# Essays on Higher Education and Gender Gap in Investments in Children's Health and Education

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# DECLARATION

I declare that Chapter 1 "Why does socio-economic status influence higher education choice? Evidence from UK university applications" is a joint work with my supervisors Dr Tania Oliveira and Dr Jesse Matheson, and that Chapter 2 "Maternal Education and Gender Gap in Family Nurture of Chinese Children" and Chapter 3 "Son Preference, Family Planning Policy, and Breastfeeding Patterns: Evidence from China" are works by me.

# THESIS ABSTRACT

Chapter 1 addresses the observation that higher education participants from low socio-economic status (SES) backgrounds on average attend less competitive universities than their high SES peers. Taking advantage of a unique set of administrative data, which is linked to data reflecting SES measures for each student's postal code of residence, we are able to decompose observed differences in type of university attended. We find that the majority of the observed difference in the type of university attended can be attributed to the application stage: conditional on having the same predicted grades, low SES students apply to less competitive universities than do high SES students.

Chapter 2 seeks answer to the question of how maternal years of schooling influence the gender gap in the nurture of children. Empirical results show that although parents believe that girls are capable of getting a higher score in exams than boys, and that girls are more conscientious about their school work, they invest more in boys' health and pay more for boys' education. The exciting bit of the results is that higher maternal education has the effect of narrowing the gender gap in postnatal health investment and education investment of children.

Chapter 3 exploits the fact that Family Planning Policy only applies to Han people but that ethnic minority couples' fertility is not affected, to investigate how breastfeeding patterns with respect to gender and birth order differs across ethnic background. Empirical results indicate that legal control for family fertility greatly restrains breastfeeding for children in low parities, especially for girls, and exacerbate the gender gap in middle parity. These effects are most remarkable among large families.

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# Chapter 1

## Why Does Socio-economic Status Influence Higher Education Choice? Evidence from UK University Applications

*Abstract:* In the United Kingdom students from low socio-economic status (SES) backgrounds are less likely than students from high SES backgrounds to attend university. Further, low-SES students who attend university, on average, attend less competitive universities than their high-SES counterparts. In this paper we address the second of these observations, the intensive margin of higher education, by decomposing observed differences in type of university attended (where competitiveness is measured by the average entry grade for previous years) into one of three explanations. Conditioning on predicted grades at time of application, a difference in observed university attendance will arise if: 1) Low SES students apply to less competitive universities than do high SES students; 2) Having applied to the same university, low SES students are less likely to receive an offer than are high SES students; 3) Given the same available offers, low SES students accept offers from less competitive universities than do high SES students.

This paper takes advantage of a unique set of administrative data. These data cover more than 20,000 students and provide information on: a) all universities to which each student applies; b) each students' predicted secondary school grades at the time of their application; c) which universities, of those applied to, offered the student a place; d) of the offers made, which each student accepts. This information is linked to data reflecting socio-economic status measures for each student's postal code of residence, as well as detailed information about the secondary school each student attended.

Using these data we decompose the average difference in observed final university choice, by socio-economic status of students residence at the time of application, according to the three explanations listed above. We find that the majority of the observed difference in the type of university attended can be attributed to the first of these explanations: conditional on having the same predicted grades, low SES students apply to less competitive universities than do high SES students. We explore some of the underlying mechanisms that may account for this difference.

# 1 Introduction

It is well documented that students from low socio-economic backgrounds are less likely to attend university (Blackburn and Jarman (1993); Blanden and Machin (2004); BIS (2015)), and, when they attend, are less likely to attend prestigious universities (Boliver (2013); BIS (2015)). What is less well understood are the underlying mechanisms behind these phenomenon. While progress has been made on examining the extensive margin of this decision process, we still know very little about the intensive margin. In many countries, including the UK and US, the university one attends can have a non-trivial impact on life-time earnings. If students from lower socio-economic neighbourhoods are systematically selecting into qualitatively worse universities than their high socio-economic neighbourhood counterparts, then there is cause for concern.

In this study we focus on the intensive margin of the university decisions, asking: Do students from lower socio-economic backgrounds attend less competitive universities and if so why? *Competitiveness* as used here refers to the university admission standards; universities which require higher secondary-school performance will be referred to as more competitive. There are a number of possible explanations for differentials in university attendance that data reflecting university-student matches cannot explain. For example, it is likely that students from different SES groups exhibit different academic performance in secondary school. It could also be that differences in attendance reflect differences in preferences, high SES students, on average, prefer a more competitive environment relative to low SES students. Finally, these difference could reflect discrimination (intentional or otherwise) on the part of the universities in their student admissions.

We compare university application outcomes between students from neighbourhoods in the top 40% of the SES quintiles to students from the bottom 40% of the SES quintiles. Competitiveness for a given university is measured by the average secondary school performance from the current year's entering class. Consistent with previously-documented findings, we show that students from lower SES neighbourhoods tend to attend less competitive universities. We find that this difference can only be partially explained by SES differences in secondary school performance. We consider alternative explanations for this persistent difference; three key results emerge. 1) There is a small, but statistically significant, difference in the types of university that low SES students apply to relative to high SES students. On average, low SES students apply to less competitive universities than high SES students with comparable predicted grades. This appears to be largely the result of low SES students "hedging" more than their high SES counterparts. 2) There is little difference in the probability of receiving an offer, conditional on applying, by SES. One notable difference is for students with average performance in secondary school. In these cases, high SES students are significantly more likely to receive a university admission when applying to medium-high competitive universities. However, the probability of admission for this group favours low SES students when applying to highly competitive schools. 3) We find a small difference in the propensity to accept less competitive universities from all available offers among low SES students relative to high SES students. However, this difference is almost entirely explained once we condition on secondary performance, students with high academic performance are more likely to select the most competitive schools from which they have received an offer than are students with relatively low academic performance.

In this study we exploit a novel dataset reflecting administrative records for all students who applied to an undergraduate programme at the University of Leicester for the academic years beginning 2011, 2012, 2103 and 2014. This results in 38,566 records. With these data we can observe: 1) All universities each student applies to; 2) The predicted A-level grades of the applicant at the time of application; 3) The secondary school attended by each applicant; 4) The admission decision for each application; 5) The achieved A-level grades. We combine this information with information reflecting the socio-economic status of each student's neighbourhood of residence (according to postcode) and information for each university. Importantly, these data reflect all applications to Leicester, including those for students who pursued their studies elsewhere.

The expansion of Higher Education in UK has raised the question of fair access; do students from all backgrounds gain admission to a programme that best suited to their ability and aspirations (DfES (2004)). This question is pertinent because of the individual benefits from higher education with regard to job security and intergenerational mobility, as well as the positive externality of higher education for the whole society. There is a dramatic variation in quality among providers of undergraduate programmes, both in terms of learning experience and wage premium of the degree (Broecke (2015)). Therefore, there may be a real long run impact on lifetime earnings and fulfilment if students are matched to the "wrong university".

In Section 2 we review some of the previous literature relevant to this study. In Section 3 we provide the necessary background information on education and university application procedures in the UK, followed by a discussion of the data in Section 4. In Section 5 we present the key results, followed by concluding remarks in Section 6.

## 2 Literature

The extent to which the choice of university matters depends on the existence of a relationship between university quality and future labour market earnings. Regarding the role of quality, Brewer et al. (1999) find evidence of a significant, and increasing with time, economic return to attending an elite private university. More recently, Dale and Krueger (2014) estimate the effects of several university characteristics that are commonly used as proxies for quality (college average SAT score, the Barron's index, and net tuition) in two cohorts of students. They find that the effect of each characteristic is sizeable for both cohorts in cross-sectional least squares regression models, but in selection- adjusted models, these effects are not significant. However, they remain large for certain minority groups, such as for black and Hispanic students.

For the UK, Chevalier and Conlon (2003) find that there is a wage premium attached to degrees from more prestigious, *Russell Group*[1], universities. Hussain et al. (2009) use different measures of quality,

[1]Russell group universities refer to 24 UK institutions widely believed to be the top universities in the UK.

create an aggregate measure of quality and examine the links between those measures of university quality and graduate earnings. Their findings also suggest a positive return to university quality. However, the relationship between university quality and wages is highly non-linear, with a much higher return at the top of the distribution. Similar pattern is found by Chevalier (2014) with heterogeneous returns to quality mostly driven by high quality institutions. Broecke (2012) is the first paper which attempts to tackle the issue of selection on unobservable characteristics in the UK context. Instead of quality he focuses on selectivity and finds that one standard deviation increase in selectivity of the institution attended leads to an increase in earnings of around 7.0% three and a half years after graduation. The magnitude of the effect is in line with the previous results.

Hoxby (2009) gives an historic perspective of the selection in American universities. She proposes a new explanation for the changes in selectivity patterns. Particularly for the most qualified students at the point of entry into University, the elasticity of a student's preference for a University with respect to its proximity to that student's home has fallen substantially over time and there has been a corresponding increase in the elasticity of each student's preference for a University with respect to its resources and peers, therefore explaining that only the top 10 percent of Universities are substantially more selective than they were in the early 1960s, while at least 50 percent of Universities are substantially less selective now.

In the UK the evidence suggests that participation in Higher Education (HE) still varies with socio economic background. In a series of reports the Higher Education Funding Council for England (HEFCE) has shown a trend of increased participation in higher education (HEFCE (2010) and HEFCE (2013)). They report the participation rates of 14 cohorts of young people who were aged 18 in the academic years from 1998-99 to 2011-12. Over the period the overall rate of participation in higher education among young people has increased from 30 per cent to 38 per cent, however there are significant differences by gender and socio economic background. The difference in participation rates between young people living in the most advantaged and most disadvantaged areas remained large (at around 40%) and stable throughout the period. There is also evidence that such differences increase with the selectivity of the higher education institutions (OFFA (2014)).

Some possible explanations for those differences have been advanced. Sutton Trust (2011) reports that the probability of going to university and particularly more prestigious ones varies with the type of school attended. Independent school pupils are more than twice as likely as pupils in comprehensive schools to be accepted into one of the 30 most highly selective universities. Chowdry et al. (2013) findings suggest that there are large differences in HE participation rates at high status universities by socio-economic background. However these differences are substantially reduced once secondary school performance is included. Anders (2012) finds that university participation, and attendance to more prestigious institutions, varies with family income but most of the difference is explained by application decisions. Gibbons and Vignoles (2012) and Mangan et al. (2010) discuss the link between geography and participation in higher education.

Research published by the Department for Business, Innovation and Skills (BIS (2009)) uses school level university application data to study the relationship between different types of post-16 schools or colleges, the average overall A-level performance at a school or college, and applications to, offers from and placement at the 'Sutton 13' group of universities[2]. The empirical findings show that there are at least three contributing factors to the divergent probabilities of placement: academic performance plays the most critical role, followed by the number and patterns of applications with independent schools having a higher proportion of students applying to selective universities than state ones, while offer rates conditional on attainment across institutions are broadly similar. These results are based on school level averages rather than on information for individual students. Consequently, the results may to some extent reflect individual differences. Schools with the same mean A-level grades may have markedly different higher moments. A school's student population can comprise of roughly equal proportions of very high attaining and very low attaining young people, or it may have mostly averagely achieving students. As a result, the different patterns of applications to the selective universities could be driven by different exam results distributions.

To the best of our knowledge, the only other paper using applicant individual data is Boliver (2013) which investigates application rates to and admission chances at the Russell group universities of students who are equally qualified to enter them. She finds that from 1996 to 2006, higher education applicants from lower socio-economic backgrounds are less likely to apply to Russell group universities than their peers from higher socio-economic backgrounds with equivalent prior educational achievement. Additionally, after educational achievement has been taken account of, the admission chances for state school pupils who applied to courses at Russell group universities are lower, in comparison with private school pupils.

Aggregate application data has been used in a couple of recent papers, which investigate the effect of quality measures in application decisions. Chevalier and Jia (2016) find that changes in the subject-level ranking score of an institution is positively correlated with number of applications per faculty. Gibbons et al. (2015) use data from the UK's National Student Survey (NSS) as a proxy for quality and find a small statistically significant effect on applications at the university-subject level that is more salient for abler students, for universities with higher entry standards and for more competitive subject-departments. Broecke (2015) studies the impact of university rankings on applicant and institution behaviour in the UK, using data from 2002 to 2009. He finds modest but significant impact of rank position on application numbers, with higher responses by candidates from higher socio-economics backgrounds, therefore concluding that changes in rankings are more significant for more prestigious institutions.

[2]The 'Sutton 13' universities are: Birmingham, Bristol, Cambridge, Durham, Edinburgh, Imperial College, London School of Economics, Nottingham, Oxford, St. Andrews, University College London, Warwick and York. These are recognised as the thirteen leading universities in UK by the Sutton Trust.

# 3 Institutional setting

## 3.1 Student applications

Compulsory education in England is made up of 4 Key Stages, ending at age 16. Students wishing to enrol at university will take two further years of studies (Key Stage 5) and accomplish the General Certificate of Education Advanced Level commonly known as *A-level*[3]. Key Stage 5 cumulates with students sitting their A-level examinations, with three completed exams being a standard requirement for most university programmes. At the beginning of the second year of Key Stage 5 students receive predicted A-level grades from their schools for each of the A-level subjects in which they are enrolled. Students use these predicted grades to apply to university.

All applications to UK universities for full-time undergraduate study are made through the Universities and Colleges Admission Service (UCAS). UCAS processes applications and sends them to the relevant institutions.

Students can apply to up to five programmes by completing a standardised application form via UCAS[4]. In the initial application students do not reveal a preference ordering. Students cannot apply to both Oxford and Cambridge. Students applying to medicine, dentistry, veterinary medicine or veterinary science, are limited to a maximum of four applications.

Institutions make one of three admission decisions for each application they receive: 1) rejection; 2) offer a place conditional on final exam performance; 3) offer a place unconditionally. The majority of institutions make decisions based on the UCAS application package with few requiring interviews[5]. As applicants' final A-level exam results have not come out yet by this time (unless they have taken a gap year), the admission decision are made based on the applicant's predicted grades, personal statement and references, and the majority of the offers made at this stage are conditional offers.

Student grades, and predicted grades, for each qualification can be converted into a defined number of UCAS tariff points. For A-level subjects, an A* in is coded as 140 UCAS points, an A is 120 UCAS points, a B is 100 UCAS points, and so on down to a grade of E which is given 40 UCAS points[6]. This permits different qualifications to be compared and combined. For example, submitting the grades ABC will yield the same UCAS points (300) as submitting a grade of BBB. Institutions generally use this point system to set entry requirements.

[3] Alternative qualifications are also considered by universities but not used in our dataset.

[4] If students have all applications rejected they can apply to another universities at a later stage in the cycle commonly known as UCAS Extra. If rejected, they then apply to another, and so on, until either they get an offer or they run out of time (the UCAS Extra service usually ends in early July).

[5] Oxford and Cambridge generally require an interview as part of the admissions decision.

[6] In 2017 the point system has been changed, but given that our data predates this we use the previous system.

By February universities will have made all offers. Students, based on the offers they receive, can accept, and reveal a preference ordering, over two. The most preferred offer is called "firm" choice and the second one "insurance" choice. All other offers are formally declined. If the student meets the conditions laid out in the offer chosen as firm, then he is accepted in that institution. If a student's firm choice makes them an unconditional offer, they can only accept that one. On the other hand, if the student's firm choice makes them a conditional offer, they can accept one conditional or unconditional offer as an insurance choice.

Students cannot choose between their firm and insurance offers after they get their exam results: if their firm choice accepts them, they cannot automatically opt to go to the insurance choice instead. If, on the other hand, the applicant does not meet the conditions for the firm offer, but meets the conditions for the insurance offer, they are committed to the insurance choice.

Students sit their A-level exams in the months of May and June and exam results are published on a set Thursday in August. Exam results are sent directly to UCAS, which automatically notifies universities. If the student achieves the grades required by their firm or insurance choice, they will attend the respective university. If, however, they have just missed the required grades, one of their choices might still offer them a place.

Students without a confirmed place automatically go into UCAS Clearing, which tries to match them with programmes that still have vacancies.

## 3.2 University tuition and student finance

As soon as students have a firm choice they can apply for a student loan (and grant if eligible) via the appropriate Student Finance Organisation (one each for England, Wales, Scotland and Northern Ireland). These generally depend on household income. Student financial policies in England, Wales, Scotland and Northern Ireland are different. Our valid sample contains only home fee status students who have A-level qualifications. All UK universities charge English undergraduate students a uniform fee, irrespective of the subject of the degree. University level courses provided by further education colleges are sometimes cheaper. But the fee differences between courses provided by universities and further education colleges are trivial. Therefore, all applicants in our valid sample can reasonably be considered as facing the same monetary cost of higher education (not considering travelling and living costs).

## 3.3 UK higher education institutions

The UK higher education sector was substantially reformed in 1992, with the abolition of the binary divide between universities and polytechnics. The passage of the 1992 Further and Higher Education Act allowed all polytechnics to acquire university status and to award their own degrees. Before 1992, polytechnics only awarded degrees governed by the Council for National Academic Awards.

The former polytechnic institutions are usually referred to as “new universities”. The old universities, or traditional universities, are those institutions that have been awarding their own degrees prior to 1992. The programmes provided by old universities tend to be more academically focused, while the courses in new universities are usually more vocationally oriented.

In 1994, a self-selected informal coalition of seventeen research-led traditional universities was formed. This is the Russell group, which is usually considered as representing leading universities in the UK and maintaining the very best research and teaching. As time went by, seven more universities were admitted as Russell group members. The most recent enlargement of the Russell group occurred in March 2012, when it was announced that three additional universities would become Russell members, for a current total of 24 universities.

There are more than 370 undergraduate courses providers that students can apply via UCAS. This involves both universities and other institutions. With the massive expansion of provision in the higher education sector, quality distinctions in terms of graduate employment prospects exist not only between old and new universities, but further emerge within old universities.

Some of the previous related UK studies use membership of the Russell group as an indicator of university quality. The drawback of this measure is that it simply divides higher education institutions into two categories and therefore the heterogeneity within each of these two categories is ignored. For this reason we use the average UCAS tariff score amongst each institution's entrant population (referred thereafter as entry tariff). It reflects the demand for a specific institution from students with different prior educational attainment, and it can be considered as roughly continuous. This will also reflect peer composition of each provider, or how selective is the university. As a measure of ?quality?, this is consistent with theoretical models of education quality if often proxied by peer group ability (Epple and Romano (1998)).

The use of entry tariff as a measurement of university quality has been criticised by some authors (Broecke (2012)), on the grounds that the measurement of "quality" should reflect the teaching quality and learning experience provided by an institution, or the institution's "value-added". There is also evidence that university rankings published in league tables which are based on raw statistics can differ substantially from those based on university "value-added", which takes account of each university's student intake (Bratti (2002)). Another limitation of using entry tariff to measure institution quality is that individual students apply not only to an institution but also to a particular course at that institution, and courses provided by the same institution can differ substantially in terms of selectivity. The use of average entrant tariff across all courses in an institution covers the divergence in degrees of selectivity among courses within the same provider. This could be a potential source of bias if students from low socio-economic areas are systematically more or less likely to apply to more selective courses at each institution.

We report the entry tariff for 131 UK universities in descending order in Appendix Table A1. From the table we see that some very selective institutions are not Russell members, and that there is divergence in terms of selectivity among Russell members.

# 4 Data summary

Our data set combines information from UCAS administrative records on student applications, HEFCE postal-code level data reflecting neighbourhood socio-economic status, and Unistats data capturing information for each university in the UK. Each of these data sources are described in detail below.

## 4.1 UCAS data

UCAS administrative records are collected for all students who applied to an undergraduate programme at University of Leicester from year 2011 to 2014. For each student, we observe: 1) All universities applied to; 2) All decisions made by the applied universities and the applicant; 3) The predicted and achieved A-level grades of the applicant; 4) Other individual information, including: gender, age on entry year, postcode, fee status, the secondary school from which the applicant completed A-levels. It is important that our observations include not only those who are placed in University of Leicester but also those who declined the university's offer or are rejected by the university. Descriptive statistics for the final sample (discussed below) are presented in Table 1.

There are two advantages of using Leicester data. First, University of Leicester provides undergraduate degrees in a wide range of disciplines, including Social Science, Science, Engineering, Medicine, Psychology, Arts, Humanities, and Law. Second, Leicester attracts applicants from a diverse segment of the population, high socio-economic backgrounds as well as low socio-economic backgrounds, and a fairly wide range of student performance.

## 4.2 Neighbourhood socio-economic status

Our primary measure of neighbourhood socio-economic status comes from the Participation of Local Areas (POLAR) classification score. POLAR is a classification of small areas (postal codes) across the UK created by the Higher Education Funding Council for England. It is based on the likelihood of young people in a defined geographic area to participate in higher education. The classification is comprised of five quintile groups of areas ordered from 1 (those areas with the lowest participation) to 5 (those areas with the highest participation)[7]. The distribution of the sample across each of these groups is presented in the bottom panel of Table 1. Consistent with previous work on SES and higher-education attendance, our sample under-represents the lowest quantiles and over-represents the highest quintiles. To simplify the analysis, we aggregate POLAR areas into three groups: Low SES areas (the bottom 40%); Middle SES areas (the 40th

[7] POLAR has four different versions, based on higher education participation rates in different time periods. The version used in this paper is POLAR3. It is based on the combined participation rates of those aged 18 between 2005 and 2009, who entered higher education between 2005-06 and 2010-11 academic years.

percentile to 60th percentile); High SES areas (the top 40%). We focus on the comparison of students from Low and High SES areas.

The measurement we adopt of neighbourhood socio-economic status is based on the POLAR quintile by postcode of residence. The postcode that we observe in the UCAS data reflects a student's correspondence address when she applies to higher education. We are therefore assuming that the student's correspondence address is the same as her residential address, or reflects the socio-economic circumstances under which she was brought up.

### 4.3 University characteristics

University competitiveness is measured by the average UCAS entry tariff of all departments in the university over the five years. It should be noted that this will ignore within-university variation in the entry tariff. For example, in University of Leicester Economics generally requires a score of 320 (equivalent to "ABB"), while Medicine requires a score of 360 (equivalent to "AAA"). Cambridge and Oxford are both measured as 600 (equivalent to ?AAAAA?), although some programmes require 580.

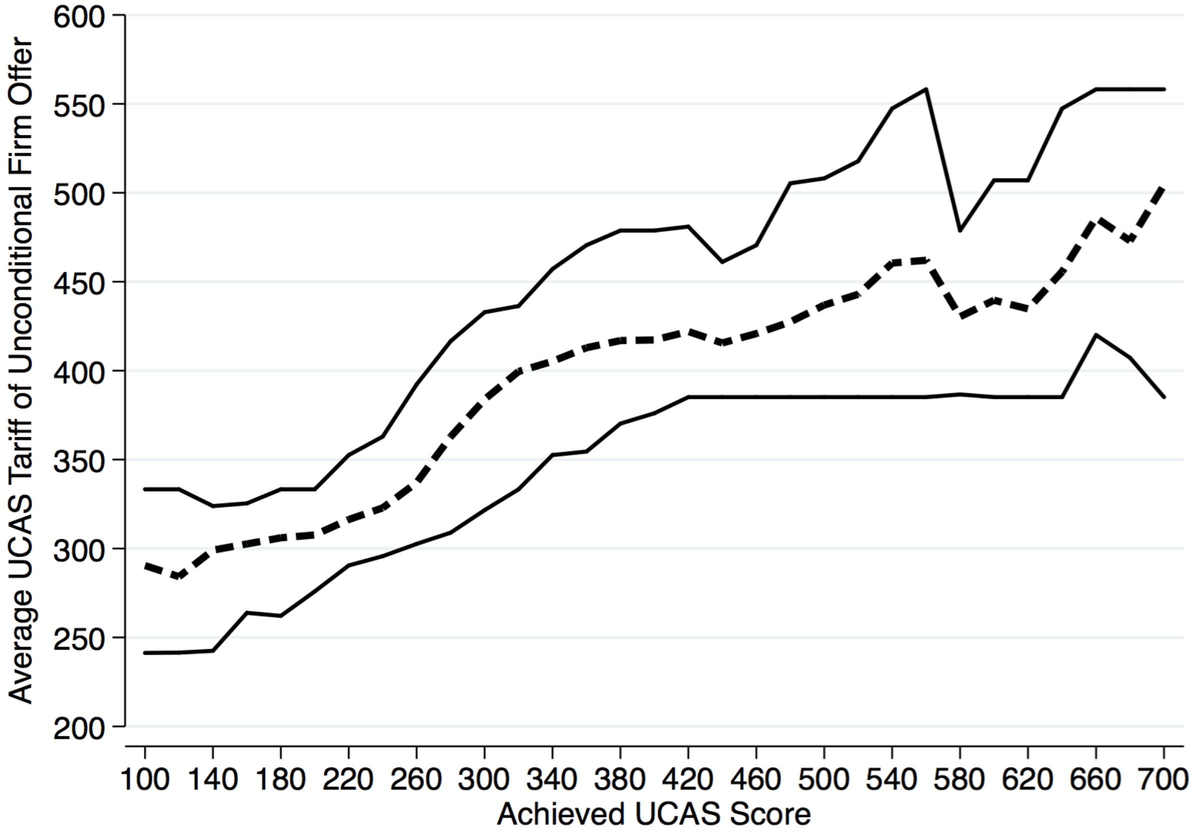
Tariff and location information about higher education institutions are drawn from Unistats 2015 data (based on HEFCE data). Unistats provides information about entrant tariff of each programme in each institution. We calculated the average entrant tariff of each institution, weighted by the entrant population of each course in that institution. If entrant tariff information about one institution is absent, we take that institution as low entry requirement institution and allocate entry tariff 150 to that institution. In Figure 1 we plot the average UCAS tariff for ?firm? choices against students? actual UCAS score (for all completed A-levels) in our sample. Clearly the relationship is not one-to-one. On average, students with very low UCAS scores place better than their performance suggest, while students with very high UCAS scores place lower than their performance suggest. However, the relationship is roughly monotonic, students with better performance are likely to choose more competitive universities.

University information also includes location information in the form of latitude and longitude reference points. The geodetic distances of each applicant's address to the institutions they apply to are calculated. An obvious disadvantage of using geodetic distance as a proxy for travelling distance is that it does not take account of natural barriers, road densities and the availability of public transport. We would expect that students from low socio-economic backgrounds are more sensitive to travelling distance.

### 4.4 Sample

The full sample contains 60,848 applications over the 4 years (2011-2014). We exclude applications which are withdrawn before an admission decision is made, applicants whose number of predicted A-level subjects does not equal that of achieved A-level subjects, and students who complete less than three subjects at

Figure 1: Firm Choice UCAS Tariff by Achieved A-level Grades




*Notes:* Dashed line shows average UCAS tariff of student's firm choice by achieved A-level grades. Solid lines show firm choice tariff at the 90th percentile (upper) and 10th percentile (lower).

A-level. The sample is further restricted to domestic students. We keep those who apply to Leicester in multiple years but those who apply to Leicester more than once in the same academic year are considered as one observation. This yields a sample of 38,569 applicants and a total of 193,860 applications. Each applicant applied to between 1 and 10 institutions, with 75% of them applying to 5. The measure of student academic performance chosen in this paper is the best three of an applicant's A-level grades, primarily for ease of categorisation, also because higher education institutions emphasise the best, most relevant three A-level subjects. However, the best three A-level subjects do not necessarily include the core subjects for the applied to programmes. Hence this cannot perfectly measure a student's prior attainment in the context of programmes to which she applies.

# 5 Results

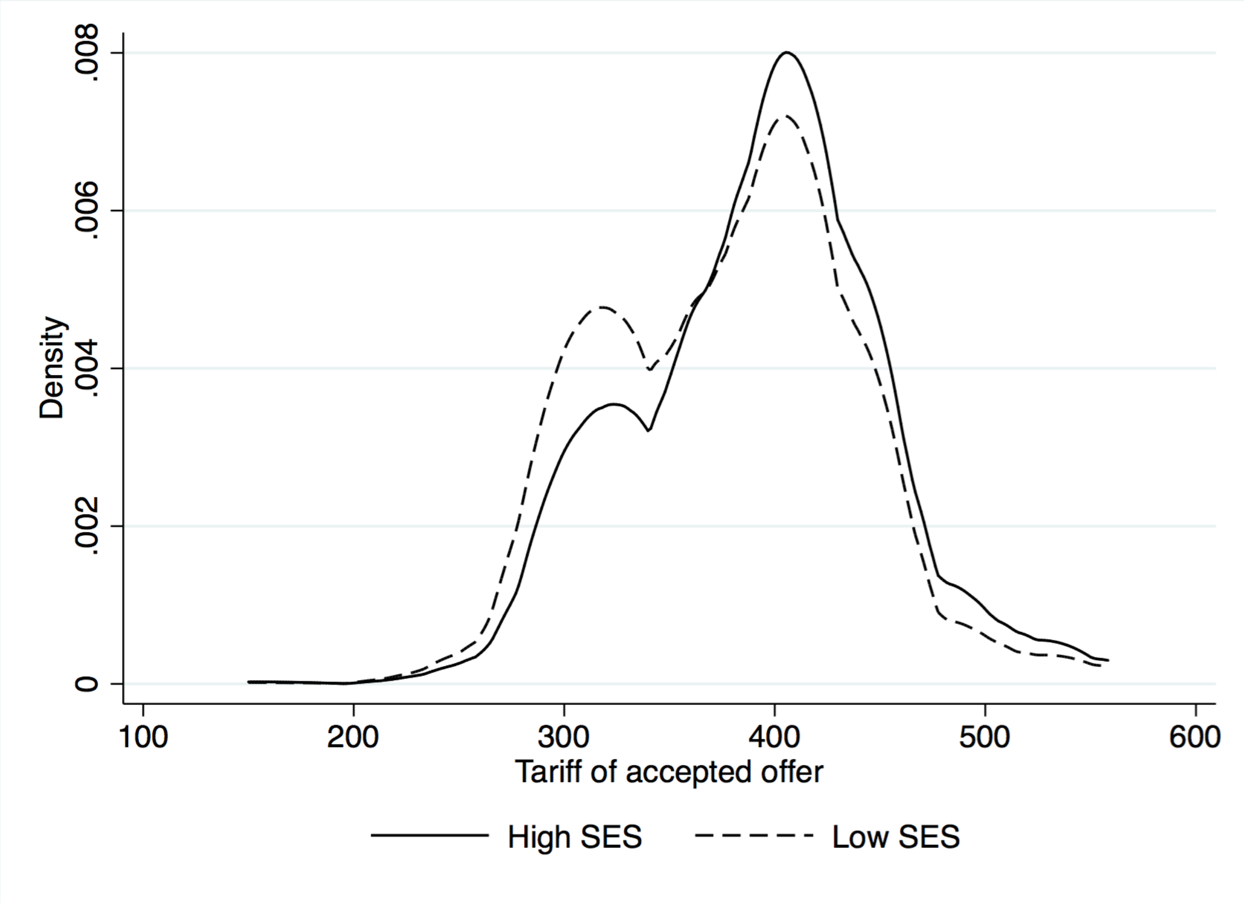
Here we document the main results of the paper, addressing in turn each of the questions brought up in the introduction. First we show the gap that exists in competitiveness of university choices between students from high and low SES neighbourhoods. We find that about half of the competitiveness gap can be explained by conditioning on secondary school performance; students from high SES neighbourhoods have, on average, higher A-level grades than do students from low SES neighbourhoods. However, grades only partially explain the difference in university competitiveness; there remains a difference in the average university tariff equivalent to half a grade point. We investigate three possible explanations for this gap in university attendance: Compared to students from high SES neighbourhood, students from low SES neighbourhoods 1) Apply to less competitive universities; 2) Are less likely to be accepted at more competitive universities; 3) Choose less competitive universities from the places which they are offered.

## 5.1 University placement and neighbourhood

Here we document the observed differences between students from low SES neighbourhoods and students from high SES neighbourhoods, according to the competitiveness of the university for which we observe accepted offers. It should be noted, this analysis does not include students who do not receive, or do not accept, an offer from any university (this accounts for 3,685, or 13% of the total applications.)

In Figure 2 we compare kernel density plots reflecting the unconditional distribution of students according to the UCAS tariff of the university for which they accept an offer, for high and low SES neighbourhoods. In this figure we show that students from low SES neighbourhoods are more likely to attend universities with a lower UCAS tariff than are high SES students. More than 52.79% (statistically different than 50 percent for p¡0.001) of low SES students attend universities below the median UCAS tariff for high SES students (390.2). In Table 3 we report the average tariff for each of these groups. The average tariff for a high SES

Figure 2: UCAS Tariff Density for Students from High and Low SES Neighbourhood




students is 392.6 comparted to the average tariff for low SES of 378.0 (this difference is significant at 1%). This 14.6 difference is equivalent to 0.75 grade points[8].

One explanation for this difference is that students from low SES neighbourhoods systematically receive lower A-level grades than do students from high SES neighbourhoods. To consider how much of the observed difference in Figure 2 can be directly explained by differences in the distribution of students from different SES across predicted grades, we can decompose the mean difference:

$$\overline{tariff^h} - \overline{tariff^l} = \sum_g (\theta_g^h \overline{tariff_g^h} - \theta_g^l \overline{tariff_g^l}) \tag{1}$$

Where $\overline{tariff^h}$ and $\overline{tariff^l}$ denote the average tariff for accepted offers for high and low SES students respectively. $\overline{tariff_g^h}$ and $\overline{tariff_g^l}$ denote the average tariff for high and low SES students with predicted grade $g$. The parameters $\theta_g^h$ and $\theta_g^l$ reflect the proportion of low and high SES students with grade $g$.

The difference in Equation (1) can be broken down as follows,

[8]The incremental difference between two sequential grades (e.g. B and A) is equivalent to 20 UCAS points.

$$\overline{tariff^h} - \overline{tariff^l} = \sum_g (\theta_g^h - \theta_g^l)\overline{tariff_g^h} + \sum_g \theta_g^l(\overline{tariff_g^h} - \overline{tariff_g^l}) \quad (2)$$

such that the portion of the difference that reflects the difference in the predicted grade distribution (captured by first sum) and that which reflects the difference in UCAS scores between groups for students within the same predicted grades.

We evaluate Equation (2) using an Oaxaca-Blinder regression decomposition and report the portion of the mean difference between SES groups that can be explained by grades and applications in Table 3. More than half of the 14.6 unit difference in UCAS tariff for students from high and low SES neighbourhoods remains unexplained after conditioning on differences in A-level grades. There is little change in this result when we use only the 3-best grades (A) versus all A-level grades (B). In Figure 3, we plot the difference, between low and high SES students, in average UCAS score of accepted offers (bars indicate 95% confidence intervals) by final grades. For all but the highest grade students, low SES students accept offers from universities which have, on average, UCAS tariffs 6 to 7 points lower than do high SES students[9]. To illustrate the magnitude of this estimate, consider that a low SES student with an achieved UCAS score of 300 attends, on average, a university with a tariff 8.58 points below the average university attended by high SES students.

In summary, much of the SES difference in university placement can be accounted for by secondary school grades. However, once secondary school grades are accounted for a persistent, statistically significant, negative difference for low-SES students persists.

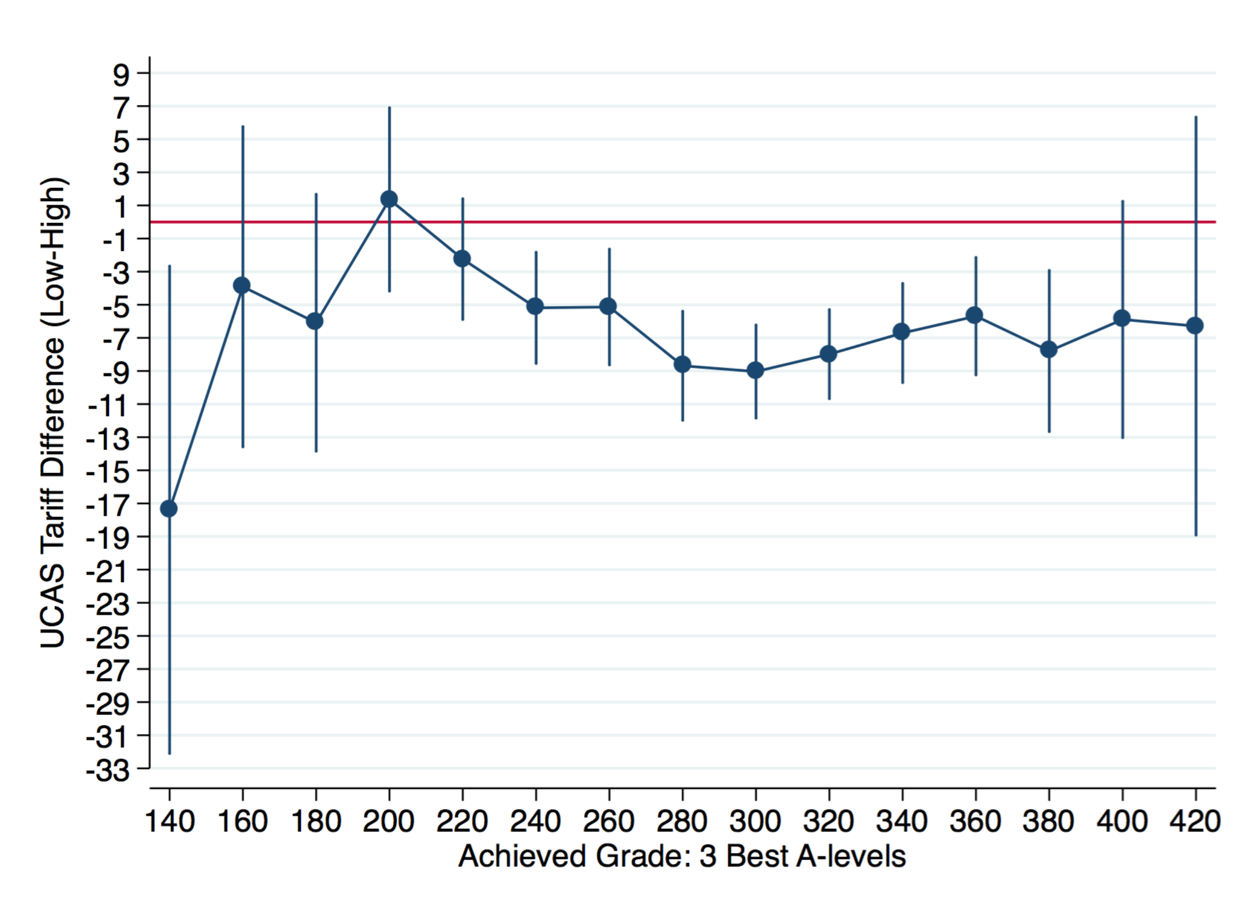
## 5.2 Do low SES students apply to less competitive universities than high SES students?

In Figure 4 we plot descriptive statistics reflecting the portfolio of schools applied to by predicted UCAS score and SES. One would expect that students with similar predicted grades apply to, on average, similar universities. We examine this by looking at the composition of the entire student "portfolio", including the mean, standard deviation, maximum and minimum of the tariffs for all schools to which a given student applied.

Starting from the top left and moving clockwise, these plots show difference between averages for high and low SES students in the mean, standard deviation, minimum and maximum UCAS tariff in student portfolios. There are a number of things worth pointing out. First, across all figures we see that most of the statistical

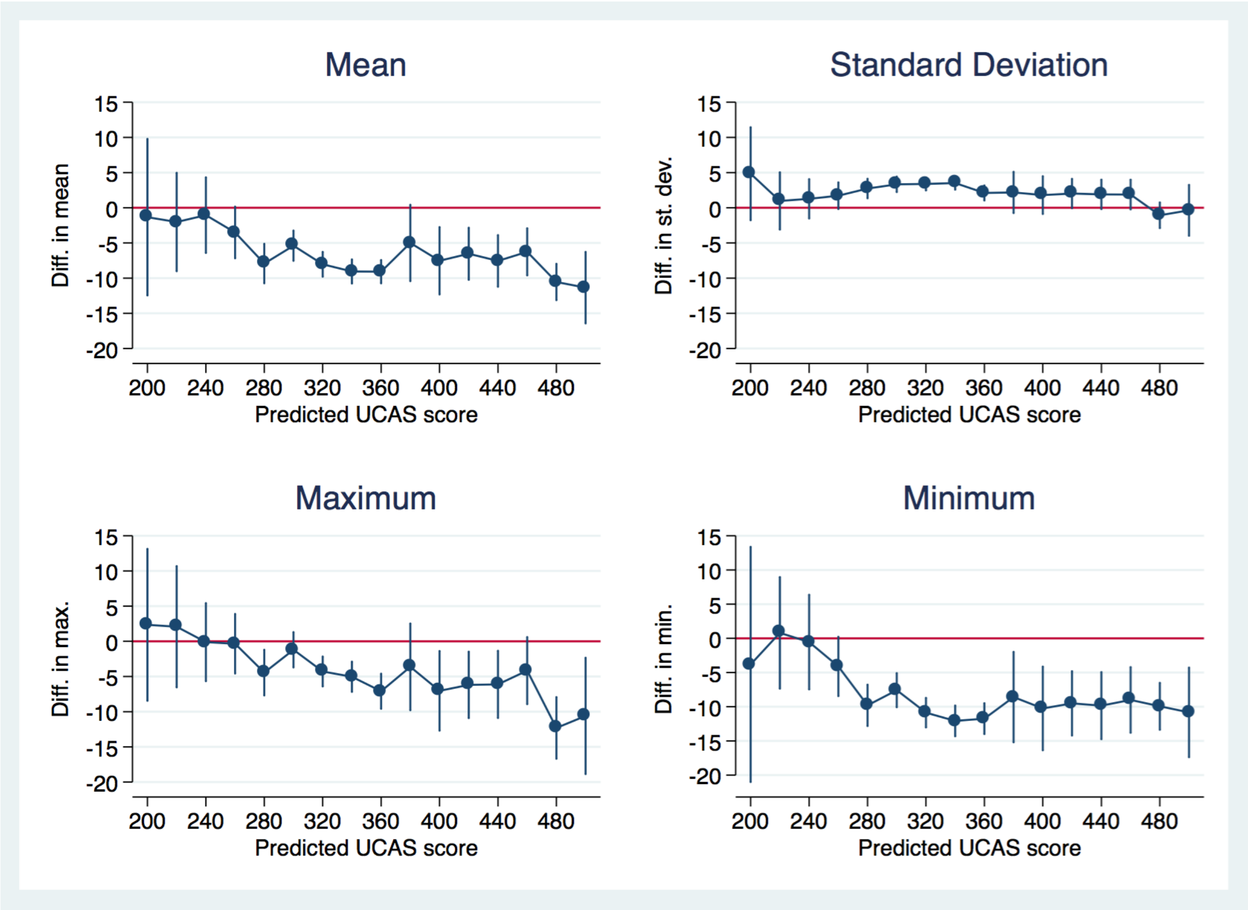
[9] Each point and corresponding standard error in Figure 2 is calculated by regressing tariff on an SES status dummy for each grade separately: $tariff_{ig} = \mu_g + \delta_g 1[ses_i = low] + \epsilon_{ig}$. The outcome, $tariff_{ig}$, is the UCAS tariff corresponding to the firm offer of student $i$ with grade $g$. $1[ses_i = low]$ is an indicator function equal to 1 if student $i$ is from a low SES neighbourhood and 0 if student $i$ is from a high SES neighbourhood. The coefficient $\mu_g$ reflects the average UCAS tariff for high SES students with grade $g$ and $\delta_g$ reflects the average incremental UCAS tariff for low SES students. $\epsilon_{ig}$ is error in the estimation of these averages.

Figure 3: Difference in Firm Offer between High and Low SES by Achieved UCAS Score




*Notes:* Points show difference in average UCAS tariff of firm choice between high and low SES applicants, conditional on A-level exams performance. Bars show 95% confidence intervals.

Figure 4: Portfolio Differences between Low and High SES



difference between high and low SES students arises from the "mid-performing" students, rather than the tails. Second, for predicted UCAS score between 260 and 480, low SES students apply, on average, to lower tariff schools than do their high SES counterparts. Third, for this same group of predicted UCAS scores low SES students? application portfolios have a higher variance than do high SES students. Forth, there is only a minor negative difference in the average maximum tariff across applications, but the minimum tariff is significantly lower for low SES students.

These results suggest a consistent difference in the schools to which low and high SES students apply. Notably, the average difference in the mean, of approximately 7.0 UCAS points, is consistent with the gap that we observe in final university placements.

### 5.3 Are low SES students less likely to receive an offer than high SES students?

The probability of admission into a university is decreasing in the entry tariff of that university. This is not unexpected given our claim that the tariff reflects the universities level of competitiveness in admissions. This is shown graphically in Figure 5 in which we plot the probability of admission against university tariff for students with predicted grades AAA and <BBB. The lines and shaded areas show corresponding fitted quadratic regressions and confidence intervals. There is a clear difference between admissions between the two predicted grades. At relatively low tariffs there is very little difference between offers, but as the tariff increases the probability of offers to <BBB students decreases much more rapidly than to AAA students. For the highest tariff schools, the probability of <BBB receiving an offer is essentially 0 while AAA students remain strictly positive[10].

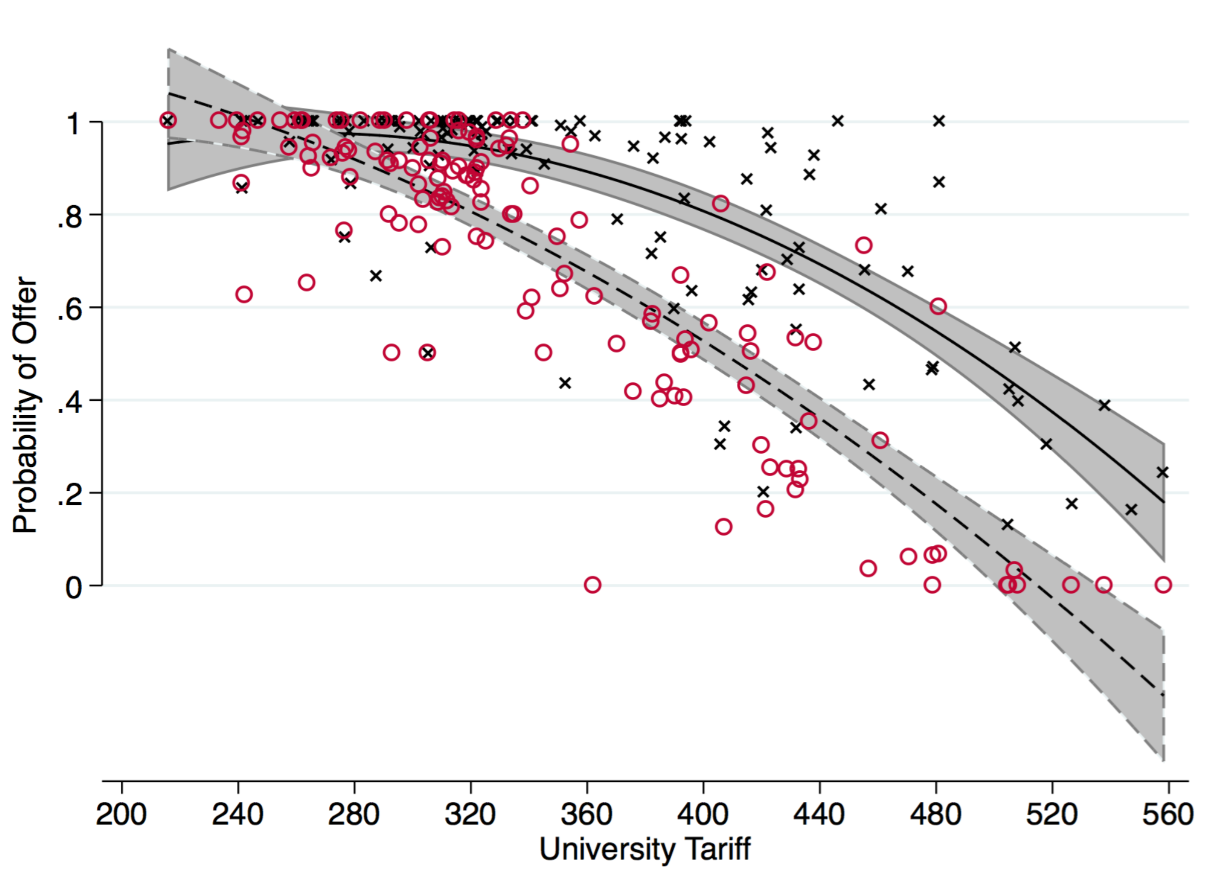
We consider the probability of receiving an offer from a university conditional on having submitted an application. This will allow us to compare two students, with the same predicted grades upon application applying to the same university, from different SES neighbourhoods. To do this we run the following regression:

$$Pr_i^g[offer_u] = \Phi(\zeta_0^g + \zeta_1^g tariff_u + \zeta_2^g ses_i + \zeta_3^g ses_i \cdot tariff_u) \tag{3}$$

The outcome reflects the probability student $i$, applying to university $u$ with predicted grade $g$, receives an offer from university $u$. $\Phi()$ denotes the standard normal cumulative distribution function, and $\zeta_k^g$, for $k = 0, 1, 2, 3$, are grade-specific parameters. This probability is written as a function of the tariff of university $u$ and the neighbourhood SES corresponding to student $i$. As before we focus on the highest and lowest SES neighbourhoods, and $ses_i$ is a dummy variable equal to 1 if student $i$ is in a high SES neighbourhood and 0 otherwise. When estimating Equation (3) we cluster errors by student.

[10]It should be noted that because offers are conditional on applications, and applications are more likely to be made by students with a higher probability of an offer regardless of grade, these curves likely understate the between-grade difference in the probability of an offer.

Figure 5: Offer Probability by University Tariff (Predicted AAA versus Predicted <BBB)




*Notes:* "x" indicate empirical probability of offer for students with predicted grade AAA. Solid line indicates fitted quadratic regression. "o" indicate empirical probability of offer for students with predicted grade less than BBB. Dashed line indicates fitted quadratic regression. Corresponding shaded areas show 95% confidence interval.

We are interested in whether the probability of having an offer accepted is different for low versus high SES students. This will be reflected by the interaction effect between SES and tariff on probability of offer in Equation (3) which can be written as:

$$\begin{aligned} \frac{\Delta}{\Delta ses}\left(\frac{\partial Pr_i^g[offer_u]}{\partial tariff}\right) &= \frac{\partial Pr_i^g[offer_u]}{\partial tariff}\Big|_{ses=1} - \frac{\partial Pr_i^g[offer_u]}{\partial tariff}\Big|_{ses=0} \\ &= (\zeta_1^g + \zeta_3^g)\cdot\phi[(\zeta_0^g + \zeta_2^g) + (\zeta_1^g + \zeta_3^g)tariff_u] - \zeta_1^g \cdot \phi[\zeta_0^g + \zeta_1^g tariff_u] \end{aligned} \tag{4}$$

$\phi()$ denotes the standard normal distribution PDF. This interaction effect tells us how the effect of tariff on probability of offer differs across SES groups. As discussed in Ai and Norton (2003), the interaction effect cannot be derived from a single coefficient estimates as it varies across different values of $tariff_u$ and $ses_i$. We follow the procedure outlined in Ai and Norton (2003) to estimates interaction effects and corresponding standard errors[11]. These estimates for each of our predicted grade categories are presented in Figure 6.

As shown in Figure 6, for the majority of applicants we do not see a statistically significant difference in the probability of receiving an offer between the two SES groups. We summarise some of the key findings from these figures in Table 5. In the groups reporting predicted grades AAA to ABB we see a significant, positive, effect of being in a high SES neighbourhood on offer rates. The average effect is approximately a 1 percentage point increase in offer receipt for students applying from a high SES neighbourhood. Surprisingly, these effects are focused in the low-middle range of school tariffs ranging from about 220 to 355 (roughly speaking the University of West London to University of Kent). Given that the predicted probability of receiving an offer from a school in this range (conditional on applying) for an AAA student is 85%, the interaction effect represents a relatively small increase.

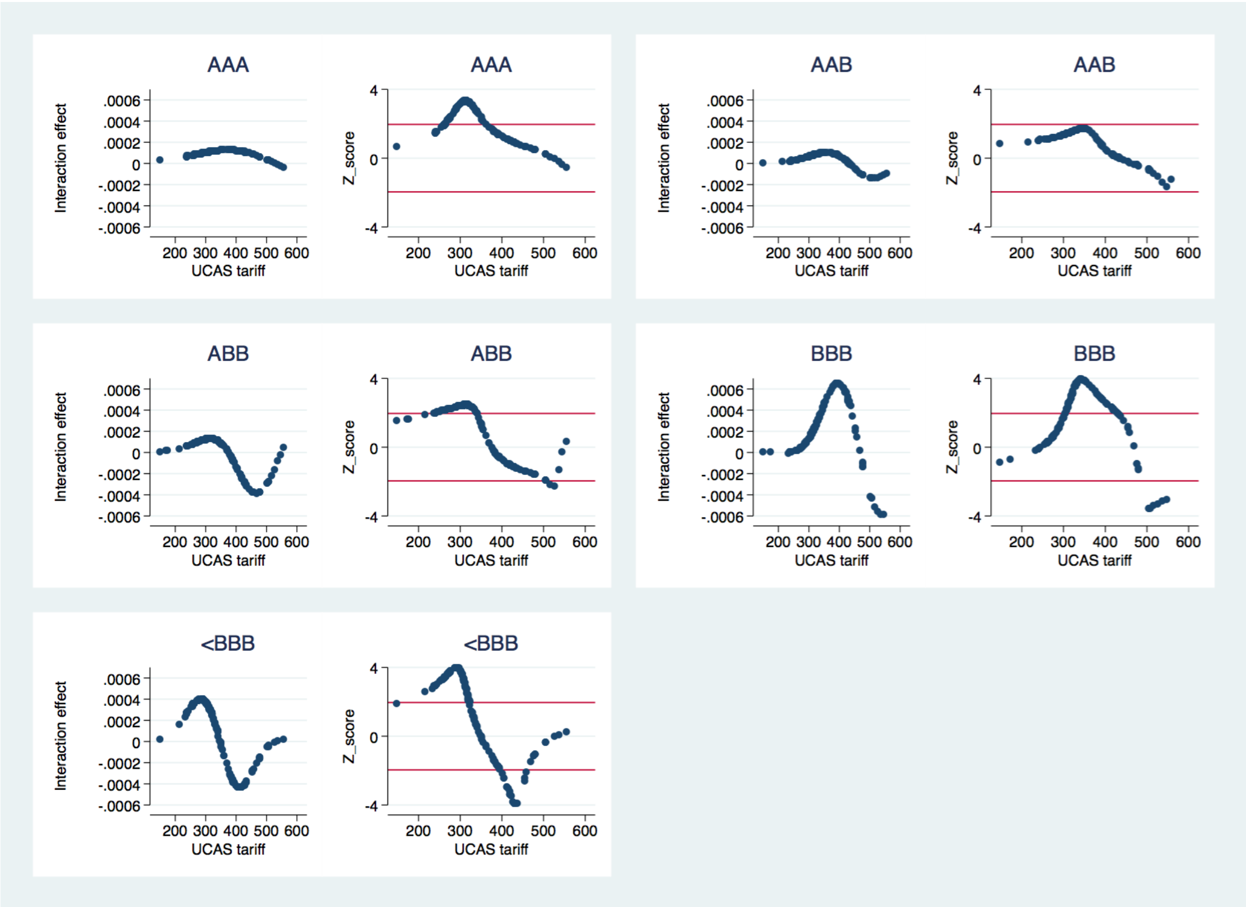
Students reporting predicted grades BBB also have a significant, positive, effect of being in a high SES neighbourhood. In this case the average effect is over a 4 percentage point increase and, these effects are focused in the relatively high range of university tariffs ranging from about 305 to 438 (roughly from Nottingham Trent to King?s College). The predicted probability of a BBB student receiving an offer from a school in this range (conditional on applying) is 80%, the interaction effect represents a relatively large increase.

Interestingly there appears to be a large negative effect for students with BBB or lower applying to universities in the highest range of tariffs. These results are notable given the fact that, on average the probability of students in these grade ranges receiving an offer from schools with the reported tariff ranges is less than 25%.

In summary the estimated difference in offer rates arising between high and low SES applicants is ambiguous. Further, it at best, can only account for small difference in observed tariffs, as much of the difference is observed among schools with lower-middle tariffs.

[11] This is done using the Stata programme discussed and provided by by Norton et al. (2004)

Figure 6: Offer Probability interaction effect (SES x Tariff) by University Tariff and the corresponding z-score.




*Notes:* AAA, AAB, ABB, BBB, and <BBB refer to best 3 predicted grades. Area between the red bars shows 95% confidence interval.

### 5.4 Do low SES students accept less competitive offers than high SES students?

The final channel through which we might expect to see enrolment differences between low and high SES students is if, conditional on schools applied to receive an offer from, low SES students accept offers to less competitive universities than do high SES students. To examine this we look at the propensity of students to accept offers from universities which do not represent their highest tariff offer. For each student we calculate this $tariffgap$ given by:

$$tariffgap_{ig} = max\{tariff_{ig}^{1} \cdot offer_{ig}^{1}, \cdots, tariff_{ig}^{10} \cdot offer_{ig}^{10}\} - \sum_{a=1}^{10}(tariff_{ig}^{a} \cdot firm_{ig}^{a}) \qquad (5)$$

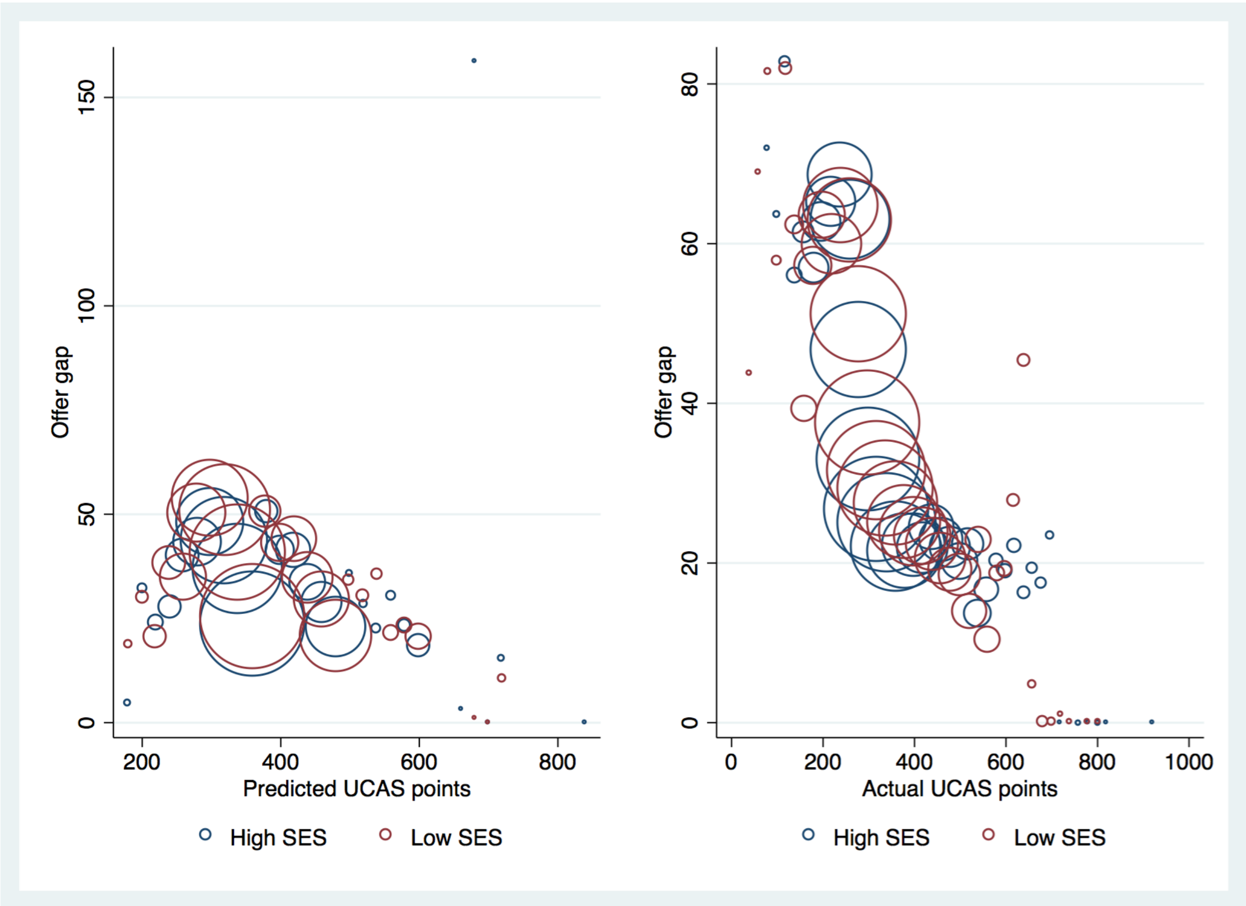
$firm_{ig}^{a}$ is a dummy variable equal to 1 if application $a$ was accepted as firm by student $i$ with grade $g$, and $offer_{ig}^{a}$ is a dummy variable reflecting whether the university applied to in application $a$ made an offer. The tariff gap, for student $i$ with grade $g$, reflects the difference between the highest-tariff university that was available and the tariff for the university chosen. If a student accepts their highest-tariff offer then the tariff gap is 0.

In Figure 7 we plot the average tariff gap for high and low SES students by grades. The top panel plots against predicted grades, the bottom panel plots against actual grades. Both plots reflect a roughly negative relationship between the tariff gap and grades, students with better grades appear to be more likely to choose the university which reflects the offer from their most competitive university. However, there appears to be more agreement in the pattern between the two SES groups when looking at actual, rather than predicted grades. To examine this more precisely we perform an Oxaca-Blinder to decompose the difference in the tariff gap as in Equation (1). The results reported in Table 7 confirm that while differences in predicted grades explain less than 25% of the difference across SES groups, actual grades can explain 87% of the difference.

## 6 Conclusions

We use a unique dataset to try to disentangle why applicants from low SES are less likely to attend more prestigious universities. This dataset allows us to look at the application stage while in most of the literature there is only data on final placements, therefore enabling us to break up the decisions that lead to those placements. We do find that on average low SES students are placed in less competitive Universities as measured the cohort entry tariff. Like in some of the literature, we also find that once previous school results are accounted for this gap between low and high SES is reduced. However we try to explain the remaining gap looking into three possible explanations. Firstly, we do find evidence that low SES students tend to apply to less competitive universities conditional on predicted grades. Secondly, the estimated difference in offer rates by SES type is ambiguous but small. Finally, once we look at actual instead of predicted grades there is little difference by SES type in the likelihood of accepting offers from less competitive universities.

Figure 7: Tariff Gap for Low and High SES by Predicted and Achieved UCAS Points




*Notes:* Tariff gap refers to the difference between the highest-tariff university that was available and the tariff for the university chosen. This is weighted by the total number of applicants within the same SES neighbourhood and with the same predicted/achieved UCAS points.

This may imply that predicted grades for low SES students are noisier and students have a better perception of what the grade will be and may not accept conditional offers from more competitive universities as they believe they will not be able to fulfil the conditions of the offer.

A possible avenue for future research would be to develop and estimate a structural model of choices made by applicants to university in the system. It would also be good to have access to UCAS data for all universities, but so far we haven?t been able to obtain such data.

Another valuable topic for future research would be to look at the the association between students' socioeconomic status and the distance from the universities to which students apply to students' residential place, as well as the applied to universities' living cost.

Table 1: Descriptive Statistics

| | Mean | SD | Min | Max | N |
|---|---|---|---|---|---|
| Female(%) | 48.37 | (49.97) | 0.00 | 100.00 | 35,053 |
| *Low SES* | 50.23 | (50.00) | 0.00 | 100.00 | 8,836 |
| *High SES* | 47.47 | (49.94) | 0.00 | 100.00 | 19,033 |
| Age | 18.22 | (0.58) | 16 | 42 | 35,053 |
| *Low SES* | 18.24 | (0.65) | 17 | 39 | 8,836 |
| *High SES* | 18.22 | (0.57) | 16 | 42 | 19,033 |
| UCAS score (predicted) | 357 | (69.20) | 180 | 840 | 35,053 |
| *Low SES* | 359 | (74.35) | 180 | 720 | 8,836 |
| *High SES* | 356 | (66.27) | 180 | 840 | 19,033 |
| UCAS score (achieved) | 330 | (84.94) | 0 | 920 | 35,053 |
| *Low SES* | 327 | (89.13) | 40 | 800 | 8,836 |
| *High SES* | 331 | (82.95) | 0 | 920 | 19,033 |
| UCAS tariff (firm choice) | 387 | (57.55) | 150 | 558 | 31,555 |
| *Low SES* | 379 | (58.00) | 150 | 558 | 7,935 |
| *High SES* | 392 | (57.14) | 150 | 558 | 17,125 |
| UCAS tariff (application average) | 393 | (35.24) | 251 | 519 | 35,053 |
| *Low SES* | 387 | (35.45) | 279 | 519 | 8,836 |
| *High SES* | 397 | (34.59) | 251 | 510 | 19,033 |
| Probability of an offer (%) | 75.49 | (26.83) | 0.00 | 100.00 | 35,053 |
| *Low SES* | 74.58 | (27.50) | 0.00 | 100.00 | 8,836 |
| *High SES* | 75.61 | (26.67) | 0.00 | 100.00 | 19,033 |
| Distance from home (average) | 134.09 | (63.98) | 1.23 | 616.43 | 35,002 |
| *Low SES* | 120.77 | (67.78) | 1.33 | 496.34 | 8,825 |
| *High SES* | 141.22 | (60.90) | 1.23 | 591.77 | 18,999 |
| Distance from home (max) | 227.75 | (109.82) | 1.23 | 826.44 | 35,002 |
| *Low SES* | 207.30 | (112.08) | 1.33 | 753.19 | 8,825 |
| *High SES* | 239.47 | (107.72) | 1.23 | 826.44 | 18,999 |
| Independent sixth form school (%) | 12.92 | (33.54) | 0.00 | 100.00 | 33,157 |
| *Low SES* | 5.91 | (23.58) | 0.00 | 100.00 | 8,328 |
| *High SES* | 17.23 | (37.76) | 0.00 | 100.00 | 18,033 |
| Neighbourhood SES (based on POLAR3) | Observations | % | | | |
| 1(Lowest) | 3,348 | 9.55 | | | |
| 2 | 5,488 | 15.66 | | | |
| 3 | 7,184 | 20.49 | | | |
| 4 | 8,963 | 25.57 | | | |
| 5(Highest) | 10,070 | 28.73 | | | |

*Notes*: UCAS score reflects the total UCAS points awarded to students for completed A-level subjects. UCAS tariff reflects the average UCAS points for entering class at universities to which each student applies. Distance from home reflects the geodetic distance (in kilometres) from students' residence at the time of application to the applied to university. The average distance from home is the average of the geodetic distance from a student's residence to all universities applied by this student. The max distance from home is the maximum among the geodetic distance from a student's residence to all universities applied by this student. Independent sixth form school reflects the percent of students attending a non-public school for A-level study.

Table 2: Applications by Programme and SES

| | Observations | All(%) | High(%) | Low(%) | Low-High Difference |
|---|---|---|---|---|---|
| Archaeology and Ancient History | 915 | 2.61 | 2.51 | 2.84 | 0.33 |
| Biology Sciences | 3538 | 10.09 | 9.83 | 10.49 | 0.66* |
| Chemistry | 1705 | 4.86 | 4.06 | 6.18 | 2.12*** |
| Computer Science | 963 | 2.75 | 2.49 | 3.33 | 0.84*** |
| Criminology | 833 | 2.38 | 2.20 | 2.56 | 0.36* |
| Economics | 2209 | 6.30 | 6.93 | 5.01 | -1.92*** |
| Engineering | 2334 | 6.66 | 6.86 | 6.36 | -0.50 |
| English | 1941 | 5.54 | 5.39 | 6.09 | 0.70** |
| Geography | 1983 | 5.66 | 6.58 | 3.73 | -2.85*** |
| Geology | 1135 | 3.24 | 3.17 | 3.09 | -0.08 |
| History | 2878 | 8.21 | 8.63 | 7.24 | -1.39*** |
| History of Art and Film | 513 | 1.46 | 1.60 | 1.12 | -0.48*** |
| Law | 1612 | 4.60 | 4.08 | 5.52 | 1.45*** |
| Management | 887 | 2.53 | 2.71 | 2.25 | -0.45** |
| Mathematics | 1306 | 3.73 | 3.30 | 4.72 | 1.42*** |
| Media and Communication | 333 | 0.95 | 1.00 | 0.77 | -0.23* |
| Medical School | 3963 | 11.31 | 12.11 | 10.69 | -1.41*** |
| Modern Languages | 778 | 2.22 | 2.48 | 1.80 | -0.68*** |
| Physics and Astronomy | 1637 | 4.67 | 4.16 | 5.31 | 1.15*** |
| Politics and International Relations | 1254 | 3.58 | 3.91 | 2.97 | -0.95*** |
| Psychology | 1820 | 5.19 | 4.66 | 6.21 | 1.56*** |
| Sociology | 516 | 1.47 | 1.36 | 1.71 | 0.35** |
| Total | 35053 | 100.00 | 100.00 | 100.00 | |

*Notes*: *, **, *** indicate statistical significance at 10%, 5%, and 1% respectively.

Table 3: Decomposition of High SES and Low SES Accepted Offer Tariff Difference

| | A | B |
|---|---|---|
| Tariff(high) | 392.0*** | 392.0*** |
| | (0.44) | (0.44) |
| Tariff(low) | 379.0*** | 379.0*** |
| | (0.65) | (0.65) |
| Difference | 13.0*** | 13.0*** |
| | (0.78) | (0.78) |
| *Decomposition* | | |
| Attributable to grades | 3.7*** | 3.0*** |
| | (0.44) | (0.44) |
| Not attributable to grades | 9.3*** | 10.1*** |
| | (0.65) | (0.66) |

*Notes*: Robust standard errors reported in parenthesis. *, **, *** indicate statistical significance at 10%, 5%, and 1% respectively. First and second row reflect average tariff of accepted university offer for high and low SES applicants. Fourth and Fifth rows report Oaxaca-Blinder decomposition results for regression of tariff on categorical grade dummies. Column A performs decomposition using 5-category groups of best 3 predicted grades. Column B performs decomposition using predicted grades for all subjects.

Table 4: Density of Sample Strictly Below the (High SES) Median and Mean

| Predicted A-level | AAA | AAB | ABB | BBB | <BBB |
|---|---|---|---|---|---|
| Median(High) | 421.5 | 393.3 | 385.1 | 352.5 | 322.1 |
| Low SES | 0.431 | 0.537 | 0.453 | 0.496 | 0.497 |
| High SES | 0.400 | 0.452 | 0.362 | 0.438 | 0.415 |
| Difference | 0.032 | 0.085 | 0.091 | 0.058 | 0.082 |
| t-statistic | 2.98*** | 5.97*** | 6.26*** | 3.16*** | 4.69*** |
| Mean(High) | 424.6 | 396.4 | 376.5 | 355.0 | 331.1 |
| Low SES | 0.516 | 0.586 | 0.449 | 0.517 | 0.601 |
| High SES | 0.465 | 0.498 | 0.355 | 0.465 | 0.558 |
| Difference | 0.051 | 0.089 | 0.094 | 0.052 | 0.043 |
| t-statistic | 4.70*** | 6.22*** | 6.48*** | 2.81*** | 2.46** |
| Observations | | | | | |
| Low SES | 3047 | 1762 | 1584 | 1087 | 1356 |
| High SES | 7165 | 3975 | 3721 | 2187 | 1985 |

*Notes*: *, **, *** indicate statistical significance at 10%, 5%, and 1% respectively. t-statistic refers to the t-statistic of the difference (Low-High). Median and mean refer to values for high SES group.

Table 5: Significance of SES interacting with tariff effects on probability of receiving an offer

| | Positive Range | | | |
|---|---|---|---|---|
| | %significant | Mean Effect | Min Tariff | Max Tariff |
| AAA | 9.04 | .000109 | 265.33 | 362.93 |
| AAB | 0.00 | - | - | - |
| ABB | 24.31 | .0001186 | 241.30 | 339.04 |
| BBB | 78.82 | .0004766 | 308.90 | 428.87 |
| <BBB | 35.85 | .0003278 | 216.00 | 322.49 |
| | Negative Range | | | |
| | %significant | Mean Effect | Min Tariff | Max Tariff |
| AAA | 0.00 | - | - | - |
| AAB | 0.00 | - | - | - |
| ABB | 0.63 | -.0002473 | 507.00 | 526.54 |
| BBB | 0.58 | -.0004546 | 505.35 | 547.39 |
| <BBB | 14.98 | -.00041 | 402.10 | 461.11 |

*Notes*: %significant reflects the percent of all interaction effects significant at 95%. Mean Effect reports the mean of the interacting effect between SES and tariff on probability of receiving an offer. Min Tariff and Max Tariff capture the full range of statistically significant tariffs for positive and negative interaction effects.

Table 6: Incremental Difference between Highest Tariff Offer and Accepted Offer for High versus Low SES Applicants

| | Mean | SD | N |
|---|---|---|---|
| All Grades | -3.33 | (0.57)*** | 25060 |
| AAA | -0.21 | (0.80) | 9199 |
| AAB | -3.69 | (1.24)*** | 5318 |
| ABB | -6.12 | (1.39)*** | 4838 |
| BBB | -4.41 | (1.75)** | 2928 |
| <BBB | -2.14 | (1.66) | 2767 |

*Notes*: Standard errors reported in parenthesis. *, **, *** indicate statistical significance at 10%, 5%, and 1% respectively.

Table 7: Decomposition of Mean Difference between High and Low SES Tariff Gap

| | A | B |
|---|---|---|
| Tariff Gap (high SES) | 34.54*** | 34.54*** |
| | (0.31) | (0.31) |
| Tariff Gap (low SES) | 37.87*** | 37.87*** |
| | (0.49) | (0.49) |
| Difference | 3.33*** | 3.33*** |
| | (0.58) | (0.58) |
| *Decomposition* | | |
| Attributable to Grades | 0.52*** | 2.25*** |
| | (0.14) | (0.23) |
| Not Attributable to Grades | 2.80*** | 1.07** |
| | (0.56) | (0.53) |

*Notes*: Robust standard errors reported in parenthesis. *, **, *** indicate statistical significance at 10%, 5%, and 1% respectively. Column A performs decomposition using 5-category groupings for best 3 predicted grades. Column B performs decomposition using 5-category groupings for best 3 achieved grades.

Table A.1: Universities and Colleges Observed in Data

| | | | | | |
|---|---|---|---|---|---|
| Cambridge$^{R}$ | 558 | Keele | 353 | Northwest Kent College | 296 |
| Oxford$^{R}$ | 547 | Brunel | 351 | Perby | 296 |
| Imperial College London$^{R}$ | 538 | Edinburgh Napier | 350 | Leeds Beckett | 295 |
| LSE$^{R}$ | 527 | Medway School of Pharmacy | 345 | Cornwall College | 294 |
| Hull York Medical School | 518 | Liverpool Institute for Performing Arts | 345 | ifs | 293 |
| St Andrews | 508 | Stranmillis University College | 344 | York St John | 293 |
| Durham$^{R}$ | 507 | Goldsmiths | 341 | Leeds Trinity | 292 |
| UCL$^{R}$ | 505 | Lincoln | 341 | Kingston | 292 |
| Brighton and Sussex Medical School | 505 | Oxford Brookes | 339 | Cumbria | 290 |
| Strathclyde | 481 | Creative Arts | 338 | Bishop Grosseteste | 289 |
| Bath | 481 | Arts London | 335 | St Mary's Twickenham, London | 288 |
| Edinburgh$^{R}$ | 479 | Bournemouth | 334 | Heythrop College | 283 |
| Bristol$^{R}$ | 479 | Abertay | 334 | Ravensbourne | 282 |
| Warwick$^{R}$ | 471 | Huddersfield | 333 | South Essex College | 281 |
| Exeter$^{R}$ | 461 | Edge Hill | 332 | Writtle College | 281 |
| KCL$^{R}$ | 457 | Arts University Bournemouth | 332 | Stratfordshire | 279 |
| Glasgow$^{R}$ | 455 | Salford | 330 | Northampton | 278 |
| Courtauld Institute of Art | 446 | University Campus Suffolk | 329 | Roehampton | 277 |
| Lancaster | 438 | Essex | 325 | Middlesex | 277 |
| York$^{R}$ | 436 | Manchester Metropolitan | 324 | Canterbury Christ Church | 276 |
| Glasgow School of Art | 433 | Swansea | 324 | Highlands and Islands | 276 |
| Sheffield$^{R}$ | 433 | Sheffield Hallam | 322 | Royal Agricultural Cirencester | 274 |
| Nottingham$^{R}$ | 433 | Hertfordshire | 322 | Wolverhampton | 272 |
| Aberdeen | 432 | Bangor | 322 | Colchester Institute | 272 |
| Leeds$^{R}$ | 432 | West of England, Bristol | 322 | City of Bristol College | 268 |
| Manchester$^{R}$ | 429 | Aberystwyth | 322 | (Thames Valley) West London | 266 |
| Surrey | 423 | Hull | 322 | West London | 266 |
| HeriotWatt | 422 | Brighton | 321 | Birkbeck | 265 |
| Birmingham$^{R}$ | 422 | South Wales, Newport | 320 | Buckinghamshire New University | 265 |
| Royal Veterinary College | 421 | South Wales, Glamorgan | 320 | Southampton Solent | 264 |
| Southampton$^{R}$ | 420 | South Wales | 320 | Exeter College | 263 |
| Newcastle$^{R}$ | 417 | Portsmouth | 319 | Wales Trinity Saint David(Swansea) | 262 |
| Cardiff$^{R}$ | 415 | Chichester | 319 | Wales Trinity Saint David(Carmarthen/Lampeter) | 262 |
| SOAS | 415 | Central Lancashire | 316 | Wales Lampeter | 262 |
| St George's | 407 | Cardiff Metropolitan | 316 | Bolton | 262 |
| Dundee | 406 | Gloucestershire | 316 | Petroc | 261 |
| Royal Holloway | 402 | West of Scotland | 315 | Ashford and West Kent | 261 |
| Liverpool$^{R}$ | 396 | Bath Spa | 314 | Glyndwr | 260 |
| Stirling | 394 | Birmingham City | 314 | Anglia Ruskin | 258 |
| UEA | 393 | Westminster | 312 | South Devon College | 254 |
| University of Law | 393 | Liverpool Hope | 311 | East London | 247 |
| Loughborough | 392 | Nottingham Trent | 310 | BPP | 242 |
| Robert Gordon | 392 | Winchester | 310 | London Metropolitan | 242 |
| London Institute in Paris | 392 | Worcester | 310 | London South Bank | 241 |
| Queen Mary$^{R}$ | 390 | Greenwich | 310 | Bedfordshire | 241 |
| Leeds College of Art | 390 | Harper Adams | 309 | Hartpury College | 240 |
| Sussex | 387 | Ulster | 309 | Richmond American International | 240 |
| Leicester | 385 | De Montfort | 309 | University College Birmingham | 234 |
| City University London | 383 | Teesside | 306 | Bournemouth and Poole College | 233 |
| Queen's Belfast$^{R}$ | 382 | Plymouth | 306 | Warwickshire College | 216 |
| Reading | 376 | Bradford | 306 | West Herts College | 199 |
| Glasgow Caledonian | 372 | Truro and Penwith College | 306 | Birmingham Metropolitan College | 198 |
| Aston, Birmingham | 370 | Falmouth | 306 | Kingston College | 177 |
| Kent | 363 | Chester | 304 | Greenwich School of Management | 174 |
| Royal Central School of Speech&Drama | 362 | Coventry | 303 | Leicester College | 172 |
| Northumbria | 357 | Buckingham | 302 | | |
| Queen Margaret, Edinburgh | 357 | Newman, Birmingham | 302 | | |
| Norwich The Arts | 357 | Sunderland | 300 | | |
| Rose Bruford College | 357 | City of Sunderland College | 299 | | |
| Liverpool John Moores | 355 | Solihull College | 298 | | |

*Notes*: R refers to Russell group member.

# Chapter 2

## Maternal Education and Gender Gap in Family Nurture of Chinese Children

*Abstract:* This study seeks answer to the question of how maternal years of schooling influence the gender gap in prenatal and neonatal investment in child health, as measured respectively by birth weight and breastfeeding duration. Apart from infant health outcome and health investment, this paper will also examine the association between maternal education and the gender gap in the nurture of children. In doing this I look at some interesting outcomes about childrearing. These outcomes are derived from questions answered by parents about their thoughts and practices in child upbringing.

Empirical results show that although parents believe girls are capable of getting a higher score in the exam than boys, and girls are more conscientious about their school work, they invest more in boys' health inputs and pay more for boys' education. The exciting bit of the results might be that higher maternal education has the effect of narrowing the gender gap in postnatal health investment and education investment of children. However, the present study cannot provide evidence about what factors are likely to be mediating between maternal education and gender gap in these outcomes, and these factors are very likely to be different for postnatal health investment, as measured by breastfeeding length, and education investment, as measured by education expenditure paid by family.

# 1 Introduction

The proverb says, "If you educate a man; you educate a man. If you educate a woman; you educate a generation." Whilst the benefits of educating men are more embodied in adding power and wealth to a nation, the value of educating women can be multiplied inter-generationally because mothers are more likely to be caregivers and educators to their children than fathers, especially in the developing world. The present study investigates the relationship between mother's education and investments in children's health and education, in particular, whether girls' and boys' health and education are valued equally by parents, and if not, how maternal education correlates with the gender gap.

Birth weight, which is the body weight of a baby at its birth, is the most widely reported single measure of infant health. In developing countries, low birth weight could stem from long-term maternal malnutrition, lack of prenatal care, ill health and hard work during pregnancy. Infants of low birth weight are at substantially higher risk of death, inhibited growth, and future cognitive deficits, relative to other infants. Low birth weight has also been shown to have long-term negative impacts on test scores, employment probabilities, and wages among young adults (Currie and Hyson (1999)). In addition to the widely documented labour market benefits of education (Card (1999)), economists also show that higher education improves the health outcomes of offspring as measured by birth weight (Currie and Moretti (2003)). Boys weigh more than girls at birth by nature. If higher maternal education is associated with higher birth weight, it could be also interesting to see if the gender gap in birth weight varies with maternal education systematically.

Breastfeeding is the ideal feeding method for both infants and young children beyond infancy. Breastmilk provides all nutrients that infants need for healthy growth and development up to six months of age. After the age of exclusive breastfeeding, partially breastfed children continue to benefit from the immunological feature of breastmilk, which lowers the risk of water- and food-borne diseases. It is documented in previous literature that boys are breastfed for longer than their sisters among developing countries in Asia, because of breastfeeding's contraceptive effects, and more importantly, because of the son-preferring stopping fertility rules prevalent in Asian countries (Jayachandran and Kuziemko (2011)). Whilst studies in the UK, US, and Australia report that maternal education is positively associated with breastfeeding prevalence and duration (Heck et al. (2006), McAndrew et al. (2012)), studies in China have reached the opposite conclusions (Zhao et al. (2017), Qiu et al. (2009)). It remained unanswered that if maternal education could intensify or mute the son advantage in breastfeeding.

The present study adds to the intergenerational mobility of human capital literature. Specifically, this study seeks answer to the question of how maternal years of schooling influence the gender gap in prenatal and neonatal investment in child health, as measured respectively by birth weight and breastfeeding duration. Apart from infant health outcome and health investment, this paper will also examine the association between maternal education and the gender gap in the nurture of children. In doing this I look at some interesting outcomes about childrearing. These outcomes are derived from questions answered by parents about their thoughts and practices in child upbringing.

Whilst education level of China's population has been rising since the early 1980s, female illiteracy rates remain markedly higher than the male ones, and women are especially disadvantaged with regard to attainment in the higher education sector (World Bank Group (2006)). Of vital interest to both policy makers and researchers might be how educating women would influence the education level of the population intergenerationally, in particular, how higher maternal years of schooling would be linked to the gender gap in education outcomes of offspring.

Although the present study lacks direct measures of education outcomes, a number of interesting outcomes reflecting parents' beliefs of and investments in children's schooling are investigated to see whether these outcomes are different for boys and girls, and if yes, whether these differences across gender are systematically correlated with the mother's education level. Specifically, I will look at the highest level of education that parents believe their children should pursue, the test score parents expect children to get, how much parents pay for children's education, as well as two factor outcome variables, which reveal how the children behave as perceived by parents, and that to what extent parents are willing to sacrifice their time and energy to care for their children's study and life.

Examining gender disparities in infant health outcome, health investment, and family nurture in the background of China is particularly fascinating, not only due to the large population, but also because of the unique One Child Policy and a long history of son preference. Furthermore, since the prenatal sex selection technology was introduced to China in the early 1980s, the male-female ratio at birth increased considerably. As the scarcity of girls increases, if girls' health and talent are valued and invested more by higher educated mothers (and hence the whole family), educating women would have the inestimable benefit of balancing the sex ratio in the population and improving girls' health and education in multiple future generations, besides an improvement in the mother's own labour market status.

While establishing a causal linkage between maternal education and the gender gap in investments in children's health and education could be too ambitious, this study does strive to address the endogeneity of maternal education in this empirical question. The exogenous variation in maternal years of schooling originates from an institutional change in Chinese education system, i.e. the Compulsory Education Reform. The sample for analysis in the present paper is from the 2010, 2012, and 2014 China Family Panel Studies. Empirical results show that although parents believe girls are more capable of getting a higher score in the exam than boys, and girls are more conscientious about their school work, they invest more in boys' health inputs and pay more for boys' education. The exciting bit of the results might be that higher maternal education has the effect of narrowing the gender gap in postnatal health investment and education investment of children. However, the present study cannot provide evidence about what factors are likely to be mediating between maternal education and gender gap in these outcomes, and these factors are very likely to be different for postnatal health investment, as measured by breastfeeding length, and education investment, as measured by education expenditure paid by family.

The remainder of the paper is laid out as follows. Section 2 reviews a selection of literature on education, son preference, and gender inequality. Section 3 discusses the institutional background. Section 4 describes the data and provides summary statistics. Section 5 describes the empirical strategy. Results appear in Section 6. Section 7 investigates how likely maternal education is jointly determined with the outcome variables by applying a control function approach. Section 8 provides concluding remarks.

# 2 Literature Review

In this section, I will review two strands of literature. The first is centred about the importance of education and how the endogeneity of education is addressed in previous literature. The second strand of literature is about son preference and gender inequality.

## 2.1 The Importance of Education

The critical role of education in modern labour market has been extensively documented. Card (1999) provides a comprehensive survey of the literature on the causal relationship between education and earnings. He concludes that, apart from individuals' inherent ability differentials that happened to be correlated with education, the observed positive association between years of schooling and labour market outcomes does reflect a positive causal effect of education. Furthermore, the return to education is not a single parameter in the population, but rather a random variable that may vary with other characteristics of individuals, such as parental education, ability, school quality, or level of schooling. Specifically, the marginal returns to schooling for disadvantaged groups with relatively low education attainment might be even higher than the average marginal returns to education in the population as a whole.

However, the return to education should not be merely confined to individuals' labour market status. Currie and Moretti (2003) demonstrate how the social return of schooling could be way more meaningful than earnings. Using Vital Statistics Natality Data from 1970 to 1999, they examine the effect of maternal education on infant health outcomes, which are measured by birth weight and gestational age.

In this empirical question, mothers' education, which is the main variable of interest, can be endogenous. The endogeneity comes from the simultaneity between maternal education, investments in health inputs, and infant health outcomes. Any measured association between these factors might reflect omitted variables such as family background or "forward looking behaviour", which would affect the health outcome and maternal education simultaneously. For example, women with high discount rates may put less weight on future benefits of schooling and hence have lower education attainment. And these same mothers tend to be less careful mothers who might invest less in their children's health.

To account for the endogeneity of maternal education, a data set on openings of two and four years of colleges between 1940 and 1996 has been compiled and maternal education is instrumented with availability of colleges in the mother's county in her 17th year. Additionally, Currie and Moretti control for many potentially unobserved confounding factors by including county-year-of-birth fixed effects. Therefore, estimates are identified by differences in the availability of educational services among different cohorts of mothers delivering in the same county and year.

Results show that higher maternal education improves infant health. Specifically, an additional year of education reduces the incidence of low birth weight by approximately ten percent, and reduces the incidence of preterm birth by six percent, on average.

Potential pathways through which maternal education may improve infant health include use of prenatal care, smoking, marriage, and fertility. More educated women earn more, hence they may be able to afford more health care. They may also live a healthier way of life and are less likely to smoke. According to the assortative matching theory, women with higher education attainment are likely to marry higher earning men, and this will further raise family income. Furthermore, as Becker's quality/quantity trade-off (Becker (1960), Becker and Lewis (1973)) suggests, education may induce women to have fewer children of higher quality. The same instrument is used in modelling these mediating factors and results show that higher maternal education indeed increase the probability that a new mother is married, reduce the total number of children born to a mother, increase use of prenatal care, and reduce the probability of smoking.

Evidence in this paper indicates that improved infant health is an important benefit of education that is not fully reflected in the wages of educated mothers. If educating women improves the health, educational attainment, and labour outcomes of their children, increases in education attainment today may benefit multiple future generations.

The present study is close to Currie and Moretti's work, which has established that maternal education improves infant health. The present study takes a different angle and attempts to seek answer to the question of whether boys and girls benefit from maternal education to the same extent.

### 2.1.1 Handling the Endogeneity of Education

Past literatures address the simultaneity between education and response variables through exploiting the institutional features of the schooling system (Angrist and Krueger (1991), Staiger and Stock (1997), Kane and Rouse (1993), Card (1995), Conneely and Uusitalo (1997), Maluccio (1997), Harmon and Walker (1995)), through instrumenting individuals' education attainment by family background or directly controlling for family background (Card (1995), Card (1999), Conneely and Uusitalo (1997), Ashenfelter and Zimmerman (1997), Miller et al. (1995), Ashenfelter and Rouse (1998), Isacsson (1997)), or through examining twins' schooling and outcomes (Ashenfelter and Rouse (1998), Rouse (1997), Miller et al. (1995), Behrman et al. (1994), Isacsson (1997)). These are reviewed in depth by Card (1999)).

As regard to empirical strategy, the present study is very close to Xie and Mo (2014) in their investigation of the causal effect of education on health. They use four waves of the China Health and Nutrition Survey (1997, 2000, 2004 and 2006).

OLS results do not show any significant effect of education on health. Possible explanations of this insignificance include the fact that the health measures explored in the paper, such as overweight and smoking, are not serious problems in China. Furthermore, average education level in China is low compared to those in western countries. Consequently, the results may only reflect the impact of education on health for the lower part of the education distribution scale.

However, the most important concern about the OLS results stems from the simultaneity between education and health outcomes. The observed correlation between education and health could reflect some unobservable variables such as genetic traits, ability, or time preference that affect health and education in the same way.

Instrumental variables approach has been applied to address the endogeneity of education. The main instruments consist of two institutional changes in China that generated discontinuities in educational attainment among individuals. The first of these is the enforcement of 9-year compulsory education law in 1986, which will also be exploited in the present study as the source of exogenous variation of maternal schooling. The second one is the enactment of the prohibition of using child labour which took place in 1991. This could also induce discontinuity in individuals' education attainment as any type of work unit are banned from employing children under the age of 16 under this law. The results indicate no causal impact of education on either perceived health or anthropometric health.

## 2.2 Literature on Son Preference and Gender Inequality

Son preference in China, India, and other Asian countries has been extensively documented. A strong preference for sons among parents could result in gender differences in intra-household allocation of resources and care, which could further induce excessive malnutrition, morbidity, and mortality of girls. Since the early 1980s, with the wide spread of prenatal sex determination technologies in Asian countries such as ultrasound, which enables parents to know child gender during pregnancy, son preference starts to manifest itself through prenatal sex selection, namely, abortion of female foetuses. Missing women, which refers to the phenomenon of smaller number of women than would be expected in the population if girls and women were born and died at the same rate as boys and men, could result from neglect and stunting of girls, or abortion of female foetuses.

The male to female ratio at birth increases in China since the early 1980s. Chen et al. (2013) investigate whether this increase in sex ratio at birth is caused by the increase in the practice of prenatal sex selection.

The differential introduction of diagnostic ultrasound into Chinese counties during the 1980s, which greatly reduces the cost of foetal gender discrimination, results in variations in local access to prenatal sex determination, both in the time-series and the cross-section dimension. These variations are exploited to demonstrate that roughly 40 to 50 percent of increase in sex ratio at birth can be explained by the access to ultrasound technology.

Further, the effect of ultrasound is driven entirely by higher-order births and is more significant for higher-order births in families with no older male children. Ultrasound only affects those couples subjected to the strict One Child Policy. The effect is more considerable for women with lower education and less income and who reside in rural areas.

It was unclear how informing son-preferring parents of child gender before birth would affect the health outcomes of girls who are finally born, until Hu and Schlosser (2015) studied the impacts of prenatal sex detection and abortion of female foetuses on the wellbeing of surviving girls, using the Indian National Family and Household Survey data.

Their study contains three important parts. Firstly, without direct observation of the use of prenatal sex detection and sex selective abortion, they show that high male-female ratios at birth reflect the practice of prenatal sex selection and hence it is reasonable to proxy parental access to prenatal sex selection using the ratio of male to female births in the year and state in which the child was born.

Secondly, a triple difference strategy is applied to examine whether the variation in health outcomes of girls in comparison with boys within states and over time is systematically associated with the variation in male-female ratios at birth. Results show that an increase in the practice of prenatal sex selection leads to a reduction in girls' malnutrition, as measured by underweight and wasting.

Thirdly, they explore potential underlying channels linking between prenatal sex selection and girls' health outcomes. No evidence was found for a selection of girls into families with different observable socio-demographic characteristics. Nevertheless, there is evidence indicating that girls are more likely to be born in families with weaker son preferences, that family size reduces for girls, and that girls are less likely to be born at higher parities. There is also suggestive evidence of better treatment of girls as reflected in breastfeeding duration.

On the other hand, evidence from China is not so positive. Almond et al. (2010) examine whether prenatal and postnatal investments in health inputs of children change when parents are able to know child gender during pregnancy. They use the 1992 Chinese Children Survey and exploit the differential introduction of diagnostic ultrasound into Chinese counties during the 1980s to test two hypotheses. Prenatally, the effect of sex-detective technology on health investments in female foetuses is ambiguous. On the one hand, for pregnancies carried to term, ultrasound reveals sex as early as six months prior to delivery, enabling gender discrimination in utero investments. On the other hand, sex selective abortions would tend to increase in utero investments in girls through preference sorting. Families with weaker son preference might actually want a girl and invest more in female foetuses. By the same logic, if health investments respond to parental sex preferences, postnatal investments in girls should also increase with the diffusion of ultrasound and prenatal sex selection.

Results show little evidence of gender difference in postnatal investments. However, a sizable increase was found in female neonatal mortality in comparison with male neonatal mortality after ultrasound was introduced, indicating that parents withheld investment in female foetuses relative to males once foetal sex was revealed.

While the evidence from India on the impacts of prenatal sex selection on the wellbeing of girls who are born is encouraging, the long-run effects of sex selection are not so optimistic. Amaral and Bhalotra (2017) investigate the role played by sex imbalance in India's population in explaining violence against women. They use district level administrative crime data by category matched to age-specific sex ratios in census data over the period 1971-2011 to analyse the main research question, and use administrative data on marriage rates and household survey data on attitudes towards violence against women and marriage quality for probing mechanisms.

Results show that the elasticity of violence against women with respect to the surplus of men aged 20-24 is unity, and that increases in the youth sex ratio can account for about 35% of the rise in gender-based violence since 1995. This is the first causal evidence linking the sex ratio of youth to violence against women.

Potential mechanisms include that men are more prone to crime than women and that the share of unmarried men is increasing in the youth sex ratio. Additionally, the self-reported attitudes towards domestic violence are evolving adversely in response to the rising sex ratio at birth. Marriage quality measures, which include self-reported domestic violence, are negatively related to male-female ratios.

People start to think how the gender discrimination, both prenatally and postnatally, and the consequential striking male-female birth ratio in the developing world could be mitigated. Sun and Zhao (2016) estimate the effect of China's pro-women divorce reform on prenatal sex selection behaviour within marriages by applying a regression-discontinuity analysis on the child sex ratio.

The 2001 divorce reform liberalised divorce in favour of women and secured women's property rights after separation. China provides an interesting context to study possible legislative tools in curbing the rising sex ratio due to the One Child Policy and the later One Son Two Children Policy. A couple can have only one child if the firstborn child is a boy. If the firstborn is a daughter, they can have another child. This second pregnancy is the last chance that a couple can have a son and this is where sex-selective abortion is most likely to happen.

A high male-female ratio among children of second birth after a firstborn daughter would indicate an increase in the incidence of sex-selective abortion. Results from the 25-percent sample of the 2005 One-Percent Population Survey show that the empowerment of women within households substantially decreases the practice of sex selection. In particular, the likelihood of having a son after a firstborn daughter decreased by 8.1 percentage points. This amounts to a reduction of 11.7% compared with the prior proportion of male children.

Additionally, the effect of divorce reform is stronger among women who face higher health costs of abortion and also stronger in provinces where divorce is a more credible threat because of more lenient family planning policies governing fertility in the next marriage.

The evidence is most encouraging in the sense that improving women's bargaining power through legal innovation is less costly and more efficient than banning ultrasound B sex screening. Furthermore, the reform takes effect much faster than economic growth, which gradually increases the returns to having daughters through increasing women's economic value.

While the One Child Policy effectively curbed the surging population growth in China, and according to Becker's quantity/quality trade-off (Becker (1960), Becker and Lewis (1973)), having less children is associated with fostering children of higher quality, the One Child Policy undoubtedly deprived Chinese children the joy of being with siblings. Qian (2009) estimates the effect of family size on school enrolment of the firstborn child.

The number of children in family and children's school enrolment status could be jointly determined by parental preference. Parents who value education more and tend to investment more in children are likely to be those parents who prefer smaller households. To address this endogeneity, Qian exploits the plausibly exogenous variation in family size as a consequence of relaxations in China's One Child Policy. As abovementioned, the One Child Policy was relaxed to One Son Two Children Policy, namely a couple can have a second child if the firstborn is a daughter.

Qian find evidence that first born children benefit from having a younger sibling. In particular, for one-child families, an additional child would significantly increase school enrolment of firstborn children.

While the study does not provide conclusive evidence on the mechanisms driving the main results, potential mediating factors may include social interaction and economies of scale in child-rearing. Having siblings provides children opportunities to teach and learn from each other. Increases in the number of children would reduce average cost of child care for items such as clothes and textbooks. Consequently, an additional child lowers the marginal cost of quality for all children.

This study is relevant to the present work in that both look at quality of family nurturing, and in doing this, the effect of family size is almost always expected to be negative. Yet Qian demonstrates novelly how the results can sometimes be counter-intuitive.

There are also a couple of fascinating theoretical, or both theoretical and empirical works, regarding how son preference would govern parents' fertility and nursing behaviour.

Yamaguchi (1989) provides theoretical evidence of how individually employed male-preferring stopping rules in childbearing would generate differences between boys and girls in birth order and in the number of siblings.

Male-preferring stopping rules affect the average birth order differentially for boys and girls only under population heterogeneity in the probability of having a boy. The rules generate apparently declining probabilities of male births with increases in the birth order in the population. It is worth noting that this result applies only in the absence of a technology that would artificially allow parents to realise their preference for sex composition of children. Male-preferring stopping rules make the average number of siblings larger for girls than for boys.

The duration of breastfeeding negatively correlates with the mother's likelihood of subsequent birth. There are two mechanisms underlying this relationship. Firstly, breastfeeding temporarily lowers a woman's fecundity. Secondly, women typically wean a child if they become pregnant again.

Jayachandran and Kuziemko (2011) develop a model of fertility decisions that synthesises this negative correlation between breastfeeding duration and subsequent conception, and son preference. The model provides several predictions regarding how long children will be breastfed. Specifically, boys are breastfed more than girls if parents have a preference for sons. This is supported by empirical results from the Indian National Family Health Survey.

# 3 Institutional Background

## 3.1 Education Reform

Institutional changes like changes to the compulsory education laws are much utilised instruments because of the quasi-experimental nature. The Chinese education system is a public system run by the Ministry of Education. The law on Nine-Year Compulsory Education, which is the first national law to dictate education policy since the establishment of the country in 1949, was enacted on 12 April, 1986 and officially took effect on 1 July, 1986. Nine-Year Compulsory Education is comprised of six years of primary education, starting at age six, and three years of junior middle school. A typical child abide by this law would go to school no later than age seven and would only be eligible to stop schooling at age fifteen. Children aged six or older should start going to school in 1986 if they haven't done so. Children younger than 15 in 1986, in particular who would have been likely to leave school, would be forced to stay in school until they are 15 according to the law. Consequently, if the law had been implemented effectively, we would expect a significant increase in years of education for children born in 1971 or later, relative to children who were born in 1970 or earlier.

However, this law does not have the effect of strictly prohibiting children from leaving school before a certain age. It is not like the statutory minimum school leaving age requirements in countries like the UK and the US. The law is more aimed at eradicating illiteracy rather than achieving universal junior middle school education, at least in the short term. The latter is virtually a long-term ambition of the government. In reality, it was not until 2011 that the government announced that universal compulsory education had been accomplished.

People's congresses at various local levels were to decide the steps and methods for implementing nine-year compulsory education, in consideration of local conditions. Although parents were required by law to send children aged six to fifteen to school, no penalty exists for those who do not comply. They might merely receive criticism from their local authorities. Furthermore, although it was stressed in the law that no tuition should be charged for students receiving compulsory education, this was also a long-term ambition rather than a realised goal throughout China. School funding was distributed from provincial-level to county-level, then to township-level authorities. Enforcement of tuition-free primary education across different provinces of China was uneven due to the geographically uneven economic development. For many families which have difficulty paying school fees, especially in these economically backward areas, children are forced to leave school earlier than the nine-year goal.

For these reasons, the immediate effectiveness of the Compulsory Education Law is difficult to assess. However, this would not hinder the law being a valid instrument for the present study. Firstly, the three-year Great Famine from 1959 to 1961 and the Cultural Revolution from 1966 to 1976 had rendered the average education level among Chinese population very low to start with. Raising the same number of years of education is easier starting with a low education level than starting with a high level. Secondly, Chinese people, especially peasants and the working-class, have traditionally been keen to respect the authorities and following any guidelines formulated by the government was considered a great honour for them. Being admonished by the local government is a real disgrace for a family. Therefore, although the Compulsory Education Law would not have the instant effect of lifting up the education level of those who were born after 1971 to junior middle school, it should somehow improve Chinese women's education level.

## 3.2 Son Preference and One Child Policy

Chinese families have a long tradition of preferring sons to daughters. Son preference culture emphasises the importance of continuing the family line through male offspring. This importance is embodied in the fertility behaviour of Chinese families. Historically, couples would continue to have children until the desired number of sons was reached.

However, this situation has been dramatically altered by the Family Planning Policy, known as the One Child Policy when it was first announced in 1979. The policy forbade second births for households of Han ethnicity, which comprise the bulk of Chinese population, except under very special circumstances. Families are prevented from having multiple children to ensure the birth of sons. Under the stringent birth control, son preference manifested itself through sex-selective abortions, female infanticide, the neglect of baby girls, and the preferential allocation of household resources to sons. Additionally, to comply with the policy, women who are pregnant with second child faced harsh punishments including forced abortion and sterilisation.

To curb the tragedies of female infanticide, forced abortion and forced sterilisation, in 1984 the Central Party Committee issued “Document 9”, allowing rural couples to have a second child if the first child was a girl. This relaxation was called the One Son Two Children Policy. The One Child Policy and One Son Two Children Policy was abolished in October 2015. Since then, couples were generally allowed to have two children.

### 3.3 Why China Is Interesting in the Sense That Girls and Boys Are Treated Differently

China provides an interesting environment for studying gender gap in family nurturing. Firstly, China is the most populous country in the world. Occupying 6.26% of the global land area, China is accommodating 18.42% of the world population. Evidence from China would shed light on similar research questions worldwide, especially for developing countries.

Secondly, 36 years’ coercive reign of Family Planning Policy combined with a deep son preference culture make China a unique background in the world for investigating gender disparities in household resources allocation and parental supporting for children. It could be interesting and important to see how the stringent birth control has been influencing Chinese parents’ thoughts and practices in bringing up sons and daughters.

Thirdly, prenatal sex detective technology and sex-selective abortion provide Chinese couples an effective pathway to achieve a desirable sex composition of children, particularly when they are prevented from having multiple children to ensure the birth of sons. Unlike Islamic countries such as Iran or Nigeria, where abortion is a controversial and even disgraceful issue, China is not religious-dominant. Abortion rarely brings stigma to a Chinese woman. Actually, after the Family Planning Policy was enacted in 1979, abortion has become an essential component of the birth-control campaign and is encouraged by the authorities, especially for pregnancies exceeding the quotas stipulated by the policy. Examining the patterns of child-rearing behaviour after such a long term and large scale of sex selection is not only of critical value to Chinese society, it could also be inspiring for other Asian countries with similar son preference culture like India.

## 4 Data

The primary data source is the China Family Panel Studies (CFPS) 2010, 2012, and 2014. CFPS is a nationally representative sample of Chinese communities, families, and individuals, that follows the same set of households across waves. It covers 25 provincial level regions where 95% of Chinese population reside. The CFPS sampling method is Probability Proportional to Size. Specifically, five provincial level regions were chosen for initial sampling (1,600 households in each) to achieve regional comparisons, and the remaining 8,000 households were drawn through weighting from the other 20 provincial level regions to make

Table 1: Sampling Variables

| Weight | Cross-Sectional Weight (Individual Level): Total Sample |
|---|---|
| Strata | 1. Shanghai Subpopulation |
| | 2. Liaoning Subpopulation |
| | 3. Henan Subpopulation |
| | 4. Gansu Subpopulation |
| | 5. Guangdong Subpopulation |
| | 6. Other Provinces |
| Primary Sampling Unit | County |

*Notes*: Six strata were initially sampled: four provinces (Gansu, Guangdong, Henan, and Liaoning) and a municipality (Shanghai) were each treated as separate stratum and a sixth stratum consisted of the remaining 20 provinces sampled. Within each of the four single-province strata, 16 counties were chosen at random with Probability Proportional to Size (PPS). In Shanghai 32 townships or streets (jiedao) were chosen with PPS at the first stage. Within the 20-province stratum, 80 counties were chosen with PPS.

the overall CFPS sample representative of the country. Table 1 shows the variables defining the sampling structure. The first wave in year 2010 included 14,798 households and 8,990 children. The 2012 follow-up data included 13,315 households and 8,626 children. The 2014 follow-up data included 13,946 households and 8,617 children.

CFPS consisted of five questionnaires (Community, Family, Family Roster, Child, and Adult), and five datasets accordingly. It contains rich information on the demographic and socioeconomic aspects of Chinese households. And it is designed to be comparable to the Panel Study of Income Dynamics (PSID) in the United States. Of central interest to the present study is the children's dataset. The sample used in this paper only includes Han families.

## 4.1 Outcome Variables

In children's questionnaire, CFPS asked parents questions about neonatal characteristics of their children such as birth weight, neonatal investment in their children's health such as breastfeeding duration, their caring about children's study and life, their expectation for and investment in their children's education, and their daily observation of children's behaviour. The seven outcome variables in the present study are derived from these survey questions.

Specifically, parents are asked about their children's weight at birth (in half kilograms, but transformed into grams for ease of analysis), how long (in months) their children have been breastfed since birth, the highest level of education they wish their children could obtain, the total cost of the child's education in the previous year paid by the family (in RMB), the average score out of a total of 100 they expect children to get in the exam.

Additionally, CFPS asked parents multiple questions which would reflect their caring about children's study and life. Parents are asked to rate, on a scale to 1 to 5, how often they (1) give up watching TV showing they like to avoid disturbing the child when he/she was studying; (2) discuss what happened at school with the child; (3) ask the child to finish homework; (4) check the child's homework; (5) restrict or stop the child from watching TV; (6) restrict the types of TV programs the child could watch, where 1 means very often and 5 means never. The answers to these six questions are summarised into a factor variable, rescaled and standardised such that it has a mean 0 and standard deviation 1 in the sample, and higher means the parent cares more about the child's study and life.

CFPS also asked parents seven questions about their daily observation of their children's behaviour. Parents are asked to rate, again on a scale from 1 to 5, how much they would agree that (1) the child studies very hard; (2) when the child finishes his/her homework, he/she checks it to see if he/she did it correctly; (3) the child plays only after he/she finished his/her study; (4) during class-time, the child is very concentrated; (5) the child respects school disciplines; (6) once he/she starts to do something, the child will complete it no matter what happens; (7) the child likes to keep all his/her school things in great order. Likewise, the answers to these seven questions are summarised into a factor variable, rescaled and standardised such that it has a mean 0 and standard deviation 1 in the sample, and higher implies the child is more conscientious about their study and school life as perceived by the parent.

In Table 2, I list these outcome variables and their corresponding survey questions. Table 3 shows some summary statistics for the outcome variables. The gender differences are (boys - girls). P-values are in parentheses beneath estimates. The conditional difference regression controls for household registration type, parental education, per capita family income, number of children in family, birth year fixed effect, and interview year fixed effect. Birth weight is measured in grams, Breastfeeding Duration in months, Expected Score in percentages, Expected Education in years, Education Cost in RMB yuan. Parental Care and Parental Observation are standardised factor variables. Their means are not zero, possibly because the sampling weights are taken account of when the means are estimated. As can be seen from the table, the sample size changes across variables. This is because when I restrict the sample, I keep those observations with nonmissing control variables and at least one nonmissing outcome variables.

Both the raw difference and the conditional difference between boys and girls are significant in birth weight, breastfeeding duration, expected score, and parental observation. Boys, on average, weigh about 130 grams more at birth than girls. Chinese babies are breastfed about 11 months on average. Additionally, boys are breastfed 0.6 months longer than girls. Chinese parents are overall very ambitious about their children's exam results. Out of a total of 100, parents expect children to get 91 on the whole, and boys are expected to get 1.8 points lower than girls. Girls are also more hard-working and make more commitment to study in parents' eyes. By and large, Chinese parents want their children to get an education qualification between

2- or 3- year college and Bachelor's degree. It is interesting to see that, although parents are more ambitious about girls' exam results than boys', they appear to expect their boys to get about 0.1 years more education than their girls, although the difference is insignificant even at 10%. It seems that parents sacrifice their time and entertainment equally for daughters' and sons' study. Overall, parents pay more for girls' education than for boys', but the difference is insignificant.

## 4.2 Explanatory Variables

These are the explanatory variables. 1) Male, which equals one if a child is a boy, is one of the main variables of interest. 2) Child's age, with which education cost is likely to increase. 3) Agricultural. It equals one if child's current household registration is agricultural. 4) Mother's education, which are measured both in years and in levels, is also one of the main variables of interest. 5) Father's education, which is also measured both in years and in levels. 6) Mother's year of birth. The instrument is constructed from this variable. 7) Family income per capita. 8) Total number of children in the family.[12] 9) Han, which is the most populous ethnicity in China. I only focus on the Han children, because the Family Planning Policy only applies to Han households.

Table 4 lists these explanatory variables and their descriptions. Table 5 shows some summary statistics for these explanatory variables except Male. Children in my sample are roughly aged eight and half years, and boys and girls are about the same age. 75% of children are registered as agricultural household members. This is higher than the proportion in the national population. According to the 2010 Chinese Census data, 71% of Chinese population, including people of all ages, are registered as agricultural household members. They can be seen as born in rural families. Girls and boys are equally likely to be from rural families. No significant difference across gender exists in parental education. On average parents get an education qualification slightly lower than junior middle school, and fathers' education levels are higher than mothers'. Both boys' and girls' mothers are born around 1978, or about 32 years old in 2010. On the whole, Chinese children are from families with per capita yearly income 10,000 RMB yuan. This is about 3,100 USD in terms of Purchasing Power Parity in 2010. Boys are born in wealthier families than girls. The difference is 850 RMB yuan per person, and this is significant at 5% level. On average each Chinese household has 1.8 children. Girls are born in larger families than boys. This echos the theoretical finding in Yamaguchi (1989) that son-preferring fertility stopping rules make the average number of siblings larger for girls than for boys.

[12]Note in the 2012 family roster dataset three variables already exist referring to the number of children in a household. These are nchd1, nchd2, nchd3. They are the number of children in a family version 1, version 2, and version 3, respectively. But for several reasons I don't use these variables. Firstly, they differ significantly. Yet a considerable number of them are equal to the generated number of children variable, which is the total number of children ever born to an adult with non-missing person ID. Secondly, they can be zero when a child has a valid person ID. Thirdly, it makes sense to use a variable constructed in the same way across three years so the results are more comparable.

#### 4.2.1 Parental Education

In 1986 the Chinese government announced nine year compulsory education. Under this scheme each child should start going to school at age 6 and should not finish school until junior middle school graduation, i.e. when the child is aged 15. Those who are born after 1971 would be aged younger than 15 when the compulsory education law took effect in 1986. They would therefore be influenced by the education reform. Those who are born before 1971 would be aged older than 15 when the new law went to effect. They would not be influenced by the education reform. As a result, if the compulsory education law had been implemented effectively, we would expect to see a significant increase in years of education for mothers born in 1971 or later, compared to mothers who were born in 1970 or earlier.

Figure 1 plots years of education against year of birth for parents. The upper left and lower left panels plot years of education against year of birth for mothers and fathers born between 1960 and 1990, respectively. The two panels on the right are the same plots but with a smaller window, between 1966 and 1976, i.e. five years before and five years after the birth year when the education reform takes effect (1971).

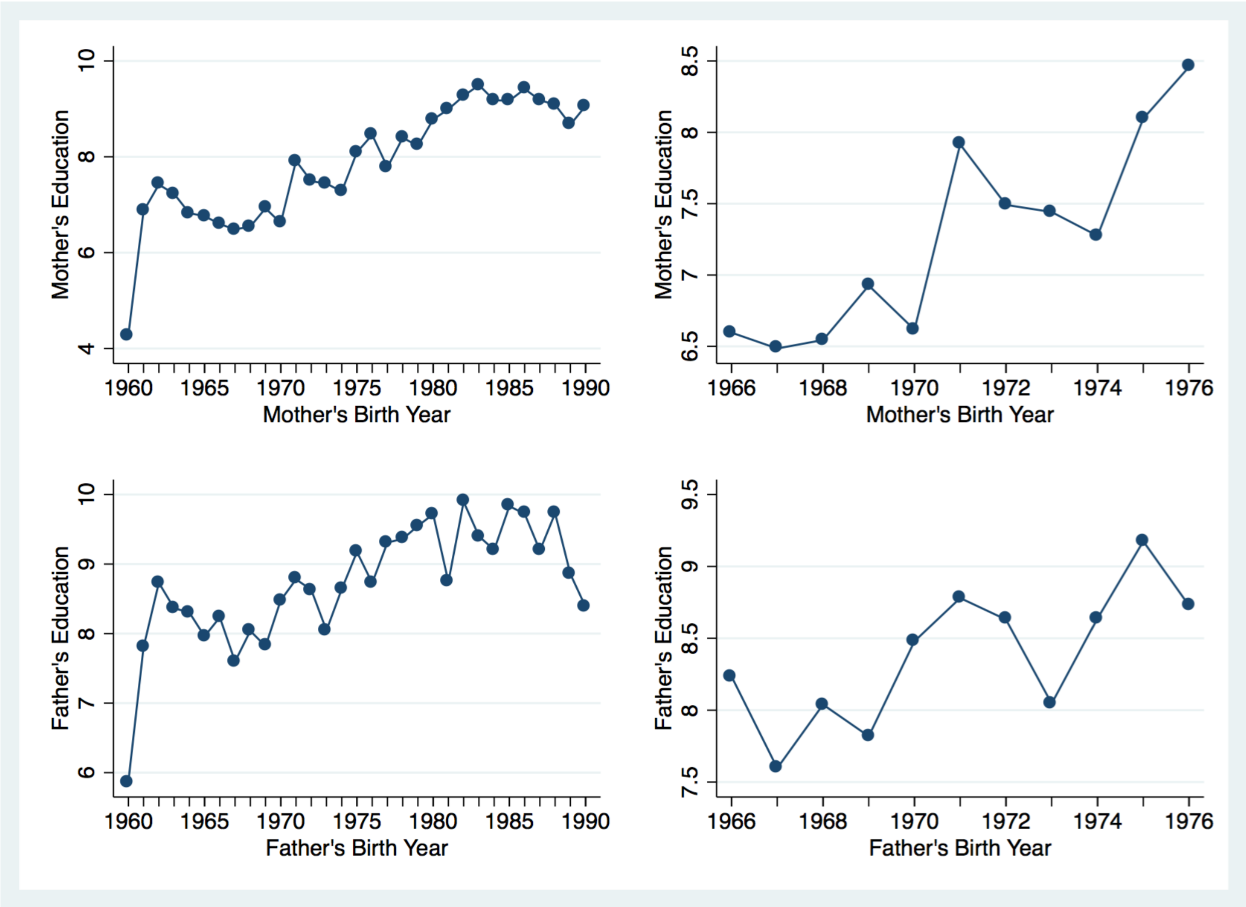
From 1960 to 1990, mothers' years of education go from slightly above 4 (semiliterate) to 9 (junior middle school), and fathers' years of education go from slightly below 6 (primary school) to 8.5 (below junior middle school). While we see a dramatic boost in Chinese parents' education, mothers' education improves a lot more than fathers' education. It is also interesting to see that, for parents born after 1987, fathers' education actually decreases from above junior middle school to slightly below, and mothers' education remains stable at around junior middle school. We also see a substantial increase in parents' education from birth year 1960 to birth year 1961. But this might be due to sampling error, as there are not much mothers or fathers born over these years (See Table 6).

Turning to panels on the right, we see that, for parents born over the 10 years of Cultural Revolution, mothers' education increases dramatically from 6.5 years to 8.5 years, and fathers' education increases from 8.3 years to 8.7 years. Furthermore, from birth year 1970 to birth year 1971, over this single birth year, mothers' education rises from 6.6 to 7.9, and fathers' education grows from 8.5 to 8.8.

### 4.3 Sample for Analysis

2010, 2012, and 2014 Children's dataset is the main source of variables used in the present study. Individuals aged between 0 and 15 are included in the children's dataset. Individuals older than 16 (included) answer the adult questionnaire. The 2010, 2012 and 2014 child datasets can have different children because some children grow older than 15 during these years so they go on to be included in the adult dataset in later year(s), also because there are newly born children across those years so they are observed in child dataset only in later year(s).

Figure 8: Parental Years of Education Along Birth Year



Children are observed in more than one year if they are aged between 0 and 15 in more than one of the interview years. To minimise the influence of missing values and increase the valid sample size, for children observed more than once, if some of his/her variables are missing in one year but non-missing in another year, I copy the information in the non-missing year to the missing year. This might not cause much problem for variables like Birth Weight and Breastfeeding Duration, but it can be problematic for Expected Education, Education Cost, Expected Score, Parental Care, and Parental Observation, which are likely to vary across years. As values of these latter variables tend to be more informative when the child is a bit older, I keep the most recent observation if the same child is observed in more than one year, so that every child appears once in the sample for analysis.

After pooling together three years' data and imputing values of some of the missing variables, I keep only those observations with nonmissing sampling information and all explanatory variables, and with at least one nonmissing outcome variables. 7936 unique observations satisfy these restrictions.

# 5 Model Setup

In Table 3 "Outcome Variables Summary Statistics", the column "Conditional Difference" estimates a model of the following form:

$$Outcome_i = a_0 + a_1 Male_i + a_2 Meduc_i + \gamma' X_i + error_{1i} \tag{1}$$

The entries in the column "Conditional Difference" of Table 3 are the estimates of $a_1$, i.e. the coefficient on $Male$, for various outcomes. $Male$ is an indicator for whether the child is a boy. $Meduc$ denotes maternal years of schooling. $\gamma$ is a vector of coefficients. $X$ is a set of family background characteristics which includes household registration type, father's education, family income per capita, total number of children in the family, plus birth year and interview year indicators. The birth year and interview year fixed effects would help to control for many characteristics specific to a year, such as national business cycle, economic growth and development, medical insurance policies, the interview circumstances, and the child's schooling stage. $Outcome$ can be birthweight, breastfeeding duration, expected years of education by parents, education cost paid by family, expected test score by parents, parental care index, and parental observation index. The coefficient $a_1$ thus measures the conditional gender gap in these outcomes.

Among these seven outcomes, birthweight would reflect prenatal investment in the foetus as well as genetic characteristics, and breastfeeding length would reflect postnatal investment in the child's health. The rest of these outcomes would reflect family nurturing and investments in formal education. As can be seen from Table 3, the conditional gender gap is significant in birthweight, breastfeeding duration, expected score, and parental observation.

The main goal of the present study is to investigate if mother's education would help to narrow the gender gap in these outcomes. In the following regression function,

$$Outcome_i = b_0 + b_1 Male_i + b_2 Male_i \cdot Meduc_i + b_3 Meduc_i + \eta' X_i + error_{2i} \tag{2}$$

$Meduc$ denotes maternal years of schooling. The sign of the coefficient on the interaction term combined with that on $Male$ would tell us if mother's education narrows or widens the gender gap.

The gender gap is measured by $b_1$. If $b_1 > 0$, boys' outcome is higher than girls' outcome, after accounting for family characteristics, birth year and interview year. If $b_2$ is also greater than 0, higher maternal education would be associated with wider gender gap. If $b_1 > 0$ and $b_2 < 0$, although the gender gap is positive at low levels of maternal education, this gap gets narrower with higher mother's education.

If $b_1 < 0$, boys' outcome would on average be lower than girls' outcome after family characteristics, birth year, and interview year fixed effects are taken account of. If $b_2$ is also less than 0, girls' outcomes would be higher than boys' outcome by more as maternal education gets higher. If $b_1 < 0$ and $b_2 > 0$, although boys' outcome is lower than girls' outcome at low levels of maternal schooling, this negative gender gap becomes smaller in magnitude with higher maternal education.

However, as many might criticise, maternal schooling is very likely to be endogenous. It can well be correlated with factors contained in the error term, such as mother's family background, mother's discount rate, health habits and study habits. These factors can affect maternal education and children's outcomes simultaneously. Hence I should obtain some exogenous variation in mother's education.

As can be seen from Figure 1, maternal years of schooling grows dramatically over the birth year from 1970 to 1971, which is the cut-off point when the compulsory education law takes effect. Hence, whether a mother is affected by the compulsory education law, as described by if she is born 1971 or later, could be credibly employed to instrument for maternal education.

If firstly maternal education is regressed on an indicator for whether the mother is affected by the compulsory education reform,

$$Meduc_i = c_0 + c_1 Postreform_i + c_2 Male_i * Postreform_i + c_3 Male_i + \theta' X_i + error_{3i} \tag{3}$$

and similarly for the interaction between child's gender and maternal education,

$$Male_i * Meduc_i = d_0 + d_1 Postreform_i + d_2 Male_i * Postreform_i + d_3 Male_i + \tau' X_i + error_{4i} \tag{4}$$

where $Postreform_i$ is a dummy variable which equals 1 if the mother's birth year is 1971 or later. This dummy serves as the instrument in a two-stage least squares setup. Identification in these first stage models comes from the fact that after the influences of household registration type, father's education, family income per capita, and number of children in family are controlled for, there are a group of mothers affected by the education reform, and another group of mothers not affected by the education reform, and their children are born and interviewed in the same years.

In the second stage, one of the outcome variables is regressed on the gender of the child, the mother's predicted years of schooling from equation (3), the prediction of the interaction between child's gender and maternal years of schooling from equation (4), and the rest of the explanatory variables:

$$Outcome_i = g_0 + g_1 Male_i + g_2 Male_i \cdot PMeduc_i + g_3 PMeduc_i + \lambda' X_i + error_{5i} \tag{5}$$

where $PMeduc$ is the prediction of mother's education from equation (3), and $Male{\cdot}PMeduc$ is the prediction of the interaction term from equation (4).

# 6 Empirical Results

## 6.1 OLS Results

Table 7 and Table 8 report the OLS results, i.e. the estimates of parameters in equation (2). In Table 7 parental education is measured in years. In Table 8 parental education is measured in levels, with illiterate/semiliterate being the omitted group. Table 7 shows significant gender disparities in birthweight (positive), education cost (positive), expected score (negative), and parental observation (negative). Table 8 shows a significant and positive gender gap in birthweight, and significant and negative gender gaps in expected education and parental observation. Recall that in Table 3 of Outcome Variables Summary Statistics, from the column of conditional gender difference estimates without the interaction between gender and maternal education, we saw statistically significant positive gender gaps in birthweight and breastfeeding duration, and statistically significant negative gender gaps in expected score and parental observation. It appears that the significance of the difference between boys and girls are most robust for birthweight and parental observation. Let's look at these outcomes one by one.

From Table 7 we see that maternal years of schooling significantly impacts on birthweight. Table 8 shows that the main effect of maternal education on birthweight is actually driven by those mothers who get a 4-year college degree. Additionally, maternal education does not narrow the gender gap in birthweight until 4-year college, and the magnitude of the estimate is huge. Children born in larger families weigh less on average at birth.

Mothers with more years of schooling tend to breastfeed their children for a shorter time. For example, if we only look at families with only one child, relative to illiterate or semiliterate mothers who breastfeed their young ones for 14.5 months on average, mothers with primary school education would nurse their children for 0.9 months shorter, and mother with junior middle school education would wean children 1.2 months earlier. This pattern is in contrast with patterns in UK, where more educated mothers breastfeed children for longer (McAndrew et al. (2012)). In either specification father's education does not seem to influence breastfeeding duration. Mothers from agricultural households breastfeed their children for longer.

The main effect of maternal education for expected score is insignificant at all levels except for mothers with a Master's degree. But we should be very cautious about this significance because there are only nine mothers in the sample with a Master's degree. The impact of paternal education on expected score is significant, although it does not show a monotonically increasing pattern, with the turning point being father Master's degree. Parents of more children are less demanding of children's test scores.

Table 7 shows that mothers with more years of schooling are likely to maintain higher expectations for their children's education. However, as can be seen from Table 8, the main effect of maternal education on expected education of children is not strictly monotonic. For instance, focusing on households with a single child, illiterate or semiliterate mothers on average expect children to get 15.8 years of education, which is slightly below 4-year college graduation. Mothers with primary school education would expect children to be educated for 0.57 years more, while mothers with junior middle school education would expect children to be educated for 0.51 years more. Most strikingly, mothers with a 4-year college degree on average expect children to be educated for 0.73 years less than illiterate or semiliterate mothers. Table 8 also shows that parents expect girls to get more education than boys. Moreover, relative illiterate or semiliterate mothers, mothers with primary school education or junior middle school education are even more ambitious about their girls education. Father's education significantly affect expected education of children. Furthermore, agricultural parents are not so ambitious about children's education as non-agricultural parents. Likewise, Parents of more children maintain lower expectations about their children' education in the future.

Turning to the education cost outcome, more educated mothers spend significantly more money on children's education. Moreover, Table 8 shows an apparent gradient in the main effect of mother's education level on children's education expense. It is very interesting that, while Table 7 shows a positive and significant main effect of gender, the interacting effect of gender and maternal years of schooling is negative and significant. What can be inferred from these estimates might be that, for a typical mother with $574/90 = 6.4$ years of education, there would be no difference in education cost between sons and daughters. For mothers with schooling more than 6.4 years, girls' education expense would exceed boys'. From Table 5, the average maternal schooling in sample is 8.2 years. This might explain why the raw gender difference in education spending is negative in Table 3 (though not significant) but the estimate of gender effect in Table 7 is positive and significant. Father's education significantly influence education cost. Agricultural parents spend less on children's education. Wealthier parents pay more for children's education. Parents of larger families pay less on average for each child's education.

Mothers with more years of schooling show more concern about children's education and they also tend to be more strict about children's daily behaviour. For the two factor outcome variables, parental care and parental observation, OLS estimates show very consistent patterns, regardless of whether education is measured in years or in levels. Girls are better behaved than boys in parents' eyes. This is true for mothers with all education levels except for those with a Master's degree, who perceive sons as much better behaved than daughters. However, as mentioned above, only a few mothers in sample have a Master's degree. Thus it is hard to decide if the positive and significant estimate of a huge magnitude reflect the true pattern or just appear entirely due to sampling error. Parents from agricultural households have a better impression about their children's behaviour than non-agricultural parents do. As parents get wealthier, they are likely to become less willing to sacrifice their own time, recreation, and energy for their children's study. On average, children from larger families get less attention of their parents for study and life.

In summary, the effect of maternal education interacting with gender seems to depend on how maternal education is measured. When measured in years, maternal education does not differentially influence sons and daughters, except for education cost. Yet when measured in levels, maternal education appears to narrow the positive gender gap in birthweight and to widen the negative gender gap in expected education. In the next subsection we will see if these results are driven by the potential endogeneity of maternal education.

## 6.2 Reduced Form and IV Estimates

Table 9 and Table 10 report the reduced form estimates for Maternal Years of Schooling, and Male*Maternal Years of Schooling, respectively. The reduced-form relationship between the dummy Post-reform and Maternal Years of Schooling, reported in Table 9 for each outcome, shows that mothers born in and after 1971 are educated more on average, compared to mothers born before 1971. The estimated coefficient on the dummy Post-reform ranges from 0.51 to 0.71 and is very precisely estimated. Additionally, higher educated women are very likely to marry higher educated men, as can be seen from the positive and significant coefficient estimates on Paternal Years of Schooling. Mothers from agricultural households tend to be less educated than mothers from non-agricultural households. Furthermore, mothers with more years of schooling are associated with higher family income and they tend to have less children. Finally, there is no evidence of a relationship between maternal years of schooling and either gender of child or the interaction between child' gender and the dummy for whether the mother is younger than 15 when the education reform takes place. It is also noteworthy that the reduced form results across seven outcomes are broadly similar, as they should be, because the outcome variable and the explanatory variables are the same in these regressions. Yet they could differ due to different observations used in these regressions.

Virtually all explanatory variables are highly significant in the reduced form regressions for Male*Maternal Years of Schooling, as reported in Table 10. This might happen as a result of the nature of the dependent variable, which equals Maternal Years of Schooling for sons, and is zero for daughters. Here too, the estimates should only differ due to sampling error.

Instrumental variables estimates are reported in Table 11. The estimation results should be compared with those reported in Table 7, where the coefficient estimates are obtained ignoring the potential endogeneity of Maternal Years of Schooling.

While OLS results show significant gender disparities in birthweight (160 grams), education cost (570 RMB), expected exam score (-1.6), and parental observation index (-0.3), instrumental variables method erases the significance of gender disparities in education cost, expected exam score, and parental observation index. Boys and girls do not behave differently any more in terms of school discipline and self-motivation, as perceived by their parents. The education expense covered by family does not seem to differ across gender. Instrumental variables estimates also suggest that parents maintain roughly the same expectation for boys' and girls' exam results.

Although the significance level of boy-girl difference in birthweight decreases, it is still significant at 10% and the magnitude of the estimate increases substantially to 420 grams. Gender gap in breastfeeding duration becomes significant at 5%. The estimate suggest that boys are on average breastfed for 7.4 months longer than girls. This difference is very large, given that the mean breastfeeding duration for boys and girls all together is only 11 months, as reported in Table 3, and that the raw and conditional gender difference is between 0.62 to 0.67 months.

Instrumental variables estimates show no evidence of the main effect of maternal years of schooling on the outcome variables, except for education cost paid by family. One more year of maternal schooling is associated with 645 RMB increase in child's education expenditure, though the estimate is merely marginally significant.

The coefficient on the interaction between gender of child and maternal years of schooling, which is the parameter of interest, is estimated to be insignificant for six out of seven outcomes. The interacting effect is only significant for breastfeeding duration, suggesting that as maternal years of schooling increases, the gender gap in breastfeeding duration narrows. For example, relative to primary school graduate mothers, mothers with a junior middle school qualification would breastfeed daughters for $0.86 * 3 = 2.58$ months longer.

Instrumental variables approach eliminates the significance of the effect of paternal years of schooling and household registration type. By contrast, every thousand RMB increase in per capita family income is associated with 40 RMB increase in child's education expenditure, which is slightly lower than the OLS estimate (50 RMB). The rest of the instrumental variables results show that wealthier parents tend to pay less attention to children's study and life. Additionally, children with more siblings weigh less on average at birth, and their parents' expectation for their exam scores are lower than that of parents with less children. These are consistent with OLS results but the estimates are with larger magnitude and less precision.

In short, while OLS estimates suggest that maternal education would narrow the positive gender gap in education cost, instrumental variables estimates indicate that mother's education would taper the positive gender gap in breastfeeding duration. However, the instrumental variables estimates are not very intuitive in the huge magnitude and hence must be treated with prudence.

# 7 A Control Function

A different approach for dealing with the endogeneity of maternal education is to break the correlation between maternal education and unobservable characteristics affecting the outcomes. This can be done by adding extra regressors to the structural equation (2).

The reduced-form equation (3) is dividing maternal education into two parts. The first part is the linear projection of maternal education onto all exogenous variables, including the dummy $postreform$ and the interaction between child's gender and $postreform$. The second part, $error_3$, is the component in maternal education that cannot be explained by the exogenous variables. This component in maternal education is the part that renders maternal education endogenous in the structural equation (2). In other words, endogeneity of maternal education arises if $error_3$ is correlated with $error_2$ in the structural equation. A similar argument applies to reduced-form equation (4). The endogeneity of the interaction between child's gender and maternal education stems from the correlation between the reduced-form error $error_4$ and the structural error $error_2$.

Therefore, if $error_3$ and $error_4$ could be incorporated in the structural model, the parts in maternal education and maternal education interacting with gender, which are suspected of being correlated with $error_2$, could be explicitly taken out and controlled for. And hence all parameters in the structural equation could be consistently estimated. However, the unobservability of $error_3$ and $error_4$ forces us to replace them with their estimates, i.e. the residuals from the reduced form regressions, in estimating the control function.

Although the control function estimators could be more precise than the two stage least squares estimators, they tend to be less robust. In addition to the standard two stage least squares assumptions, including zero expectation of the structural error conditional on all exogenous variables, and the partial correlation between each of the instrumental variables and the endogenous explanatory variable that they are instrumenting for, we have to impose two more assumptions, respectively, on the statistical relation between the reduced-form errors, the structural error, and the exogenous variables, and on the conditional distribution of the endogenous explanatory variables, for conducting the control function. Firstly, the structural error, $error_2$, and the reduced form errors, $error_3$ and $error_4$, should be independent of all exogenous variables (including the instrumental variables). Secondly, the expectation of the endogenous variables, i.e. maternal education and maternal education interacting with child's gender, conditional on all exogenous variables (including the instrumental variables), must be linear. Either of these assumptions is very restrictive and hard, if not impossible, to test. Nevertheless, it is still worth estimating a control function, not only because there are more than one endogenous explanatory variables in the structural model, but because of the nonlinearity of the interaction term as well.

The estimates from the control function are reported in Table 12. The last row, which reports the P-value from an F test of the joint significance of the reduced form residuals, gives us an idea of the likelihood of maternal years of schooling being simultaneously determined with the response variables in the structural equation (2). It shows that, apart from Breastfeeding Duration, where the reduced form residuals are jointly significant at 5%, maternal education does not seem to be endogenous in the structural equation for all other outcomes of children. The rest of the estimates of the control function are broadly similar to those obtained using the IV approach. If these results are valid, they are suggesting that an OLS estimation would be sufficient to capture the causal linkage from maternal years of schooling to the gender gaps in all outcome variables except Breastfeeding Duration, for which an IV method would be more suitable.

# 8 Conclusion

This paper seeks answer to the question of whether gender gap exists for Chinese children in neonatal health, as measured by birth weight, in postnatal investments in health inputs by parents, as measured by breastfeeding duration, and in parents' attitudes towards, and practices in children's education and family nurture, as measured by child's education cost paid by family, and a set of outcomes derived from questions answered by parents, which, though subjective, are capable of credibly reflecting parents' impression of children's talent and commitment, and their ambition and care about children's study and life.

If gender disparity exists in these outcomes, this study goes a step further to investigate if the difference across gender would be systematically influenced by maternal education. This question is of particular meaning in the context of China where the sex ratio at birth starts to be staggering since the 1980s, and a strong preference for sons is deeply embedded in its culture and society.

OLS results from China Family Panel Studies 2010, 2012, and 2014 show a significant son advantage in birth weight and education cost paid by family. The son advantage in birth weight could be driven by gender differences in prenatal investments in health care, or the genetic differences between boys and girls. On the other hand, OLS also indicates a female advantage in parents' expectation of children's exam results, and parents' beliefs of children's efforts and commitment. Higher maternal education is associated with narrower gender gap in education cost paid by family.

An instrumental variables approach, which utilises China's education reform, shows a strong son advantage in breastfeeding duration which is gradually tapered off with higher maternal years of schooling. Additionally, estimates from a control function suggest that maternal education does not seem to be jointly determined with children's outcomes except for breastfeeding duration. If these results are valid, it could be concluded that educating women in a society where males are traditionally believed to be superior to females has the effect of narrowing the gender gap in postnatal health investment and education investment of offspring.

However, the present study has the limitation that it does not account for the trending of maternal education. Additionally, it does not provide evidence about the underlying mechanisms driving these patterns. These inspire interesting directions for future research.

Table 2: Outcome Variables Description

| Outcome Variables | Survey Questions |
|---|---|
| Birth Weight | Your child's weight at birth (transformed into grams) |
| Breastfeeding Duration | How long has your child been breastfed since birth? (months) |
| Expected Score | What is the average score out of a total of 100 that you expect your child to obtain this/next semester? |
| Expected Education | What is the highest level of education |
| (Also measured in years) | you wish your child can complete? |
| No need to go to school (0 years) | No need to go to school |
| Illiterate/Semiliterate (3 years) | Illiterate/Semiliterate |
| Primary school (6 years) | Primary school |
| Middle school (9 years) | Middle school |
| High school (12 years) | High school |
| 2- or 3-year College (14 years) | 2- or 3-year College (14 years) |
| 4-year College/Bachelor's Degree (16 years) | 4-year College/Bachelor's Degree |
| Master's Degree (18 years) | Master's Degree |
| PhD (20 years) | PhD |
| Education Cost | The total cost of the child's education last year paid by your family. (in RMB yuan) |
| Parental Care | The following questions are related to your caring about your child's study and life: |
| (answers to these questions are rescaled | 1. Very often (5-7 times a week) |
| and summarised into a factor variable, | 2. Often (2-4 times a week) |
| and standardised such that it has | 3. Sometimes (Once a week) |
| a mean 0 and standard deviation 1 | 4. Rarely (Once a month) |
| in the sample, | 5. Never |
| and higher implies more parental caring) | a. How often did you give up watching TV to avoid disturbing your child when he/she was studying? |
| | b. How often did you discuss what happened at school with your child? |
| | c. How often did you ask the child to finish homework? |
| | d. How often did you check the child's homework? |
| | e. How often did you restrict or stop the child from watching TV? |
| | f. How often did you restrict types of TV programs the child could watch? |
| Parental Observation | The following questions are related to your daily observation of *** (child's name): |
| (answers to these questions are rescaled | 1. Totally agree |
| and summarised into a factor variable, | 2. Agree |
| and standardised such that it has | 3. Neither agree nor disagree |
| a mean 0 and standard deviation 1 | 4. Disagree |
| in the sample, | 5. Totally disagree |
| and higher implies better | a. This child studies very hard. |
| behaviour observed by parents) | b. When this child finishes his/her homework, he/she checks it to see if it is done correctly. |
| | c. This child plays only after he/she finishes homework. |
| | d. This child can concentrate during class-time. |
| | e. This child respects school disciplines. |
| | f. Once this child starts to do something, he/she will complete it no matter what happens. |
| | g. This child likes to keep all his/her school things in great order. |

*Notes*: All seven outcome variables are constructed from questions answered by parents.

Table 3: Outcome Variables Summary Statistics

| Outcome Variable | Mean | Girls' Mean | Boys' Mean | Raw Difference | Conditional Difference | Sample Size |
|---|---|---|---|---|---|---|
| Birth Weight | 3253.348 | 3181.400 | 3319.271 | 137.872<br>(.000) | 127.677<br>(.000) | 6830<br>(3236 girls, 3594 boys) |
| Breastfeeding Duration | 10.960 | 10.615 | 11.279 | .665<br>(.001) | .617<br>(.001) | 7617<br>(3628 girls, 3989 boys) |
| Expected Score | 91.153 | 92.052 | 90.300 | -1.752<br>(.000) | -1.813<br>(.000) | 5110<br>(2433 girls, 2677 boys) |
| Expected Education | 15.844 | 15.789 | 15.895 | .106<br>(.119) | .066<br>(.297) | 6738<br>(3206 girls, 3532 boys) |
| Education Cost | 2660.970 | 2727.364 | 2599.917 | -127.446<br>(.339) | -158.899<br>(.189) | 7800<br>(3716 girls, 4084 boys) |
| Parental Care | -.015 | -.022 | -.008 | .014<br>(.706) | .009<br>(.811) | 5110<br>(2433 girls, 2677 boys) |
| Parental Observation | -.030 | .107 | -.166 | -.267<br>(.000) | -.257<br>(.000) | 6421<br>(3029 girls, 3392 boys) |

*Notes*: Raw difference and conditional difference are (boys - girls). P-values are in parentheses beneath each estimate. The conditional difference regression controls for household registration type, parental education, per capita family income, number of children in family, birth year fixed effect, and interview year fixed effect. Birth weight is measured in grams, Breastfeeding Duration in months, Expected Score in percentages, Expected Education in years, Education Cost in RMB yuan. Parental Care and Parental Observation are standardised factor variables. Their means are not zero, possibly because the sampling weights are taken account of when the means are estimated. Sample size changes across variables. This is because when I restrict the sample, I keep those observations with nonmissing control variables and at least one nonmissing outcome variables.

Table 4: Explanatory Variables Description

| Explanatory Variables | Description |
|---|---|
| Male | = 1 if child is a boy |
| Age | = (interview year - birth year) |
| Agricultural | = 1 if child's current household registration type is agricultural |
| Mother's Education | 0. No need to go to school (0 years)<br>Illiterate/Semiliterate (3 years)<br>Primary school (6 years)<br>Middle school (9 years)<br>High school (12 years)<br>2- or 3-year College (14 years)<br>4-year College/Bachelor's Degree (16 years)<br>Master's Degree (18 years)<br>PhD (20 years) |
| Father's Education | Same as Mother's Education |
| Mother's Year of Birth | From which the main instrument is constructed |
| Family Income Per Capita | In thousands of RMB yuan |
| Number of Children in Family | The total number of children ever born to an adult with nonmissing Person ID |
| Han | Only focus on Han children |

Table 5: Explanatory Variables Summary Statistics

| Explanatory Variables | Mean | Girls' Mean | Boys' Mean | Difference |
|---|---|---|---|---|
| Age | 8.494 | 8.527 | 8.463 | -.065<br>(.696) |
| Agricultural | .754 | .755 | .753 | -.002<br>(.881) |
| Mother's Education | 8.232 | 8.253 | 8.213 | -.039<br>(.708) |
| Father's Education | 8.866 | 8.853 | 8.877 | .025<br>(.802) |
| Mother's Year of Birth | 1978.210 | 1978.175 | 1978.242 | .067<br>(.708) |
| Family Income Per Capita | 10.146 | 9.699 | 10.555 | .856<br>(.045) |
| Number of Children in Family | 1.785 | 1.869 | 1.709 | -.160<br>(.000) |

*Notes*: Difference = (boys - girls). P-values are in parentheses beneath each estimate. Mother's Education and Father's Education are measured in years.

Table 6: Parents' Year of Birth and Number of Observations

| Mother | | Father | |
|---|---|---|---|
| Birth Year | N | Birth Year | N |
| 1960 | 18 | 1960 | 14 |
| 1961 | 9 | 1961 | 23 |
| 1962 | 40 | 1962 | 61 |
| 1963 | 47 | 1963 | 94 |
| 1964 | 50 | 1964 | 90 |
| 1965 | 74 | 1965 | 135 |
| 1966 | 106 | 1966 | 145 |
| 1967 | 136 | 1967 | 173 |
| 1968 | 206 | 1968 | 312 |
| 1969 | 200 | 1969 | 270 |
| 1970 | 317 | 1970 | 335 |
| 1971 | 353 | 1971 | 429 |
| 1972 | 352 | 1972 | 475 |
| 1973 | 427 | 1973 | 491 |
| 1974 | 449 | 1974 | 382 |
| 1975 | 339 | 1975 | 382 |
| 1976 | 410 | 1976 | 388 |
| 1977 | 363 | 1977 | 346 |
| 1978 | 392 | 1978 | 390 |
| 1979 | 366 | 1979 | 374 |
| 1980 | 334 | 1980 | 308 |
| 1981 | 318 | 1981 | 291 |
| 1982 | 323 | 1982 | 357 |
| 1983 | 368 | 1983 | 280 |
| 1984 | 305 | 1984 | 255 |
| 1985 | 294 | 1985 | 232 |
| 1986 | 263 | 1986 | 216 |
| 1987 | 292 | 1987 | 217 |
| 1988 | 249 | 1988 | 131 |
| 1989 | 196 | 1989 | 115 |
| 1990 | 162 | 1990 | 65 |

*Notes*: Parents born earlier than 1960 or later than 1990 are not listed.

Table 7: OLS Estimates Part A

| | Birth Weight | Breastfeeding Duration | Expected Score | Expected Education | Education Cost | Parental Care | Parental Observation |
|---|---|---|---|---|---|---|---|
| Male | 161.098*** | -.016 | -1.60** | -.061 | 573.628* | -.032 | -.297*** |
| | (43.642) | (.529) | (.731) | (.209) | (347.471) | (.107) | (.080) |
| Maternal Years of Schooling | 7.802* | -.190*** | -.023 | .043* | 163.277*** | .033*** | -.019** |
| | (4.427) | (.054) | (.079) | (.022) | (47.484) | (.009) | (.009) |
| Male*Maternal Years of Schooling | -3.960 | .708 | -.028 | .015 | -89.660* | .005 | .005 |
| | (5.426) | (.061) | (.078) | (.022) | (50.183) | (.012) | (.010) |
| Paternal Years of Schooling | 2.277 | -.040 | .163** | .083*** | 111.105*** | .015 | .001 |
| | (3.899) | (.048) | (.073) | (.019) | (34.161) | (.010) | (.008) |
| Agricultural Household | 8.385 | .830** | .501 | -.344** | -847.547*** | -.079 | .108** |
| | (26.719) | (.412) | (.499) | (.135) | (208.462) | (.059) | (.050) |
| Per Capita Family Income | .261 | -.018 | -.014 | -.002 | 50.139*** | -.006*** | -.003 |
| | (.569) | (.013) | (.014) | (.002) | (5.512) | (.002) | (.002) |
| Number of Children in Family | -62.144*** | -.206 | -.789*** | -.221*** | -408.656*** | -.134*** | .025 |
| | (14.159) | (.197) | (.241) | (.075) | (86.166) | (.025) | (.021) |
| Constant | 3078.782*** | 15.162*** | 89.747*** | 15.756*** | 784.960 | -.231 | .081 |
| | (71.926) | (1.107) | (1.342) | (.349) | (526.056) | (.173) | (.141) |
| Sample Size | 6,830 | 7,617 | 5,110 | 6,738 | 7,800 | 5,110 | 6,421 |
| R-squared | .0393 | .0766 | .0701 | .0739 | .1832 | .1147 | .0395 |

*Notes*: Variables in the top row are outcome variables. Variables in the left column are explanatory variables, sample size, and R-squared from the regressions. * denotes significant at 10%, ** significant at 5%, ***significant at 1%. Linearised standard errors are in parentheses beneath each estimate.

Table 8: OLS Estimates Part B

| | Birth Weight | Breastfeeding Duration | Expected Score | Expected Education | Education Cost | Parental Care | Parental Observation |
|---|---|---|---|---|---|---|---|
| Male | 122.050*** | -.058 | -1.001 | -.517** | 169.008 | .067 | -.228*** |
| | (40.775) | (.536) | (.741) | (.206) | (174.469) | (.098) | (.072) |
| Mother Primary School | -6.292 | -.913* | .632 | .574** | 205.749 | .118 | .023 |
| | (41.916) | (.515) | (.785) | (.224) | (190.250) | (.077) | (.078) |
| Mother Junior Middle School | 45.660 | -1.233** | .207 | .514** | 658.009*** | .301*** | -.050 |
| | (39.823) | (.518) | (.728) | (.243) | (192.586) | (.074) | (.069) |
| Mother Senior Middle School | 3.578 | -2.146*** | .156 | .633*** | 980.812*** | .428*** | -.198* |
| | (51.346) | (.588) | (.832) | (.227) | (293.192) | (.092) | (.113) |
| Mother 2-/3-year College | 29.100 | -2.768*** | -.046 | .550* | 2028.504** | .145 | -.188 |
| | (67.037) | (.887) | (1.141) | (.316) | (978.936) | (.134) | (.121) |
| Mother 4-year College | 186.880*** | -1.052 | -.886 | -.730** | 2221.769** | .472*** | .014 |
| | (91.117) | (.887) | (1.245) | (.340) | (1103.984) | (.151) | (.165) |
| Mother Master | -106.805 | -2.875 | -2.530** | .559 | 5713.888 | -1.879*** | -1.000*** |
| | (94.771) | (1.815) | (1.141) | (.427) | (9972.697) | (.236) | (.243) |
| Male*Mother Primary School | 6.222 | .704 | -1.263 | -.908*** | -95.621 | -.118 | -.074 |
| | (51.095) | (.635) | (.965) | (.268) | (243.389) | (.120) | (.102) |
| Male*Mother Junior Middle School | 17.208 | .739 | -.988 | -.440* | -482.449** | -.063 | -.039 |
| | (49.141) | (.609) | (.863) | (.240) | (214.449) | (.106) | (.096) |
| Male*Mother Senior Middle School | 17.834 | .693 | -.629 | -.183 | 45.471 | -.216 | .058 |
| | (62.963) | (.718) | (.963) | (.270) | (490.203) | (.137) | (.121) |
| Male*Mother 2-/3-year College | 17.611 | 2.316** | -.654 | -.293 | -1190.280 | .380** | .019 |
| | (73.724) | (1.023) | (1.338) | (.381) | (994.939) | (.189) | (.166) |
| Male*Mother 4-year College | -206.732* | -1.070 | .503 | -.360 | -1845.427 | -.197 | -.189 |
| | (111.277) | (1.079) | (1.440) | (.384) | (1414.083) | (.248) | (.194) |
| Male*Mother Master | -46.707 | 9.492*** | 7.899*** | .318 | -17342.220 | 2.831*** | 3.802** |
| | (150.367) | (3.195) | (2.680) | (.567) | (10844.36) | (.243) | (1.63) |
| Father Primary School | 100.414*** | -.121 | 1.709** | .085 | 285.309** | .141 | .052 |
| | (36.227) | (.419) | (.708) | (.186) | (140.199) | (.089) | (.065) |
| Father Junior Middle School | 92.276** | .094 | 1.553** | .400** | 615.009*** | .218*** | .032 |
| | (41.811) | (.502) | (.675) | (.189) | (180.038) | (.076) | (.074) |
| Father Senior Middle School | 58.871 | -.606 | 1.763** | .636*** | 644.867*** | .148 | -.002 |
| | (47.365) | (.552) | (.835) | (.227) | (235.949) | (.096) | (.089) |
| Father 2-/3-year College | 81.844 | -.606 | 3.373*** | .936*** | 1113.279** | .278** | .110 |
| | (54.091) | (.689) | (.922) | (.213) | (435.176) | (.134) | (.109) |
| Father 4-year College | 138.014** | -.206 | 3.194*** | .933*** | 1690.733 | .142 | .076 |
| | (62.119) | (.812) | (.891) | (.271) | (1026.686) | (.177) | (.137) |
| Father Master | 67.028 | 1.300 | -6.874*** | 1.065* | 11352.890** | -.022 | .738*** |
| | (180.220) | (2.384) | ( 2.629) | (.635) | (5391.336) | (.165) | (.267) |
| Father PhD | 252.132** | .584 | -.724 | 1.532*** | 10153.460*** | .763*** | -.904*** |
| | (99.411) | (1.200) | (1.530) | (.525) | (903.238) | (.270) | (.193) |
| Agricultural Household | -2.596 | .761* | .483 | -.342** | -781.122*** | -.111* | .098* |
| | (27.204) | (.405) | (.502) | (.133) | (212.706) | (.061) | (.055) |
| Per Capita Family Income | .435 | -.027** | -.016 | -.002 | 49.243*** | -.005*** | -.006*** |
| | (.513) | (.011) | (.016) | (.003) | (6.064) | (.002) | (.002) |
| Number of Children in Family | -62.233*** | -.230 | -.796*** | -.220*** | -419.012*** | -.133*** | .020 |
| | (14.129) | (.195) | (.248) | (.075) | (84.262) | (.025) | (.021) |
| Constant | 3063.195*** | 14.707*** | 89.128*** | 15.992*** | 1917.827*** | -.213* | -.012 |
| | (68.048) | (1.047) | (1.351) | (.349) | (347.712) | (.126) | (.127) |
| Sample Size | 6,830 | 7,617 | 5,110 | 6,738 | 7,800 | 5,110 | 6,421 |
| R-squared | .0454 | .0818 | .0751 | .0789 | .1979 | .1305 | .0451 |

*Notes*: Variables in the top row are outcome variables. Variables in the left column are explanatory variables, sample size, and R-squared from the regressions. The omitted group for parental education levels is illiterate/semiliterate. * denotes significant at 10%, ** significant at 5%, ***significant at 1%. Linearised standard errors are in parentheses beneath each estimate.

Table 9: Reduced Form Regression for Maternal Years of Schooling

| | Reduced Form Regressor: Maternal Years of Schooling | | | | | | |
|---|---|---|---|---|---|---|---|
| 2nd Stage Regressor: | Birth Weight | Breastfeeding Duration | Expected Score | Expected Education | Education Cost | Parental Care | Parental Observation |
| Post-reform | .580*** | .573*** | .510*** | .705*** | .573*** | .514*** | .515*** |
| | (.168) | (.161) | (.175) | (.194) | (.157) | (.174) | (.171) |
| Male* Post-reform | -.114 | -.116 | -.135 | -.255 | -.118 | -.137 | -.114 |
| | (.197) | (.188) | (.207) | (.222) | (.179) | (.207) | (.196) |
| Male | -.091 | -.113 | -.116 | .034 | -.083 | -.122 | -.125 |
| | (.193) | (.173) | (.186) | (.212) | (.166) | (.186) | (.181) |
| Paternal Years of Schooling | .424*** | .419*** | .389*** | .411*** | .425*** | .387*** | .409*** |
| | (.021) | (.021) | (.023) | (.022) | (.020) | (.023) | (.021) |
| Agricultural Household | -1.582*** | -1.613*** | -1.821*** | -1.585*** | -1.610*** | -1.824*** | -1.773*** |
| | (.135) | (.128) | (.138) | (.143) | (.126) | (.138) | (.134) |
| Per Capita Family Income | .020** | .020** | .036*** | .021** | .020** | .036*** | .018** |
| | (.008) | (.008) | (.007) | (.009) | (.008) | (.007) | (.008) |
| Number of Children in Family | -.691*** | -.707*** | -.654*** | -.708*** | -.708*** | -.654*** | -.691*** |
| | (.084) | (.075) | (.081) | (.085) | (.076) | (.081) | (.080) |
| Constant | 5.859*** | 5.934*** | 6.187*** | 7.053*** | 5.866*** | 6.238*** | 6.176*** |
| | (.333) | (.314) | (.345) | (.543) | (.315) | (.339) | (.330) |
| Sample Size | 6,830 | 7,617 | 5,110 | 6,738 | 7,800 | 5,110 | 6,421 |
| R-squared | .4536 | .4604 | .4462 | .4504 | .4638 | .4463 | .4465 |

*Notes*: Variables in the second row are 2nd-stage outcome variables. Variables in the left column are explanatory variables, sample size, and R-squared from the reduced form regressions. * denotes significant at 10%, ** significant at 5%, ***significant at 1%. Linearised standard errors are in parentheses beneath each estimate.

Table 10: Reduced Form Regression for Male*Maternal Years of Schooling

| | Reduced Form Regressor: Male*Maternal Years of Schooling | | | | | | |
|---|---|---|---|---|---|---|---|
| 2nd Stage Regressor: | Birth Weight | Breastfeeding Duration | Expected Score | Expected Education | Education Cost | Parental Care | Parental Observation |
| Post-reform | -.475*** | -.511*** | -.252*** | -.596*** | -.545*** | -.245*** | -.353*** |
| | (.092) | (.087) | (.087) | (.086) | (.086) | (.086) | (.086) |
| Male* | 1.594*** | 1.659*** | 1.121*** | 1.769*** | 1.704*** | 1.121*** | 1.318*** |
| Post-reform | (.209) | (.196) | (.212) | (.214) | (.189) | (.211) | (.197) |
| Male | 6.943*** | 6.640*** | 6.718*** | 6.643*** | 6.649*** | 6.725*** | 6.758*** |
| | (.235) | (.214) | (.227) | (.226) | (.211) | (.226) | (.220) |
| Paternal Years | .210*** | .202*** | .181*** | .203*** | .208*** | .181*** | .196*** |
| of Schooling | (.014) | (.014) | (.018) | (.015) | (.013) | (.018) | (.014) |
| Agricultural | -.847*** | -.836*** | -1.017*** | -.832*** | -.848*** | -1.014*** | -.913*** |
| Household | (.105) | (.097) | (.115) | (.116) | (.099) | (.113) | (.106) |
| Per Capita | .016*** | .016*** | .023*** | .017*** | .016*** | .023*** | .014*** |
| Family Income | (.004) | (.004) | (.005) | (.005) | (.004) | (.005) | (.003) |
| Number of Children | -.272*** | -.288*** | -.247*** | -.276*** | -.296*** | -.249*** | -.271*** |
| in Family | (.051) | (.045) | (.049) | (.054) | (.045) | (.050) | (.049) |
| Constant | -.652*** | -.466** | -.266 | .351 | -.485** | -.265 | -.386 |
| | (.251) | (.233) | (.265) | (.416) | (.233) | (.258) | (.248) |
| Sample Size | 6,830 | 7,617 | 5,110 | 6,738 | 7,800 | 5,110 | 6,421 |
| R-squared | .8173 | .8093 | .7895 | .8137 | .8104 | .7900 | .8006 |

*Notes*: Variables in the second row are 2nd-stage outcome variables. Variables in the left column are explanatory variables, sample size, and R-squared from the reduced form regressions. * denotes significant at 10%, ** significant at 5%, ***significant at 1%. Linearised standard errors are in parentheses beneath each estimate.

Table 11: IV Estimates

| | Birth Weight | Breastfeeding Duration | Expected Score | Expected Education | Education Cost | Parental Care | Parental Observation |
|---|---|---|---|---|---|---|---|
| Male | 423.228* | 7.437** | 1.876 | .372 | 1957.906 | .474 | -.206 |
| | (245.107) | (3.152) | (5.141) | (1.402) | (1411.667) | (.621) | (.490) |
| Maternal Years of Schooling | -33.561 | -.401 | -.544 | .198 | 644.971* | .166 | -.093 |
| | (57.064) | (.763) | (.841) | (.202) | (343.660) | (.135) | (.110) |
| Male*Maternal Years of Schooling | -36.425 | -.855** | -.502 | -.034 | -249.304 | -.057 | -.009 |
| | (29.031) | (.386) | (.673) | (.169) | (173.993) | (.080) | (.062) |
| Paternal Years of Schooling | 26.712 | .237 | .453 | .029 | -61.780 | -.026 | .034 |
| | (24.364) | (.341) | (.300) | (.099) | (150.923) | (.051) | (.045) |
| Agricultural Household | -85.014 | -.305 | -.929 | -.140 | -213.038 | .099 | -.036 |
| | (96.247) | (1.293) | (1.435) | (.369) | (606.019) | (.231) | (.197) |
| Per Capita Family Income | 1.591 | .000 | .016 | -.004 | 42.858*** | -.009* | -.001 |
| | (1.488) | (.017) | (.032) | (.006) | (9.516) | (.005) | (.002) |
| Number of Children in Family | -101.289** | -.659 | -1.282** | -.122 | -106.715 | -.061 | -.033 |
| | (45.041) | (.619) | (.581) | (.193) | (262.879) | (.100) | (.080) |
| Constant | 3296.833*** | 15.562*** | 92.885*** | 14.045*** | -2359.729 | -1.132 | .552 |
| | (360.871) | (4.831) | (5.672) | (1.607) | (2196.434) | (.914) | (.730) |
| Sample Size | 6,830 | 7,617 | 5,110 | 6,738 | 7,800 | 5,110 | 6,421 |
| R-squared | Negative | Negative | .0137 | .0550 | .1297 | .0419 | Negative |

*Notes*: Variables in the top row are outcome variables. Variables in the left column are explanatory variables, sample size, and R-squared from the regressions. * denotes significant at 10%, ** significant at 5%, ***significant at 1%. Linearised standard errors are in parentheses beneath each estimate.

Table 12: Control Function Estimates

| | Birth Weight | Breastfeeding Duration | Expected Score | Expected Education | Education Cost | Parental Care | Parental Observation |
|---|---|---|---|---|---|---|---|
| Male | 397.901* | 7.185*** | .703 | .465 | 1928.791 | .332 | -.227 |
| | (205.219) | (2.640) | (3.357) | (1.423) | (1275.415) | (.403) | (.378) |
| Maternal Years of Schooling | -37.300 | -.456 | -.583 | .226 | 644.423** | .136 | -.088 |
| | (55.151) | (.760) | (.685) | (.230) | (322.671) | (.111) | (.094) |
| Male*Maternal Years of Schooling | -34.021 | -.814** | -.328 | -.045 | -245.170 | -.038 | -.005 |
| | (24.860) | (.322) | (.419) | (.171) | (159.041) | (.049) | (.046) |
| Paternal Years of Schooling | 27.629 | .256 | .464* | .017 | -61.678 | -.020 | .033 |
| | (23.242) | (.337) | (.279) | (.110) | (142.979) | (.048) | (.041) |
| Agricultural Household | -89.593 | -.371 | -.646 | -.104 | -219.265 | .047 | -.010 |
| | (93.223) | (1.249) | (1.132) | (.402) | (593.622) | (.175) | (.159) |
| Per Capita Family Income | 1.696 | .002 | .002 | -.004 | 42.746*** | -.007*** | -.001 |
| | (1.268) | (.020) | (.021) | (.006) | (9.405) | (.003) | (.003) |
| Number of Children in Family | -104.883** | -.695 | -1.312** | -.106 | -104.736 | -.072 | -.030 |
| | (44.325) | (.605) | (.559) | (.207) | (247.218) | (.092) | (.073) |
| $err\hat{o}r_3$ | 44.850 | .252 | .558 | -.185 | -486.172 | -.104 | .069 |
| | (55.077) | (.757) | (.686) | (.235) | (326.071) | (.112) | (.093) |
| $err\hat{o}r_4$ | 30.988 | .925*** | .311 | .062 | 161.684 | .045 | .011 |
| | (25.225) | (.330) | (.422) | (.172) | (160.347) | (.049) | (.046) |
| Constant | 3325.448*** | 15.872*** | 92.925*** | 14.528*** | -2351.528 | -.909 | .497 |
| | (349.738) | (4.754) | (4.567) | (1.491) | (2037.461) | (.707) | (.603) |
| Sample Size | 6,830 | 7,617 | 5,110 | 6,738 | 7,800 | 5,110 | 6,421 |
| R-squared | .0399 | .0787 | .0705 | .0740 | .1836 | .1153 | .0396 |
| Joint Significance $err\hat{o}r_3$ $err\hat{o}r_4$ | .2898 | .0189 | .4419 | .6894 | .1933 | .4984 | .7245 |

*Notes*: Variables in the top row are outcome variables. Variables in the left column are explanatory variables, sample size, and R-squared from the regressions, plus the p-value from an F test of the joint significance of $err\hat{o}r_3$ and $err\hat{o}r_4$. * denotes significant at 10%, ** significant at 5%, ***significant at 1%. Linearised standard errors are in parentheses beneath each estimate.

# Chapter 3

## Son Preference, Family Planning Policy, and Breastfeeding Patterns: Evidence from China

*Abstract:* The biological constraint binding the length of breastfeeding and a mother's likelihood of subsequent pregnancy indicates that breastfeeding increases with birth order, that boys are breastfed more than girls if parents have a preference for sons, and that the son advantage in breastfeeding is most significant amongst children in middle parity.

Chinese parents have a deep preference for sons. Historically Chinese couples keep having children until they reach the desired number of sons. However, Family Planning Policy, which restricts the fertility of Chinese Han couples from the late 1970s to 2015, prevents Han couples from having as many children as they want.

The present study exploit the fact that Family Planning Policy only applies to Han people but that ethnic minority couples' fertility is not affected, to investigate how breastfeeding patterns with respect to gender and birth order differ across ethnic background. And, if the identification is clean enough, the difference (if there is) could be reasonably attributed to the Family Planning Policy.

Empirical results indicate that legal control for family fertility greatly restrains breastfeeding for children in low parities, especially for girls, and exacerbate the gender gap in middle parity by 2.5 months. These effects are most remarkable among large families.

# 1 Introduction

Breastfeeding is the ideal feeding method for both infants and young children beyond infancy. Breastmilk provides all nutrients that infants need for health growth and development up to six months of age. After the age of exclusive breastfeeding, partially breastfed children continue to benefit from the immunological feature of breastmilk, which lowers the risk of water- and food-borne diseases.

Although breastfeeding benefits a child in so many ways, it temporarily lowers a mother's fecundity. Based on the negative association between breastfeeding duration and mother's subsequent fertility, Jayachandran and Kuziemko (2011) provides a formal model predicting how breastfeeding duration varies with gender and birth order in the presence of son preference.

Firstly, the biological constraint binding the length of breastfeeding and a mother's likelihood of subsequent pregnancy indicates that, as birth order increases and mothers' demand for contraception grows, they would be willing to breastfeed longer to suppress fertility. Therefore, breastfeeding is expected to increase with birth order.

Secondly, if parents have a preference for sons, then boys are breastfed more than girls. After the birth of a girl, parents are more likely to continue having children. Thus mothers limit breastfeeding for the newborn girl and try to conceive again.

Thirdly, the son advantage in breastfeeding is expected to be most significant amongst children in middle parity (i.e. birth order). For children in low parity, mothers would want to continue having children regardless of the sex of their children and thus breastfeed boys and girls equally (short). For children in high parity, mothers would want to stop having children regardless of the sex of their children and thus breastfeed boys and girls equally (long).

Following these predictions, the present study examines how these patterns would change when parents' fertility is legally constrained. Chinese parents have a deep preference for sons. Historically Chinese couples keep having children until they reach the desired number of sons. However, Family Planning Policy, which restricts the fertility of Chinese Han couples from the late 1970s to 2015, prevents Han couples from having as many children as they want.

The present study exploits the fact that Family Planning Policy only applies to Han people but that ethnic minority couples' fertility is not affected, to investigate how breastfeeding patterns with respect to gender and birth order differs across ethnic background. And, if the identification is clean enough, the difference (if there is) could be reasonably attributed to the Family Planning Policy.

Empirical results indicate that legal control for family fertility greatly restrains breastfeeding for children in low parities, especially for girls, and exacerbate the gender gap in middle parity by 2.5 months. These effects are most remarkable among large families.

The remainder of the paper is organised as follows. Section 2 discusses the institutional background. Section 3 describes the conceptual framework. Section 4 summarises the data. Section 5 examines the association between breastfeeding and birth order. Section 6 investigates the gender effects on breastfeeding. Section 7 looks at the pattern of breastfeeding duration with respect to gender and birth order. Section 8 provides concluding remarks.

# 2 Institutional Background

## 2.1 Family Planning Policy

Beginning in 1970, after two decades of explicitly encouraging couples to have as many children as possible, policy makers in China enacted a series of measures to curb population growth. These measures were only enforced on individuals of Han ethnicity, who comprise 92% of China's population. Han couples were encouraged to marry at later ages, space the birth of their children further apart, and have fewer children. Although fertility rate started to decline, the pressure of the surging population and increasing demand for water and other resources still existed. The Family Planning Policy, which was first known as One Child Policy, was officially adopted in 1979. Han couples were only allowed to have one child. Second births were forbidden except under very special circumstances. Local authorities were given economic incentives to suppress fertility rates. The Family Planning Policy was enforced through financial penalties, forced abortions and forced sterilisation of women. Women who refuse abortion or sterilisation procedures were in risk of losing their jobs and their children could lose access to education or health services. Reports of female infanticide started to be widespread in the early 1980s.

To curb the tragedy of female infanticide and to better address the variety of local conditions, second child permission was announced by the Central Party Committee in 1984 and regional variation in enforcement of Family Planning Policy was allowed. Rural couples (those with agricultural household registration) whose first child was a girl were permitted to have a second child. This is usually referred to as the "One Son Two Children" policy. If the second child turned out to be female again, couples would not allowed to have more children. However, some rural couples managed to hide the baby girl and try another pregnancy.

## 2.2 Son Preference

Son preference is an old characteristic of the Chinese society. Male superiority is deeply embedded in Chinese culture, which emphasises a strictly patrilineal family structure. It is not worth investing in daughters' health or education. Because once they get married, they become members of her husband's family. Maintaining the lineage through male offspring is so important that historically, if a man does not have any sons, he may adopt one or take another wife to achieve his objective.

Child-bearing and child-rearing behaviour in China is profoundly influenced by son preference. Historically, parents stop having children only when the desired number of sons is reached. The situation, however, is dramatically altered by China's Family Planning Policy, which is enacted in 1979. The Family Planning Policy, in essence, is a stringent birth control policy. By placing a legal limit on family size, couples are prevented from having multiple children to ensure the birth of desired number of sons.

As investigated by Fred and Liu (1986), son preference is prevalent in ethnic minority households as well. There are 55 minor ethnicities in China. Although the Tibetans, Mongolians, and the Yi minority exhibit different sex preference for children than Han people, the majority of minor ethnicities exhibit a preference for sons. For example, the Manchu minority even has a stronger son preference than the Han people.

Male-preferring parents react to the Family Planning Policy by sex-selection practices. These are conducted either prenatally, through aborting foetuses of unwanted sex, or postnatally, through female infanticide, neglecting baby girls, or allocating household resources preferentially to sons.

### 2.3 Prenatal Sex Selection

An important form of prenatal sex selection is sex-selective abortion, i.e. terminating pregnancies of daughters. Sex-selective abortion hinges on access to prenatal sex determination technologies. The affordability and easy access of ultrasound makes it the most frequently utilised prenatal sex determination technology in China.

In the early 1980s, a considerable quantity of imported and domestically-made ultrasound machines was introduced to hospitals and clinics around China.

Concurrent with the surging access to ultrasound technology, China witnessed an unprecedented rise in the sex ratio at birth in the 1980s. In 1989, realising the tragic consequences of unbalanced sex ratio in the long run, Chinese government outlawed foetal sex determination for non-medical purposes. The regulation proved ineffective in practice. Additionally, the misuse of ultrasound technology was aggravated by the Family Planning Policy. Local authorities were pressed to maintain a low fertility rate. They were motivated to overlook sex-selective abortions rather than stopping them.

Under the One Son Two Children policy, rural couples were allowed to have a second child if the firstborn was a girl. The second pregnancy, which was the last chance to have a son, was the parity in which sex-selective abortion was most likely to be performed.

## 3 Conceptual Framework

The duration of breastfeeding negatively correlates with the mother's likelihood of subsequent birth. There are two mechanisms underlying this relationship. Firstly, breastfeeding temporarily lowers a mother's fecundity. Secondly, women typically wean a child if they become pregnant again.

The conceptual framework in the present study follows Jayachandran and Kuziemko (2011), who develop a model of fertility decisions that synthesises this negative correlation between breastfeeding duration and subsequent conception, and son-preferring stopping fertility rule, provide several predictions regarding breastfeeding duration with respect to child's gender and birth order, and empirically test these predictions using data from the Indian National Family Health Survey.

### 3.1 Birth Order

Breastfeeding increases with birth order. As mothers reach their ideal family size, their demand for contraception grows. They either breastfeed longer to suppress fertility, or use other forms of birth control that would allow them to continue breastfeeding without being interrupted by another pregnancy. For the same reasons, breastfeeding increases discretely once women reach their ideal family size.

The present study lacks information about women's ideal family size. However, because family fertility is legally constrained, the concept of "ideal" family size is not very important here. Nevertheless, in the context of family planning program, the ideal family size might be defined as the total number of children born to a mother once she gets a son.

### 3.2 Gender

If parents have a preference for sons, then boys are breastfed more than girls. After the birth of a girl, parents are more likely to continue having children and thus limiting breastfeeding to try for a boy. Results from data show that sons are breastfed 0.9 months longer than daughters.

Although the present study is not capable of demonstrating this formally, it can be speculated that the gender gap in breastfeeding among Han families could be even more striking.

### 3.3 Gender and Birth Order

The gender effect is smallest for high and low values of birth order. For low birth order children, mothers will want to continue having children regardless of the sex of their children and thus breastfeed boys and girls equally short. For high birth order children, mothers will want to stop having children regardless the sex of their children and thus breastfeed boys and girls equally long. The peak gender effect for the population should occur at a birth order somewhere between the average ideal family size and the average realised family size. For birth order values in this range, a mother's joint decision about breastfeeding and further childbearing is highly marginal and thus most dependent on considerations such as children sex composition.

Empirical results from the Indian National Family Health Survey indicate that the son advantage peaks around a birth order value of four and displays a discrete jump when mothers reach their ideal family size. The average ideal family size is 2.7 in the sample and the average realised family size is about 4.

Parents valuing sons' health more than daughters' health is not the main explanation for these results. Estimates show that about two-thirds of the son advantage in breastfeeding is due to the value parents place on having future sons. Intuitively, this should also apply to Chinese Han families. Unlike average Indian families, the ideal family size for Chinese Han people is likely to be larger than the realised family size, and the family size which is ideal for a couple is closely related to the gender composition of their current children, as well as the gender of the next pregnancy. For example, for couples governed by the One Son Two Children policy, if their firstborn is a boy, then the ideal family size should be one. If their firstborn is a girl, then the ideal family size should at least be two, although the legal family size is at most two.

# 4 Data

The data used in the present study are from the 2010, 2012, and 2014 China Family Panel Studies (CFPS). Following the same set of households across waves, CFPS contains a nationally representative sample of Chinese communities, families, and individuals. 25 provincial level regions, which accommodating 95% of Chinese population, are covered by the CFPS sample. CFPS consists of five questionnaires, namely Community, Family, Family Roster, Child, and Adult, and five datasets accordingly. It contains rich information on the demographic and socioeconomic aspects of Chinese households. It is designed to be comparable to the Panel Study of Income Dynamics (PSID) in the United States.

The main advantage of the CFPS data for the present study is that, in the Child questionnaire, parents are asked, for each child, how long (in months) the child has been breastfed since birth. In the 2012 and 2014 wave, parents are also asked whether the child is still being breastfed. Furthermore, in the Family Roster questionnaire, each adult (those aged 16 or older) is asked about the gender, birth year, birth month, and whether the child is still alive of all children ever born to that adult. From these information I can calculate, for each child, the birth order in his/her family, total number of children in the family, the gender and birth order of all the child's siblings, and whether the child is a singleton birth.

Individuals under age 15 (included) are included in the Child dataset. The 2010, 2012 and 2014 Child dataset contain different observations, because some individuals who defined by CFPS as children in earlier waves grow up in later wave(s) so they go on to be included in the Adult dataset, also because there are newly born children between waves and they are observed only in later wave(s). Children who are aged between 0 and 15 in more than one wave are observed more than once in the pooled 2010, 2012, and 2014 dataset. To minimise the influence of missing values and to increase the valid sample size, for children observed more than once, if some of his/her variables are missing in one wave but nonmissing in another wave, I copy the values of these variables in the observation for which these variables are nonmissing to the observation for which these variables are missing.

As above-mentioned, parents are not asked about whether child is still being breastfed in the 2010 wave. As older children are more likely to be weaned, only the most recent observation is kept if the same child is observed in more than one wave, so that every child appears once in the pooled sample.

After pooling together three waves' data and imputing values of some of the missing variables, I dropped children who are still being breastfed, for whom the outcome variable breastfeeding duration is censored, and children who are from multiple births, for whom the definition of birth order is ambiguous. Also dropped are children from families with 4 or more children, which is the 95th percentile of family size. Finally, only children with full information of breastfeeding duration, birth year, ethnic background, household registration type, mother's education, and mother's birth year are kept. These contain 8892 children who are all alive when the interview is conducted.

Table 1 summarises the outcome variable breastfeeding duration, and some of the child's characteristics, mother's characteristics, and family characteristics, separately for each birth order, ethnic category, and gender. Of these characteristics, birth order, gender, and ethnic category are the main explanatory variables. Child's household registration type, mother's years of schooling, mother's age at child's birth, and family size are control variables.

The ethnic category, Han, serves as an indicator for whether child's family is affected by the Family Planning Policy. 11.25% of the children in final sample (1000 out of 8892) are from ethnic minority families, which are not affected by the family planning policy. This seemingly small proportion is actually higher than the national average, According to the 2010 census, 8.40% of individuals (of all ages) are classified as ethnic minorities in China.

Children of higher birth order, those of ethnic minority, and boys are breastfed for longer. Higher-order births are more likely to happen in agricultural households. 89% of ethnic minority children are from agricultural households, comparing to 77% of Han children. Boys are slightly more likely to be from agricultural households than girls. Mother's education is monotonically decreasing with parity (i.e. birth order). Han mothers are more educated than ethnic minority mothers. As is consistent with intuition, both mother's age at child's birth and mother's age are strictly increasing in birth order.

69% of Han children are the youngest child in family, as compared to 62% of ethnic minority children. As predicted by the male-preferring stopping fertility rule, boys are substantially more likely to be the youngest child in family than girls (76% vs. 60%). The average family size is larger for ethnic minority children, who are not governed by the Family Planning Policy, and girls, as is consistent with the theoretical finding by Yamaguchi (1989) which predicts that if couples continue to have children until they have the desired number of sons, girls will on average have a larger number of siblings.

About half of the children in sample are from 2-child families. Relative to 37% of boys who are the only child in family, only 32% of girls are the only child in family. This might reflect the fact that, following the birth of a girl, parents are eager to try again to have a boy. 21% of ethnic minority children are from 3-child families, as compared to 13% of Han children, which mirrors the larger average family size of ethnic minorities relative to Han people (1.96 vs. 1.78).

Table 1: Descriptive Statistics

| | BirthOrder =1 | BirthOrder =2 | BirthOrder =3 | Han | Ethnic Minority | Male | Female | Total |
|---|---|---|---|---|---|---|---|---|
| Months of Breastfeeding | 10.820 | 12.151 | 13.856 | 11.206 | 13.209 | 11.799 | 11.019 | 11.431 |
| | (7.212) | (7.666) | (10.534) | (7.409) | (9.065) | (7.898) | (7.316) | (7.639) |
| Agricultural Household | 0.707 | 0.893 | 0.944 | 0.768 | 0.888 | 0.788 | 0.774 | 0.781 |
| | (0.455) | (0.309) | (0.231) | (0.422) | (0.316) | (0.409) | (0.418) | (0.413) |
| Mother's Years of Education | 8.462 | 6.496 | 5.311 | 7.826 | 6.137 | 7.541 | 7.743 | 7.636 |
| | (3.507) | (2.920) | (2.612) | (3.410) | (3.400) | (3.434) | (3.465) | (3.450) |
| Mother's Age at Child's Birth | 24.423 | 28.882 | 30.278 | 26.264 | 25.883 | 26.335 | 26.092 | 26.221 |
| | (3.824) | (4.671) | (5.062) | (4.747) | (5.034) | (4.781) | (4.780) | (4.782) |
| Mother's Age | 33.781 | 37.997 | 40.268 | 35.570 | 35.270 | 35.651 | 35.407 | 35.536 |
| | (5.973) | (6.263) | (6.581) | (6.476) | (6.813) | (6.476) | (6.557) | (6.515) |
| Child Has No Younger Sibling | 0.561 | 0.858 | 1 | 0.691 | 0.624 | 0.761 | 0.596 | 0.683 |
| | (0.496) | (0.349) | (0) | (0.462) | (0.485) | (0.426) | (0.491) | (0.465) |
| Family Size | 1.501 | 2.142 | 3 | 1.777 | 1.956 | 1.752 | 1.848 | 1.797 |
| | (0.612) | (0.349) | (0) | (0.663) | (0.683) | (0.658) | (0.675) | (0.668) |
| Observations | 5468 | 2910 | 514 | 7892 | 1000 | 4698 | 4194 | 8892 |
| *Of Which* | | | | | | | | |
| Family Size=1 | 3067 | 0 | 0 | 2811 | 256 | 1744 | 1323 | 3067 |
| (%) | (56.09) | (0) | (0) | (35.62) | (25.60) | (37.12) | (31.55) | (34.49) |
| Family Size=2 | 2065 | 2496 | 0 | 4029 | 532 | 2376 | 2185 | 4561 |
| (%) | (37.77) | (85.77) | (0) | (51.05) | (53.20) | (50.57) | (52.10) | (51.29) |
| Family Size=3 | 336 | 414 | 514 | 1052 | 212 | 578 | 686 | 1264 |
| (%) | (6.14) | (14.23) | (100.00) | (13.33) | (21.20) | (12.30) | (16.36) | (14.22) |

*Notes*: Multiple births and children still being breastfed are dropped.

Table 2 summarises male-female ratio by family size, birth order and ethnic background. The increase of gender ratio in parity for families with two and three children is almost strictly monotonic. At high parity of 2- and 3-child families, both Han and ethnic minority households display a very high sex ratio, indicating that son preference is prevalent amongst Han as well as minority households. As pointed out by Sun and Zhao (2016), if couples are allowed to have another children when the firstborn is female, prenatal sex selection is most likely to be performed in parity 2. This is consistent with what we see in Table 2. For 2-child families, gender ratio in parity 2 ranges from 1.5 to 1.6. For 3-child families, while gender ratio in the parity 2 lies in the range 0.5 to 0.6, gender ratio in the highest parity is a strikingly 2.1 for Han families and 1.5 for minority families. Possible explanation for the patterns in 3-child Han families could be that, parents managed to hide the second-born child or place the child with foster parents, usually being the parents' relatives, and try another pregnancy of boy.

Table 2: Male Female Ratio by Family Size, Birth Order, and Ethnic Background

| | | Birth Order=1 | | | Birth Order=2 | | | Birth Order=3 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Male | Female | M/F | Male | Female | M/F | Male | Female | M/F |
| Family Size=1 | Han | 1607 | 1204 | 1.33 | | | | | | |
| | Minority | 137 | 119 | 1.15 | | | | | | |
| Family Size=2 | Han | 773 | 1042 | 0.74 | 1316 | 898 | 1.47 | | | |
| | Minority | 113 | 137 | 0.82 | 174 | 108 | 1.61 | | | |
| Family Size=3 | Han | 77 | 207 | 0.37 | 113 | 227 | 0.50 | 291 | 137 | 2.12 |
| | Minority | 19 | 33 | 0.58 | 26 | 48 | 0.54 | 52 | 34 | 1.53 |

*Notes*: Multiple births and children still being breastfed are dropped.

Table 3 break down families with one child, two children, and three children along gender in each parity and ethnic category. Amongst 2-child families, the highest proportion of families are those with the first child being a girl, and second child being a boy. Likewise, amongst 3-child families, the largest proportion is the group of families with the oldest two children being daughters, and the youngest child being a son. These patterns imply that, for Han families, whose fertility is legally restricted, are most likely to bear the cost of having more children if their existing children are not of the wanted sex. The same patterns in gender sequence are observed for ethnic minority children, indicating that minority parents, overall, prefer sons to daughters.

# 5 Breastfeeding with respect to Birth Order

The biological constraint binding the length of breastfeeding and a mother's likelihood of subsequent pregnancy indicates that, as birth order increases and mothers' demand for contraception grows, they would be willing to breastfeed longer to suppress fertility. Therefore, breastfeeding is expected to increase with birth order. This section is aimed at testing how breastfeeding duration varies with birth order, and how the pattern of breastfeeding duration with respect to birth order differs across ethnic status.

The empirical model is set up as

$$\begin{aligned} Breastfeed_i = a_0 + a_1 BO2_i + a_2 BO3_i \\ + a_3 BO1_i \cdot Han_i + a_4 BO2_i \cdot Han_i + a_5 BO3_i \cdot Han_i \\ + \gamma' X_i + \epsilon_i \end{aligned} \tag{1}$$

Table 3: Gender Sequence for Each Family Size

| | Birth Order=1 | Birth Order=2 | Birth Order=3 | Observations | Han | Percentage | Minority | Percentage |
|---|---|---|---|---|---|---|---|---|
| *Family Size=1* | M | | | 1744 | 1607 | 57% | 137 | 54% |
| | F | | | 1323 | 1204 | 43% | 119 | 46% |
| *Family Size=2* | F | M | | 1762 | 1564 | 39% | 198 | 37% |
| | M | F | | 1016 | 897 | 22% | 119 | 22% |
| | M | M | | 965 | 831 | 21% | 134 | 25% |
| | F | F | | 806 | 725 | 18% | 81 | 15% |
| *Family Size=3* | F | F | M | 516 | 457 | 44% | 59 | 28% |
| | F | M | M | 140 | 115 | 11% | 25 | 12% |
| | M | M | F | 135 | 108 | 10% | 27 | 13% |
| | M | F | M | 123 | 97 | 9% | 26 | 12% |
| | F | F | F | 99 | 81 | 8% | 18 | 9% |
| | F | M | F | 95 | 81 | 8% | 14 | 7% |
| | M | M | M | 80 | 63 | 6% | 17 | 8% |
| | M | F | F | 71 | 47 | 5% | 24 | 11% |

*Notes*: The sum of observations is not the total sample size 8892, because of missing values for gender in each parity for families with two or three children. Percentages in some sections do not sum to 100% because of rounding errors.

The dependent variable $Breastfeeding$ is child $i$'s breastfeeding duration in months. The $BO1$, $BO2$, and $BO3$ are indicators for birth order 1, birth order 2, and birth order 3, respectively. $Han$ equals 1 if the child is Han ethnicity. $X_i$ is a vector of control variables, which include mother's years of education, mother's age at child's birth, the square of mother's age at child's birth, household registration type, a set of year indicators and child's birth year indicators. The year and birth year fixed effects intend to control for unobserved characteristics specific to a year, such as the price and quality of alternatives to breast milk, infant food regulation, national business cycle, economic growth and development, and the interview circumstances. The omitted group in the above equation is the oldest child in an ethnic minority family.

There are also unobserved characteristics specific to a mother, for example, the mother's lifestyle, how much the mother value her children's health in general, how agreeable the home environment is for breastfeeding. For this reason I also try the model with mother fixed effect for children with at least one sibling also observed in the sample for analysis.

$$\begin{aligned} Breastfeed_{ij} = a_1 BO2_{ij} &+ a_2 BO3_{ij} \\ &+ a_3 BO1_{ij} \cdot Han_{ij} + a_4 BO2_{ij} \cdot Han_{ij} + a_5 BO3_{ij} \cdot Han_{ij} \\ &+ \alpha_j + \epsilon_{ij} \end{aligned} \tag{2}$$

In addition to the substantially reduced sample size, another pitfall of the mother fixed effect method is the selection problem. The One Son Two Children policy, which covers the longest time length of the family planning program, implies that, households with more than one child are likely to be those for whom the lower parities are female births. If mothers are eager to conceive again to try for a boy following the birth of a girl, there would be a birth order effect in the mother fixed effect sample, even if birth order does not affect breastfeeding duration in the population. In other words, gender effect on breastfeeding would be mistakenly interpreted as birth order effect in the mother fixed effect setup.

In the above estimation equations, the birth order effect for ethnic minority children is captured by $a_1$ and $a_2$, which respectively, represents the effect of birth order 2 relative to birth order 1, and the effect of birth order 3 on breastfeeding duration relative to birth order 1.

The difference in breastfeeding duration between Han and ethnic minority children, in birth order 1, birth order 2, and birth order 3, is captured by the coefficients on the interaction terms, namely $a_3$, $a_4$, and $a_5$. Apart from unobserved differences between Han and ethnic minority mothers, a positive sign of the estimates of these parameters would imply that Family Planning Policy encourages breastfeeding, while a negative sign would indicate that mothers are deterred from breastfeeding their children when their fertility is restricted by the Family Planning Policy.

The birth order effect for Han children can be represented by linear combinations of the coefficients. The effect of birth order 2 on breastfeeding relative to birth order 1 is captured by $a_1 + a_4 - a_3$, and the effect of birth order 3 relative to birth order 1 is captured by $a_2 + a_5 - a_3$.

## 5.1 Empirical Results for Birth Order Effect

The empirical results are presented in Table 4. Column (1) and (2) estimates equation (1), without and with controls, respectively, for the whole sample. Column (3) and (4) carry out the same estimation but only for families with 2 children. Likewise, results for families with 3 children, without and with controls, are presented in column (5) and (6). Column (7) and (8) estimate the mother fixed effect equation (2). Observations used in column (7) are children from 2-child families, with his/her sibling also in sample. Observations used in column (8) are children from 3-child families, with at least one of his/her siblings also in sample.

Starting from column (1), ethnic minority children of higher birth orders are breastfed significantly and substantially longer than their older siblings. However, after control variables are included in the estimation equation, the effect of birth order 2 relative to birth order 1 reduces in magnitude and the significance vanishes. The effect of birth order 3 relative to birth order 1 shrinks from 5 months to 3.8 months but the significance remains. For 2-child ethnic minority households, the younger child is estimated to be breastfed for 1.2 months longer than the older child. Yet when control variables are added, the birth order effect disappears. It seems that birth order effects on breastfeeding are absent in 3-child ethnic minority households. Mother fixed effect method does not show any birth order effect for ethnic minority households, regardless of family size.

Han children of all birth orders are breastfed significantly and substantially less than ethnic minority children of the same birth order. This fall in breastfeeding for Han children could be caused by Family Planning Policy, or other differences between Han and ethnic minority mothers. As described in column (1), Han children of birth order 1, birth order 2, and birth order 3 are breastfed for 1.6, 1.6, and 4.4 months less, respectively, comparing to ethnic minority children of the same birth order. However, these differences can be driven by mothers' education background, or the household registration type of the child's family. Recall that Table 1 has seen a gap in years of education between Han mothers and ethnic minority mothers (7.8 years vs. 6.1 years), and a gap in the likelihood of being from agricultural household (77% vs. 89%). After these controls are incorporated in the model, in each birth order the difference between Han and ethnic minority children reduces in magnitude but remains significant at 1%. For 2-child Han households, the breastfeeding duration for the younger child is 0.9 months shorter, relative to a younger child from 2-child ethnic minority households with comparable mother and family background characteristics. For 3-child Han families, the fall in breastfeeding relative to ethnic minority children in each birth order is significant without and with controls. Mother fixed effect eliminates the significance of the drop in breastfeeding for 2-child Han families. On the other hand, the breastfeeding duration of the oldest child from 3-child Han families is significantly and substantially shorter than that for an otherwise comparable child from ethnic minority households, even after mother fixed effects are taken account of.

The birth order effect for Han children can be obtained by tests of linear combinations of parameters in equation (1) and (2). These are not presented in table but are summarised here. Starting from column (1), Han children of birth order 2 and 3 are breastfed for 1.4 months and 2.2 months longer, respectively, than the oldest child. Both are significant at 1%. When controls are added, the birth order 2 effect reduces to 0.5 month with the significance level downgrading to 5%, and the birth order 3 effect shrinks to 0.9 month, which is significant at 10%. For 2-child families, the younger child is breastfed for 0.9 month longer than the older one, and this is significant at 1%. When mother and family background characteristics are taken account of, the birth order effect reduces to 0.5 months with significance level 5%. For 3-child families, there is no difference in breastfeeding duration for the firstborn and second-born. But the youngest child is breastfed for 2.4 months (significant at 1%) when no controls are in model, or 1.5 months (significant at 10%) when controls are taken account of, longer than the oldest children in a typical Han household of three children. Mother fixed effect method exhibits significant birth order effect on breastfeeding for 2-child Han families (1.1 months, significant at 1%), and significant birth order effect for 3-child Han families, but only for birth order 3 (3.6 months, significant at 1%).

In summary, the birth order effects on breastfeeding duration among ethnic minority families are not robust to accounting for mother and family background characteristics, family size, or mother-specific effect. Breastfeeding for Han children of each birth order, especially the oldest child in a family of three children, is substantially less than an otherwise comparable child of ethnic minority. This could be caused by Family Planning Policy which suppresses Han families' fertility, or other differences between Han and ethnic minority mothers. Nevertheless, if mother fixed effects are capable of mopping up all unobserved characteristics of mothers, it could be stated with confidence that Family Planning Policy greatly restrains the breastfeeding for the oldest child in families of three children. Finally, regardless of the model specification, Han children with no younger siblings are breastfed significantly longer than their older brothers or sisters.

Table 4: Effect of Birth Order on Breastfeeding Duration

| | Whole Sample | Whole Sample | 2-Child Family | 2-Child Family | 3-Child Family | 3-Child Family | 2-Child Family with 2 Children in Sample | 3-Child Family with at least 2 Children in Sample |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Birth Order 2 | 1.431*** | 0.608 | 1.161** | 0.917 | -1.738 | -2.294 | 0.600 | -1.821 |
| | (0.462) | (0.478) | (0.548) | (0.571) | (1.388) | (1.466) | (0.615) | (1.339) |
| Birth Order 3 | 5.018*** | 3.840*** | | | 2.245 | 1.320 | | 0.172 |
| | (1.396) | (1.383) | | | (1.794) | (1.892) | | (1.721) |
| Birth Order 1*Han | -1.581*** | -1.009*** | -1.192** | -0.543 | -4.287*** | -3.723*** | -2.126 | -5.394** |
| | (0.349) | (0.339) | (0.496) | (0.490) | (1.628) | (1.591) | (1.548) | (2.657) |
| Birth Order 2*Han | -1.610*** | -1.159*** | -1.417*** | -0.920* | -2.911*** | -2.344** | -1.595 | -3.254 |
| | (0.452) | (0.447) | (0.489) | (0.485) | (1.119) | (1.118) | (1.549) | (2.655) |
| Birth Order 3*Han | -4.412*** | -3.939*** | | | -4.114*** | -3.523** | | -1.947 |
| | (1.477) | (1.460) | | | (1.460) | (1.442) | | (2.599) |
| Mother's Years of Education | | -0.277*** | | -0.288*** | | -0.431*** | | |
| | | (0.031) | | (0.045) | | (0.109) | | |
| Mother's Age at Child's Birth | | 0.300*** | | 0.327** | | 0.397 | | |
| | | (0.091) | | (0.135) | | (0.278) | | |
| Mother's Age at Child's Birth Squared | | -0.005*** | | -0.005** | | -0.006 | | |
| | | (0.002) | | (0.002) | | (0.004) | | |
| Agricultural Household | | 1.269*** | | 1.964*** | | -0.247 | | |
| | | (0.220) | | (0.345) | | (1.178) | | |
| Constant | 15.398*** | 11.657*** | 16.101*** | 10.981*** | 17.480*** | 13.698*** | 17.126*** | 18.220*** |
| | (0.515) | (1.435) | (0.732) | (2.103) | (1.870) | (4.651) | (1.559) | (2.358) |
| Year Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Birth Year Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Mother Fixed Effect | No | No | No | No | No | No | Yes | Yes |
| R-squared | 0.1038 | 0.1271 | 0.0887 | 0.1131 | 0.1147 | 0.1300 | within 0.0744<br>between 0.0791<br>overall 0.0774 | within 0.1067<br>between 0.0970<br>overall 0.1076 |
| Observations | 8892 | 8892 | 4561 | 4561 | 1264 | 1264 | 3281 | 1044 |

*Notes*: * denotes significant at 10%, ** significant at 5%, ***significant at 1%. Clustered standard errors at mother's level are in parentheses beneath each estimate.

# 6 Breastfeeding with respect to Gender

If parents have a preference for sons, then boys are breastfed more than girls. After the birth of a girl, parents are more likely to continue having children. Thus mothers limit breastfeeding for the girl and try to conceive again. This section seeks to test if gender gap exists in breastfeeding duration and how the gender gap varies across ethnic category.

Following a difference-in-difference specification, the baseline empirical model can be described as

$$Breastfeed_i = b_0 + b_1 Male_i + b_2 Han_i + b_3 Male_i \cdot Han_i + \delta' X_i + \xi_i \tag{3}$$

where $Male$ is an indicator for male child. The rest of the variables are defined the same as in the previous section. In this equation, $b_1$ represents the gender gap in breastfeeding for ethnic minority children. $b_2$ characterises the difference in breastfeeding between Han and ethnic minority girls. The difference between boys across ethnic status is captured by $b_2 + b_3$. Gender gap for Han children can be summarised by $b_1 + b_3$. $b_3$ would tell us how gender gap in breastfeeding varies between Han and ethnic minority children. The omitted group in this functional form is ethnic minority girls.

Mother fixed effect method is also applied to mitigate the concern of unobserved maternal characteristics driving the results.

$$Breastfeed_{ij} = b_1 Male_{ij} + b_2 Han_{ij} + b_3 Male_{ij} \cdot Han_{ij} + \mu_j + \xi_{ij} \tag{4}$$

The $\mu_j$s are aimed at mopping up mother-specific effects.

## 6.1 Empirical Results for Gender Effect

The estimates of equation (3) and (4) are presented in Table 5, for the whole sample, for each family size, and for multiple observations born to the same mother by a mother fixed effect approach.

No gender gap exists in breastfeeding for ethnic minority children. It appears that gender disparity presents among ethnic minority families of three children. The disparity varies from 3.5 to 4 months but is completely erased away by mother fixed effects.

Han girls are breastfed greatly less than ethnic minority girls. Depending on the model specification and family size, the fall in breastfeeding for Han girls ranges from 1.1 months to 4.7 months, and is most striking for 3-child families, weakest for 1-child families. On the other hand, no difference across ethnic category in the gender disparity in breastfeeding is observed.

The last two rows in Table 5 show the test results of linear combinations which, respectively, represent the gender gap for Han children, and to what extent the breastfeeding duration for Han boys differs from that for ethnic minority boys. Regardless of model specification, the gender gap in breastfeeding among Han children is very significant. The son advantage ranges between 0.6 months and 2.3 months in magnitude and is most remarkable among 3-child families.

Han boys are breastfed 1.4 months less than otherwise comparable boys of ethnic minority. Separate estimation for each family size indicates that this fall in breastfeeding for Han boys is driven entirely by a decrease in breastfeeding of boys from 3-child families.

In summary, there is no gender disparity in breastfeeding among ethnic minority children. Han girls and boys, especially those from larger families, are breastfed substantially less than similar girls and boys of ethnic minority. Son advantage among Han children ranges from 0.6 months to 2.3 months in magnitude and is most remarkable in families with three children. Overall, however, if mother fixed effects effectively capture all characteristics specific to a mother, it could be concluded that Family Planning Policy does not seem to either reinforce or mute the son advantage in breastfeeding among Han children.

Table 5: Effect of Gender on Breastfeeding Duration

| | Whole Sample (1) | Whole Sample (2) | 1-Child Family (3) | 1-Child Family (4) | 2-Child Family (5) | 2-Child Family (6) | 3-Child Family (7) | 3-Child Family (8) | 2-Child Family with 2 Children in Sample (9) | 3-Child Family with at least 2 Children in Sample (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| Male | 0.897 | 0.867 | 0.920 | 0.937 | -0.159 | -0.208 | 3.974** | 3.490* | 0.136 | 0.729 |
| | (0.598) | (0.579) | (0.907) | (0.893) | (0.653) | (0.639) | (1.963) | (1.924) | (0.706) | (1.120) |
| Han | -1.904*** | -1.238*** | -1.147** | -0.759 | -1.722*** | -1.159** | -2.605** | -2.108* | -1.971 | -4.740*** |
| | (0.425) | (0.413) | (0.565) | (0.557) | (0.540) | (0.532) | (1.167) | (1.154) | (1.657) | (1.239) |
| Male*Han | -0.103 | -0.184 | -0.064 | -0.281 | 0.933 | 0.792 | -2.369 | -2.144 | 0.442 | 1.556 |
| | (0.618) | (0.599) | (0.942) | (0.931) | (0.690) | (0.676) | (2.008) | (1.966) | (0.738) | (1.194) |
| Mother's Years of Education | | -0.298*** | | -0.210*** | | -0.293*** | | -0.440*** | | |
| | | (0.030) | | (0.043) | | (0.044) | | (0.108) | | |
| Mother's Age at Child's Birth | | 0.370*** | | 0.186 | | 0.414*** | | 0.399 | | |
| | | (0.086) | | (0.135) | | (0.125) | | (0.247) | | |
| Mother's Age at Child's Birth Squared | | -0.005*** | | -0.004 | | -0.006*** | | -0.005 | | |
| | | (0.001) | | (0.002) | | (0.002) | | (0.004) | | |
| Agricultural Household | | 1.361*** | | 0.797*** | | 1.966*** | | -0.249 | | |
| | | (0.218) | | (0.308) | | (0.345) | | (1.199) | | |
| Constant | 15.819*** | 10.456*** | 13.673*** | 12.378*** | 16.719*** | 10.034*** | 15.982*** | 11.376*** | 15.816*** | 15.447*** |
| | (0.577) | (1.362) | (0.820) | (2.118) | (0.785) | (1.964) | (1.556) | (4.144) | (1.588) | (1.175) |
| Year Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Birth Year Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Mother Fixed Effect | No | No | No | No | No | No | No | No | Yes | Yes |
| R-squared | 0.0942 | 0.1266 | 0.0989 | 0.1183 | 0.0872 | 0.1135 | 0.1066 | 0.1262 | within 0.0719<br>between 0.0635<br>overall 0.0638 | within 0.0893<br>between 0.0705<br>overall 0.0821 |
| Observations | 8892 | 8892 | 3067 | 3067 | 4561 | 4561 | 1264 | 1264 | 3281 | 1044 |
| Gender Gap for Han Children ($b_1 + b_3$) | 0.794*** | 0.683*** | 0.856*** | 0.655*** | 0.774*** | 0.584*** | 1.605*** | 1.345*** | 0.578** | 2.285*** |
| | (0.157) | (0.155) | (0.246) | (0.244) | (0.219) | (0.218) | (0.475) | (0.468) | (0.235) | (0.539) |
| Gap of boys across ethnicity ($b_2 + b_3$) | -2.007*** | -1.422*** | -1.211 | -1.041 | -0.839 | -0.367 | -4.974*** | -4.253** | -1.530 | -3.184** |
| | (0.487) | (0.469) | (0.748) | (0.735) | (0.519) | (0.510) | (1.712) | (1.678) | (1.554) | (1.263) |

*Notes*: * denotes significant at 10%, ** significant at 5%, ***significant at 1%. Clustered standard errors at mother's level are in parentheses beneath each estimate.

# 7 Breastfeeding with respect to Birth Order and Gender

For low birth-order children, mothers would want to continue having children regardless of the sex of their children and thus breastfeed boys and girls equally (short). For high birth-order children, mothers would want to stop having children regardless of the sex of their children and thus breastfeed boys and girls equally (long). This section empirically investigates the pattern of gender difference in breastfeeding along birth order, and how this pattern differs across ethnic category.

The estimation equation takes the following form.

$$\begin{aligned} Breastfeed_i = c_0 &+ c_1 Male_i + c_2 Han_i + c_3 BO2_i + c_4 BO3_i \\ &+ c_5 BO2_i \cdot Male_i + c_6 BO3_i \cdot Male_i + c_7 BO2_i \cdot Han_i + c_8 BO3_i \cdot Han_i \\ &+ c_9 BO1_i \cdot Male_i \cdot Han_i + c_{10} BO2_i \cdot Male_i \cdot Han_i + c_{11} BO3_i \cdot Male_i \cdot Han_i \\ &+ \eta' X_i + \zeta_i \end{aligned} \tag{5}$$

The variables in this equation are defined the same as in previous sections. The omitted group is female firstborns in ethnic minority families. Mother-fixed effect approach is also applied.

$$\begin{aligned} Breastfeed_{ij} = c_1 Male_{ij} &+ c_2 Han_{ij} + c_3 BO2_{ij} + c_4 BO3_{ij} \\ &+ c_5 BO2_{ij} \cdot Male_{ij} + c_6 BO3_{ij} \cdot Male_{ij} + c_7 BO2_{ij} \cdot Han_{ij} + c_8 BO3_{ij} \cdot Han_{ij} \\ &+ c_9 BO1_{ij} \cdot Male_{ij} \cdot Han_{ij} + c_{10} BO2_{ij} \cdot Male_{ij} \cdot Han_{ij} + c_{11} BO3_{ij} \cdot Male_{ij} \cdot Han_{ij} \\ &+ \kappa_j + \zeta_{ij} \end{aligned} \tag{6}$$

Mother fixed effects are captured by the $\kappa_j$s.

In the above equations, $c_2$, the parameter on the ethnic background indicator, captures how breastfeeding duration of Han girls of birth order 1 differ from that of ethnic minority girls of birth order 1. The sum of $c_2$ and $c_7$ denotes the difference in breastfeeding of girls across ethnic status in birth order 2. Likewise, $c_2 + c_8$ represents by how much breastfeeding duration of Han girls of birth order 3 would exceed or fall short of that of ethnic minority girls of the same birth order.

Similarly, the difference in breastfeeding of boys across ethnic status in parity 1, parity 2, and parity 3, is captured respectively by, $c_2 + c_9$, $c_2 + c_7 + c_{10}$, and $c_2 + c_8 + c_{11}$.

The gender gap in breastfeeding, which is the breastfeeding duration of boys minus that of girls, for Han children of birth order 1, birth order 2, and birth order 3, is represented by, respectively, $c_1 + c_9$, $c_1 + c_5 + c_{10}$, and $c_1 + c_6 + c_{11}$. Likewise, gender disparity in breastfeeding duration for ethnic minority children of birth order 1, birth order 2, and birth order 3, are denoted by $c_1$, $c_1 + c_5$, and $c_1 + c_6$, respectively.

The coefficients on the three-way interactions, i.e. $c_9$, $c_{10}$, and $c_{11}$, tell us how, respectively, the son advantage in breastfeeding in birth order 1, birth order 2, and birth order 3, differs across ethnic category.

### 7.1 Empirical Results for Gender Effect along Birth Order

The estimation results for equation (5) and (6) are presented in Table 6. Following the same manner as in the previous section, equation (5) is estimated for the whole sample, families with one child,[13] families with two children, and families with three children, and equation (6) is estimated for families with two children, both of which are observed in sample, as well as families with three children, at least two of whom are observed in sample.

Linear combinations of coefficient estimates, which are meaningful for explaining how the breastfeeding duration for boys and girls of each birth order varies across ethnic background, or the gender gap in breastfeeding for Han and ethnic minority children in each birth order, are shown in Table 7.

Han girls of birth order 1 are breastfed 1.2 months less than ethnic minority girls of the same birth order, according to column (1) of Table 7, i.e. estimates of equation (5), without controls and for the whole sample. However, this drop in breastfeeding is completely eliminated by mother's years of education, mother's age at birth, and household registration type. Similarly, although estimation for one child families without controls show a 1.1 months less of breastfeeding for Han girls, comparing to ethnic minority girls, the significance of this difference disappears with controls adding to the equation. Separate estimation for families with two and three children does not show that Han girls of birth order 1 are breastfed significantly differently from ethnic minority girls of the same birth order. Surprisingly, the fixed effect estimation results show a substantial and highly significant fall (5.3 months) in breastfeeding duration of a Han girl who is the oldest child in a family of three children, relative to a similar girl of ethnic minority.

Han girls of birth order 2 are breastfed for 2.4 months less than an otherwise comparable girl of ethnic minority, as exhibited by estimation of equation (5) for the whole sample. For families with two children, girls of birth order 2 have no younger siblings. The breastfeeding of these girls of Han ethnicity fall short of similar ethnic minority girls by 2.2 months. But this reduction in breastfeeding becomes insignificant when mother fixed effect method is applied. A typical Han girl of birth order 2 from families with three children, who has a younger brother or sister, is breastfed for 3.4 months less than a girl of ethnic minority with similar background as described by mother's education, mother's age at child's birth, and household registration type. Mother fixed effects raise the magnitude of this difference to 4.7 months, but the significance level is downgraded from 1% to 5%.

Han girls of birth order 3, who have no younger siblings, are not shown to be breastfed significantly differently from otherwise comparable girls of ethnic minority.

Han boys of birth order 1, from all sizes of families, are breastfed for 1.4 months less than ethnic minority boys of birth order 1 with similar family background. It seems that this difference is driven to a large extent

[13] Column (3) and (4) in Table 6, i.e. coefficient estimates of equation (5) for families with only one child, are actually the same as column (3) and (4) in Table 5. These are presented here for ease of comparison.

by a fall in breastfeeding of boys who are the firstborns in Han families of three children. The very large point estimate (7.5 months) slightly decreases to a marginally significant 7 months when mother specific effects are taken account of.

For birth order 2 boys, Han children are not shown to be breastfed significantly different from ethnic minority children, either separately for families with two or three children, or for all sizes of families together.

For boys who are the youngest children in 3-child families, estimation using all observations in sample (including children of lower birth orders from smaller family sizes) exhibit a highly precise 5.7 months fall in breastfeeding, comparing to otherwise comparable boys of ethnic minority. When children of smaller family sizes are dropped, the point estimate barely decreases to 5.3 months which remains highly significant. However, this difference is completely erased away by mother fixed effects. Therefore, the fall in breastfeeding of Han boys who have no siblings, relative to ethnic minority boys, might be attributed to differences in Han and ethnic minority mothers' lifestyle, rather than the Family Planning Policy.

Among Han families of all sizes, male firstborns are breastfed for 0.44 months longer than firstborns who are girls. This son advantage should to a large extent be attributed to the fact that, for 1-child families, boys are estimated to be breastfed for a highly precise 0.66 months longer than girls who are the only child in family. The intuition of this estimation could be that Han families, whose fertility are restricted, limit the breastfeeding of firstborns if they turn out to be girls and try another pregnancy possibly of a boy.

For ethnic minority children who are the oldest in family, estimation for all family sizes together show a marginally significant 1.2 months son advantage in breastfeeding. But this son advantage disappears in separate regressions for each family size.

The difference in gender gap in breastfeeding (if it exists) across Han and ethnic minority children, separately for each birth order, are characterised by the parameters on the three-way interactions, as presented in Table 6. No difference is observed between the gender disparities of Han and ethnic minority children of birth order 1.

For Han children of birth order 2, boys are on average breastfed for 1.1 months longer than girls. Separate regressions for families of two and three children show that this son advantage in birth order 2 is more remarkable among 3-child families (1.8 months) than among 2-child families (0.6) months. Mother fixed effects eliminate the gender gap among the younger children in 2-child Han families but upgrade the son advantage amongst children of middle parity in 3-child Han families to a highly precise 2.5 months.

No difference is observed between boys and girls of ethnic minority in birth order 2, either for the younger children of 2-child families or for middle parity children of 3-child families.

Amongst the younger children of 2-child households, the gender gap of Han children (which is 0.6 months with controls for family background), surpasses the gender difference of ethnic minority children (insignificant) by 2 months, as shown in Table 6. This seemingly exacerbating effect of Family Planning Policy on son advantage in breastfeeding is eliminated by mother fixed effects, implying that the observed difference in gender disparity across ethnic status should be more reasonably attributed to variation in unobserved characteristics between Han and ethnic minority mothers, rather than the Family Planning Policy. While among middle parity children of 3-child Han families, boys are breastfed significantly and substantially more than girls (2.5 months), the gender disparity amongst comparable children of ethnic minority is an insignificant 0.3 months. The difference between these two gender gaps is not shown to be significant.

Han children in the highest parity in sample are not shown to be breastfed distinctively across gender. On the other hand, regression for 3-child families (without mother fixed effects) exhibits a 5.4 months son advantage among ethnic minority children. Gender gap in this parity among Han families (insignificant) seems to be 4.6 months less than that among ethnic minority families. But mother fixed effects erase this difference in gender gap across ethnic status.

In summary, for families with three children, Han female firstborns are breastfed 5.3 months less than female firstborns of ethnic minority. Han girls in the middle parity are breastfed 4.7 months on average less than ethnic minority girls who are also in the middle parity in a 3-child family. No significant difference in birth order 3 of girls across ethnic background is observed. For boys, however, the only observed difference in breastfeeding duration across ethnic category is among male firstborns in 3-child families, which is 7 months with marginal significance.

Son advantage is most remarkable in middle parity amongst Han families of three children. No significant difference is observed in gender gap across ethnic status for all parities and family sizes. If mother fixed effects are sufficient to capture all mother-specific characteristics, it could be stated that the breastfeeding of girls in the low and middle parity in 3-child families is greatly restrained by the Family Planning Policy. And Family Planning Policy boosts the son advantage in parity 2 among 3-child families by 2.5 months.

Table 6: Effect of Gender on Breastfeeding Duration along Birth Order

| | Whole Sample | Whole Sample | 1-Child Family | 1-Child Family | 2-Child Family | 2-Child Family | 3-Child Family | 3-Child Family | 2-Child Family with 2 Children in Sample | 3-Child Family with at least 2 Children in Sample |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Male | 1.200* | 1.234* | 0.920 | 0.937 | 0.969 | 0.793 | 5.967 | 5.512 | 0.332 | 2.482 |
| | (0.681) | (0.663) | (0.907) | (0.893) | (0.945) | (0.925) | (3.743) | (3.667) | (1.114) | (3.079) |
| Han | -1.225*** | -0.634 | -1.147** | -0.759 | -0.986 | -0.379 | -1.928 | -1.592 | -2.379 | -5.327*** |
| | (0.422) | (0.414) | (0.565) | (0.557) | (0.636) | (0.626) | (1.623) | (1.618) | (1.582) | (2.039) |
| Birth Order 2 | 2.654*** | 1.815*** | | | 2.568*** | 2.141** | 0.727 | 0.254 | 0.784 | -1.018 |
| | (0.701) | (0.706) | | | (0.917) | (0.935) | (1.528) | (1.591) | (1.238) | (1.626) |
| Birth Order 3 | 2.579 | 1.263 | | | | | 1.225 | 0.067 | | 1.068 |
| | (1.651) | (1.638) | | | | | (1.556) | (1.678) | | (1.906) |
| Birth Order 2*Male | -2.351** | -2.325** | | | -2.546* | -2.221* | -6.736* | -6.873** | -0.427 | -2.168 |
| | (1.052) | (1.037) | | | (1.339) | (1.323) | (3.523) | (3.458) | (1.746) | (3.504) |
| Birth Order 3*Male | 3.784 | 3.998 | | | | | -0.805 | -0.148 | | -2.645 |
| | (2.641) | (2.607) | | | | | (4.100) | (4.035) | | (4.294) |
| Birth Order 2*Han | -1.655** | -1.728** | | | -1.823* | -1.790* | -1.933 | -1.846 | 0.321 | 0.638 |
| | (0.739) | (0.731) | | | (0.958) | (0.951) | (1.632) | (1.640) | (1.221) | (1.579) |
| Birth Order 3*Han | -0.670 | -0.690 | | | | | 0.546 | 0.869 | | 1.807 |
| | (1.843) | (1.829) | | | | | (1.802) | (1.815) | | (2.012) |
| Birth Order 1*Male*Han | -0.760 | -0.798 | -0.064 | -0.281 | -0.417 | -0.355 | -6.644* | -5.948 | 0.213 | -1.690 |
| | (0.708) | (0.690) | (0.942) | (0.931) | (1.002) | (0.982) | (3.833) | (3.753) | (1.167) | (3.237) |
| Birth Order 2*Male*Han | 2.267** | 2.147** | | | 2.290** | 2.038** | 2.775 | 3.174 | 0.468 | 2.175 |
| | (0.911) | (0.904) | | | (1.010) | (1.003) | (2.557) | (2.539) | (1.333) | (1.866) |
| Birth Order 3*Male*Han | -4.251 | -4.419 | | | | | -4.491 | -4.609* | | 1.260 |
| | (2.803) | (2.771) | | | | | (2.765) | (2.735) | | (2.377) |
| Controls | No | Yes | No | Yes | No | Yes | No | Yes | NA | NA |
| Mother Fixed Effect | No | No | No | No | No | No | No | No | Yes | Yes |
| R-squared | 0.1075 | 0.1307 | 0.0989 | 0.1183 | 0.0912 | 0.1149 | 0.1275 | 0.1422 | within 0.0766<br>between 0.0790<br>overall 0.0779 | within 0.1249<br>between 0.1015<br>overall 0.1146 |
| Observations | 8892 | 8892 | 3067 | 3067 | 4561 | 4561 | 1264 | 1264 | 3281 | 1044 |

*Notes*: * denotes significant at 10%, ** significant at 5%, ***significant at 1%. Clustered standard errors at mother's level are in parentheses beneath each estimate. All regressions include year and birth year fixed effects. Controls include mother's years of education, mother's age at child's birth, the square of mother's age at child's birth, and household registration type.

Table 7: Linear Combination of Coefficient Estimates from Table 6

| | Whole Sample | Whole Sample | 1-Child Family | 1-Child Family | 2-Child Family | 2-Child Family | 3-Child Family | 3-Child Family | 2-Child Family with 2 Children in Sample | 3-Child Family with at least 2 Children in Sample |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Gap of Girls across ethnicity | -1.225*** | -0.634 | -1.147** | -0.759 | -0.986 | -0.379 | -1.928 | -1.592 | -2.379 | -5.327*** |
| Birth Order 1 ($c_2$) | (0.422) | (0.414) | (0.565) | (0.557) | (0.636) | (0.626) | (1.623) | (1.618) | (1.582) | (2.039) |
| Gap of Girls across ethnicity | -2.880*** | -2.362*** | | | -2.809*** | -2.168*** | -3.861*** | -3.438*** | -2.058 | -4.689** |
| Birth Order 2 ($c_2 + c_7$) | (0.678) | (0.674) | | | (0.800) | (0.798) | (1.273) | (1.268) | (1.967) | (2.171) |
| Gap of Girls across ethnicity | -1.895 | -1.324 | | | | | -1.382 | -0.722 | | -3.520 |
| Birth Order 3 ($c_2 + c_8$) | (1.876) | (1.860) | | | | | (1.764) | (1.774) | | (2.586) |
| Gap of Boys across ethnicity | -1.984*** | -1.432*** | -1.211 | -1.041 | -1.404* | -0.734 | -8.572** | -7.540** | -2.166 | -7.017* |
| Birth Order 1 ($c_2 + c_9$) | (0.566) | (0.547) | (0.748) | (0.735) | (0.776) | (0.764) | (3.414) | (3.330) | (1.746) | (3.703) |
| Gap of Boys across ethnicity | -0.613 | -0.215 | | | -0.519 | -0.131 | -1.087 | -0.264 | -1.590 | -2.515 |
| Birth Order 2 ($c_2 + c_7 + c_{10}$) | (0.605) | (0.598) | | | (0.615) | (0.608) | (2.190) | (2.186) | (1.513) | (2.389) |
| Gap of Boys across ethnicity | -6.145*** | -5.743*** | | | | | -5.873*** | -5.332*** | | -2.260 |
| Birth Order 3 ($c_2 + c_8 + c_{11}$) | (2.075) | (2.045) | | | | | (2.086) | (2.046) | | (1.947) |
| Han, Birth Order 1 | 0.440** | 0.436** | 0.856*** | 0.655*** | 0.551* | 0.437 | -0.677 | -0.437 | 0.545 | 0.792 |
| Gender Gap ($c_1 + c_9$) | (0.192) | (0.189) | (0.246) | (0.244) | (0.332) | (0.328) | (0.853) | (0.860) | (0.360) | (0.990) |
| Han, Birth Order 2 | 1.116*** | 1.055*** | | | 0.713** | 0.610** | 2.005** | 1.813** | 0.373 | 2.488*** |
| Gender Gap ($c_1 + c_5 + c_{10}$) | (0.289) | (0.285) | | | (0.314) | (0.310) | (0.790) | (0.779) | (0.360) | (0.839) |
| Han, Birth Order 3 | 0.734 | 0.813 | | | | | 0.671 | 0.755 | | 1.097 |
| Gender Gap ($c_1 + c_6 + c_{11}$) | (0.986) | (0.985) | | | | | (1.002) | (1.017) | | (1.298) |
| Minority, Birth Order 1 | 1.200* | 1.234* | 0.920 | 0.937 | 0.969 | 0.793 | 5.967 | 5.512 | 0.332 | 2.482 |
| Gender Gap ($c_1$) | (0.681) | (0.663) | (0.907) | (0.893) | (0.945) | (0.925) | (3.743) | (3.667) | (1.114) | (3.079) |
| Minority, Birth Order 2 | -1.151 | -1.091 | | | -1.577 | -1.428 | -0.769 | -1.361 | -0.095 | 0.314 |
| Gender Gap ($c_1 + c_5$) | (0.865) | (0.858) | | | (0.961) | (0.954) | (2.446) | (2.428) | (1.286) | (1.658) |
| Minority, Birth Order 3 | 4.985* | 5.232** | | | | | 5.162** | 5.364** | | -0.163 |
| Gender Gap ($c_1 + c_6$) | (2.623) | (2.589) | | | | | (2.577) | (2.540) | | (2.032) |
| Controls | No | Yes | No | Yes | No | Yes | No | Yes | NA | NA |
| Mother Fixed Effect | No | No | No | No | No | No | No | No | Yes | Yes |

*Notes*: * denotes significant at 10%, ** significant at 5%, ***significant at 1%. Clustered standard errors at mother's level are in parentheses beneath each estimate. The estimates are from regressions in Table 6.

# 8 Conclusion

This study exploits the fact that Family Planning Policy only applies to Han people but that ethnic minority couples' fertility is not affected, to investigate how breastfeeding patterns with respect to gender and birth order differs across ethnic background.

The birth order effects on breastfeeding duration among ethnic minority families are not robust to accounting for mother and family background characteristics, family size, or mother-specific effect. Breastfeeding for Han children of each birth order, especially the oldest child in a family of three children, is substantially less than an otherwise comparable child of ethnic minority. This could be caused by Family Planning Policy which suppresses Han families' fertility, or other differences between Han and ethnic minority mothers. Nevertheless, if mother fixed effects are capable of mopping up all unobserved characteristics of mothers, it could be stated with confidence that Family Planning Policy greatly restrains the breastfeeding for the oldest child in families of three children. Finally, regardless of the model specification, Han children with no younger siblings are breastfed significantly longer than their older brothers or sisters.

There is no gender disparity in breastfeeding among ethnic minority children. Han girls and boys, especially those from larger families, are breastfed substantially less than similar girls and boys of ethnic minority. Son advantage among Han children ranges from 0.6 months to 2.3 months in magnitude and is most remarkable in families with three children. Overall, however, if mother fixed effects effectively capture all characteristics specific to a mother, it could be concluded that Family Planning Policy does not seem to either reinforce or mute the son advantage in breastfeeding among Han children.

For families with three children, Han female firstborns are breastfed 5.3 months less than female firstborns of ethnic minority. Han girls in the middle parity are breastfed 4.7 months on average less than ethnic minority girls who are also in the middle parity in a 3-child family. No significant difference in birth order 3 of girls across ethnic background is observed. For boys, however, the only observed difference in breastfeeding duration across ethnic category is among male firstborns in 3-child families, which is 7 months with marginal significance.

Son advantage is most remarkable in middle parity amongst Han families of three children. No significant difference is observed in gender gap across ethnic status for all parities and family sizes. If mother fixed effects are sufficient to capture all mother-specific characteristics, it could be stated that the breastfeeding of girls in the low and middle parity in 3-child families is greatly restrained by the Family Planning Policy. And Family Planning Policy boosts the son advantage in parity 2 among 3-child families by 2.5 months.

The present study is limited in at least two aspects. Firstly, it lacks a model which would formally demonstrate the impacts of legal birth control on the association between breastfeeding and gender and parity. Secondly, it lacks evidence on whether the results found in this study would mirror the mortality, morbidity, or other health outcomes of children. These inspire interesting directions for future research.

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