Research Article

When investment backfires:
Unbalanced sex ratios and mental health
among boys in rural areas

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Contents

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Abstract

BACKGROUND

In China, a key feature of demographic transition is the abnormally high sex ratio, resulting in a shortage of brides. In addition, depressive symptoms among Chinese adolescents have risen sharply in the last decade, and among these adolescents, boys in rural areas are most likely to be depressed.

OBJECTIVE

In this study, we investigate the phenomenon of depression in a large number of rural boys. We hypothesize that upon perceiving the strong competition in the local marriage market, rural parents tend to increase educational investment to improve their sons' relative standing in the market, thereby leading to high pressure and depression among rural boys.

METHODS

By leveraging variations across counties and cohorts, we constructed a difference-in-differences model featuring rich fixed effects to absorb invariant confounding factors and cohort trends across provinces. To ensure the exogeneity of sex ratios, we studied the first children in families, in cognition of the randomness of the first child's gender.

CONCLUSIONS

Empirical evidence suggests that high sex ratios motivate rural parents to elevate their educational expectations of and tangible and intangible investments in their sons, invariably increasing performance pressure and lowering academic performance, thereby deepening mental depression.

CONTRIBUTION

Our study contributes to multidisciplinary theories, such as son preference, competitive motive, and tiger parenting theory. Moreover, our findings have relevant implications:

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(1) A population control policy combined with a son-preference culture induces several unanticipated negative consequences. (2) The unrestrained educational investment is in disagreement with human capital outcomes.

1. Introduction

In China, a prominent feature of the demographic transition is the abnormally high sex ratio at birth. This phenomenon, named 'missing girls,' is caused by the combined effects of the son-preference culture, implementation of the one-child policy, and widespread use of ultrasound technology (Ebenstein 2010). In this perspective, an emerging body of literature has begun focusing on the consequences of unbalanced sex ratios. In particular, demographers have revealed the direct impact of missing girls, including a drop in the reproductive potential of the population (Cai and Feng 2005; Ebenstein 2010) and an increase in the social security burden and criminal risk owing to the large number of unmarried men, also known as 'left men' (Greenhalgh 2013).

Furthermore, economic studies document the diverse spillover effects of the missing girls phenomenon by exploring the manner in which the parents of sons respond to the marriage squeeze (Wei and Zhang 2015; Wei, Zhang, and Liu 2017). These studies primarily argue that parents either alter their financial strategies (Wei and Zhang 2011; Li et al. 2020) or change their work behaviors (Tan, Wei, and Zhang 2021) to strengthen their family's financial capacity and, accordingly, deal with the shortage of potential brides. In addition to financial preparation, parents may also directly increase investment in their sons' human capital to raise their value in the marriage market. However, the consequences of such potentially excessive investment in sons, especially in terms of psychological well-being, have not been sufficiently investigated.

Over the past decade, in addition to the elevated sex ratio at birth, the frequency of depressive symptoms among Chinese children and adolescents has risen strikingly. Interestingly, although evidence suggests that the overall depression prevalence among adolescent girls is higher than that among boys in other counties, the conditions in China are otherwise. According to a systematic review and meta-analysis, 10 of 25 studies report that in China, the prevalence of depression among boys is greater than that among girls. Notably, this result is inconsistent with the results of most studies in other countries (Tang, Zhao, and Zhao 2019). Moreover, based on a meta-analysis, Li et al. (2016) report that in China, the prevalence of depression is higher among boys than girls and higher in rural areas than in urban areas.

Depression is a severe public health problem that threatens the future of Chinese families and societies. The gender gap in depression prevalence among children and

adolescents has drawn limited interest. Nevertheless, further research is required to reveal potential reasons behind this phenomenon. To address this gap in the literature, our study considers a vital aspect of this phenomenon: the excessive investment in boys. We argue that upon perceiving the strong competitive pressure of the local marriage market, parents, especially in rural areas, are inclined to elevate their educational expectations of and to raise both tangible and intangible investments in their sons. Such high expectations and the greater pressure to perform result in a higher prevalence of depression in rural boys.

To comprehend the unintended consequences of the missing girls phenomenon among adolescents, we scrutinized empirical evidence obtained from the 2013 China Education Panel Survey (CEPS), which provides a wealth of information on middle school students and their parents. Our identification strategy utilizes two facts. First, sex ratios vary across counties; second, students of different cohorts are exposed differently within the same county depending on their birth year. To reduce the confounding effects of unobservable characteristics, we employed a difference-in-differences strategy featuring rich fixed effects (FEs) to absorb invariant confounding factors and cohort trends across provinces, such as the preference for investment in sons. Furthermore, considering the randomness of the first child's gender (Ebenstein 2010), we solely included the first child of families to mitigate the endogeneity of sex ratios. Our key independent variable, the sex ratio, was measured using two different data sources to attenuate any measurement errors.

Our study contributes to the literature in several ways. First, our findings extend the discussion on the spillover effects of the missing girls phenomenon from the parental aspect to that of children. Moreover, we hypothesize a possible mechanism connecting unbalanced sex ratios to the mental health of children influenced by the actions of their parents as intermediary agents. Second, our study reveals that actions taken by parents to increase the value of their male offspring in the marriage market could have a harmful impact on these sons; not only daughters but also sons can be victims of elevated sex ratios at birth. Third, as depression poses a serious health risk to Chinese children and adolescents, we identify a pathway that may contribute to the increase in the prevalence of depression. Thus, for reducing depression in children and adolescents, imbalanced sex ratios and the underlying son-preference culture should be addressed. Finally, our results suggest that excessive educational investment is detrimental to the development of human capital, including cognitive abilities and psychological well-being.

The remainder of this paper is organized as follows. The relevant background theory is briefly reviewed in section 2. The dataset and measures of variables used in this study are summarized in section 3, our econometric setup is introduced in section 4, and evidence of the causal chain of sex ratios in depression among boys is characterized in section 5. Conclusions are presented in section 6.

2. Theoretical foundations

This study examines the indirect and potentially harmful consequences of the missing girls phenomenon on the mental health of rural male students that result from excess educational expectations and investment. Our hypothesis is as follows: The unnaturally high male-to-female ratio at birth owing to a son-preference culture subsequently induces a shortage of potential brides, thereby forcing most parents to invest in their sons' competitive edge in the marriage market (Du and Wei 2013). To improve their sons' human capital, parents gradually elevate their educational expectations and intangible and tangible investments. This parenting style, known as tiger parenting, is significantly associated with lower academic performance and the pressures of higher expectations (Kim et al. 2013). Consequently, male adolescent students are more likely to suffer from depressive symptoms. Despite the positive outcomes generally related with educational investment, the consequent mental disorder is detrimental to human capital considering that mental health is a subset of human capital (Mushkin 1962).

Considering these aspects, our paper addresses three relevant theories: son preference, competitive motive, and tiger parenting theory. Furthermore, by introducing these related perspectives from the domains of economics, sociology, demography, and psychology, we hypothesize possible mediated factors of the unintended negative impact of high sex ratios on rural male students.

2.1 Son preference

Prior research indicates a long history of preference for sons in China (Banister 1987; Edlund 1999). Male superiority is a concept reflecting Confucian values, which are deeply rooted in Chinese culture. Complying with the cultural tradition stressing the continuation of the family line through male offspring, males reinforce their dominance within a household. In addition, in patriarchal families, the perceived economic value of sons is greater than that of daughters. After marriage, daughters and their natal families generally grow apart over the years, whereas sons generally continue residing with their parents. Accordingly, sons often perform menial tasks in the household, operate the family business, and provide care to their aging parents. These cultural values and economic factors together form a strictly patriarchal family structure (Almond, Li, and Meng 2010).

Gender bias in China has resulted in two devastating consequences. First, the abnormally high sex ratio (number of males per female), especially after implementation of the one-child policy, comprises direct evidence of discrimination against daughters. As estimated by researchers, China has tens of millions of missing girls (Coale 1991;

Johansson and Nygren 1991). Sen (1992) suggests that the massive deficit in Chinese females results from substantial female mortality. Second, extensive literature on gender inequality documents discrimination faced by the surviving girls. Compared to sons, parents in rural China undertake fewer material sacrifices and shoulder lower health care expenditures to provide for their daughters (Song 2008).

This study focuses mainly on the missing girls phenomenon in China rather than discrimination against surviving girls. In addition, the results presented in this paper add to the literature by exploiting novel data in which students report on parental expectations, parenting styles, and private tutorials. Moreover, we examine gender bias in educational investment, particularly in terms of expectations and intangible and tangible inputs. Notably, the negative consequences of a son-preference culture on girls is well documented in studies. In contrast, our study reveals that this preference has harmful effects on boys as well, which further broadens the range of literature on son-preference cultures.

2.2 Competitive motive theory

A direct consequence of the son-preference culture in China is sex-selective abortion, which has declined owing to implementation of the government's one-child policy in the 1980s (Ebenstein 2010). Under this regime, parents with additional children were subjected to fines and their children were excluded from free public education. This policy, combined with the historical tradition of family resources directed toward sons, resulted in a large number of missing girls in China (Coale and Banister 1994). Ebenstein (2011) presents a model of fertility choice for parents facing a mandated fertility limit; reportedly, in terms of years of income, a couple's first son is worth 1.42 times that of their first daughter. This higher perceived value of a son relative to that of a daughter is highest among families in rural areas and among uneducated mothers.

The growing female deficit suggests that the squeeze of the Chinese marriage market has become more severe over the years, especially for rural males, because of a lack of potential brides (Poston and Glover 2005). Concurrently, the household savings rate in China has risen rapidly since the beginning of the twenty-first century. Wei and Zhang (2011a) propose the theory of competitive savings motive to bridge the rise in premarital sex ratio and saving rates. This theory primarily argues that a high sex ratio triggers a competitive race in the savings rate among households with sons. Moreover, men constantly raise their savings rates to improve their relative attractiveness in the marriage market (Du and Wei 2013). Several studies have extended this theory in various directions. A growing number of studies examine the effect of sex ratio on entrepreneurship and economic growth, the higher incidence of accidental injuries and

workplace deaths, and more aggressive household portfolio choices for households with sons (Li et al. 2020; Tan, Wei, and Zhang 2021; Wei and Zhang 2011b). In particular, to improve their relative standing in the marriage market, sons of marriageable age are more likely to establish private domestic firms, accept relatively dangerous jobs, and provide service for a greater number of workdays. Concomitantly, their parents work harder and seek higher-paying dangerous jobs to accumulate wealth for their sons. In response, employers invest less in workplace safety, thereby leading to a higher work-related mortality. For households with sons, a higher sex ratio is associated with greater participation in the stock market, which is a measure for improving the competitive edge of sons in the marriage market.

In view of the aforementioned findings, this study applies the competitive savings motive theory to the phenomenon of increased parental educational investment in middle school students, especially rural male students. Driven by the competitive motive, parents of sons tend to have stricter expectations of them and invest excessively in their education, unintentionally causing these sons to face greater pressure and mental depression.

2.3 Tiger parenting

Following the publication of Amy Chua's memoir, the concept of tiger parenting has drawn tremendous attention from media and psychology research (Chua 2011). This perspective has enabled us to further understand the authoritarian parenting style of Chinese parents and its effect on student outcomes.

Research on parenting styles is rooted in the concept of parental control and identifies three styles: authoritative, authoritarian, and permissive (Baumrind 1966). Furthermore, a subsequent study extended Baumrind's research by reassessing parenting profiles using two dimensions: responsiveness (warmness) and demandingness (control). This approach helped identify an additional parenting style: negligence (Maccoby and Martin 1983). Authoritative parenting is perceived as a style in which the parents support autonomy, encourage communication, and are open to negotiation and reasoning. In contrast, in authoritarian parenting, parents use coercive power, control, and fear to implement behavioral compliance. Although both parenting styles use control, the style of control differs (Baumrind 2012). A negligent parenting profile is characterized by an unresponsive attitude of parents toward their children and infrequent use of control (Baumrind 1966).

Prior studies question whether these classic parenting categories accurately capture Asian American and native Asian parenting practices, whereby parents exercise authoritarian control over schoolwork and extracurricular activities. Certain studies on

Asian parents introduce caveats to the authoritarian label, such as an authoritative and psychologically controlling attitude, and propose the style of tiger parenting (Juang, Qin, and Park 2013; Lui and Rollock 2013). This parenting style emphasizes children's academic achievements by strengthening discipline and minimizing leisure time and nonacademic interactions. Focusing on this authoritarian style of parenting, Kim et al. (2013) report that a tiger parenting profile is associated with lower educational attainment, increased academic pressure, and a higher risk of developing depressive symptoms among children. Furthermore, economists suggest that this trait–environment interaction determines cognitive and noncognitive skills (Lundberg 2015). Considering the parenting style in contemporary China, Yang and Zhao (2020) report that the parenting styles of Chinese parents are predominantly authoritarian, whereas parents of higher social classes tend to assume a permissive parenting style. Particularly, this finding indicates that disadvantaged families, such as rural families, are more likely to follow an authoritarian parenting style. Other studies, such as those conducted by Ping, Duanqin, and Chunyan (2003) and Kang and Moore (2011), suggest that an authoritarian parenting style hinders the development of children's mental health and harms their academic progress. Xie and Li (2018) further identify the effects of tiger parenting styles on students by exploring the relationships between parenting profiles and children's school readiness, suggesting that tiger parenting affects student outcomes.

This study aims to determine whether tiger parenting fits the context of middle school students in China and provides a reasonable explanation for this style by considering the unique perspective of unbalanced sex ratios.

3. Data

3.1 The China Education Panel Survey

We obtained primary data for two periods – waves 2013–2014 and 2015–2016 – from the CEPS. These data were obtained through a nationally representative panel survey that gathers substantial information from students, teachers, parents, and school principals via questionnaires. The data follow a stratified probability-proportional-to-size sampling design. Twenty-eight county/city districts spread over 20 provinces were chosen. Four middle schools and multiple classrooms within each school represented each county/city district. The first wave was administered to all students in grades 7 and 9, the head teacher, and the main subject teachers in each classroom. In the second wave, responses were collected from grade 8 students, who were also surveyed in grade 7. The survey also inquired about one parent of each student to obtain information on their basic demographics, family education, school relationships, and children's backgrounds. In

other words, the CEPS provided detailed data on school performance, parental discipline, the parent–child relationship, and mental stress, which enabled us to conduct systematic empirical analyses.

The second dataset used was China's 2010 census microdata, a nationally representative sample covering 3.5% of the total population. Such large data ensured that sex ratios in each county across single-age cohorts could be obtained.

3.2 Sample construction

Our empirical strategy relies on a panel sample drawn from the CEPS that encompasses the most comprehensive set of information on students' mental stress, regular activities, and parental investment.

We are primarily interested in examining the gendered impact of sex ratios on depression in rural students, considering that they will face a severe marriage squeeze upon attaining adulthood. Accordingly, we extracted a sample of rural students from the CEPS according to a survey question that asked parents about their children's *hukou* status. *Hukou* is an official household registration system identifying a person as a resident of a certain area. In addition, we extracted a sample of students with an agricultural *hukou* and those who had transferred from an agricultural *hukou* to a nonagricultural *hukou* in recent years. The inclusion all these students was essential for obtaining a causal inference considering their parents' eligibility for the 1.5-children policy during the one-child policy period.

Note that we attach the contextual sex ratio of the county to students according to their school location. We do this to fit our econometric setting to account for the fact that student enrollment in middle school follows the principle of 'division by district and nearby admission,' as proposed by the Compulsory Schooling Laws (CSLs).[3] Specifically, local administrations divide their administrative regions into several school districts and establish specific admission procedures to enroll age-eligible children living in each district. Consequently, parents pay more attention to the marriage market of the county where their children currently live and attend school. Our approach helps us avoid an inconsistency between de facto residence and *hukou* location in view of the large floating population in China.

Our identification strategy was based on the exogeneity of sex ratios. To ensure this condition, recognizing that the sex ratios for first births are rather stable and fall within the biologically normal range, we further extracted a sample of students who were only children or the first child in the family (Ebenstein and Leung 2010). Thus, for an only

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[3] Article 12 of the CSLs: "The local administration shall ensure that age-eligible children enroll in school nearby their registered residence."

child or a first child in the family, the variation in sex ratios is plausibly exogenous. We further discuss this feature in the following section detailing assumptions for the identification strategy.

3.3 Measures of variables

Our sample contains 8,505 observations. Table 1 presents summary statistics for the outcome variables, independent variables, mechanism variables, and control variables.

3.3.1 Outcome variables

The outcome measure was obtained from students' responses to the mental stress survey items. We measured students' depression via responses to a question asking them to report their mental stress. Students were asked to report the frequency, during the previous seven days, of feeling depressed, blue, unhappy, or meaningless and to rank these feelings on a scale from 1 (never) to 5 (always). We converted these responses to binary indicators to determine if the students had persistently felt depressed, blue, unhappy, or meaningless in the past seven days. Using these components, we employed principal component analysis to compress the indicators of different aspects into a single index – i.e., the first component – with a mean of zero. In our restricted sample, depressive symptoms were more prevalent among male than female students.

3.3.2 Independent variables

The key independent variable in our study is the sex ratio. We identified sex ratios by one-year groups for the corresponding student cohort in each county, with data based on microdata from the 2010 population census. We employed gender ratios for the cohort that corresponded to the students in our sample from 1996 to 2002, and these were projected onto the corresponding age of the 2010 microdata. By calculating the size of the male and female population for single-age cohorts across counties, we obtained the measure of sex ratios. As shown in Panel B of Table 1, the mean sex ratio is 135 boys per 100 girls, which is higher than the normal level, varying from 103 to 107. The distribution of sex ratios at the student level, in Figure A-1 in the appendix, indicates that the standard deviation (SD) is 0.561. By leveraging these variations, we could examine effects of the sex ratio on symptoms of depression. As the incorporation of micro-censuses may introduce measurement error, particularly for regions featuring a small

population, in the robustness checks, we employed another measure for sex ratios from the 2010 aggregated population census. Considering that the official census statistics provided sex ratios by only five-year age groups, we projected students born in 1996–2000 to the sex ratios for the 10–14 age group in 2010, and those born in 2001–2002 were projected to the sex ratios for the 5–9 age group in 2010.

3.3.3 Control variables

The CEPS provides detailed information on student demographics, which allows for control of any possible confounding student characteristics. The control variables included gender (boy = 1), ethnicity (Han ethnicity = 1), left-behind children (yes = 1), grade, parent's years of schooling, and family economic conditions on a scale from 1 (very poor) to 5 (extremely wealthy). As illustrated by the results in Table 1, there are no strong differences between the corresponding male- and female-related variables.

3.3.4 Channel variables

We previously hypothesized four possible channels between sex ratio and adolescent depression. Herein, three measures of parental expectation, four measures of parental intangible investment, four measures of parental tangible investment, and five measures of students' responses were constructed.

We obtained measures of parental expectations on the basis of students' responses to three survey questions. The first question concerned whether parents expected a child's academic scores to rank in the top five in the class (yes = 1). The second question concerned parents' expectations of educational level (a bachelor's degree or above = 1). The last question concerned parental expectations of a child's future living place (large city or abroad = 1).

Measures of intangible parental investment were obtained via students' responses to four questions concerning parental discipline. These measures involved strict parental discipline during examinations and homework, school performance, time spent at home, and internet usage (yes = 1).

Table 1: **Descriptive statistics**

	Male		Female	
	N	Mean (SD)	N	Mean (SD)
Panel A: Outcome variable				
Depression	4,317	0.123 (1.817)	4,198	−0.117 (1.272)
Panel B: Independent variable				
Sex ratios	4,317	1.345 (0.550)	4,198	1.346 (0.574)
Panel C: Control variables				
Han ethnicity (= 1)	4,317	0.937 (0.244)	4,198	0.943 (0.232)
Grade 9 (= 1)	4,317	0.651 (0.476)	4,198	0.683 (0.465)
Left-behind children (= 1)	4,317	0.178 (0.382)	4,198	0.175 (0.380)
Parent's years of schooling	4,317	10.076 (2.906)	4,198	10.009 (2.921)
Family economic condition	4,317	2.805 (0.592)	4,198	2.787 (0.586)
Panel D: Channel variables				
Parental expectation				
Score ranking (top five in class = 1)	4,297	0.202 (0.402)	4,176	0.279 (0.448)
Expectation of educational level (bachelor's degree or above = 1)	4,106	0.614 (0.487)	4,051	0.683 (0.465)
Future residence (large city or abroad = 1)	3,006	0.634 (0.482)	2,852	0.615 (0.487)
Parental intangible investment				
Exam and homework (strict discipline = 1)	4,310	0.517 (0.500)	4,197	0.480 (0.500)
School performance (strict discipline = 1)	4,308	0.430 (0.495)	4,193	0.370 (0.483)
Time spent at home (strict discipline = 1)	2,862	0.435 (0.496)	2,893	0.513 (0.500)
Internet usage	4,287	0.643 (0.479)	4,165	0.631 (0.483)
Parental tangible investment				
Mathematical Olympiad (yes = 1)	4,303	0.101 (0.302)	4,186	0.029 (0.169)
Mathematics (yes = 1)	4,303	0.190 (0.392)	4,186	0.226 (0.418)
Chinese (yes = 1)	4,303	0.109 (0.312)	4,186	0.113 (0.316)
English (yes = 1)	4,303	0.226 (0.418)	4,186	0.231 (0.421)
Student outcomes				
Pressure owing to parental expectations (yes = 1)	4,287	0.422 (0.494)	4,179	0.313 (0.464)
Chinese scores (standardized)	4,212	−0.298 (1.018)	4,142	0.303 (0.840)
Math scores (standardized)	4,209	−0.077 (1.016)	4,139	0.072 (0.939)
English scores (standardized)	4,213	−0.298 (1.019)	4,142	0.297 (0.844)
Feel confident about future outlook (yes = 1)	4,281	0.850 (0.357)	4,166	0.840 (0.367)

Notes: This table reports summary statistics of our restricted sample, which includes 5,708 students. Data on county-level sex ratios were obtained from the 2010 China population census. Data on other variables were obtained from the CEPS. The first row of each variable shows the mean, with the standard deviation in parentheses. Columns 1–2 and 3–4 represent male and female student samples, respectively.

Parental tangible investment was measured in terms of students' additional tutorials in four academic courses: mathematical Olympiads, Chinese, mathematics, and English. Parents are obligated to invest in extracurricular tutorials to improve a child's position in the queue for optimal secondary education. Among these courses, mathematical Olympiad tutorials are common for middle school students; by securing a high rank in the mathematical Olympiad, a student can enroll in a superior high school or even in a university without taking a college entrance exam (*gaokao*). Moreover, Chinese, mathematics, and English are compulsory courses for all middle school students and are the main components of the high school entrance examination (*zhongkao*).

We measured the children's responses to questions about parental expectations, discipline, and investment using five survey items. First we constructed a measure of whether students felt immense mental pressure owing to parental expectations (yes = 1). Subsequently, on the basis of test scores obtained from school administrations, we constructed measures of students' academic performance in the three core courses of Chinese, mathematics, and English. The last measure of children's responses was obtained by asking them to report whether they felt confident about their future (yes = 1).

4. Empirical strategy

4.1 Regression specification

Our empirical strategy builds on two sources of variation. First, counties have different sex ratios. Second, students from different cohorts face different local sex ratios within the same county. Specifically, we estimate the following regression equation:

$$y_{i,g,c,p} = \beta_0 + \beta_1 sex\_ratio_{g,c,p} + \beta_2 X_{i,g,c,p} + \lambda_c + \mu_{g,p} + \varepsilon_{i,g,c,p} , \qquad (1)$$

where the dependent variable, $y_{i,g,c,p}$, represents either the outcome variable or the mechanism variable of individual i of cohort g in county c or province p; the key independent variable, $sex\_ratio_{g,c,p}$, denotes the sex ratio of the student cohort g in county c of province p; and $X_{i,g,c,p}$ includes exogenous control variables that may be related to the outcome variables, including gender (boy = 1), ethnicity (Han ethnicity = 1), left-behind child (yes = 1), grade, parent's years of schooling, and family economic conditions on a scale from 1 (extremely poor) to 5 (extremely wealthy). Moreover, we nonparametrically controlled for the type of community in which the school was located to reflect the urbanization level within the county. λ_c denote county FEs that absorb all

county-level characteristics that are invariant across time, such as endogenous son-centered investment preferences; $\mu_{g,p}$ depict province-cohort FEs that allow different provinces to exhibit different cohort trends. Because the invariant confounding factors in student cohorts in different provinces are absorbed, the method used to control the province-cohort FEs is stricter than that used to control the province and cohort FEs separately. If we introduced such FEs, we could make no assumptions regarding the functional form of the cohort trend and the trend could differ across provinces. The error term is denoted by $\varepsilon_{i,g,c,p}$, and standard errors are clustered at the county level to account for any potential correlation across students in the same county (Bertrand, Duflo, and Mullainathan 2004).

The primary parameter of interest in our study is the β_1 multiple of the $sex\_ratio_{g,c,p}$. Moreover, we are particularly interested in the gendered effect of sex ratios on students, considering that parents of boys vehemently wish to ensure that their sons get married in the face of a shortage of brides (Tan, Wei, and Zhang 2021). Thus we divided our sample by gender, estimated Equation (1) separately, and expected the impact of sex ratios to be statistically significant solely in the boy sample.

Furthermore, we assume that parents enhance their educational expectations and investments in their children, leading to high rates of adolescent depression in regions with high sex ratios. Upon observing the high sex ratio, parents strive to improve their children's competitive edge in the marriage market. As restrictions of the *hukou* system hinder migration (Davin 2007), sex ratios at the county level can be used to accurately reflect the local marriage market.

4.2 Identification assumption

To obtain unbiased ordinary least squares (OLS) estimates of the sex ratio effect (β_1) defined in Equation (1), we must ensure that the error term is not substantially correlated with the local sex ratio. Notably, in Equation (1), sex ratios between counties are included in the county FEs λ_c and the student cohort is included in the province-cohort Fes $\mu_{g,p}$. Thus our estimation strategy adopts the difference-in-differences specification. Although this setting can help maximally avoid any omitted-variable bias, the variation in sex ratios may not be exogenous because each person within the county comprises the local gender composition. This implies that the more males there are in a region, the higher will be the local sex ratio. To tackle this endogeneity of sample selection, we confined our sample to only or first children. In particular, this strategy partly relies on a well-recognized demographic regularity: the chances of the first child in a family being a boy or girl is

plausibly random. The statistical results from four Chinese population censuses (1982, 1990, 2000, and 2010) are illustrated in Figure 1, indicating that the imbalances between second and higher-order births drive high sex ratios in China, whereas the sex ratio for first births remains stable in the normal range. Therefore, for students who are the first child in the family, the variation driven by higher-order births can be viewed as exogenous.

Figure 1:   Male fraction of births by birth order in China
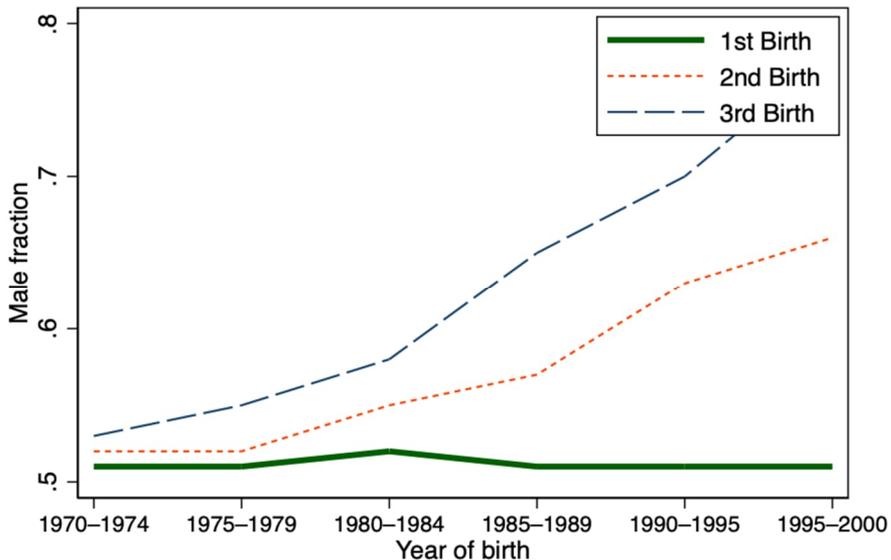
Notes: Data were obtained from results reported by Ebenstein (2010). The figure indicates a rise in the sex ratio following second and higher-order births after implementation of the one-child policy in China in 1979. However, first births are exceptions.

People in rural areas with strong son preferences are more likely to abort their first daughter, which is a matter of concern, thereby causing endogenous selection of the first child's gender. However, a policy known as 1.5 children states that households in rural areas can bear a second child if the first is a girl. This policy was applied to residents accounting for more than 60% of the Chinese population, which considerably mitigated motivation to abort a first child. Jiang and Zhang (2021) revisited sex ratios in China; reportedly, sex-selective abortions are seldom employed for the first birth in rural areas but are heavily used for the second pregnancy if the firstborn child is a daughter. Interestingly, an average family in our restricted sample features 1.5 children, which is

consistent with the aforementioned policy. In view of these results, we believe that our identification is powerful to prevent sample selection by exploiting our sample characteristics.

Statistical evidence from our sample supporting the randomness of the first child's gender is summarized in Table 2. Specifically, the mean and standard deviation of the first-son dummy is 0.500, implying that the sex ratio falls into the standard range and the occurrence of a first child is akin to a random Bernoulli trial in which the probability of birthing a boy or a girl is equal. In addition, the results of the balance test of family characteristics between first-son and first-daughter families, as listed in Table 2, suggest that families exhibit the most similar predetermined parental and household characteristics except for parental age. For instance, the means of parent's schooling age of first-son families and first-daughter families are 10.015 and 9.946, respectively; the difference is 0.069 and not statistically different from zero at the 10% level or below. In addition to the balance test, we regressed the first-son dummy on the complete set of control variables used in our analyses and discovered no significant effect of these variables. Thus these exercises strengthen our confidence in assumptions made for the identification strategy.

Table 2:   Balance test: first-son versus first-daughter families in first wave

	Mean (SD)			Difference	SE
	All families	First-son families	First-daughter families		
	(1)	(2)	(3)	(4)	(5)
First-born son	0.500 (0.500)				
Sex ratio	1.327 (0.007)	1.331 (0.010)	1.324 (0.011)	0.007	0.015
Parent's age	40.168 (0.091)	39.925 (0.119)	40.402 (0.137)	−0.477	0.182
Parent's schooling years	9.980 (0.038)	10.015 (0.054)	9.946 (0.054)	0.069	0.077
Parent's ethnicity (majority = 1)	0.949 (0.004)	0.955 (0.004)	0.944 (0.004)	0.011	0.007
Parent's political status (party = 1)	0.105 (0.005)	0.112 (0.006)	0.096 (0.006)	0.016	0.010
Family economic condition (5-point scale)	2.801 (0.008)	2.821 (0.011)	2.798 (0.011)	0.023	0.016
Observations	5708	2858	2850		

Notes: Data were obtained from the CEPS. Statistics were based on our sample of CEPS students. Standard deviations are shown in parentheses.

5. Results

5.1 Baseline results

The baseline results obtained via estimating Equation (1) on the basis of our sample are reported in Table 3. All regressions include individual and family characteristics, province single-year cohort FEs, and county FEs. Standard errors are clustered at the county level and presented in parentheses.

Table 3:   Baseline results

	(1)	(2)	(3)	(4)	(5)
			Depression		
Dependent variable	All	Boy	Girl	Boy	Girl
Sex ratios	0.223	0.515	−0.001		
	(0.072, 0.375)	(0.255, 0.775)	(−0.087, 0.085)		
Sex ratios × wave 1				0.441	−0.045
				(0.223, 0.659)	(−0.145, 0.055)
Sex ratios × wave 2				0.652	0.073
				(0.317, 0.987)	(0.009, 0.138)
Son	0.170				
	(0.073, 0.267)				
Controls	Yes	Yes	Yes	Yes	Yes
Province-cohort FEs	Yes	Yes	Yes	Yes	Yes
County FEs	Yes	Yes	Yes	Yes	Yes
Observations	8,505	4,305	4,192	4,305	4,192
R-squared	0.020	0.030	0.037	0.033	0.037

Notes: Data on county-level sex ratios were obtained from the 2010 Chinese population census. Data on other variables were obtained from the CEPS. Results are estimated using Equation (1) based on our sample of CEPS students. Confidence intervals are adjusted for the clustering structure of respondents at the county level. Robust 95% confidence intervals are indicated in parentheses.

The results in Column 1 of Table 3, based on the full sample, provide weak evidence for the increase in the frequency of depression among all students owing to high sex ratios. As indicated by the results in Columns 2 and 3, we further explored whether high sex ratios exerted differential effects on boys and girls and discovered that high sex ratios were associated with more frequent depression among boys. To appreciate the economic significance of these effects, we interpreted the results as follows: The estimates obtained from our preferred specification in Column 2 suggested that a 1-SD increase in the sex ratio (0.550) for families with sons will increase the depression frequency by 28.3% of the SD. However, a high sex ratio did not exert a significant effect on the frequency of depression in girls. In other words, rural male students exhibit a higher frequency of depression in regions with higher sex ratios, thereby suggesting that marriage market

conditions, as measured by the local level of sex ratio imbalance, are a prerequisite for explaining depression in middle school rural male students.

To determine if the effects of sex ratios hold up or fade over time, we incorporated sex ratios with wave indicators in the model specifications. The results presented in Table 3 indicate that the impact of the sex ratio on depression symptoms increases in significance with time. Specifically, an increase of 1 SD in the sex ratio (0.562) for families with sons will increase depression frequency by 24.8% and 36.6% of the SD in the first year and second year, respectively, suggesting that the effects not only are long-lasting but also get stronger with time. In contrast, the results for female students indicate a minimal reaction to the sex ratios.

5.2 Mechanism

We revealed strong evidence that sex ratios exerted a significant effect on higher rates of depression among male rural students. This section details potential mechanisms and in particular focuses on the mechanism through which higher sex ratios affect parental expectations, intangible and tangible investments, and students' outcomes, thereby leading to further deepening of depressive symptoms. Through mechanism analyses, this study characterizes the aforementioned theories.

5.2.1 Sex ratios and parental expectations

We examined how parental expectations for academic performance, educational levels, and future residential outcomes for children vary according to local sex ratios. The estimation results are listed in Table 4, suggesting that in regions with high sex ratios, parents of sons have high score-ranking requirements for their children, demand higher educational degrees, and expect sons to live in a large city or abroad. Particularly, a 1-SD increase in sex ratios raises the probability of a first-son family having expectations for high scores, a high educational levels, and a son living in a large city or abroad by 4.9 (= 0.550*0.089), 4.7 (= 0.550*0.086), and 4.6 (= 0.550*0.084) percentage points, respectively. In contrast, parents of daughters in regions with high sex ratios do not have significant expectations for their children in terms of academic performance and future living outcomes.

Table 4:   Mechanism: the impact of sex ratios on parental expectations

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
	Score requirement (ranked top five = 1)		Education expectation (bachelor's degree or above = 1)		Future residence (large cities or abroad = 1)	
	Boy	Girl	Boy	Girl	Boy	Girl
Sex ratios	0.089 (−0.001, 0.179)	0.018 (−0.009, 0.045)	0.086 (0.040, 0.133)	−0.021 (−0.083, 0.041)	0.084 (0.012, 0.157)	-0.049 (−0.096, −0.003)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Province-cohort FEs	Yes	Yes	Yes	Yes	Yes	Yes
County FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,284	4,170	4,093	4,045	2,993	2,846
R-squared	0.061	0.047	0.143	0.108	0.126	0.084

Notes: Data on county-level sex ratios were obtained from the 2010 Chinese population census. Data for other variables were obtained from the CEPS. The results were estimated using Equation (1) based on our sample of CEPS students. Confidence intervals were adjusted for the clustering structure of the respondents at the county level. Robust 95% confidence intervals are indicated in parentheses.

5.2.2 Sex ratios and parental investment

Parents with a preference for educational investment in sons or wishes to increase their sons' human capital and standing in the marriage market will increase their expectations of their children's academic achievement and thus increase the educational investment. Such educational investments can be classified as intangible and tangible. In this study, we used parental discipline and private student tutorials to measure intangible and tangible investments, respectively.

The results using parental discipline as independent variables are reported in Table 5. They suggest that sex ratios also exert differential effects on parental discipline among boys and girls. Noticeably, in regions with higher sex ratios, parents of sons exercise stricter discipline regarding examinations and homework, academic performance, time spent at home, and internet usage. In particular, the effects of sex ratios on parental discipline regarding examinations and homework, academic performance, and internet usage among boys are strong and robust. A 1-SD increase in sex ratios raises the probability that a first-son family will exercise strict parental discipline regarding examinations and homework, academic performance, time taken to return home, and internet usage by 3.6 (= 0.550*0.066), 4.3 (= 0.550*0.078), 3.9 (= 0.550*0.071), and 3.1 (= 0.550*0.056) percentage points, respectively. However, sex ratios weakly impact parental discipline regarding academic performance and internet usage for girls. In

addition, high sex ratios are significantly associated with stricter discipline regarding time spent at home for girls, which fits the context of the Chinese parental style for girls.

Table 5: **Mechanism: the impact of sex ratios on parental disciplines**

Dependent variable	(1) Examinations and homework (strict =1) Boy	(2) Examinations and homework (strict =1) Girl	(3) Academic performance (strict =1) Boy	(4) Academic performance (strict =1) Girl	(5) Time spent at home (strict =1) Boy	(6) Time spent at home (strict =1) Girl	(7) Internet usage (strict =1) Boy	(8) Internet usage (strict =1) Girl
Sex ratios	0.066 (0.013, 0.119)	0.015 (−0.012, 0.042)	0.078 (0.009, 0.147)	0.005 (−0.065, 0.075)	0.071 (−0.014, 0.156)	0.085 (0.024, 0.145)	0.056 (0.024, 0.088)	0.018 (−0.042, 0.078)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-cohort FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,298	4,191	4,296	4,187	2,849	2,887	4,275	4,159
R-squared	0.078	0.063	0.072	0.061	0.067	0.074	0.073	0.079

Notes: Data on county-level sex ratios were obtained from the 2010 Chinese population census. Data for other variables were obtained from the CEPS. The results were estimated using Equation (1) based on our sample of CEPS students. Confidence intervals were adjusted for the clustering structure of the respondents at the county level. Robust 95% confidence intervals are indicated in parentheses.

We further explored the chances of sex ratios affecting the tangible investment – i.e., more private tutorials for students. As demonstrated by the results in Table 6, higher sex ratios are strongly associated with an increased number of private tutorials for mathematical Olympiads, mathematics, and English courses. (The exception is Chinese tutorials.) Specifically, an increase of 1 SD in the sex ratio (0.550) increases the probability of male students from first-son families participating in mathematical Olympiads, mathematics, and English courses by 8.1%, 5.3%, and 5.1%, respectively. In contrast, sex ratios showed no significant effects on the frequency of academic tutorials for girls, indicating a gender bias in the tangible parental investment in education. In this study, we report empirical evidence of competitive motives leading to a gender bias in educational expectations and investment. Moreover, these analyses explain the rise of tiger parenting in China.

Table 6:   **Mechanism: the impact of sex ratios on private tutorials**

Dependent variable	(1) Mathematical Olympiad (yes =1)	(2)	(3) Math (yes =1)	(4)	(5) Chinese (yes =1)	(6)	(7) English (yes =1)	(8)
	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl
Sex ratios	0.147	0.008	0.097	−0.025	−0.004	−0.004	0.093	−0.066
		(−0.008,	(0.026,	(−0.055,	(−0.033,	(−0.022,	(0.044,	(−0.079,
	(0.133, 0.162)	0.023)	0.167)	0.004)	0.025)	0.013)	0.142)	−0.053)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-cohort FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,292	4,180	4,291	4,180	4,291	4,180	4,291	4,180
R-squared	0.250	0.070	0.133	0.188	0.081	0.098	0.164	0.172

Notes: Data on county-level sex ratios were obtained from the 2010 Chinese population census. Data for other variables were obtained from the CEPS. The results were estimated using Equation (1) based on our sample of CEPS students. Confidence intervals were adjusted for the clustering structure of the respondents at the county level. Robust 95% confidence intervals are indicated in parentheses.

5.2.3 Sex ratios and student outcomes

Finally, we analyzed the mechanism through which sex ratios affected student outcomes. The estimation results are listed in Table 7. The results show that boys in regions with higher sex ratios are more likely to experience mental pressure stemming from parental expectations and, consequently, lower academic performance in Chinese, mathematics, and English courses. Moreover, for boys, higher sex ratios are strongly associated with lower confidence regarding their future outlook. A 1-SD increase in sex ratios raises the probability that male students in first-son families experience parental pressure and low confidence in their future outlook by 7.5 (= 0.550*0.136) and 2.0 (= 0.550*0.037) percentage points, respectively, and decreases their Chinese, mathematics, and English scores by 8.2% (= 0.550*0.149), 4.5% (= 0.550*0.082), and 3.5% (= 0.550*0.063) of the SD, respectively. These findings suggest that tiger parenting negatively affects students' academic performance and adds to their mental stress, thereby indicating that excessive investment in education impedes the development of human capital under certain circumstances. However, we did not observe strong evidence for such effects among girls, proving that gender bias regarding student outcomes continues to exist.

Table 7: **Mechanism: the impact of sex ratios on student outcomes**

Dependent variable	(1) Expectation pressure (yes = 1) Boy	(2) Girl	(3) Chinese Boy	(4) Girl	(5) Mathematics Boy	(6) Girl	(7) English Boy	(8) Girl	(9) Confident (yes = 1) Boy	(10) Girl
Sex ratios	0.136	−0.014	−0.149	−0.122	−0.082	−0.011	−0.063	−0.099	−0.037	−0.008
	(0.111 – 0.161)	(−0.081 – 0.052)	(−0.176 – −0.121)	(−0.156 – −0.089)	(−0.161 – −0.004)	(−0.118 – 0.096)	(−0.111 – −0.016)	(−0.124 – −0.073)	(−0.053 – −0.020)	(−0.033 – 0.017)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-cohort FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,275	4,173	4,202	4,136	4,199	4,133	4,203	4,136	4,269	4,160
R-squared	0.135	0.071	0.041	0.039	0.048	0.043	0.049	0.051	0.059	0.071

Notes: Data on county-level sex ratios were obtained from the 2010 Chinese population census. Data for the other variables were obtained from the CEPS. The results were estimated using Equation (1) based on our sample of CEPS students. Confidence intervals were adjusted for the clustering structure of the respondents at the county level. Robust 95% confidence intervals are indicated in parentheses.

We examined all the possible aforementioned mechanisms. These results are consistent with our hypothesis that parents living in regions with higher sex ratios are more likely to increase their expectations of and intangible and tangible investments in their sons, leading to greater pressure (stemming from high parental expectations), lower academic performance, and lower confidence in future outcomes. Moreover, prior research reports that these effects are statistically associated with a greater frequency of depressive symptoms. Considering these aspects, we verified the inferred channels.

5.3 Robustness checks

By changing measures for outcome and independent variables, examining the endogeneity of the son-preferring fertility-stopping rule and the gendered-peer effect, and determining the applicability of potential instruments in this study, we conducted several empirical exercises to examine the robustness of our main results.

5.3.1 Changing measures for outcome and independent variables

Although the microdata sample of the 2010 population census was randomly selected from the original data, the measurement of local sex ratios may be overestimated or underestimated in counties featuring a smaller population size. We addressed this issue

by using sex ratios reported in the 2010 aggregated population census. As the 2010 population census reports local sex ratios solely by five-year age groups, we projected students born in 1996–2000 using the 10–14 age group and students born in 2001–2002 using 5-9 age group. Because only two cohorts remained for use, we adjusted our estimation strategy to mitigate collinearity between the sex ratios and FEs. In other words, we controlled for province five-year cohort FEs rather than province single-year FEs. The results are reported in Columns 1–2 of Table 8 and indicate a pattern similar to the baseline but more substantial effects and a more reliable statistical significance of sex ratios, thereby increasing the reliability of the findings. Notably, we did not use this measure for sex ratios in the baseline regression because we could not exploit as many variations across cohorts as compared to the preferred measure.

In addition, although parents tend to perceive local sex ratios for their children's cohort, some consider sex ratios of male adolescents paired with girls two years younger in view of the two-year difference in the average first-born marriage age between males and females. Thus we estimated the effects of sex ratios with different pairs on depressive symptoms. The results, as presented in Columns 3–4 of Table 8, remain relatively stable.

Finally, the sex ratios are more balanced among ethnic minorities because they were granted excessive birth quotas during the one-child policy period. Thus our difference-in-differences estimator might be confounded by the sex ratios of different ethnic groups. To rule out any confusion, we re-estimated Equation (1) using a more detailed sex ratio measure for each ethnic group. In particular, the results reported in Columns 5–6 of Table 8 indicate that the estimated coefficients are robust.

Table 8:   Robustness: changing the measures for sex ratios

	(1)	(2)	(3)	(4)	(5)	(6)
			Depression			
Dependent variable	Boy	Girl	Boy	Girl	Boy	Girl
Five-year age group sex ratios	1.713	−0.067				
	(0.683, −2.743)	(−2.774, 2.639)				
Sex ratios with different pairs			0.367	0.049		
			(0.004, 0.738)	(−0.017, 0.116)		
Sex ratios at the ethnic level					0.577	−0.020
					(0.376, 0.777)	(−0.083, 0.042)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Province-cohort FEs	Yes	Yes	Yes	Yes	Yes	Yes
County FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,178	4,054	4,178	4,054	4,178	4,054
R-squared	0.027	0.042	0.030	0.043	0.033	0.043

Note: Confidence intervals were adjusted for the clustering structure of respondents at the county level. Robust 95% confidence intervals are indicated in parentheses.

5.3.2 Potential issues related to son-preferring fertility-stopping rules

To ensure the exogeneity of our model specifications, we employed two strategies. First, we introduced rich FEs, including province-cohort FEs and county FEs, resembling a difference-in-differences setting to absorb any potential confounding factors. Second, we verified that the gender of the first child was plausibly random to avoid problems during sample selection. However, as Ebenstein (2011) points out, son preference may cause differences in subsequent fertility between first-son and first-daughter families. In this regard, first-daughter families are typically willing to bear a second or third child in pursuit of a boy, whereas first-son families will cease childbearing and exhibit a smaller family size.

A concern is that parents may have more expectations of and investments in rural male students because they do not need to support large families. Thus we controlled for our model's potential confounding factor, family size, to mitigate such an effect. The results, reported in Columns 1–2 of Table 9, suggest that family size has no significant impact on depression. Moreover, the other results were similar to our main findings, and we checked robustness in cases where parental expectations and investments were dependent variables. The results remained the same in terms of the effects of the sex ratio.

5.3.3 Potential issues related to gendered-peer effects

Using a design featuring random student assignment, Gong, Lu, and Song (2018) reveal that a higher proportion of female peers in a class is associated with positive student outcomes, which suggests that our results may be confounded by gender proportion. To rule out this possibility, we further controlled for the proportion of female peers in a class, as shown in Columns 3–4 of Table 9. We discovered that the results remained similar to the baseline findings.

5.3.4 Restriction to Han and non-migrant students

Given their relatively low sex ratios combined with their parents' attention to the same-ethnicity marriage market, students from non-Han families would presumably not react to competitive marriage pressure. To exclude the impact of minority students, we restricted the sample to the Han Chinese. The estimated results in Columns 5–6 of Table 9 show that the effects of sex ratios on depression symptoms are more salient than those reflected in the baseline results, providing further evidence for the competitive motive theory.

In addition to ethnic heterogeneity, a related question arises: As left-behind children are usually cared for by their grandparents, the educational pressure on these children may differ from that on others. To examine this hypothesis, we restricted the sample to these students and re-estimated Equation (1). The results reported in Columns 7–8 of Table 9 indicate that the coefficients of sex ratios remain similar to the baseline estimates, thereby suggesting that although parents do not directly make daily decisions for them, left-behind children are also affected by local sex ratios. Presumably, parents' educational expectations can still be propagated by directing the actions of grandparents.

Table 9:   Robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent				Depression				
variable	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl
Sex ratios	0.503 (0.254, 0.752)	−0.018 (−0.104, 0.067)	0.499 (0.249, 0.750)	−0.019 (−0.105, 0.067)	0.536 (0.281, 0.791)	−0.005 (−0.084, 0.073)	0.527 (0.338, 0.715)	−0.029 (−0.140, 0.081)
Family size	0.094 (−0.057, 0.245)	−0.034 (−0.121, 0.053)						
Female ratio			−0.417 (−1.259, 0.425)	0.056 (−0.337, 0.450)				
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-cohort FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,178	4,054	4,172	4,054	4,150	4,013	3,520	3,460
R-squared	0.033	0.044	0.033	0.044	0.033	0.040	0.045	0.044

Note: Confidence intervals were adjusted for the clustering structure of respondents at the county level. Robust 95% confidence intervals are denoted in parentheses.

5.3.5 Applicability of potential instruments

This study did not employ typical candidates for instruments such as variations in the financial penalty levied for unauthorized births. We adopted this approach because such instruments are cross-sectional, forcing us to drop any province or county FEs. This implies that we may introduce more endogeneity, thereby affecting the robustness of our results. Hence we focused on the OLS estimates to investigate the sex ratio effects.

6. Conclusion

Using nationally representative data regarding Chinese middle schools, this study explores the negative mental health consequences of high sex ratios among male rural middle school students. Empirical evidence indicated that high sex ratios drove rural parents to elevate their expectations of and investment in sons, leading to increased parental pressure, lower academic performance, and, consequently, greater depression. A 1-SD increase in the sex ratio (0.550) for families with sons increased depression frequency by 28.3% of the SD. Moreover, we characterized a series of possible channels to further demonstrate our results. As parents aimed to improve their sons' attractiveness in the marriage market, they reacted to imbalanced sex ratios by increasing their educational expectations of and investment in their sons. As a result, rural male students faced greater pressure, exhibited lower academic outcomes, and thusly experienced a higher frequency of depression. Furthermore, imbalanced sex ratios boosted the probability of stricter parental discipline and more private tutorials for firstborn sons but not for firstborn daughters. These findings clarified to an extent the puzzling phenomenon of the rise in tiger parenting and depression among male adolescent students in China.

Competitive pressure as a cause of educational overinvestment and mental health symptoms among Chinese students has not been systematically explored. Our study contributes to multidisciplinary theories, such as son preference, competitive motive, and tiger parenting theory. Our findings that the missing girls phenomenon exerts unintended effects on male adolescent students also entail relevant policy implications. First, a population control policy combined with a son-preference culture could induce several unanticipated negative consequences. Previous studies have focused on the adverse effects on girls, whereas our research demonstrated that boys are also victims of adverse effects. Thus alleviating the imbalance in sex ratios plays a pivotal role in reducing the mental burden on middle school male students and reducing their symptoms of depression. Second, excessive educational investment is in disagreement with desirable human capital outcomes. Hence parents should strive for a balanced parenting position for their children. Notably, as China witnessed rapid economic and policy changes in 2014, discussions on future trends are warranted. With the relaxation of the population control policy, we expect that the phenomenon of parental pressure on and depression in male children induced by the competitive marriage market, as described by the competitive motive theory, will fade to a certain extent. However, the overall parental pressure on children's studies may not decrease because of the tiger parenting culture in China and ever-increasing competition in the job market.

Particularly, a limitation of this study is related to another explanation for our findings. In contrast to the competitive motive theory, a potential hypothesis would be that girls are better at withstanding stress levels since they mature earlier than boys.

Although this speculation cannot explain the higher parental educational expectations of boys in regions with high sex ratios, a formal exercise will be valuable for ruling out this possible channel. However, owing to data limitations, we could not measure the level of maturity; thus a direct method shall be devised to examine this potential explanation in the future. Another caveat is that the parental expectation and behavioral information was obtained from student reports. Although we combined two waves of data, our identification strategy may still be confounded by measurement errors to some extent.

7. Acknowledgement

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Appendix

Figure A-1: Distribution of sex ratios