proportional to size (PPS) sampling strategy and divides the whole population into six sampling frames aimed at generating national representative and provincial representative samples. In the first

[1] Tibet, Qinghai, Xinjiang, Ningxia, Inner Mongolia, Hainan, Hong Kong, and Macao were not included.

stage, 144 county-level units are randomly selected. In the second stage, 640 village-level units (villages in rural areas) are selected; and lastly, 14,000 households are selected at the third stage in these areas. All members within each household are interviewed, except those who were not currently at home. In this paper, we will use the national representative sample, which includes 9658 households and 21,822 adults. There is another category of persons who also enter into our sample besides these respondents from the adult questionnaire: siblings of the respondents even if they don't live together and children of the respondents even if they do not live together.

Household members are defined as family members who live together and who are directly related due to genetics, marriage, adoption or fostering, or nonfamily members living together for more than 3 months who share economic resources as a unit. CFPS asks information on all of these household members across the full age distribution. For the purpose of this paper, we mainly use data from the household questionnaire and adult questionnaire. The household questionnaire collects demographic and socioeconomic information on families, including their fertility histories, while the adult questionnaire collects demographic, social relationship, economic, educational and health information on individuals in the households. From these two questionnaires, we know each adult's sibling gender composition, and everyone's education level. Education levels are known even for adult's siblings who are no longer living in the parental home. As a result, CFPS provides very good data to study sibling gender composition's effect on educational attainment.

Table 1 provides summary statistics of CFPS 2010. We first split the full sample into three age cohorts (aged 25–34, aged 35–44, aged 45–65), according to the degree of being affected by OCP.[2] For each age cohort, the statistics are calculated for six subgroups: male and female, urban/rural male, and urban/rural female.[3] On average, education levels of male and urban residents are higher than those of female and rural residents. Younger cohorts are better educated than older cohorts, a reflection of the large secular increase in education in China, especially for Chinese women (Lei et al. 2012). Reflecting the same forces, respondents' fathers always have higher education level than their mothers which are both much lower than their same-gender children.

The numbers of siblings for male and female cohorts are decreasing over time, from 4.19 and 4.30 for the 45–65 cohort to 2.30 and 2.50 for the 25–34 cohort. In all three age groups, women have more siblings than men, a reflection of the desire of many Chinese families to have at least one son (Smith et al. 2014). This gender gap is wider among rural younger cohorts. Rural residents have more siblings due to less strict implementation of OCP in such areas.[4]

[2] Even though OCP started from 1979 (it was written into the Constitution in 1982 and was effective since 1983), we used a more strict criteria of 1976 (aged 34) in case OCP had been informally enforced in some areas before 1979.

[3] Note that the Hukou status used here is the Hukou status in 2010, which might be different from the Hukou status at birth due to migration/urbanization. In our regression, we include a dummy for father's Hukou status to control for such effect.

[4] We observe that the number of siblings are high even for the cohort subject to OCP in urban area, and this is consistent with census 2010. This could be due to three reasons: (1) because we used a very strict year standard to identify the OCP era, the youngest group still include children born before OCP; (2) children born in the OCP era may have older siblings who were born before OCP; (3) as mentioned in footnote 3, a certain fraction of the urban households as defined this way may actually be rural when the child(ren) was/were born, so the number of siblings could still be larger.

Table 1 Summary statistics: CFPS 2010

Variable	All male	All female	Urban male	Urban female	Rural male	Rural female
Age 25–34						
Education	8.77	8.20	11.48	11.52	7.92	7.23
Have sister	0.72	0.71	0.57	0.59	0.77	0.74
Girl %	0.35	0.69	0.28	0.74	0.38	0.67
Num brother	0.94	1.17	0.62	0.86	1.04	1.26
Num sister	1.36	1.34	0.94	0.96	1.49	1.44
Num sibling	2.30	2.50	1.55	1.82	2.53	2.70
Dad ed years	6.18	6.23	8.24	8.49	5.54	5.59
Mom ed years	4.48	4.55	6.59	6.76	3.81	3.91
Oldest kid	0.31	0.34	0.42	0.44	0.28	0.31
Birth order	2.68	2.53	2.19	2.16	2.83	2.64
Dad urban	0.21	0.19	0.75	0.74	0.04	0.04
Mom urban	0.18	0.15	0.70	0.65	0.02	0.01
Age	30.12	29.99	30.30	30.19	30.06	29.93
Age 35–44						
Education	7.99	7.00	10.52	9.97	7.20	6.05
Have sister	0.86	0.85	0.81	0.80	0.87	0.86
Girl %	0.38	0.62	0.38	0.64	0.39	0.61
Num brother	1.73	1.85	1.45	1.60	1.82	1.92
Num sister	1.88	1.91	1.70	1.73	1.94	1.97
Num sibling	3.61	3.76	3.15	3.33	3.75	3.90
Dad ed years	5.06	5.01	6.84	6.75	4.51	4.46
Mom ed years	3.49	3.53	4.94	4.98	3.04	3.06
Oldest kid	0.17	0.19	0.20	0.24	0.17	0.18
Birth order	3.38	3.32	3.18	3.09	3.44	3.39
Dad urban	0.23	0.23	0.85	0.83	0.04	0.04
Mom urban	0.19	0.19	0.77	0.76	0.01	0.01
Age	39.93	39.90	39.88	39.87	39.94	39.90
Age 45–65						
Education	7.54	6.00	9.39	8.53	6.80	4.97
Have sister	0.88	0.88	0.87	0.87	0.88	0.89
Girl %	0.38	0.60	0.37	0.61	0.38	0.59
Num brother	2.14	2.20	2.03	2.09	2.19	2.24
Num sister	2.05	2.10	1.99	2.03	2.08	2.13
Num sibling	4.19	4.30	4.02	4.12	4.26	4.37
Dad ed years	3.91	3.89	4.80	4.78	3.58	3.55
Mom ed years	2.63	2.65	3.17	3.18	2.43	2.44
Oldest kid	0.27	0.28	0.26	0.27	0.27	0.28
Birth order	2.76	2.76	2.82	2.83	2.73	2.74
Dad urban	0.28	0.28	0.95	0.95	0.01	0.02
Mom urban	0.26	0.26	0.90	0.90	0.01	0.01
Age	53.90	53.63	54.03	53.66	53.85	53.62

Girl % includes the respondent himself/herself; dummy variable "oldest" also equals to 1 if there is only one child in a family; Dad urban and Mom urban are the dummy variables for father's and mother's Hukou status; 1 means have an urban Hukou

Hukou is a special term in China that shows the legal residence registration of the Chinese. A person's Hukou status is determined at birth by his/her parents and can only be changed under special conditions; for example, a rural Hukou person may be able to change his/her status to urban if he/she is admitted to a university. The urban ratio based on Hukou status is much lower than that based on current residence since many rural Hukou people have moved to the urban areas. In this paper, Table 1 documents that those with rural Hukou status overwhelmingly share that status with their parents, while that is much less true for those with urban Hukou status.

4 Results

Before exploring the relationship between siblings' sex composition and educational attainment in China, we first describe in more detail Chinese respondents' educational outcomes. Table 2 lists the fraction of men and women with their completed education level falling into the following five groups—below primary (essentially no schooling), primary, middle school, high school, and college and above. The numbers are calculated from the perspectives of age cohort, gender, and Hukou status as in Table 1. Once

Table 2 Percentage of men and women having finished each education level

Variable	Age 25–34		Age 35–44		Age 45–65	
	Male	Female	Male	Female	Male	Female
All						
Below primary school	11.5 %	16.9 %	14.1 %	23.7 %	20.4 %	39.6 %
Primary school	20.0 %	22.2 %	26.1 %	29.8 %	25.9 %	23.5 %
Middle school	41.7 %	37.9 %	41.3 %	32.8 %	33.3 %	22.9 %
High school	14.0 %	11.1 %	11.3 %	8.7 %	16.1 %	11.7 %
College and above	12.7 %	11.9 %	7.2 %	5.0 %	4.3 %	2.2 %
Observations	3804	4239	8828	9061	15,724	15,270
Urban Hukou sample						
Below primary school	1.7 %	1.7 %	2.5 %	4.9 %	6.9 %	14.9 %
Primary school	6.8 %	6.0 %	9.6 %	12.4 %	16.9 %	17.7 %
Middle school	32.0 %	34.7 %	41.7 %	42.9 %	40.1 %	36.1 %
High school	26.3 %	22.6 %	25.6 %	23.6 %	25.5 %	25.2 %
College and above	33.1 %	35.1 %	20.6 %	16.3 %	10.6 %	6.2 %
Observations	908	957	2110	2184	4482	4416
Rural Hukou sample						
Below primary school	14.6 %	21.3 %	17.8 %	29.7 %	25.7 %	49.7 %
Primary school	24.2 %	27.0 %	31.2 %	35.4 %	29.5 %	25.9 %
Middle school	44.8 %	38.9 %	41.2 %	29.6 %	30.6 %	17.5 %
High school	10.1 %	7.7 %	6.8 %	3.9 %	12.4 %	6.3 %
College and above	6.3 %	5.1 %	3.0 %	1.3 %	1.9 %	0.6 %
Observations	2896	3282	6718	6877	11,242	10,854

again, there are two salient patterns highlighted in Table 2—large gender disparities in education and rapid growth in education over time especially among Chinese women.

To highlight gender disparities, we examine the last age group in Table 2—those aged 45–65. The fraction of the population with below primary school education is almost twice as high among Chinese women (39.6) compared to Chinese men (20.4 %), with similar relative gender education disparities for those with college or above. In absolute terms, in this age group, this gender discrepancy is particularly large for those with rural Hukou. Fifty percent of rural Hukou women had no formal schooling—twice the rate of comparably aged rural Hukou men.

The age patterns in Table 2 also highlight dramatic improvements in education across birth cohorts in China over time, especially for women. A total of 39.6 % of women ages 45–65 had less than primary education compared to 16.9 % of women between ages 25–34. Rates of obtaining college degrees more than doubled over this time period for men while they increased almost fivefold among Chinese women.

Changes over time taking place among Chinese men were large as well, but not as rapid as among women so that the gender gap in education in China has narrowed significantly over time (Lei et al. 2012). The improvement patterns in education are different for urban and rural female residents, with urban female's mainly coming from increases in higher education while rural female's primarily reflects reductions in illiteracy. To illustrate, 6.2 % of urban females aged 45–65 have some college or more, compared to 35.1 % of the youngest counterparts. Correspondingly, the illiteracy rate of the rural female decreased from 49.7 % for the oldest cohort to 21.3 % for the youngest cohort. Among the youngest age group in Table 2 in the urban Hukou status, there appears actually to be a small education advantage for Chinese women compared to Chinese men. With that exception, the gender gap in education outcomes still exists no matter which age cohorts we examine, but it is much smaller now than was historically the case in China. In light of the dramatic patterns highlighted in Table 2, we will estimate separate models below by gender, for all three age groups, and for urban and rural Hukou respondents separately.

Table 3 illustrates the descriptive relationship between sibling gender composition and educational attainment stratified by number of siblings for both Chinese men and women for the combined age group of those ages 25–65. These descriptions are also provided separately by Hukou status. Within each sibship group, Table 3 provides a test of differences in education by gender composition with the no-sister sibling group always being the comparison group. Before discussing gender composition effects, note that for both Chinese men and women mean education declines with number of siblings. Men with no siblings have 8.79 years of schooling compared to 7.85 years of schooling for men with three siblings. The parallel comparison for Chinese women gives 7.70 years of schooling for the 0 sibling category compared to 6.82 years for women with three siblings. Similar patterns exist within both Hukou statuses.

Within number of sibship groupings, sibling gender composition has a significant association with mean completed years of schooling for both men and women alike. Having only sisters leads to higher levels of education than having only brothers, an association that is particularly strong for men in general and in the three-sibling grouping in particular. For example, for men with three sisters, their mean years of schooling are 1.22 years higher than for men with three brothers. For women, the comparable difference in the three-sibling example is 0.15 more years of schooling when all three siblings are sisters rather than brothers, an association that is statistically insignificant. This pattern of

Table 3 Mean years of complete education by number and gender of siblings

		All men		All women		Urban men		Urban women		Rural men		Rural women	
Number of siblings	Gender composition	Mean	Test diff	Mean	Test diff	Mean	Test diff	Mean	Test diff	Mean	Test diff	Mean	Test diff
(a) Ages 25–65													
0 siblings	–	8.79	–	7.70	–	11.35	–	11.25	–	6.86	–	5.13	–
1 sibling	0 sister	8.53	–	8.19	–	11.17	–	10.95	–	7.21	–	6.84	–
	1 sister	8.89	0.359**	8.29	0.102	11.11	−0.060	11.28	0.331	7.77	0.559***	6.77	−0.069
	All	8.73	–	8.23	–	11.13	–	11.08	–	7.53	–	6.81	–
2 siblings	0 sister	8.28	–	7.33	–	10.34	–	9.84	–	7.34	–	6.29	–
	1 sister	8.37	0.087	7.42	0.087	10.36	0.025	10.06	0.217	7.51	0.169	6.33	0.038
	2 sisters	8.51	0.231	7.87	0.538***	10.57	0.228	10.18	0.334	7.61	0.268	6.42	0.131
	All	8.38	–	7.47	–	10.41	–	10.02	–	7.50	–	6.33	–
3 siblings	0 sister	7.28	–	6.64	–	10.16	–	8.96	–	6.29	–	5.83	–
	1 sister	7.65	0.362**	6.60	−0.032	9.75	−0.413	9.13	0.166	6.93	0.633***	5.73	−0.100
	2 sisters	8.01	0.724***	7.10	0.462***	9.95	−0.214	9.76	0.800***	7.34	1.042***	6.13	0.298*
	3 sisters	8.50	1.217***	6.78	0.147	10.41	0.246	9.82	0.852**	7.79	1.492***	5.70	−0.130
	All	7.85	–	6.82	–	9.97	–	9.43	–	7.12	–	5.89	–
(b) Ages 25–34													
0 sibling	–	10.38	–	11.21	–	12.47	–	13.45	–	8.30	–	8.29	–
1 sibling	0 sister	9.31	–	9.16	–	11.91	–	11.53	–	8.07	–	8.27	–
	1 sister	9.56	0.249	9.77	0.611***	11.50	−0.410	12.06	0.532	8.80	0.727***	8.62	0.355
	All	9.47	–	9.39	–	11.67	–	11.76	–	8.53	–	8.40	–
2 siblings	0 sister	9.21	–	8.02	–	10.46	–	11.18	–	8.88	–	7.22	–
	1 sister	8.97	−0.236	8.45	0.429	10.95	0.489	11.21	0.027	8.41	−0.464	7.64	0.421
	2 sisters	9.03	−0.178	8.96	0.943***	11.34	0.874	11.70	0.518	8.34	−0.535	7.81	0.590

Table 3 (continued)

		All men		All women		Urban men		Urban women		Rural men		Rural women	
Number of siblings	Gender composition	Mean	Test diff	Mean	Test diff	Mean	Test diff	Mean	Test diff	Mean	Test diff	Mean	Test diff
	All	9.03	–	8.45	–	11.02	–	11.31	–	8.46	–	7.57	–
3 siblings	0 sister	7.67	–	7.48	–	11.00	–	8.82	–	6.71	–	7.20	–
	1 sister	7.84	0.170	7.08	−0.406	10.86	−0.143	10.50	1.682*	7.20	0.494	6.48	−0.711
	2 sisters	8.01	0.338	7.93	0.444	10.59	−0.414	11.17	2.356**	7.68	0.971	7.44	0.240
	3 sisters	9.03	1.355**	7.64	0.152	11.20	0.200	11.05	2.234*	8.57	1.857***	7.00	−0.196
	All	8.18	–	7.56	–	10.88	–	10.70	–	7.69	–	7.03	–
(c) Ages 35–44													
0 sibling	–	8.48	–	7.22	–	11.52	–	10.81	–	6.43	–	5.07	–
1 sibling	0 sister	8.96	–	8.86	–	11.34	–	11.74	–	7.41	–	6.48	–
	1 sister	9.45	0.490*	8.58	−0.280	11.63	0.286	12.19	0.448	7.77	0.359	5.81	−0.673*
	All	9.21	–	8.76	–	11.50	–	11.89	–	7.59	–	6.24	–
2 siblings	0 sister	8.72	–	7.78	–	11.10	–	9.92	–	7.73	–	6.82	–
	1 sister	8.57	−0.149	7.83	0.055	10.90	−0.208	10.67	0.752**	7.60	−0.130	6.56	−0.260
	2 sisters	8.63	−0.085	8.55	0.778***	10.78	−0.320	11.02	1.098***	7.58	−0.153	6.54	−0.280
	All	8.62	–	7.92	–	10.91	–	10.53	–	7.62	–	6.64	–
3 siblings	0 sister	7.59	–	7.07	–	10.84	–	9.47	–	6.42	–	6.35	–
	1 sister	7.79	0.195	6.70	−0.363	10.17	−0.664	9.48	0.012	7.18	0.764***	5.98	−0.372
	2 sisters	8.12	0.531**	7.50	0.435*	10.50	−0.342	10.49	1.016**	7.41	0.994***	6.53	0.177
	3 sisters	8.47	0.874**	7.02	−0.051	10.99	0.147	10.59	1.118*	7.55	1.129***	5.88	−0.463
	All	7.99	–	7.11	–	10.51	–	10.04	–	7.25	–	6.24	–
(d) Ages 45–65													
0 sibling	–	6.81	–	5.26	–	9.10	–	8.61	–	5.56	–	3.62	–

Table 3 (continued)

		All men		All women		Urban men		Urban women		Rural men		Rural women	
Number of siblings	Gender composition	Mean	Test diff	Mean	Test diff	Mean	Test diff	Mean	Test diff	Mean	Test diff	Mean	Test diff
1 sibling	0 sister	7.06	–	5.57	–	9.80	–	8.70	–	5.99	–	4.16	–
	1 sister	7.10	0.039	5.33	−0.243	9.77	−0.024	8.21	−0.486	5.78	−0.209	4.28	0.117
	All	7.08	–	5.47	–	9.78	–	8.52	–	5.88	–	4.21	–
2 siblings	0 sister	7.69	–	6.45	–	9.83	–	9.28	–	6.51	–	5.06	–
	1 sister	7.79	0.106	6.07	−0.380	9.66	−0.165	8.74	−0.543	6.78	0.276	4.75	−0.311
	2 sisters	7.91	0.225	6.24	−0.215	9.88	0.053	8.24	−1.044**	6.89	0.379	4.90	−0.159
	All	7.79	–	6.21	–	9.76	–	8.80	–	6.73	–	4.87	–
3 siblings	0 sister	7.09	–	6.20	–	9.74	–	8.71	–	6.18	–	5.17	–
	1 sister	7.52	0.437**	6.43	0.235	9.47	−0.262	8.83	0.125	6.69	0.506**	5.33	0.156
	2 sisters	7.92	0.835***	6.47	0.268	9.61	−0.130	9.11	0.401	7.17	0.990***	5.16	−0.014
	3 sisters	8.28	1.195***	6.09	−0.103	9.80	0.062	9.03	0.319	7.56	1.379***	4.55	−0.617*
	All	7.69	–	6.39	–	9.59	–	8.94	–	6.88	–	5.19	–

Test is a test of differences by gender composition with the all-brothers the comparison group

– means not applicable (no gender division) or the category for the all-brother reference group

Statistically significant at the *10 % level; **5 % level; and ***1 % level having sisters resulting in higher education levels particularly for men holds not just in the extremes of all or none. The clear tendency in Table 3 is that an additional sister within a sibship group raises the education of respondents especially for men.

These associations of sibling composition with education attainment by sib size are particularly statistically significant consistent and strong for rural Hukou men and to a lesser extent for urban Hukou women. At each sibling size, having sisters leads to a statistically significant increase in men's education, an effect that is particularly large when there are only sisters in the sibship. These associations are much weaker among rural Hukou women.

To gauge whether these descriptive patterns are sensitive to the addition of other controls, we estimated a regression model that parallels the more descriptive Table 3 for the all-age sample. This model is estimated separately by sibsize and gender and is included as Appendix Table 9. The estimated coefficients of the girl percent variable mostly closely parallel the patterns in Table 3. For example, for the two-sibling case, the coefficients are 0.231 (men) and 0.538 (women). The estimated coefficients in the regression model in the Appendix are 0.084 (men) and 0.593 (women). Therefore, the descriptive patterns in Table 3 remain in regression models with a fuller set of demographic controls.

There are many salient secular changes that have taken place in China over the last 50 years that may have impacted the relationships contained in Table 3. At a minimum, these significant changes would include rapid economic growth, rising education levels across birth cohorts particularly for Chinese women, and declining levels of fertility, especially as induced by the OCP. To gauge the collective summary impact of these secular changes, Table 3 also provides mean education by gender stratified by number of siblings and gender composition of siblings for age groups 25–34, 35–44, and 45–65, respectively. These age groups correspond to very different birth cohort groups—on average those born between 1976 and 1985, those born between 1966 and 1975, and those born between 1945 and 1965. Due to economic and education growth and declining fertility trends, these three cohort groupings are situated very differently in terms of the likely influence of factors such as the OCP.

In all three age groupings, there is a clear tendency for male education to rise more than female education as sibling composition becomes more female intensive especially at the high number of siblings group. These differences appear to be particularly larger in the youngest birth cohorts in Table 3. For example, among those 25–34 years old, men with three sisters have 1.4 years more years of schooling than men with three brothers in the same age group. When we stratify the data by age, the strongest sibling composition effects of increasing the number of sisters take place for those over 35 years old especially if they have rural Hukou and at the higher sibling levels. Increasing the number of sisters for those ages 25–34 increases the education levels of both women and men.

To access birth order effects within each sibship group and gender sibling composition, Table 4 provides the oldest and youngest child's mean years of education stratified by number of siblings and gender composition of siblings as in Table 3. Once again, separate estimates are provided those with urban and rural Hukou. For each sibship size and gender composition, we provide a test of the difference between the education of the youngest and oldest sibling with the oldest sibling being the reference group.

When there are three siblings, the pattern is clear where, especially for women, the youngest child has the most education. We attribute this effect to the sharp secular rise in education in China over time with the youngest child being born in the most recent calendar year. This pattern mainly comes from the women with rural Hukou, consistent with the findings in Table 2 that the improvement of female education with rural Hukou is most striking. There is no clear pattern for respondents with two children, which we interpret as offsetting effects of favoring the oldest child and secular changes in education favoring the most recent child. When there is only one sibling, the secular change effect is smaller and the tendency especially among women is that the oldest child has the most education.

In order to investigate the impact of family background on educational attainment, we next estimate models of completed education years on sibling gender composition, being the oldest child, birth order, a quadratic in age, fathers' and mothers' years of schooling, and whether father's Hukou status was urban. We compared father's Hukou status with those of his children at age 12 and found that 89 % are identical. We also compared father's Hukou status and that of the mother and once again found that it was virtually identical with father's Hukou status. For these reasons, we only use father's Hukou urban status in these models.

Table 5 presents results for the full combined male and female sample for ages 25–65, men and women separately, and finally our three age groupings used above. Table 6 contains results for Chinese men only alongside the three age groups, while Table 7 has a parallel set of results for Chinese women. For both Tables 6 and 7, we estimate separate models for those with urban and rural Hukou. In all these three regression tables, we exclude singletons since by definition they do not have any siblings.[5]

In Tables 5, 6, and 7 following Butcher and Case (1994), we use a variable for the percent of siblings who are female to measure the sex composition of siblings in the family. The other fertility-related covariates included in the models in Tables 5, 6, and 7 are standard—birth order and a dummy for being the oldest child, an age quadratic to ascertain whether there are combinations of life cycle and cohort effects, a dummy for whether the father belonged to an urban Hukou, and the number of years of education of the father and mother.[6] In each table, models are estimated across the combined 25–64-year-old age sample, and three age groups separately—those ages 25–34, those ages 35–44, and those ages 45–65. We estimate these models not controlling for number of siblings since adjustments in family size are one way parents can react to the gender of their child. The results are basically similar controlling for number of siblings.

We first discuss estimated effects of the nonfamily composition variables whose estimated effects are consistent across all models. On average, men have an advantage of about 1.37 years of schooling than women do, a female disadvantage that has been narrowing over time (as indicated by the smallest male coefficient in the younger samples). An increase in years of education both of the father and mother increases years of education of both male and female progeny typically by a little more than a fifth of a year of schooling for every extra year of schooling of the parents. Similarly, having a father associated with an urban Hukou is consistently associated with more than 2 years

[5] The proportion of singletons is 1.8 and 9.4 % for the 1966–1975 (age 35–44) and 1976–1985 (age 25–34) cohorts, respectively. Thus, not surprisingly, including singletons does not significantly change our main results.

[6] The results were very similar when we included a control for number of siblings. Not surprisingly in light of the data summarized above in Tables 3 and 4, an increase in the number of siblings is associated with fewer years of schooling of both male and female respondents, consistent with previous studies (Blake 1989). The standard interpretation is that increasing number of siblings reduces each child's access to remaining family resources (Cáceres-Delpiano 2006; Li et al. 2008). This effect is stronger in the younger age group, most likely reflecting the fact that there are economies of scale and a reduction of a single sibling is a bigger proportionate effect in the younger sample.

Table 4 Mean years of complete education by number of siblings and birth order

Ages 25–65

Number of siblings	Gender composition		All men		All women		Urban men		Urban women		Rural men		Rural women	
			Mean	Test	Mean	Test	Mean	Test	Mean	Test	Mean	Test	Mean	Test
1 sibling	0 sister	Oldest	8.65	–	8.46	–	11.13	–	11.03	–	7.46	–	7.15	–
		Youngest	8.40	−0.256	7.85	−0.619***	11.20	0.074	10.83	−0.198	6.93	−0.531*	6.45	−0.703***
	1 sister	Oldest	8.78	–	8.53	–	11.12	–	11.44	–	7.70	–	6.98	–
		Youngest	9.02	0.239	8.00	−0.530*	11.09	−0.034	11.06	−0.384	7.85	0.159	6.51	−0.461
	All	Oldest	8.72	–	8.49	–	11.13	–	11.19	–	7.59	–	7.08	–
		Youngest	8.75	0.023	7.90	−0.584***	11.14	0.012	10.92	−0.269	7.45	−0.148	6.47	−0.612***
2 siblings	0 sister	Oldest	8.36	–	7.34	–	10.61	–	9.74	–	7.39	–	6.30	–
		Youngest	8.36	−0.006	7.68	0.334	10.16	−0.452	10.39	0.656	7.50	0.108	6.47	0.171
	1 sister	Oldest	8.36	–	7.45	–	10.34	–	10.19	–	7.61	–	6.37	–
		Youngest	8.32	−0.040	7.39	−0.056	10.28	−0.066	10.37	0.179	7.41	−0.195	6.06	−0.303
	2 sisters	Oldest	8.33	–	7.80	–	10.44	–	10.20	–	7.49	–	6.33	–
		Youngest	8.85	0.514**	8.12	0.320	10.70	0.257	10.63	0.427	8.01	0.521*	6.50	0.174
	All	Yldest	8.36	–	7.47	–	10.43	–	10.07	–	7.53	–	6.34	–
		Youngest	8.48	0.121	7.60	0.131	10.36	−0.070	10.43	0.358	7.60	0.071	6.26	−0.087
3 siblings	0 sister	Oldest	7.04	–	6.06	–	10.53	–	8.48	–	5.94	–	5.23	–
		Youngest	7.60	0.560	7.10	1.038***	10.53	0.006	9.28	0.799	6.59	0.644	6.37	1.139***
	1 sister	Oldest	7.67	–	6.86	–	9.82	–	9.20	–	6.93	–	6.06	–
		Youngest	7.94	0.270	6.79	−0.071	10.03	0.213	9.45	0.251	7.19	0.263	5.92	−0.146
	2 sisters	Oldest	8.14	–	6.88	–	10.04	–	9.76	–	7.44	–	5.92	–
		Youngest	8.35	0.209	7.43	0.554**	10.41	0.372	9.50	−0.257	7.53	0.090	6.49	0.570**
	3 sisters	Oldest	8.68	–	6.47	–	10.71	–	9.06	–	7.97	–	5.62	–
		Youngest	8.83	0.155	7.37	0.893*	11.19	0.475	10.35	1.292	8.07	0.097	6.19	0.566
	All	Oldest	7.89	–	6.74	–	10.09	–	9.33	–	7.12	–	5.86	–
		Youngest	8.20	0.304**	7.11	0.376***	10.41	0.319	9.53	0.203	7.39	0.266*	6.20	0.335**

a. Test is a test of differences by gender composition with the oldest as the reference group
b. * Statistically significant at the 10 % level; **statistically signficant at the 5 % level; *** statistically significant at the 1 % level
c. – means not applicable (no gender division) or the category for the oldest reference group

Table 5 Models of years of education with family composition variables—full sample

Variables	All	Men	Women	Ages 25–34	Ages 35–44	Ages 45–65
Girl percent	0.485***	0.551***	0.293**	0.890***	0.460***	0.275**
	(0.099)	(0.128)	(0.140)	(0.185)	(0.147)	(0.138)
Oldest child	0.209***	0.133**	0.250***	−0.053	0.299***	0.211***
	(0.041)	(0.063)	(0.058)	(0.108)	(0.079)	(0.060)
Birth order	0.028*	−0.022	0.076***	−0.171***	0.089***	0.059***
	(0.015)	(0.019)	(0.019)	(0.038)	(0.022)	(0.022)
Age	−0.075***	−0.060***	−0.091***	−0.116	0.065	−0.151***
	(0.003)	(0.004)	(0.003)	(0.206)	(0.067)	(0.008)
Age squared	−0.002***	−0.003***	−0.002***	−0.003	0.005	0.001
	(0.000)	(0.000)	(0.000)	(0.005)	(0.003)	(0.001)
Male	1.374***	–	–	0.927***	1.109***	1.672***
	(0.032)	–	–	(0.086)	(0.055)	(0.046)
Dad urban Hukou	2.458***	2.054***	2.865***	1.753***	2.285***	2.673***
	(0.061)	(0.069)	(0.075)	(0.130)	(0.084)	(0.076)
Dad ed years	0.199***	0.176***	0.222***	0.272***	0.212***	0.169***
	(0.009)	(0.011)	(0.011)	(0.017)	(0.012)	(0.012)
Mom ed years	0.218***	0.184***	0.247***	0.267***	0.236***	0.154***
	(0.015)	(0.020)	(0.015)	(0.018)	(0.016)	(0.026)
Constant	3.994***	5.915***	3.567***	3.547*	4.175***	4.373***
	(0.094)	(0.113)	(0.122)	(2.028)	(0.331)	(0.138)
Observations	44,559	21,995	22,564	6581	14,783	23,195
R^2	0.267	0.184	0.315	0.287	0.261	0.262

Clustered standard errors at household level in parentheses

– not applicable

*Statistically significant at the 10 % level; ** statistically significant at the 5 % level; ***statistically significant at the 1 % level

extra schooling of his children, with a somewhat larger effect for women (about 2.9 years) compared to men (2.1 years). The urban Hukou effect reflects the large gap of education resources and opportunities between urban and rural areas in China. The age-specific models indicate that the urban Hukou advantage has been declining over time.

Finally, being the oldest child in the family is associated with more education, so that education investments in first-born children are particularly high in China, a traditional Chinese pattern. When we examine gender-specific estimates within the three age groups in Tables 6 and 7, we find an education advantage both for men and women from being the oldest child in all age groups. However, from the birth order variable, we find that birth order has a significantly positive impact on female education after controlling for the oldest child. It is mainly because the oldest child and youngest child could have more resources for their education.

An increase in the percent of girls in the family positively impacts one's education attainment, an effect that is larger for men compared to women and larger in the younger cohort compared to the older birth cohorts. Apparently in China, having more and more sisters increases the education investments in boys but it does so for girls as well, albeit to a lesser extent, since they have fewer brothers with whom to compete.

Table 6 Models of years of education with family composition variables—male results

Variables	Urban sample				Rural sample			
	All men	Ages 25–34	Ages 35–44	Ages 45–65	All men	Ages 25–34	Ages 35–44	Ages 45–65
Girl percent	0.189	−0.211	0.256	0.287	0.661***	0.833***	0.506**	0.627***
	(0.232)	(0.498)	(0.374)	(0.324)	(0.149)	(0.312)	(0.223)	(0.209)
Oldest child	0.262**	0.187	−0.021	0.419**	0.076	−0.196	0.071	0.126
	(0.118)	(0.329)	(0.209)	(0.165)	(0.074)	(0.192)	(0.138)	(0.105)
Birth order	−0.052	−0.092	−0.065	−0.018	−0.010	−0.177***	0.084**	−0.011
	(0.039)	(0.120)	(0.059)	(0.052)	(0.022)	(0.059)	(0.033)	(0.034)
Age	−0.068***	−0.634	−0.515***	−0.110***	−0.057***	0.464	0.069	−0.095***
	(0.008)	(0.674)	(0.188)	(0.020)	(0.004)	(0.346)	(0.111)	(0.012)
Age squared	−0.002***	−0.016	−0.023**	−0.001	−0.003***	0.012	0.003	−0.004***
	(0.000)	(0.017)	(0.009)	(0.002)	(0.000)	(0.009)	(0.005)	(0.001)
Dad urban Hukou	−0.144	−0.015	−0.388*	−0.085	0.751***	0.302	0.756***	1.204***
	(0.157)	(0.286)	(0.220)	(0.269)	(0.167)	(0.324)	(0.214)	(0.300)
Dad ed years	0.128***	0.227***	0.175***	0.091***	0.193***	0.245***	0.189***	0.179***
	(0.017)	(0.040)	(0.027)	(0.023)	(0.013)	(0.026)	(0.017)	(0.019)
Mom ed years	0.155***	0.164***	0.164***	0.133**	0.183***	0.253***	0.198***	0.098***
	(0.038)	(0.049)	(0.033)	(0.062)	(0.018)	(0.029)	(0.023)	(0.031)
Constant	8.807***	2.325	6.224***	9.017***	5.706***	10.182***	5.665***	6.340***
	(0.258)	(6.556)	(0.890)	(0.385)	(0.124)	(3.421)	(0.543)	(0.183)
Observations	5549	608	1680	3261	16,446	2371	5546	8529
R^2	0.134	0.149	0.139	0.093	0.093	0.161	0.077	0.090

Clustered standard errors at household level in parentheses

*Statistically significant at the 10 % level; ** statistically significant at the 5 % level; ***statistically significant at the 1 % level

Table 7 Models years of education with family composition variables—female results

Variables	Urban sample				Rural sample			
	All women	Ages 25–34	Ages 35–44	Ages 45–65	All women	Ages 25–34	Ages 35–44	Ages 45–65
Girl percent	0.462*	1.420***	0.430	0.174	0.172	0.815***	0.247	−0.151
	(0.266)	(0.474)	(0.379)	(0.384)	(0.159)	(0.300)	(0.232)	(0.223)
Oldest child	0.272**	−0.190	0.393*	0.377**	0.230***	0.122	0.384***	0.139
	(0.115)	(0.325)	(0.206)	(0.170)	(0.066)	(0.162)	(0.123)	(0.095)
Birth order	0.007	−0.234*	−0.059	0.107*	0.096***	−0.129**	0.159***	0.144***
	(0.038)	(0.141)	(0.059)	(0.055)	(0.021)	(0.053)	(0.032)	(0.032)
Age	−0.100***	−0.449	0.080	−0.153***	−0.088***	−0.468	0.172	−0.222***
	(0.008)	(0.590)	(0.187)	(0.021)	(0.004)	(0.319)	(0.108)	(0.011)
Age squared	−0.002***	−0.011	0.009	−0.000	−0.002***	−0.011	0.010*	0.008***
	(0.000)	(0.015)	(0.009)	(0.002)	(0.000)	(0.008)	(0.005)	(0.001)
Dad urban Hukou	0.838***	0.371	0.733***	1.277***	1.172***	0.900***	1.238***	1.489***
	(0.176)	(0.257)	(0.229)	(0.326)	(0.203)	(0.325)	(0.261)	(0.349)
Dad ed years	0.156***	0.201***	0.171***	0.140***	0.250***	0.283***	0.248***	0.228***
	(0.019)	(0.039)	(0.025)	(0.026)	(0.013)	(0.023)	(0.018)	(0.019)
Mom ed years	0.216***	0.216***	0.196***	0.230***	0.244***	0.266***	0.250***	0.171***
	(0.025)	(0.039)	(0.030)	(0.038)	(0.019)	(0.026)	(0.025)	(0.034)
Constant	6.371***	3.155	7.013***	6.068***	3.379***	−0.417	4.145***	3.897***
	(0.286)	(5.809)	(0.975)	(0.453)	(0.141)	(3.133)	(0.548)	(0.210)
Observations	5693	712	1827	3154	16,871	2890	5730	8251
R^2	0.215	0.206	0.172	0.159	0.194	0.223	0.130	0.157

Clustered standard errors at household level in parentheses

*Statistically significant at the 10 % level; ** statistically significant at the 5 % level; ***statistically significant at the 1 % level

In Tables 6 (men) and 7 (women), we present separate estimates by Hukou status using the same framework as Table 5. The coefficients of the other variables besides sibling composition do not vary that much by Hukou status. For men, an increase in the percent of girls as siblings appears to have a much larger and statistically significant effect on education in the rural Hukou sample. As son preference is more prevalent in rural areas, families with a larger percent of girls tend to prefer sons more; hence, boys may receive more familial resources in the form of more education investment. For women in Table 7, the estimated effects of sibling composition while generally positive are quantitatively smaller. These effects are statistically significant in the rural Hukou sample but that appears largely to be due to larger sample sizes in the rural Hukou sample.

Traditionally, parents did not invest much in daughters regardless of number of sons, because daughters were meant to marry out and did not contribute to family economic resources as well as maintaining blood ties. Therefore, we do not observe positive effect of more girl percent on education for the older cohorts of women. For the younger generation, however, the status of females has been much improved and education investments in them are not trivial although not as large as men so that the positive effect is observed even if it is not as big as that in the Chinese male subsample.

5 Discussion and Conclusions

In this paper, we find strong associations of sibling gender composition of educational accomplishments of both Chinese men and women. China is an interesting setting to test this relationship since China is widely and correctly thought to have a tradition of strong boy preference. China is also of interest since its history over the last few decades is not only rising education levels of younger generations but a sharp drop across birth cohorts in the gender disparity in schooling.

We find in this analysis that being the oldest child in the family gives an education benefit both to male and female children. Most importantly, after controlling for the number of siblings, we find that an increase in the fraction of siblings who are girls leads to a significant increase in the education of Chinese men and to a less extent Chinese women. Traditionally, in China, male children absorbed more education resources so that in a credit-constrained family increases in the fraction of siblings who are sisters free up more resources for educating boys. This is less so for Chinese girls since in the past their education levels were lower and the additional resources would not be used for them as much. Based on analysis of subsamples with urban or rural Hukou, we can find that most of the impacts come from samples with rural Hukou.

Barcellos et al. (2014) pointed out a number of possible reasons for the endogeneity of sibship percent female variables. In a boy-preference society families favoring sons tend to have more children till they have a son. Based on the observation that probability of a family's youngest child being a boy is an increasing function of the age of the youngest child, their identification strategy is to restrict the sample to families with the youngest child being 0–12 months of age. Such a problem may be relevant in China, but we cannot employ the same strategy of restricting the sample to children of very young age because our outcome variable is the completed education.

The impact of the stopping rule in fertility decisions may be lessened with the introduction of OCP in China, as under this policy families are no longer free to choose their

Table 8 Sex ratio by birth order

Birth order	All		Urban		Rural	
	Sex ratio	Obs	Sex ratio	Obs	Sex ratio	Obs
1	0.95	15,008	0.95	4250	0.96	10,758
2	1.02	13,442	1.05	3574	1.01	9868
3	1.05	11,577	1.04	3012	1.06	8565
4 and above	1.03	19,480	1.03	4818	1.03	14,662

stopping points. We therefore have divided our sample into three age groups—those 25–34 years old, those 35–44 years old, and those 45–65 years old. Given that the data we use were collected in 2010, those in the oldest age group were clearly born before the OCP (born between 1945 and 1965), and those in the youngest age group were likely affected by the OCP (born between 1976 and 1985). In all three age groups, we find similar results in that an increasing fraction of siblings who are girls increases education levels of both men and women. This is the case whether or not we control for family size in the models. Thus, our main finding is not driven by the male-biased stopping rule. At the same time, the size of the estimated coefficient on percent of girls did increase in younger cohorts, and more so among men. This observation indicates that OCP may have increased boy preference, especially at higher birth parities, and therefore investment in boys' education when they had only sisters.

Similarly, on the issue of sex-selective abortion, although the first ultrasound B machine was produced in 1979, the expansion of its usage in hospitals and clinics had been slow in the early 1980s. The percentage of counties with ultrasound B machines did not reach 30 % until 1984 (Chen et al. 2013) and even in 1987, the average number of B-scan machines was roughly six per county (Chu 2001), equivalent to only one machine per 90,000 persons (the population was 1072.33 million and number of counties was 1986 in 1987). As the two older groups of our sample were born before 1976 and the youngest group was born between 1976 and 1985, the two older groups of our sample are clearly not affected by the technology and the impact on the youngest group is itself limited due to the slow introduction of this technology into China. To check this conjecture, we calculate the sex ratios at different birth orders. As shown in Table 8, the sex ratios are quite balanced, which confirms that sex selection is limited for the studied cohorts.[7] On the other hand, we acknowledge that even if we have not found evidences of sex selection, sibling composition could still be endogenous, which is a priority for future research on this topic in China as well as elsewhere in the world. For example, this could be addressed in the future with the new policy shock of allowing parents in China to have two children since 2016.

Acknowledgments This research was supported by grants from the National Institute on Aging (P01-AG022481 and R37-AG025529) and the Natural Science Foundation of China (grant nos. 71490732 and 2016KEY02). The authors thank the editor and anonymous referees of this journal and recognize their help and guidance.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

[7] We thank the editor for suggesting to do this test.

Appendix

Table 9 Model of mean years of completed education by number and gender of siblings and family background, ages 25–65

Number of siblings	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Male				Female			
	One	Two	Three	Four	One	Two	Three	Four
Girl percent	0.499	0.084	1.317***	0.557*	0.045	0.593**	0.545*	−0.125
	(0.315)	(0.270)	(0.262)	(0.310)	(0.326)	(0.295)	(0.285)	(0.336)
Oldest child	−0.072	0.214	0.565***	0.505***	0.035	0.342*	0.341**	0.447***
	(0.134)	(0.201)	(0.158)	(0.160)	(0.131)	(0.200)	(0.139)	(0.138)
Birth order	–	0.063	0.249***	0.146***	–	0.201*	0.236***	0.266***
	–	(0.116)	(0.063)	(0.049)	–	(0.120)	(0.060)	(0.045)
Age	−0.090***	−0.068***	−0.049***	−0.048***	−0.142***	−0.113***	−0.082***	−0.074***
	(0.012)	(0.009)	(0.007)	(0.008)	(0.011)	(0.009)	(0.007)	(0.007)
Age squared	−0.003***	−0.002***	−0.003***	−0.005***	−0.003***	−0.003***	−0.003***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)
Dad urban Hukou	1.784***	1.900***	2.067***	2.131***	2.640***	2.550***	2.742***	2.947***
	(0.192)	(0.147)	(0.133)	(0.140)	(0.196)	(0.157)	(0.146)	(0.162)
Dad ed years	0.208***	0.196***	0.169***	0.148***	0.229***	0.233***	0.228***	0.230***
	(0.027)	(0.021)	(0.021)	(0.022)	(0.027)	(0.021)	(0.020)	(0.023)
Mom ed years	0.231***	0.178***	0.199***	0.153***	0.255***	0.263***	0.224***	0.189***
	(0.030)	(0.026)	(0.029)	(0.036)	(0.026)	(0.025)	(0.028)	(0.038)
Constant	5.644***	5.751***	4.826***	5.791***	3.974***	3.185***	3.328***	3.502***
	(0.230)	(0.338)	(0.246)	(0.264)	(0.281)	(0.374)	(0.270)	(0.280)
Observations	1846	3584	4518	4678	1772	3374	4645	4892
R^2	0.328	0.222	0.206	0.153	0.485	0.366	0.311	0.265

*Statistically significant at the 10 % level;** statistically significant at the 5 % level; ***statistically significant at the 1 % level

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