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The only child, birth order and educational outcomes

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Abstract
The one-child policy was implemented in September 1980 and abolished in late 2015. With this change in the demographic policy, the fertility decision of families also changed. Such decisions can result in an increase in the number of siblings in a family. Individuals' educational outcomes may be affected by a change in their parents' fertility decision. The objective of this paper is to provide evidence of the difference of educational outcomes between the only-child and the non-only child. The authors try to estimate the change of educational outcomes when the only child of a family turns to the child with siblings. Moreover, they estimate different channels to interpret these effects. They employ the data set of China Education Panel data in this paper. In the part of mechanism check, the Sobel- Good test is used for checking the mediation effects of different channels. The authors found the only child has significant higher educational outcomes comparing to a child who has siblings. To explain these effects, the authors use four channels to interpret: (1) money resource, (2) parenting time, (3) closeness of parent-child relationships, and (4) personality traits. The policy implication is to help the policymaker estimate and predict the impact of new demographic policy.

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Keywords Only child; personality traits; educational outcomes; parent-child relationship

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1 Introduction

The one-child policy was implemented in September 1980 and abolished in late 2015. With this change in the demographic policy, the fertility decision of families also changed. Such decisions can result in an increase in the number of siblings in a family. Individuals' educational outcomes may be affected by a change in their parents' fertility decision. Current research indicates that a tradeoff exists between the number of children (Becker 1960), meanings that the quality of children decreases when the number of children in a family increases.

We focus on the difference in educational outcomes between only children and children with siblings, which we define as the only-child effect. To achieve this aim, we use the China Education Panel Survey dataset combined with a treatment effect model. There are two waves in the investigation of this dataset: the academic year 2013–14 and that of 2014–15. Because the grade 7 students of the academic year 2013–14 are followed in the wave of the academic year 2014–15, we combine this sample as a pool to obtain cross-sectional data. Because schools adopt difference systems; for example, some schools adopt 150 scores as the full mark to assess students' outcomes in math, Chinese and English, we translate all outcomes of students into a 100-mark system. To explain these effects, we use four channels for interpretation, namely (1) financial resources, (2) time spent parenting, (3) closeness of parent-child relationships, and (4) personality traits. We reveal that only children have significantly greater money resources, more parenting time, closer parent-child relationships, and a better personality than a child who has siblings. The Sobel-Goodman test reveals that financial resources, parenting time, the closeness of parent-child relationships, and personality traits are mediators of these effects. An only child has superior academic attainment compared with children with siblings. The difference in financial resources, parenting time, the closeness of parent-child relationships, and personality traits can be used to interpret these effects.

2 Literature review

From an evolutionary perspective, both theoretical and empirical studies have shown that parents do not express their feelings toward and invest in their children equally (Daly and Wilson, 1988). Although parents may attempt to invest in their children equally, the fact that investment in children is heterogeneous due to parental favoritism may affect the perceptions of favoritism (Hertwig et al., 2002). These parental perceptions are considered to be catalysts for different processes related to personality development among siblings, affecting their approach to dealing with family, friends, partners, and colleagues (Salmon and Schumann, 2011). Regarding the influence of the sibling structure on academic achievement, scholars posit that the effect of birth order on cognitive achievement is mainly influenced by the family's intellectual environment and access to intellectual resources (Zajonc and Markus 1975). As the size of a family increases, its intellectual environment declines.

The resource dilution hypothesis (Downey 2001) posits that parental resources (such as money and personal concern) are limited and diluted as the number of siblings increases. According to this hypothesis, parents can fully devote themselves to only children. However, the arrival of

newborns causes parents to reallocate their resources. Studies suggest that having more siblings dilutes a family's financial resources (Thomson et al., 1994; Downey 1995), other studies that have investigated the educational effects of the number of siblings in a family indicate that only children have the same academic performance as children in two-child families, or that their academic performance is slightly poor in terms of test scores and years of schooling (Blake 1989). In addition, this hypothesis suggests that the relative abundance of parental resources affects a person's educational attainment. Therefore, only children academically outperform children born in larger size families. Downey (2001) argues that different types of parental resources are crucial in the different stages of their child's life. For example, children require the concern of their parents in childhood, savings for college tuition fees while in high school, and their parents' heritage in adulthood. In addition, parental resources may only be part of parents' total family resources; parents may invest resources in activities that are not targeted at children (such as participation in bowling leagues and expenditure related to book clubs or golf courses). This means that the proportion of child's resources from parental investment in relation to household resources is not fixed. Some resources (such as books) can be shared, and there is little or no dilution effect of resources. However, other resources (such as savings for college in the future) can not be shared. Therefore, Powell and Steelman (1990) believe that certain family resources are more sensitive to the number of children in a family than others. Parental resources are classified as base and surplus parental resources from attributes. Surplus parental resources are not essential for the survival of children; instead, they aimed at improving childrenâs long-term human capital by, for example, reading with children face-to-face, hiring math tutors, buying computers, providing special learning spaces, and saving money for their college education. By contrast, base parental resources are those that meet a child's general survival needs, such as the provision of adequate food, clothing, and shelter. The sibship effect has different degrees of sensitivity to these two resources. Although few parents question whether their children require basic resources, most attempt to determine the optimal allocation of surplus resources, in part because they are expensive and optional (Downey 2001). A specific threshold can be observed for the size of the child. Before this threshold is reached, parents do not consider the surplus needs of their children and are concerned more with their basic needs (Downey 1995).

For individuals, the marginal cost of siblings is a reduction in the number of schooling years they receive, and the marginal cost of each sibling is approximately one-fifth of that of schooling years (Featherman and Hauser 1978; Blake 1981,1989; Heer 1985; Powell and Steelman 1990). For families with more children, parents must allocate their limited material and nonmaterial resources (such as time and energy) to different children. Each child from a large family, compared with each child from families with fewer children, must obtain diluted material and nonmaterial resources so that the number of siblings has a negative effect on resources allocated to them, regardless of education level, occupation, or even intelligence.

3 Variable and data description

The data must have two features. First, a background to observations, such as the size of the family, the gender of family members, and parents' backgrounds (e.g., socioeconomic), must be included. Second, education background, such as test scores for each subject, must be included.

For the aforementioned reasons, this paper uses data from the China Education Panel Survey (CEPS). The data were collected by the National Survey Research Center at the Renmin University of China through administering questionnaires to students, parents, homeroom teachers, main subject teachers (but not homeroom teachers), and school administrators. This is a school-based, nationally representative, longitudinal survey of over 20,000 seventh and ninth graders in 438 classrooms of 112 schools in 28 county-level units in mainland China. The samples are chosen using Probability proportional to size. There are three frames in this sample. In the first frame, fifteen counties are selected randomly from all counties (2870) of mainland China. In the second frame, three counties are selected randomly from Shanghai, the wealthiest city of China. In the third frame, ten counties are chosen randomly from one hundred and twenty counties which own most floating population. Twenty-eight county-level units of the sample are made of these three frames. In each county of the sample, four schools are chosen randomly. In each school of the sample, if there are equal or less than two classes in the surveyed grade of the sample school, all of them are sampled. If there are more than two classes in the surveyed grade of the sample school, two of them are chosen randomly. All students in the surveyed class are sampled.

This survey concerned the 2013–2014 academic year. The contents of the CEPS include basic personal and family information, mobility and migration status, personal experiences, cognitive ability, non-cognitive ability, relationship with parents, in-school performance, extracurricular activities, relationship with teachers and peers, family member information, living environment information, health status, and family spending on education. The CEPS also collects students' test scores in each subject, such as Chinese, mathematics, and English. In the 2013-2014 school year, the first round of surveys was conducted, and in the 2014-2015 school year, the original seventh graders were followed; most of the sample students were tracked successfully.

We merged two waves of data (2013–2014 and 2014–2015 academic year). Because the seventh graders were tracked in two waves, this part of the sample was retained. The wave of 2014–2015 provides some important variables such as parentsâ characteristics and the full mark of each subject in particular schools. However, the ninth grade students are not tracked in the 2014–2015 academic year. Therefore, we have to drop them. Students with more than six siblings account for approximately 1% of the entire sample; these students were excluded to remove extreme values. Therefore, the number of students in the sample is 8931. Descriptive statistics for variables are shown in Table 1.

Mat, chn, and eng are the original scores of mathematics, Chinese, and English, respectively, which are all translated into a 100-mark system. Schools have different marking systems for each subject, with full marks for the respective subjects being 100, 120, 130, and 150 respectively. Only the data of the 2014–2015 academic year provides the full marks for each subject. Because a school generally does not change the marking system it has adopted, (for example, if a school adopts the 130-mark system, then this system will be adopted for all grades in the school for a

Table 1: Variable and data description

Variable	Observation	Mean	Std	Minimum	Maximum
mat	17340	65.391	24.694	0	100
chn	17334	68.282	14.521	0	98.33334
eng	17340	66.943	23.150	0	100
expense	16038	1030.396	3530.714	0	98618.34
concern_par	17237	2.496	0.549	1	3
self_museum	17958	2.364	1.347	1	6
self_show	18041	2.345	1.448	1	6
relation_fa	18123	2.566	0.570	1	3
relation_mo	18117	2.723	0.496	1	3
extra1	18071	2.819	0.997	1	4
extra2	17980	2.970	0.917	1	4
extra3	18020	1.667	0.874	1	4
openness1	17464	3.124	0.799	1	4
openness2	17478	3.022	0.784	1	4
openness3	17301	3.015	0.805	1	4
only_child	17340	0.456	0.498	0	1
steco_5c	17267	2.881	0.604	1	5
birth_age_fa	15585	27.014	5.056	14	65
birth_age_mo	15567	28.835	5.340	14	70
ethnicity_fa	16716	1.405	1.576	1	8
political_fa	16506	2.703	0.705	1	3
ethnicity_mo	16622	1.416	1.578	1	8
political_mo	16448	2.858	0.504	1	3
stsex	17340	0.518	0.500	0	1
stprhedu	17340	4.633	2.029	1	9
birth_year	17808	2000.464	0.701	1996	2002
hukou_place	17474	1.610	0.762	1	4
clsids	17340	228.491	126.901	1	436
schids	17340	59.248	32.686	1	112
time	17298	2013.500	0.500	2013	2014

long period), full marks in the 2014–2015 academic year were matched to the exam scores of individuals in the 2013–2014 academic year. Exam scores in mathematics, Chinese, and English in the two waves of the survey, which are translated into the 100-mark system by dividing them by full marks of the subject, are used. Table 1 shows that the average scores of students in these three subjects are 65.47, 68.43, and 67.18, respectively, which are approximately at the pass level. The standard deviations are 24.62, 14.37, and 23.07, respectively. Of the subjects, variances in Chinese test scores are the smallest, whereas variances in mathematics scores are the largest. This may be

because the relationship between mathematics and cognitive ability is relatively large, whereas Chinese is a common language.

The expense refers to an individual's expenses for extracurricular activities per semester. Because the survey year spans the 2013–2014 and 2014–2015 academic years, the real expenditure is based on the year 2014, which is identified based on whether the individual was surveyed in the spring semester of 2013-14 or the fall semester of 2014–15. If an individual's survey time is the 2013–14 fall semester or the 2014–15 spring semester, the expenditure on extracurricular activities is used as the 2013 price and the 2015 price, respectively; thus, the 2014 consumer price index (CPI) and 2015 CPI are used to obtain the actual value of the 2014 base year.[1] The variable concern_par is "how strict your parents are with your homework and exams." It is a dummy variable, with answers being "not strict", "average" and "very strict." The variables self_museum and self_show are respectively "the frequency of visiting museums, zoos, science museums, etc. with the parents" and "the frequency of watching shows with parents", both of which are dummy variables, with answers being "never", "once a year", "every six months", "once a month", "once a week" and "more than once a week".

The variables extra1, extra2 and extra3 are respectively "I often take part in school/class activities.", "I feel close to people in this school." and "I feel bored in this school. (reversed)", all of which are dummy variables, with answers being "strongly disagree", "disagree", "agree" and "strongly agree". All of these variables measure students' extraversion.

The variables openness1, openness2 and openness3 are respectively "Do you always express your opinions clearly?", "Are you quick to responses?" and "Are you quick to understand things", all of which are dummy variables, with answers being "strongly disagree", "disagree", "agree" and "strongly agree". All of these variables measure students' openness to experience.

The variables relation_fa and relation_mo are ârelationship with fatherâ and ârelationship with motherâ, respectively, which measure a child's closeness to their parents. These are dummy variables, with answers being "not close", "average" and "close" respectively.

According to the mean values of only_child, only children accounts for 45.6% in the study sample.

The reproductive age, the ethnicity, and political status of parents are instrumental variables related to their fertility decision (i.e., whether the study participant is an only child). The reproductive ages of fathers and mothers range from 14 to 65 years and from 14 to 70 years, respectively. Samples that parents' reproductive age is less than 14 are excluded. The variables "father's ethnicity" and "mother's ethnicity" relate to Han, Mongolia, Manchu, Hui, Tibetan, Zhuang and other ethnic groups. The dummy variables "father's political status" and "mother's political status" relate to Community Party of China, democratic parties and the general public. The variable "parents' highest education level" relate to the following responses: "illiterate", "primary school", "junior high school", "secondary school/technical school", "vocational high school", "high school", "university college", "university undergraduate" and "graduate and above". The year of birth of the participants ranges from 1996 to 2002. The hukou status at birth (variable hukou_place) includes agricultural hukou, non-agricultural hukou, resident hukou, and others.

[1] In 2014, the CPI was 1.5%, and the 2015 CPI was 1.6% (source: China Statistics Bureau www.stats.gov.cn).

4 Empirical analysis

Columns (1), (4), and (7) in Table 2 report the results using the ordinary least squares (OLS) approach without any controls, whereas columns (2), (5), and (8) in Table 2 report the results with controls. Considering that a class is taught by the same teacher and that the teaching concept, learning progress, and class climate have the same effect on all individuals in the class, the results of columns (3), (6), and (9) in Table 2 report are adjusted by the class ID clustering standard error. The results of (1), (4) and (7) indicate that the test scores of an only child are higher than that of a child with siblings, with mathematics scores being 6.69 points higher, Chinese scores being 2.31 and English scores being 7.85 points higher.

The results of the only_child variable with controls for mathematics and English are 1.68 and 2.5, respectively, which are all significant at the 1% level. This means that the mathematics and English scores of only children are respectively 1.68 and 2.5 points higher than those of children with siblings after all the individual's characteristics are controlled. The result for Chinese is not significant, which may be caused by the small standard deviation of the variable chn. The column (3) and (9) show that the results of the only_child variable for mathematics and English are still significant with the class ID clustering standard errors.

Table 3 presents the results of children of different genders obtained using the OLS estimation. OLS is a robust estimation method that adjusts standard errors through personal ID clustering. The results shown in columns (1) and (3) indicate that for females, only children scored higher than those with siblings with mathematics scores being 2.04.50 points higher, and the English scores being 2.72 points higher. The results in columns (4) and (6) demonstrate that male only children outperformed males with siblings, with mathematics scores being 1.47 points higher, and English scores being 2.60 points higher. The only-child effect in girls affects mathematics and English scores to a greater extent than does this effect males.

Table 2: The only-child effect on the individual's educational outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	ols	ols	ols	ols	ols	ols	ols	ols	ols
Dep. VarïŒmat		mat	mat	chn	chn	chn	eng	eng	eng
only_child	6.686***	1.679***	1.679*	2.308***	-0.234	-0.234	7.850***	2.502***	2.502***
	(0.368)	(0.579)	(0.915)	(0.210)	(0.306)	(0.506)	(0.340)	(0.509)	(0.762)
steco_5c		1.356***	1.356**		0.769***	0.769**		2.198***	2.198***
		(0.423)	(0.567)		(0.232)	(0.350)		(0.363)	(0.522)
stsex									
male		-2.915***	-2.915***		-5.756***	-5.756***		-9.682***	-9.682***
		(0.501)	(0.569)		(0.268)	(0.318)		(0.435)	(0.497)
stprhedu		1.981***	1.981***		1.199***	1.199***		2.009***	2.009***
		(0.149)	(0.228)		(0.080)	(0.124)		(0.130)	(0.193)
birth_year		3.992***	3.992***		1.740***	1.740***		3.618***	3.618***
		(0.404)	(0.518)		(0.228)	(0.324)		(0.347)	(0.486)
ethnicity_fa									
Mongolia		-6.146	-6.146		-5.687	-5.687		-9.716	-9.716
		(7.213)	(7.152)		(3.724)	(3.686)		(6.443)	(6.293)

Manchu		-2.479	-2.479		-3.997***	-3.997***		-2.976	-2.976
		(3.008)	(2.758)		(1.509)	(1.358)		(2.694)	(2.435)
Hui		-4.766	-4.766		0.993	0.993		-0.974	-0.974
		(3.529)	(3.206)		(1.485)	(1.878)		(2.674)	(3.070)
Tibetan		2.466	2.466		-3.742	-3.742		-6.988	-6.988
		(8.218)	(8.047)		(4.744)	(3.452)		(8.264)	(7.692)
Zhuang		-13.603*	-13.603		-7.316***	-7.316***		-13.937**	-13.937**
		(8.038)	(8.354)		(2.637)	(2.404)		(6.026)	(6.043)
Others		0.430	0.430		-0.712	-0.712		-0.912	-0.912
		(2.045)	(2.798)		(1.153)	(1.866)		(1.736)	(2.455)
ethnicity_mo									
Mongolia		-5.873	-5.873		-1.601	-1.601		-6.339	-6.339
		(4.730)	(4.595)		(2.730)	(2.622)		(5.059)	(4.975)
Manchu		-0.591	-0.591		-0.054	-0.054		0.610	0.610
		(2.370)	(2.524)		(1.221)	(1.357)		(2.110)	(1.844)
Hui		-0.377	-0.377		-0.369	-0.369		1.282	1.282
		(3.477)	(3.361)		(1.353)	(1.254)		(2.187)	(2.327)
Tibetan		-1.143	-1.143		0.833	0.833		3.408	3.408
		(8.123)	(8.166)		(2.190)	(2.687)		(6.456)	(7.222)
Zhuang		-9.297	-9.297		-5.245**	-5.245**		-11.888**	-11.888**
		(7.421)	(7.775)		(2.397)	(2.248)		(5.746)	(5.741)
Other		-3.253	-3.253		-4.491***	-4.491**		-1.220	-1.220
		(2.067)	(3.048)		(1.215)	(2.162)		(1.768)	(2.970)
Hukou_place									
Non-agricultural		0.797	0.797		0.001	0.001		2.825***	2.825***
		(0.668)	(1.126)		(0.357)	(0.544)		(0.588)	(0.908)
Resident		-1.984**	-1.984*		-1.554***	-1.554**		-1.156*	-1.156
		(0.772)	(1.061)		(0.439)	(0.644)		(0.684)	(0.906)
Others		-7.890	-7.890		-8.243**	-8.243**		-9.312*	-9.312*
		(6.056)	(6.422)		(3.865)	(3.697)		(5.572)	(5.277)
birth_age_fa		-0.199**	-0.199*		-0.050	-0.050		-0.191**	-0.191**
		(0.098)	(0.108)		(0.052)	(0.058)		(0.084)	(0.091)
birth_age_mo		-0.055	-0.055		-0.124**	-0.124**		0.005	0.005
		(0.093)	(0.106)		(0.051)	(0.056)		(0.079)	(0.087)
political_fa									
Democratic		-2.406	-2.406		-0.861	-0.861		-1.497	-1.497
		(3.025)	(2.852)		(1.475)	(1.325)		(2.431)	(2.335)
Public		-2.039***	-2.039***		-1.198***	-1.198***		-2.459***	-2.459***
		(0.700)	(0.757)		(0.348)	(0.393)		(0.613)	(0.660)
political_mo									
Democratic		-3.185	-3.185		-2.718*	-2.718		-5.826**	-5.826**
		(3.238)	(3.168)		(1.619)	(1.769)		(2.552)	(2.460)
Public		0.296	0.296		0.288	0.288		0.956	0.956
		(0.988)	(1.150)		(0.492)	(0.552)		(0.857)	(1.084)
Cons	69.840***	-7,916.723***	-7,916.723***	72.484***	-3,406.926***	-3,406.926***	71.956***	-7,167.289***	-7,167.289***
	(0.452)	(809.072)	(1,036.751)	(0.252)	(456.694)	(647.425)	(0.413)	(693.538)	(971.791)
Year fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
Class fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	17,170	14,005	14,005	17,164	14,002	14,002	17,170	14,005	14,005
adj. R2	0.047	0.109	0.109	0.065	0.179	0.179	0.082	0.213	0.213

Note: $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$. Robust standard errors are shown in parentheses. (2), (5) and (8) use personal ID clustering standard errors, and (3), (6) and (9) use class ID clustering standard errors.

Table 3: The only-child effect on the individual's educational outcomes (subsample of genders)

	(1)	(2)	(3)	(4)	(5)	(6)
	mle1	mle2	mle3	mle4	mle5	mle6
Subsample:		female			male	
Dep. Variable:	mat	chn	eng	mat	chn	eng
only_child	2.038**	0.189	2.717***	1.468*	-0.519	2.598***
	(0.815)	(0.389)	(0.663)	(0.829)	(0.466)	(0.765)
steco_5c	1.845***	0.986***	2.787***	0.974*	0.602*	1.713***
	(0.621)	(0.324)	(0.505)	(0.576)	(0.328)	(0.515)
stprhedu	1.871***	1.075***	1.868***	2.084***	1.299***	2.124***
	(0.200)	(0.102)	(0.161)	(0.223)	(0.124)	(0.204)
birth_year	4.167***	1.574***	3.218***	3.853***	1.884***	3.933***
	(0.564)	(0.295)	(0.461)	(0.578)	(0.345)	(0.513)
ethnicity_fa						
Mongolia	8.363	4.172*	3.047	-21.413**	-16.584***	-27.041***
	(5.201)	(2.518)	(5.298)	(9.797)	(1.114)	(3.038)
Manchu	-3.009	-4.730**	-1.933	-1.975	-2.507	-4.050
	(4.047)	(1.879)	(3.261)	(4.409)	(2.610)	(4.768)
Hui	-5.712	0.956	-0.311	-1.414	1.318	-0.056
	(5.336)	(2.061)	(3.752)	(4.328)	(2.083)	(3.724)
Tibetan	9.230	-14.008***	-15.749**	-7.433	-0.650	-5.765
	(10.612)	(3.176)	(7.027)	(9.088)	(4.636)	(11.503)
Zhuang	-10.644	-7.051**	-9.411	-25.482***	-10.889***	-32.647***
	(10.477)	(3.286)	(6.386)	(4.647)	(3.361)	(2.542)
Others	-1.715	-2.021	-2.382	3.123	0.794	1.535
	(2.793)	(1.348)	(2.260)	(2.998)	(1.875)	(2.659)
ethnicity_mo						
Mongolia	-12.104**	-4.707	-5.917	0.514	2.332	-14.498
	(4.911)	(3.059)	(4.564)	(8.390)	(4.136)	(12.331)
Manchu	-1.898	0.240	-0.492	1.039	-0.509	2.071
	(3.243)	(1.379)	(2.660)	(3.415)	(2.176)	(3.360)
Hui	-3.943	-1.158	-1.827	3.575	0.420	3.752
	(5.724)	(2.058)	(3.292)	(3.565)	(1.707)	(2.508)
Tibetan	-5.465	1.409	3.227	10.871	4.478	8.827
	(10.368)	(1.011)	(6.802)	(9.149)	(4.671)	(11.517)
Zhuang	-6.649	-3.406*	-8.214	-17.503	-10.130*	-23.607***
	(9.378)	(1.947)	(7.496)	(12.748)	(5.809)	(7.572)
Other	-3.521	-4.332***	-0.961	-3.732	-4.966***	-2.424
	(2.944)	(1.489)	(2.397)	(2.904)	(1.884)	(2.606)
Hukou_place						
Non-agricultural	0.227	-0.681	1.084	1.281	0.680	4.520***
	(0.901)	(0.450)	(0.735)	(0.993)	(0.557)	(0.923)
Resident	-2.160**	-1.495***	-2.014**	-1.939*	-1.602**	-0.387
	(1.060)	(0.566)	(0.902)	(1.118)	(0.660)	(1.017)
Others	-11.391	-5.441	-11.522	-5.030	-11.314*	-5.724
	(9.869)	(4.884)	(7.957)	(7.247)	(5.839)	(7.860)
birth_age_fa	-0.273**	-0.065	-0.159	-0.123	-0.035	-0.216*
	(0.133)	(0.068)	(0.109)	(0.146)	(0.079)	(0.128)
birth_age_mo	0.026	-0.107	-0.056	-0.122	-0.137*	0.070
	(0.125)	(0.067)	(0.105)	(0.139)	(0.077)	(0.119)

political_fa						
Democratic	-0.526	1.377	2.134	-3.702	-3.310	-5.011
	(3.676)	(1.380)	(3.037)	(4.877)	(2.713)	(3.866)
Public	-1.862**	-0.947**	-2.104***	-2.135**	-1.354**	-2.727***
	(0.939)	(0.429)	(0.734)	(1.036)	(0.546)	(0.972)
political_mo						
Democratic	-1.600	-3.876*	-4.031	-3.745	-1.165	-6.705
	(4.158)	(2.187)	(3.064)	(4.945)	(2.428)	(4.088)
Public	-0.585	-0.306	1.063	1.234	0.846	0.661
	(1.288)	(0.546)	(1.019)	(1.508)	(0.827)	(1.387)
Cons	-8,266.109***	-3,073.542***	-6,367.820***	-7,641.361***	-3,701.069***	-7,807.732***
	(1,128.343)	(590.573)	(921.535)	(1,156.980)	(689.856)	(1,026.890)
Year fixed effect	Y	Y	Y	Y	Y	Y
Class fixed effect	Y	Y	Y	Y	Y	Y
N	6,982	6,982	6,982	7,023	7,020	7,023
adj. R2	0.119	0.155	0.174	0.097	0.127	0.176

Note: $* p < 0.1$, $** p < 0.05$, $*** p < 0.01$. Class ID clustering standard errors are shown in parentheses.

5 Mechanism check

5.1 Parental material reources for different children

The results discussed in the previous section show that the only-child effect significantly influences educational outcomes. The mechanism behind this effect is discussed in this section. For results presented in Table 4, the expense for extracurricular activities per semester is employed as a proxy variable to estimate the resource allocation of parents to only children and children with siblings. The results of column (1) and (2) report the estimations with full sample, whereas results of column (3) and (4) report the estimations with subsamples of female and male, respectively. Table 4 exclude samples with a maximum of 1% of the dependent variable, column (2) eliminates samples with a maximum of 5% of the dependent variable. The results of column (1) estimate using OLS show that extracurricular activity expenses for only children per semester are 440.57 yuan (based on purchasing power in 2014) higher than that of children with siblings. The results of column (2) show that extracurricular activity expenses for only children per semester are 294 yuan (based on purchasing power in 2014) higher than that of children with siblings. The results are still robust even the estimation of column (2) excludes the maximum of 5% of the dependent variable. Columns (3) and (4) respectively report the estimation results using subsamples of female and male, showing that the average expenses for the extracurricular activities of only girls per semester are 597.52 yuan (based on purchasing power in 2014) at a significance level of 1% more than that of girls with siblings and the average expenses for the extracurricular activities of only boys per semester are 277.69 yuan (based on purchasing power in 2014) more than that of boys with siblings. Lao et al. (2018) found that financial resources have a positive effect on individuals' education. Results of Table 3 may be explained partially the results of column (3) and (4) in Table 4.

Table 4: The only-child effect on the expense for extracurricular activities per semester

	(1)	(2)	(3)	(4)
	ols	ols	ols	ols
	full sample	full sample	female	male
Dep. Var	expense	expense	expense	expense
only_child	440.569***	294.004***	597.524***	277.694***
	(50.652)	(29.069)	(79.428)	(64.478)
steco_5c	249.373***	110.241***	328.121***	185.616***
	(36.390)	(20.566)	(54.766)	(48.843)
stsex	-160.639***	-75.339***		
	(43.852)	(25.133)		
stprhedu	158.424***	80.230***	140.030***	173.739***
	(14.275)	(7.798)	(20.325)	(19.943)
birth_year	38.835	50.767***	-4.300	82.146**
	(29.032)	(17.090)	(43.917)	(38.253)
ethnicity_fa				
Mongolia	-392.443	-453.513*	-169.762	-1,301.794**
	(632.059)	(269.862)	(780.398)	(510.577)
Manchu	-175.759	-72.708	-6.222	-510.566
	(208.097)	(131.075)	(267.939)	(316.196)
Hui	818.581**	269.857	664.429	682.674
	(415.783)	(270.794)	(581.024)	(533.376)
Tibetan	-137.995	-301.393	-1,056.590	132.755
	(573.521)	(574.967)	(658.229)	(199.220)
Zhuang	-443.713**	-312.735**	-538.045*	-242.681
	(183.439)	(134.365)	(285.835)	(197.600)
Others	-61.460	-127.994	66.926	-252.948*
	(128.459)	(78.572)	(202.553)	(153.631)
ethnicity_mo				
Mongolia	478.726	245.002	779.530	-767.193***
	(476.027)	(320.641)	(558.330)	(224.701)
Manchu	107.341	184.983	46.063	214.604
	(190.749)	(124.087)	(284.275)	(241.833)
Hui	-438.533	-325.096	1.609	-666.186
	(331.567)	(237.544)	(542.407)	(423.861)
Tibetan	-51.050	207.456	-228.097	1,151.658***
	(491.698)	(507.842)	(586.083)	(297.629)
Zhuang	-376.436***	-286.251***	-320.605**	-227.441
	(102.997)	(74.465)	(144.249)	(152.587)
Others	-206.090*	-172.194**	-326.476*	-80.329
	(124.260)	(81.779)	(174.969)	(167.064)
Hukou_place				
Non-agricultural	333.883***	301.762***	296.519***	354.123***
	(61.188)	(36.325)	(92.654)	(79.997)
Resident	285.586***	182.152***	393.271***	166.799*
	(66.413)	(37.404)	(99.888)	(88.097)
Others	-367.525	-377.399***	-9.463	-510.529
	(395.541)	(145.601)	(714.681)	(328.240)
birth_age_fa	-20.232**	-7.599	-11.139	-28.585**
	(8.519)	(4.671)	(12.933)	(11.286)
birth_age_mo	23.330***	5.649	24.134*	21.868**
	(8.405)	(4.602)	(12.837)	(10.938)

political_fa				
Democratic	-86.060	92.797	-18.675	-162.026
	(339.803)	(189.046)	(382.853)	(643.332)
Public	21.786	-51.991	-30.429	64.943
	(74.487)	(44.224)	(108.406)	(102.082)
political_mo				
Democratic	499.714	40.927	651.016	485.202
	(426.564)	(193.397)	(630.869)	(647.864)
Public	-209.447*	-7.258	-297.153*	-111.425
	(117.019)	(65.573)	(176.295)	(152.397)
Constant	-78,541.349	-101,963.235***	7,401.175	-165,005.215**
	(58,064.916)	(34,183.283)	(87,825.090)	(76,510.744)
Year fixed effect	Y	Y	Y	Y
School fixed effect	Y	Y	Y	Y
Sobel-Goodman test				
mat				
indirect effect	0.252***	0.426***	0.196	0.253***
p-value	0.000	0.000	0.110	0.002
% of mediated	13.62%	25.99%		10.34%
eng				
indirect effect	0.311***	0.513***	0.231**	0.326***
p-value	0.000	0.000	0.024	0.000
% of mediated	9.17%	15.23%	9.10%	7.36%
N	8,094	7,628	4,052	4,042
adj. R2	0.135	0.152	0.149	0.128

Note: $*\ p < 0.1$, $**\ p < 0.05$, $***\ p < 0.01$. Personal ID clustering standard errors are shown in parentheses. In order to reduce the influence of extreme values on the estimation, (1), (3) and (4) exclude the sample with the maximum value of the dependent variable at 1%; (2) exclude the sample with the maximum value of the dependent variable at 5%.

5.2 Parental non-material resources for different children

To examine the parental nonmaterial resources, the impacts of the only-child effect on parental concern are analyzed.

To reduce the influence of bias, we exclude children who live with either or neither of their parents. Columns (1) and (2) of Table 5 report parents' strictness toward individuals regarding assignments and exams, columns (3) and (4) report the frequency of visiting museums with parents, and columns (5) and (6) report the frequency of watching lives shows with parents. Columns (1), (3), and (5) report the results of the linear probability model (LPM), revealing that only children are more likely to obtain more concern from their parents than children with siblings are. For example, the parents of only children may be stricter toward their children in terms of assignments and examinations than parents of larger size family, and they may spend more time with their children than parents of larger size family. Columns (2), (4), and (6) report the results of an ordered probit model, in which the absolute value of the only_child's coefficient is larger than the coefficient of the OLS approach. Therefore, the results estimated using the two methods are consistent; only children are given access to more nonmaterial resources than other children.

Del Boca et al. (2013) state out that the time parents spend on their children is critical to their development, especially in terms of educational output (Blau and Currie, 2006; Knudsen et al., 2006). Therefore, this evidence provides support for the supposition that "parents' nonmaterial

Table 5: The only-child effect on the parental non-material resource

	(1)	(2)	(3)	(4)	(5)	(6)
	LPM	oprobit	LPM	oprobit	LPM	oprobit
Dep. Variable:	concern_par	concern_par	self_museum	self_museum	self_show	self_show
only_child	0.030**	0.070**	0.206***	0.188***	0.254***	0.211***
	(0.015)	(0.034)	(0.035)	(0.030)	(0.038)	(0.031)
steco_5c	0.032***	0.071***	0.436***	0.420***	0.450***	0.409***
	(0.012)	(0.026)	(0.025)	(0.025)	(0.027)	(0.025)
stprhedu	0.025*	0.056*	-0.050*	-0.056**	-0.025	-0.022
	(0.013)	(0.030)	(0.030)	(0.026)	(0.032)	(0.027)
birth_year	0.007*	0.017*	0.100***	0.090***	0.129***	0.104***
	(0.004)	(0.009)	(0.009)	(0.008)	(0.010)	(0.008)
ethnicity_fa						
Mongolia	0.279**	0.757*	0.102	0.070	-0.517	-0.410
	(0.129)	(0.433)	(0.652)	(0.533)	(0.592)	(0.486)
Manchu	0.011	0.024	0.324*	0.246*	0.257	0.197
	(0.061)	(0.143)	(0.171)	(0.130)	(0.164)	(0.123)
Hui	0.084	0.198	-0.308	-0.258	-0.070	-0.051
	(0.107)	(0.269)	(0.267)	(0.228)	(0.265)	(0.198)
Tibetan	-0.161	-0.411	0.185	0.072	1.136***	0.794**
	(0.107)	(0.278)	(0.453)	(0.375)	(0.411)	(0.313)
Zhuang	-0.202	-0.423	0.447	0.402	0.235	0.212
	(0.124)	(0.265)	(0.443)	(0.372)	(0.459)	(0.364)
Others	-0.049	-0.106	-0.169	-0.331***	-0.100	-0.205*
	(0.053)	(0.117)	(0.115)	(0.126)	(0.124)	(0.124)
ethnicity_mo						
Mongolia	-0.368**	-0.828**	-0.129	-0.083	0.109	0.108
	(0.172)	(0.366)	(0.284)	(0.212)	(0.280)	(0.198)
Manchu	0.063	0.146	-0.087	-0.060	-0.034	-0.030
	(0.059)	(0.145)	(0.143)	(0.112)	(0.148)	(0.110)
Hui	0.023	0.055	0.533**	0.462**	0.317	0.254
	(0.100)	(0.243)	(0.263)	(0.218)	(0.247)	(0.182)
Tibetan	0.191	0.482	0.345	0.367	-0.401	-0.269
	(0.118)	(0.339)	(0.386)	(0.335)	(0.269)	(0.237)
Zhuang	0.070	0.145	-0.296	-0.364	-0.216	-0.171
	(0.179)	(0.410)	(0.307)	(0.346)	(0.286)	(0.295)
Other	-0.005	-0.008	-0.248**	-0.317***	-0.266**	-0.301**
	(0.050)	(0.113)	(0.110)	(0.118)	(0.123)	(0.121)
Hukou_place						
Non-agricultural	0.043**	0.101***	0.100**	0.096***	0.226***	0.191***
	(0.017)	(0.039)	(0.041)	(0.035)	(0.044)	(0.035)
Resident	-0.002	-0.007	0.071	0.056	0.188***	0.151***
	(0.020)	(0.045)	(0.047)	(0.041)	(0.050)	(0.042)
Others	-0.223	-0.483	0.581	0.450	0.969*	0.711*
	(0.142)	(0.294)	(0.471)	(0.344)	(0.545)	(0.392)
birth_age_fa	0.001	0.002	-0.010*	-0.010**	-0.013**	-0.013***
	(0.003)	(0.006)	(0.006)	(0.005)	(0.006)	(0.005)
birth_age_mo	-0.005**	-0.011**	-0.005	-0.005	-0.003	-0.002
	(0.002)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)
political_fa						
Democratic	-0.099	-0.240	-0.170	-0.143	-0.257	-0.196
	(0.109)	(0.249)	(0.227)	(0.203)	(0.275)	(0.233)

Public	-0.043**	-0.104**	-0.051	-0.048	-0.086*	-0.068*
	(0.019)	(0.044)	(0.044)	(0.036)	(0.047)	(0.035)
political_mo						
Democratic	0.122	0.292	0.065	0.094	-0.130	-0.064
	(0.088)	(0.217)	(0.185)	(0.159)	(0.231)	(0.178)
Public	0.051*	0.119*	-0.041	-0.013	-0.187***	-0.113**
	(0.027)	(0.062)	(0.063)	(0.049)	(0.068)	(0.049)
Cons	-79.990***		-202.779***		-102.707**	
	(20.440)		(47.687)		(49.753)	
Year fixed effect	Y	Y	Y	Y	Y	Y
Class fixed effect	Y	Y	Y	Y	Y	Y
Sobel-Goodman test						
mat						
indirect effect	0.072**		-0.044		0.024	
p-value	0.015		0.308		0.634	
% of mediated	3.62%					
eng						
indirect effect	0.116***		0.013		0.100**	
p-value	0.005		0.733		0.030	
% of mediated	3.29%				2.79%	
N	8,588	8,588	8,494	8,494	8,536	8,536
adj. R2	0.024		0.150		0.180	

Note: $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$. Personal ID clustering standard errors are shown in parentheses. In order to reduce the bias, we exclude the sample lives with either or neither of parents.

resources for different children are heterogeneous", which shows that the only-child effect on academic achievement is partly achieved through this channel.

5.3 Closeness of parent-child relationships for different children

Turning now to the closeness of parent-child relationships for different children.

Table 6 reports the results obtained using an LPM and an ordered probit model. Columns (1) and (2) demonstrate the closeness of parent-child relationships between the respondent and their mother, whereas columns (3) and (4) report the closeness of parent-child relationships between the respondent and their father. Columns (1) and (3) report the results obtained using an LPM. These results show that only children are more likely to have a closer parent-child relationship than children with siblings are. Columns (2) and (4) report results obtained using an ordered probit model. According to these results, the absolute value of the only children is larger at the 1% level. Therefore, results obtained by estimation using the two methods are consistent; that is, the difference parent-child relationships between parents and only children is positive and significant. These results support the findings of Del Boca et al. (2013). Therefore, the evidence supports the hypothesis that "the closeness of parent-child relationships to different children is heterogeneous", which shows that the only child effect on academic achievement is partly achieved through this channel.

Table 6: The only-child effect on the closeness of parent-child relationships

	(1)	(2)	(3)	(4)
	LPM	oprobit	LPM	oprobit
Dep. Variable:	relation_mo	relation_mo	relation_fa	relation_fa
only_child	0.058***	0.179***	0.051***	0.117***
	(0.013)	(0.039)	(0.015)	(0.035)
steco_5c	0.034***	0.102***	0.036***	0.083***
	(0.010)	(0.031)	(0.012)	(0.027)
stprhedu	-0.045***	-0.146***	0.000	0.001
	(0.011)	(0.035)	(0.013)	(0.031)
birth_year	0.008**	0.025**	0.006	0.016*
	(0.003)	(0.010)	(0.004)	(0.009)
ethnicity_fa				
Mongolia	0.118***	4.332***	-0.334	-0.729
	(0.036)	(0.131)	(0.365)	(0.711)
Manchu	0.048	0.188	0.038	0.104
	(0.040)	(0.178)	(0.061)	(0.172)
Hui	-0.080	-0.256	-0.013	-0.034
	(0.106)	(0.314)	(0.107)	(0.266)
Tibetan	0.086	4.147***	-0.254	-0.544
	(0.060)	(0.210)	(0.202)	(0.407)
Zhuang	-0.094	-0.250	-0.118	-0.245
	(0.113)	(0.273)	(0.116)	(0.232)
Others	-0.043	-0.113	-0.005	-0.004
	(0.047)	(0.133)	(0.053)	(0.121)
ethnicity_mo				
Mongolia	0.099*	0.615	0.149	0.362
	(0.051)	(0.463)	(0.121)	(0.324)
Manchu	0.016	0.040	0.086*	0.234
	(0.039)	(0.153)	(0.050)	(0.151)
Hui	0.099	0.327	0.102	0.259
	(0.082)	(0.277)	(0.083)	(0.222)
Tibetan	0.185***	4.446***	0.088	0.182
	(0.041)	(0.153)	(0.171)	(0.384)
Zhuang	-0.100	-0.244	0.027	0.056
	(0.114)	(0.268)	(0.118)	(0.265)
Other	0.016	0.063	-0.030	-0.063
	(0.047)	(0.134)	(0.054)	(0.120)
Hukou_place				
Non-agricultural	-0.025*	-0.077*	-0.019	-0.041
	(0.015)	(0.046)	(0.017)	(0.041)
Resident	-0.034**	-0.101**	-0.013	-0.031
	(0.017)	(0.051)	(0.020)	(0.046)
Others	-0.112	-0.311	0.058	0.136
	(0.174)	(0.452)	(0.138)	(0.359)
birth_age_fa	0.005**	0.015**	0.004*	0.010*
	(0.002)	(0.007)	(0.003)	(0.006)
birth_age_mo	-0.003	-0.008	-0.002	-0.005
	(0.002)	(0.006)	(0.002)	(0.006)
political_fa				
Democratic	-0.036	-0.105	-0.041	-0.089
	(0.084)	(0.247)	(0.117)	(0.268)

Public	-0.031**	-0.106**	-0.026	-0.061
	(0.015)	(0.053)	(0.020)	(0.047)
political_mo				
Democratic	-0.101	-0.317	-0.108	-0.257
	(0.083)	(0.242)	(0.100)	(0.234)
Public	-0.014	-0.059	-0.042	-0.106
	(0.020)	(0.074)	(0.027)	(0.069)
Cons	1.191		41.462*	
	(18.649)		(21.310)	
Year fixed effect	Y	Y	Y	Y
Class fixed effect	Y	Y	Y	Y
Sobel-Goodman test				
mat				
indirect effect	0.138***		0.069**	
p-value	0.001		0.017	
% of mediated	6.93%		3.50%	
eng				
indirect effect	0.142***		0.087***	
p-value	0.000		0.004	
% of mediated	4.04%		2.49%	
N	8,585	8,585	8,583	8,583
adj. R2	0.019		0.021	

Note: $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$. Personal ID clustering standard errors are shown in parentheses. In order to reduce the bias, we exclude the sample lives with either or neither of parents.

5.4 Personality traits for different children

To examine the personality traits for different children, the impacts of the only-child effect on extraversion and openness are analyzed.

Table 7 reports the results obtained using an LPM and an ordered probit model. Columns (1) and (2) demonstrate "I often take part in school/class activities", columns (3) and (4) report "I feel close to people in this school", and columns (5) and (6) report "I feel bored in this school". Columns (1), (3) and (5) report the results obtained using an LPM. These results show that only children are more likely to have a higher level of extraversion. Columns (2), (4) and (6) report results obtained using an ordered probit model. According to these results, the absolute value of the only children is larger at the 1% level. Therefore, results obtained by estimation using the two methods are consistent.

Table 8 reports the results obtained using an LPM and an ordered probit model. Columns (1) and (2) demonstrate "Do you always express your opinions clearly" and "Are you quick to understand things", columns (3) and (4) report "Are you quick to responses", and columns (5) and (6) report "Are you quick to understand things". Columns (1), (3) and (5) report the results obtained using an LPM. These results show that only children are more likely to have a higher level of extraversion. Columns (2), (4) and (6) report results obtained using an ordered probit model. Results obtained by estimation using the two methods are consistent.

Previous studies focus on cognitive-personality correlations. The openness has been defined by scholars as the culture, openness to experience, intellect or imagination (DeYoung 2015). In fact, Shuerger and Kuna (1987) point out that openness has been linked with academic success in

Table 7: The only-child effect on the extraversion of students

	(1)	(2)	(3)	(4)	(5)	(6)
	LPM	oprobit	LPM	oprobit	LPM	oprobit
Dep. Variable:	extra1	extra1	extra2	extra2	extra3	extra3
only_child	0.086***	0.096***	0.060***	0.073***	-0.049***	-0.071***
	(0.021)	(0.024)	(0.019)	(0.024)	(0.018)	(0.025)
steco_5c	0.126***	0.143***	0.111***	0.135***	-0.090***	-0.116***
	(0.016)	(0.018)	(0.015)	(0.019)	(0.015)	(0.020)
stprhedu	-0.076***	-0.081***	-0.087***	-0.103***	0.086***	0.102***
	(0.019)	(0.021)	(0.017)	(0.021)	(0.016)	(0.022)
birth_year	0.020***	0.022***	0.019***	0.023***	-0.003	-0.005
	(0.005)	(0.006)	(0.005)	(0.006)	(0.005)	(0.007)
ethnicity_fa						
Mongolia	0.479***	0.676**	0.103	0.124	0.075	0.091
	(0.128)	(0.285)	(0.198)	(0.311)	(0.183)	(0.251)
Manchu	0.133	0.174	0.046	0.078	-0.057	-0.128
	(0.095)	(0.121)	(0.097)	(0.134)	(0.091)	(0.147)
Hui	0.298*	0.344	0.029	0.071	0.141	0.106
	(0.165)	(0.210)	(0.169)	(0.218)	(0.204)	(0.280)
Tibetan	0.102	0.135	0.071	0.096	-0.365	-0.574
	(0.337)	(0.383)	(0.413)	(0.525)	(0.357)	(0.504)
Zhuang	-0.231	-0.256	-0.298	-0.344	0.013	0.085
	(0.267)	(0.280)	(0.276)	(0.307)	(0.220)	(0.295)
Others	-0.140*	-0.150*	-0.054	-0.053	0.128**	0.141*
	(0.074)	(0.080)	(0.067)	(0.079)	(0.064)	(0.080)
ethnicity_mo						
Mongolia	0.206	0.304	0.202	0.322	0.169	0.264
	(0.165)	(0.247)	(0.157)	(0.258)	(0.173)	(0.228)
Manchu	0.051	0.038	0.073	0.086	-0.001	-0.013
	(0.078)	(0.095)	(0.082)	(0.113)	(0.089)	(0.135)
Hui	0.012	0.012	0.126	0.142	-0.060	-0.045
	(0.185)	(0.224)	(0.131)	(0.168)	(0.168)	(0.234)
Tibetan	0.282	0.284	0.232	0.277	0.133	0.197
	(0.172)	(0.196)	(0.278)	(0.352)	(0.315)	(0.386)
Zhuang	-0.237	-0.242	-0.197	-0.247	0.089	0.118
	(0.276)	(0.300)	(0.199)	(0.217)	(0.228)	(0.280)
Other	-0.249***	-0.262***	-0.113*	-0.120	0.001	0.016
	(0.074)	(0.080)	(0.068)	(0.080)	(0.062)	(0.080)
Hukou_place						
Non-agricultural	0.079***	0.089***	0.067***	0.086***	-0.057***	-0.085***
	(0.025)	(0.029)	(0.023)	(0.028)	(0.021)	(0.030)
Resident	0.010	0.010	0.021	0.030	0.002	-0.005
	(0.028)	(0.032)	(0.026)	(0.032)	(0.024)	(0.033)
Others	-0.061	-0.077	0.031	0.045	-0.260**	-0.405
	(0.187)	(0.216)	(0.179)	(0.235)	(0.132)	(0.264)
birth_age_fa	0.002	0.003	0.004	0.005	-0.003	-0.005
	(0.004)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)
birth_age_mo	-0.000	-0.001	-0.005	-0.006	0.006*	0.008**
	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)

political_fa						
Democratic	-0.116	-0.135	-0.117	-0.158	0.031	0.044
	(0.121)	(0.139)	(0.108)	(0.135)	(0.109)	(0.148)
Public	-0.030	-0.038	-0.013	-0.025	0.035	0.061*
	(0.028)	(0.033)	(0.027)	(0.034)	(0.024)	(0.036)
political_mo						
Democratic	0.094	0.121	0.176*	0.230	0.097	0.143
	(0.138)	(0.164)	(0.105)	(0.141)	(0.100)	(0.133)
Public	-0.021	-0.026	0.019	0.019	0.010	0.017
	(0.039)	(0.046)	(0.037)	(0.047)	(0.033)	(0.050)
Cons	84.824***		-54.837**		151.615***	
	(30.130)		(27.844)		(25.402)	
Year fixed effect	Y	Y	Y	Y	Y	Y
Class fixed effect	Y	Y	Y	Y	Y	Y
Sobel-Goodman test						
mat						
indirect effect	0.144***		0.130**		0.162***	
p-value	0.001		0.025		0.002	
% of mediated	6.92%		6.58%		7.67%	
eng						
indirect effect	0.146***		0.111**		0.150***	
p-value	0.001		0.025		0.001	
% of mediated	4.09%		3.22%		4.09%	
N	13,938	13,938	13,864	13,864	13,887	13,887
adj. R2	0.056		0.045		0.035	

Note: $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$. Personal ID clustering standard errors are shown in parentheses.

Table 8: The only-child effect on the openness of students

	(1)	(2)	(3)	(4)	(5)	(6)
	LPM	oprobit	LPM	oprobit	LPM	oprobit
Dep. Variable:	openness1	openness1	openness2	openness2	openness3	openness3
only_child	0.037*	0.056*	0.037*	0.057*	0.064***	0.093***
	(0.022)	(0.030)	(0.020)	(0.030)	(0.021)	(0.030)
steco_5c	0.063***	0.093***	0.090***	0.134***	0.086***	0.122***
	(0.014)	(0.020)	(0.014)	(0.020)	(0.014)	(0.020)
stprhedu	-0.058***	-0.081***	0.191***	0.293***	0.026	0.044
	(0.019)	(0.027)	(0.018)	(0.027)	(0.019)	(0.027)
birth_year	0.014**	0.021***	0.033***	0.052***	0.033***	0.049***
	(0.006)	(0.008)	(0.005)	(0.008)	(0.006)	(0.008)
ethnicity_fa						
Mongolia	0.432**	0.784*	0.170	0.313	0.361**	0.630*
	(0.186)	(0.460)	(0.229)	(0.442)	(0.150)	(0.345)
Manchu	0.086	0.120	0.054	0.065	-0.004	-0.005
	(0.103)	(0.156)	(0.086)	(0.132)	(0.108)	(0.159)
Hui	0.445***	0.687***	0.114	0.168	0.355***	0.557***
	(0.147)	(0.242)	(0.155)	(0.244)	(0.135)	(0.215)
Tibetan	-0.292	-0.410	-0.697**	-1.096**	-0.491	-0.708
	(0.459)	(0.680)	(0.312)	(0.501)	(0.317)	(0.436)
Zhuang	-0.237	-0.314	-0.044	-0.057	-0.132	-0.129
	(0.276)	(0.356)	(0.345)	(0.473)	(0.393)	(0.528)

Others	-0.008	0.006	0.026	0.033	0.109	0.152
	(0.073)	(0.098)	(0.071)	(0.101)	(0.074)	(0.100)
ethnicity_mo						
Mongolia	0.131	0.208	0.337	0.626	0.041	0.055
	(0.240)	(0.389)	(0.219)	(0.418)	(0.186)	(0.296)
Manchu	-0.012	-0.008	-0.012	-0.008	0.063	0.093
	(0.098)	(0.143)	(0.096)	(0.146)	(0.098)	(0.148)
Hui	-0.092	-0.126	-0.002	0.010	-0.337**	-0.519***
	(0.157)	(0.229)	(0.165)	(0.254)	(0.135)	(0.193)
Tibetan	0.222	0.340	0.697***	1.169***	0.065	0.104
	(0.267)	(0.452)	(0.193)	(0.427)	(0.295)	(0.431)
Zhuang	-0.047	-0.080	-0.124	-0.153	-0.300	-0.393
	(0.187)	(0.247)	(0.246)	(0.336)	(0.236)	(0.303)
Other	-0.120*	-0.170*	-0.142**	-0.193*	-0.111	-0.142
	(0.072)	(0.095)	(0.071)	(0.100)	(0.074)	(0.099)
Hukou_place						
Non-agricultural	0.027	0.040	0.071***	0.111***	0.046*	0.066*
	(0.026)	(0.037)	(0.024)	(0.037)	(0.025)	(0.036)
Resident	0.010	0.015	0.052*	0.081**	0.030	0.044
	(0.028)	(0.040)	(0.027)	(0.040)	(0.029)	(0.040)
Others	-0.242	-0.295	-0.151	-0.229	0.146	0.217
	(0.304)	(0.403)	(0.206)	(0.292)	(0.185)	(0.285)
birth_age_fa	-0.003	-0.004	-0.006	-0.009*	0.000	0.000
	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)
birth_age_mo	0.004	0.006	0.006*	0.010**	-0.002	-0.003
	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)
political_fa						
Democratic	0.149	0.247	0.157	0.250	0.108	0.136
	(0.124)	(0.195)	(0.114)	(0.181)	(0.109)	(0.170)
Public	-0.012	-0.018	-0.022	-0.034	-0.024	-0.037
	(0.030)	(0.043)	(0.028)	(0.042)	(0.029)	(0.043)
political_mo						
Democratic	-0.084	-0.117	-0.108	-0.172	0.040	0.049
	(0.136)	(0.198)	(0.116)	(0.177)	(0.109)	(0.170)
Public	0.007	0.011	-0.026	-0.040	-0.052	-0.080
	(0.040)	(0.059)	(0.038)	(0.059)	(0.040)	(0.060)
Cons	39.349		-8.950		-63.030**	
	(29.471)		(28.697)		(29.713)	
Year fixed effect	Y	Y	Y	Y	Y	Y
Class fixed effect	Y	Y	Y	Y	Y	Y
Sobel-Goodman test						
mat						
indirect effect	0.000		0.095**		0.0280***	
p-value	0.988		0.041		0.005	
% of mediated			5.55%		14.45%	
eng						
indirect effect	0.029*		0.095**		0.216***	
p-value	0.098		0.039		0.006	
% of mediated	8.62%		2.87%		6.23%	
N	13,479	13,479	13,497	13,497	13,379	13,379
adj. R2	0.019		0.056		0.042	

Note: $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$. Personal ID clustering standard errors are shown in parentheses.

school. Goff and Ackerman (1992) explain that students with high openness are likely to invest their efforts in intellectual activities. Carretta and Ree (2018) suggest that there is a positive relationship between cognitive ability and openness. Moreover, Steel et al. (2008) suggest that the sociability component of extraversion help students learn due to frequent interactions with teachers. Teachers have the tendency to perceive talkative children as more intelligent and more academically gifted than shy students (Coplan et al., 2011). This may explain the positive association between extraversion and educational outcomes. Therefore, results in this subsection show that the only child effect on academic achievement is partly achieved through the personality trait channel.

6 Conclusion

The one-child policy was implemented in September 1980 and abolished in late 2015. With this change in the demographic policy, the fertility decision of families also changed. To evaluate the only child effect on educational outcomes and to find out mechanisms of this effect are very important for the policymaker and parents.

This paper examines the only-child effect and birth order effect on educational outcomes. The results show that the academic performance of only children is significantly better than that of children with siblings. This is a result of differences in parental material and nonmaterial resources, the closeness of parent-child relationships, and the difference of personality traits. Comparing to children with siblings, the only children are beneficial to have more money and concern from parents. Also, they feel closer to parents than children with siblings do. A higher grade of openness and extraversion help the educational outcomes of only children, as well.

The conclusions presented in this paper can guide parenting decisions and human capital investment in children. Furthermore, the social welfare system can be improved referring to these conclusions as well. For example, policymakers may decide to spend more on students' psychological health. In conclusion, it is very important to estimate the only-child effect and analyze the mechanism of this effect.

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Dataset used in the article "The only child and educational outcomes" by Yehui Lao and Zhiqiang Dong

Description of dataset:

The empirical analysis of this article has been carried out using microdata from the China Education Panel Survey (CEPS).

The CEPS is a large-scale, nationally representative, longitudinal survey starting with two cohorts â the 7th and 9th graders in the 2013–2014 academic year. Documenting educational processes and transitions by which students progress through various educational stages, the CEPS aims at explaining the linkages between individuals' educational outcomes and multiple contexts of families, school processes, communities and social structure, and further studying the effects of educational outcomes during people's life course.

The CEPS applies a stratified, multistage sampling design with probability proportional to size (PPS), randomly selecting a school-based, nationally representative sample of approximately 20,000 students in 438 classrooms of 112 schools in 28 county-level units in mainland China. The baseline survey of CEPS was completed in the 2013–2014 academic year, conducted by National Survey Research Center (NSRC) at Renmin University of China. The data are currently available for academic research. Follow-up surveys are annual as the sample adolescents matriculate throughout the junior-high stage and in the 1st, 3rd, 7th, 8th, 17th and 27th year after they graduate from junior-high. CEPS will last more than 30 years, during which a new cohort of 7th graders will be started in a 10-year interval.

The CEPS administers 5 different questionnaires to the sample students, parents, homeroom teachers, main subject teachers who are not the homeroom teacher, and school administrators. The student questionnaire includes topics such as students' demographic characteristics, mobility and migration status, childhood experience, health status, household structure, parent-child interactions, in-school performance, extra curricular activities, relationship with teachers and peers, social behavior development, and expectations for the future.

Parent questionnaire consists of questions about parents' demographic characteristics and lifestyles, parent-child interactions, educational environment and investment for child, community environment, parent-teacher interactions, and parents' perceptions of school education and expectations for the future of the child.

The questionnaire for homeroom and main subject teachers involves questions concerning teachers' demographic characteristics, teaching experience, commentson student behaviors, parent-teacher interactions, comparison between local and non-local students, perceptions of education, and degree of stress and job satisfaction.

The questionnaire for school administrators asks about administrators' demographic characteristics, perceptions of education, school's educational facilities, daily management, enrollment of students, statistics of the student body and staff body.

Copyright information:

China Education Panel Survey was designed by National Survey Research Center at Renmin University of China, cooperating with 19 local universities and institutions of China Social Survey Network (CSSN) system. NSRC and CSSN Co-PIs will continue their cooperation on CEPS in the coming years, initiating a new pattern of academic cooperation in social surveys in China. To achieve the permission of dataset, please contact:
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