GENDER AND EDUCATION: HOW SIBLING GENDER DISTRIBUTION AFFECTS CHILD EDUCATIONAL OUTCOMES

By

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Abstract

There are many factors that may influence a child's likelihood of attending school. I examine the impact of a gender ratio gap, a difference between parents desired sibling cohort gender ratio and their realised sibling cohort gender ratio, on a child's likelihood of attending school. Consistent with the literature, I find that gender ratio gap has a positive relationship with a female child's likelihood of attending school. However, unlike previous work, I find that gender ratio gap has no statistically significant relationship with school attendance for a male child.

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1. Introduction

What if children are being born into families where the odds are stacked against them from the moment they open their eyes? We commonly ask an expecting couple: "Are you hoping for a boy or a girl?" We like to think, however, that a parent will love all their children equally regardless of sex and do everything in their power to ensure each child succeeds. In thinking this way, we are ignoring scarcity constraints, which force parents to make difficult choices about how to best allocate resources among their children. If gender preferences are strong enough, they may influence the ways in which parents allocate resources. This implies that children of the unwanted gender may be substantially disadvantaged relative to their brothers or sisters.

I will examine how these gender preferences affect the likelihood of a child attending school by conducting an empirical analysis of Ethiopia. My results suggest that when proportionately more girls than desired are born into a family, the educational attainment of these girls increases. I also observe, contrary to the existing literature, that gender preferences have no measurable effect on male children. This raises interesting questions about how the effect of these gender preferences differs across time and across local.

This paper builds on a study by Tesfu and Gurmu (2013). They conduct the first analysis into the effects of a different-than-desired sibship gender ratio, using Demographic and Household Survey (DHS) data from 2000 and 2005.[1] Employing the mother's gender preferences as representative of both parents, they find that an increase in the proportion of girls relative to the desired proportion results in increased education rates for both male and female children.

[1] Sibship is a term borrowed from the sociology literature, and refers to the cohort of children from a given family.

Building on this work, I will re-examine this issue using more recent Ethiopian DHS data from 2011. This new dataset includes the father's gender preferences, thus allowing both parents' preferences to be taken into account. Using IV estimation to control for the endogeneity of gender preferences, I apply the same linear probability model suggested by Tesfu and Gurmu to this new dataset. I will then explore possible reasons for the differences between my results and those of Tesfu and Gurmu.

2. Existing Literature

Becker (1960) was the first to apply economic analysis to explore family functioning and decision-making. In this (1960) and later work (Becker & Lewis, 1973; Becker & Tomes, 1976; Becker, 1981), he outlines a framework in which parents are concerned with both the quantity and quality of their sibship. Becker (1973) explains how an increase in quantity (quality) raises the shadow price of quality (quantity). As a result, an increase in the number of children in a family causes an increase in the shadow price of raising the quality of these children. In later work, Becker (1981) proposes that parents tend to smooth quality across their children.

A variety of authors have explored other factors that may influence parental investment in childhood education. Rosenzweig and Wolpin (1980) conduct an empirical analysis using household data from India, and conclude that an exogenous decrease in sibship size would result in increased schooling rates. This is consistent with Becker's earlier work. Black, Devereux, and Salvanes (2005) employ Norwegian data to analyze the effect of family size on IQ scores. They find that when proper instruments are used and birth order is controlled for, expected increases in family size have little effect on IQ scores.[2] In later work, however, Black et al. (2010) find that

[2] Refer to the discussion on identification strategy in section 4

unexpected increases in family size resulting from twin births do have a negative effect on IQ scores.

Another factor that may affect parental investment in child quality is the gender ratio of the sibship. Butcher and Case (1994) employ American data for the years 1920-1965 and find that a higher proportion of boys in a sibship increases a girl's educational attainment. They attribute this to a reference group theory, where the early education system focuses on traits that boys are generally deficient in (impulse control and language) while neglecting traits that young girls tend to be deficient in (investigatory and experimental skills). Girls who grow up in a sibship dominated by boys are more likely to excel at typically male traits, and as a result, benefit more from early education. Butcher and Case believe that this benefit carries through to later education, resulting in higher overall educational attainment for girls from these sibships. In particular, they find that having at least one sister reduces the educational attainment of children of either gender by an average of 6 months.

Hauser and Kuo (1998) conduct a follow-up study, using American household data from the late 1980s. They find no evidence that either the proportion or the number of girls in a sibship has any effect on the educational attainment of a female child. They go so far as to argue that Butcher and Case (1994) "made too much of an intriguing, but weak set of findings" (pp. 656).

Garg and Morduch (1998) also examine the effect of sibling gender distribution, using household survey data from Ghana. They employ a composite measure of health outcomes as a proxy for child quality. Garg and Morduch find that children born into a sibling cohort of all girls fare 25-40% better than children born into a sibship of all boys; this effect does not differ

according to the sex of the child in question. They conclude that sibling gender distribution may have a significant effect on a child's welfare.

Another factor that may affect parental investment in a child's education is birth order. In addition to their findings on the effects of family size, Black et. al (2005) conclude that birth order has a significant negative effect on educational outcomes. Children born earlier in the sibship achieve less education on average. Parish and Willis (1993) arrive at the same conclusion, and add that this effect is particularly pronounced if the children born early in the sibship are female.

Tesfu and Gurmu (2013) build on this literature by analyzing the effect of differences between a mother's desired sibship gender distribution and her actual sibship gender distribution on children's educational outcomes. While the effect of a sibship's gender distribution has been examined, Tesfu and Gurmu's study is novel because it accounts for a mother's preferences regarding the gender distribution of her sibship. Using a linear probability model (LPM) and pooled DHS data from 2000 and 2005, they conduct 2SLS analysis for Ethiopia, where parents face significant resource constraints due to low income levels. They conclude that if the proportion of girls in a sibship is higher than the mother desired, children of both sexes face improved educational outcomes.

I extend this analysis by accounting for the gender preferences of both the mother and the father. I apply Tesfu and Gurmu's LPM model to new Ethiopian data from 2011. Adding the father's preferences to the model allows me to account for possible conflict between parents. This allows me to offer a robustness check on their results. Interestingly, I find that gender ratio preferences do not have a significant effect on boys. These differing results may have several explanations, but they suggest that at the very least further analysis is needed.

3. Data

The data for this analysis is taken from the 2011 Demographic and Household Survey of Ethiopia, which was conducted by the Ethiopian Central Statistical Agency. The survey sampled 16 072 households, and woman in each household answered and extensive questionnaire. The goal of the survey was to obtain information regarding HIV/AIDS, fertility control, vaccinations, and other health measures. The surveys conducted by DHS are part of an international initiative, funded by the US Agency for International Development, carried out in many developing countries.

From this sample, I consider 6745 households in which couples are married and both partners are surveyed. I further restrict the sample to households with at least 2 school-aged children (ages 6-18), as this allows measurable differences in educational outcomes (one child attending school and one child not attending school) to be observed. I am left with a sample of 2570 children. My unit of observation is the child.

The key policy variable, the gender ratio gap, is the difference between a family's desired gender ratio and their realised gender ratio. The realised gender ratio is the number of girls in the sibship divided by the total number of children in the sibship. The desired gender ratio for each parent was constructed by asking questions about desired gender preferences.[3] Thus a parent's desired gender ratio is their desired number of girls divided by their desired total number of children.[4] A positive gender ratio gap, therefore, implies that the parent has more female children than they desire.

[3] The survey questions were: ''If you could go back to the time you did not have any children and choose exactly the number of children to have in your whole life, how many would that be? How many of these children would you like to be boys? How many would you like to be girls?"

[4] Some parents gave non-numerical answers to these questions, such as "As God wishes". Children from these households were also excluded from my analysis.

Unified gender ratio preferences were constructed by weighting each parent's desired gender ratio by 50% and then summing them. The gender ratio gaps used in the empirical analysis that follows will contain these unified gender ratio preferences, in order to analyze schooling as a joint household decision. Summary statistics for the selected population are given in Figure 1.

Figure 1: Summary Statistics

Variables	Mean	Standard Deviation	Minimum	Maximum
Child is in school (Dummy)	0.680	0.467	0	1
Male child and in school	0.345	0.476	0	1
Female child and in school	0.335	0.472	0	1
Mother's desired gender ratio	0.472	0.114	0	1
Father's desired gender ratio	0.425	0.133	0	1
Unified desired gender ratio	0.449	0.092	0	0.8
Actual gender ratio	0.514	0.235	0	1
Gender ratio gap	0.065	0.264	-0.75	0.917
Child is female (Dummy)	0.487	0.500	0	1
Child is a twin (Dummy)	0.024	0.152	0	1
Age of the child	10.250	3.330	6	18
Household size	6.881	1.739	3	14
Rural household	0.769	0.421	0	1
Birth order	3.159	2.026	1	12
First wealth quintile	0.218	0.413	0	1
Second wealth quintile	0.171	0.376	0	1
Third wealth quintile	0.163	0.369	0	1
Fourth wealth quintile	0.200	0.400	0	1
Fifth wealth quintile	0.248	0.432	0	1

Note: All statistics are calculated using 2570 observations. All children examined are between the ages of 6 and 18.

We see that 68% of the children examined attend class; 34.5% of the children sampled are male and attend class, while 33.5% of the children are female and attend class. Given that

49% of children in the sample are female, this works out to roughly equal school attendance rates for boys and girls.

The mothers' and fathers' average desired gender ratios are both less than 0.5; this indicates that they prefer, on average, more sons than daughters. Given that the average of the actual gender ratio is 0.51, on average parents will have more daughters than they desire. This is seen in a positive average gender ratio gap of 0.07.

In this sample, 2.4% of children are twins. This will be important in the identification strategy, where twins are employed as an instrument for IV estimation. The average age of children is 10.3, and the average household contains slightly fewer than 7 people. Almost 77% of the children examined are from households that the Ethiopian Central Statistical Agency identifies as rural. Finally, wealth quintiles from the original population of 16 072 households are shown. It is notable that my subsample of children is evenly distributed across the wealth quintiles.

4. Ethiopian Society

Ethiopia is a largely rural society, as 84% of the population lives outside metro areas (CSA, 2009). Agriculture generates 43% of national GDP, and is the predominant rural industry (DHS 2011). It is not a wealthy economy; per capita GNI was estimated at $410 U.S. for the year 2012 ("Ethiopia Country Statistics", 2013).

Ethiopian agriculture consists largely of subsistence, single-family farming (US, 2011). Multi-generational households are common. The division of labour is strict across genders. Male tasks on the farm include plowing, seeding, and harvesting the crops, herding and slaughtering animals, and cutting wood. Female tasks include hauling water, buying and selling spices, brewing beer, making butter, cooking meals, and cleaning the household. Crossover between

these tasks is rare, and women only occasionally helping men in the fields. It is socially undesirable for a woman to be seen doing a man's work (Library of Congress, 2011).

Education rates are very low in the country, though they have increased significantly in recent years. While primary school is compulsory by law, the law is rarely enforced ("Education Policy Data Center: Ethiopia", 2014). The United Nations Children's Fund (UNICEF) estimates that the primary school attendance rate is 64.3% for male children and 65.5% for female children ("Ethiopia Country Statistics", 2013). The decline in attendance from primary school to secondary school is substantial; secondary school attendance rates are estimated to be 15.7% for males and 15.6% for females.

Arranged marriages remain very common in Ethiopia, with matches chosen by the family elders (Library of Congress, 2011). Representatives from the groom's family will travel to a potential bride's household to ask for her hand in marriage. A dowry is paid by the family of the groom to the family of the bride. The dowry may consist of money, livestock, or other items of social value. The value of the dowry will vary based on the wealth of the groom's family and the desirability of the potential bride. The perceived desirability of the bride will depend on physical traits, but also on her upbringing and her earning potential (Kodama, 2013).

Gender discrimination remains a powerful actor in Ethiopian culture. The patriarchal lineage is significantly more important than the matriarchal lineage, and upon marrying, a woman leaves her home to live in the village of her husband (Kodama, 2013). Ethiopia lacks a universal pension program, and elderly parents reside in the home of one of their sons. There is also a perception that men are inherently more able than women, and that education is wasted on female children. Men have an easier time obtaining employment, and are much more likely to be promoted. Male children have far more freedom, and are able to leave the farm to visit friends or

work on neighbouring farms, while female children are expected to remain at home ("Ethiopia", 2014).

While gender discrimination remains a very powerful force in Ethiopia, recent initiatives have made some headway in reducing discrimination and increasing education rates among women. The third of the United Nations Millennium Development Goals related to the economic empowerment of women, with a specific goal of increasing female education rates and providing more jobs for women (Hallward-Driemeier & Gajigo, 2013). This brought increased funding and attention to women's issues in Ethiopia. An Ethiopian government act implemented in 2000, the Revised Family Code 2000, reduced employment barriers for women outside the home. Another government initiative, the Education Sector Development Program (ESDP) was instituted in 2002 with a goal of increasing female education rates (Kodama, 2013).

5. Theoretical Framework

Consider a traditional family unit consisting of a husband, wife, female child, and male child. Suppose that the parents believe that they require equal labour from their male and female children, so they specify their desired gender ratio as 0.5. I will assume that a child's waking hours can be spent either performing labour that benefits the household or obtaining knowledge at school. The waking hours of the female child (t_g) will be split between the hours she spends at school (s_g) and the hours she spends working at home (h_g):

$$t_g = s_g + h_g$$

In the same way, the waking hours of the male child (t_b) will be divided between schooling (s_b) and his gender-specific labour (h_b):

$$t_b = s_b + h_b$$

Parents` utility is specified jointly, as a function of current household wealth (C_0) and future consumption (C_1):

$$Utility = U(C_0, C_1)$$

Current household wealth (C_0) depends on the amount of labour supplied by the members of the household. The man's labour and the woman's labour are assumed constant, regardless of the schooling decisions they make for their children. The man's labour (h_m) and the boy's labour (h_b) are inputs into an agricultural production function $f(\ )$, which is strictly positive. Similarly, the woman's labour (h_w) and the girl's labour (h_g) are inputs into a domestic production function $d(\ )$, which is also strictly positive.

$$C_0 = c(d(h_w, h_g), f(h_m, h_b))$$

As discussed above, there is a significant gender division of labour. As a result, there is very limited substitutability between male child labour (h_g) and female child labour (h_b). A household will require some positive amount of labour from both their male and female children.

Future consumption is a function of the time spent in school by both male and female children:

$$C_1 = f(s_g, s_b)$$

Parents' future consumption depends on their children's schooling for a multitude of reasons. As elderly parents typically reside with the family of one of their sons, they have an incentive to promote the financial well-being of their sons. Similarly, parents have an incentive to invest in the schooling of their daughters, as the dowry parents receive for marrying their daughter depends in part on her social desirability, which is related to her level of education (Kodama, 2013). As a result, increasing the quality of both their male and female children through schooling will increase the parents' consumption in the future period.

As the children spend more time in school, they will nescessarily have less time to complete their gender-specific household labour. Therefore, parents' choices regarding their children's education can be interpreted as balancing a trade-off of current consumption and future consumption.

The parents in this simple family will require some minimum amount of labour from both their male and female child in order to satisfy their current consumption needs. If there is time remaining after satisfying the household's current consumption needs, they will want to have their children in school so as to increase future consumption.

Now suppose that a third child, a girl, is born into this family. This will result in a positive gender ratio gap, as there are now proportionately more girls in the family than the parents desired. The additional child will marginally increase the minimum household wealth required in the current period. However, once this girl is old enough, she will add additional hours to the domestic labour pool. Now that the need for domestic child labour is split between two female children, we would expect to see increased education for both these children.

This simple model gives the basic intuition behind the expected effect of the gender ratio gap. Given that parents are conscious of the social norms regarding the gender division of labour, they will specify their desired gender ratios in anticipation of their child labour needs. As a result, having proportionately more girls than desired results in more female child household labour (h_g) than the parents require. This will increase the education rates of the girls in this sibship by freeing up more time for them to attend school. Parents will have more than enough labour from their daughters to attain a satisfactory level of current consumption, and therefore can send them to school to increase future consumption. Thus, we expect a positive relationship between the gender ratio gap and a girl's likelihood of attending school.

Prima facie, it may appear that a similar relationship should exist for male children. A positive gender ratio gap, which also implies fewer boys than desired, could decrease a boy's likelihood of attending school by an analogous argument. This does not appear to be the case for two reasons. First, as discussed in section 4, there is a belief that the return on education for boys is higher than for girls. This will render the schooling of boys less sensitive to changes in the gender ratio gap than the schooling of girls. Second, there is more flexibility of labour demand in the agricultural sphere in which boys work. Parents faced with a higher proportion of boys than expected may expand their farm, adopt more labour intensive farming techniques, or send some of their boys to work on neighbouring farms.[5] As a result of these factors, parents may be less willing to modify their schooling decisions in response to a gender ratio gap of either direction.

6. Empirical Model

The model I will employ here was first proposed by Tesfu and Gurmu (2013):

$$y_{ij}^{*} = \delta_o + \delta_1 S_{ij} + \delta_2 (r_j - d_j) + \delta_3 (r_j - d_j) * S_{ij} + X_{ij}'\beta + Z_j'\gamma + \mu_j^{*} + \varepsilon_{ij}^{*}$$

Let j(j=1,…..,n_j) index the households and i(i=1,…..,n_i) index the children in that household. The variable y_{ij}^{*} is an unobserved variable that represents the demand that parents from family *j* have for child *i*'s school attendance. S_{ij} is a gender dummy variable that takes a value of 1 if child i is a girl, r_j is the ratio of the number of girls over the total number of children in family *j*, and d_j is the ratio of the number of girls desired over the total number of children desired in family *j*. The variable of interest, the gender ratio gap $(r_j - d_j)$, gives the difference between these two measures. X_{ij} is a vector that contains the child-specific characteristics age and birth

[5] This same flexibility of labour supply does not seem to be present, or at least not to the same extent, in the domestic sphere in which female children work.

order, and Z_j is a vector that contains the household-specific characteristics family size and wealth quintile. The wealth quintiles were already constructed in the DHS data, and are discussed in the data section. For illustrative purposes, the error term has been split into two parts: μ_j^* represents unobserved household characteristics, while ε_{ij}^* is the idiosyncratic error term.

To implement this, I employ the following linear probability model:

$$y_{ij} = \delta_0 + \delta_1 S_{ij} + \delta_2 (r_j - d_j) + \delta_3 (r_j - d_j) * S_{ij} + X'_{ij}\beta + Z'_j\gamma + \epsilon_{ij}$$

Where y_{ij} is a binary variable for school attendance that takes a value of 1 if the child is currently attending school.

Early discussions of this paper have raised the issue that the desired sibship gender ratio may change over time due to interactions parents have with their children. Thus, it may be problematic to interpret the desired gender ratio as determined prior to the parents having children. Instead, the desired gender ratios should be seen as indicative of how the parents currently feel about their sibship. It can be argued that the decision of whether or not to send a child to school depends solely on parents' current gender preferences, and not on their gender preferences past or future. Therefore, the desired gender ratios are representative of how the parents would like to change the gender distribution of their sibship. If panel data were available, a dynamic relationship between the gender ratio gap and schooling decisions could be analyzed, but I believe the static relationship examined here is also worthy of analysis.

7. Identification Strategy

An identification strategy must be considered, as there is potential endogeneity in the linear probability model specified above. The concern is that unobserved household

characteristics in the error term may be correlated with both the gender ratio gap and with a child's likelihood of attending school. Potentially problematic unobserved household characteristics include parental views regarding the value of education for both female children and male children. These unobserved parental preferences will certainly affect a child's likelihood of attending classes. Given that Ethiopian society regards education as more beneficial for boys, this will result in a negative bias on both the gender ratio gap coefficient and its interaction with the female dummy.

It also seems likely these preferences will be correlated with the gender ratio gap. The issues of sex-selective abortion and infanticide are not prevalent in Ethiopia, so the realised gender ratio (r_j) can be treated as exogenous. However, the desired gender ratio (d_j) may be affected by these parental preferences. If parents view the returns on education to be much higher for boys, this will affect both their desired gender ratio and the respective likelihoods of boys and girls attending school.

To address this endogeneity, Tesfu and Gurmu (2013) propose three instruments. The first is the gender ratio of the mother's own siblings. This may be correlated with the desired gender ratio (d_j) in one of two ways: Either the mother enjoyed the gender distribution in her own sibling cohort and wants to replicate that with her children, or she did not enjoy the gender distribution in her sibling cohort and seeks some other distribution for her own children. Information on the fathers' siblings was not available in the survey. As a result, this instrument may be weaker than it was in Tesfu and Gurmu's study.

Same-sex twin births are also used to address potential endogeneity. Twin births (of either same or mixed sex) have been used in the literature (Rosenzweig & Wolpin, 1980; Black et al., 2005; Black et al., 2010) as an instrument for family size when the researcher is concerned

about the effect of family size on a child's educational attainment. A twin birth creates unexpected variation in family size that can be treated as exogenous. This variation will be correlated with family size, but will not be correlated with anything in the error term (such as parental views on education).

A similar logic can be applied to same-sex twin births (either two male twins or two female twins). When parents are expecting a child, they expect that movement in their realised gender ratio (r_j) will shift their gender ratio gap in one of two possible ways, depending on the sex of the child. When a same-sex twin birth occurs, there is unexpected variation in their realized gender ratio that can be treated as exogenous. This will affect their gender ratio gap, but should not be correlated with parental views regarding the value of female education versus male education. Therefore, female same-sex twin births and male same-sex twin births are also employed as instruments.

Figure 2: Summary Statistics - Instruments

Variable	Mean	Standard Deviation	Minimum	Maximum
Gender ratio of mother's own sibship	0.475	0.2423	0	1
Family has experienced a male same-sex twin birth	0.048	0.214	0	1
Family has experienced a female same-sex twin birth	0.033	0.180	0	1

Note: All statistics are calculated using 2570 observations. All children examined are between the ages of 6 and 18.

Summary statistics for the instruments described above can be seen in Figure 2. The gender ratio of the mother's own sibship is less than 0.5, which is to be expected as the mother

herself was not included in the calculation.[6] Of the children in the sample, 4.8% come from a family where at least one male same-sex birth occurred, while 3.3% come from a family where at least one female same-sex twin birth occurred. These percentages are significantly larger than the literature deems necessary for same-sex twin births to function effectively as instruments (Black et al., 2005).

The empirical approach I will undertake using these instruments was introduced by Wooldridge (1997, 2003). This modified application of the IV approach is necessary because the potentially endogenous variable, gender ratio gap $(r_j - d_j)$, interacts with another variable (the female dummy S_{ij}). In order for the procedure to produce consistent estimates, the following conditions must hold:

1. The endogenous variable must be continuous.

2. The model must be linear in the endogenous variable.

3. The instruments may only influence the likelihood of a child attending school through their effect on the gender ratio gap.

Given that these conditions hold, the procedure involves regressing the gender ratio gap $(r_j - d_j)$ on the three proposed instruments and all of the control variables:

$$\widehat{(r_j - d_j)} = \eta_0 + \eta_1 MGR_j + \eta_2 MT_j + \eta_3 FT_j + X'_{ij}\beta + Z'_j\gamma + u$$

Where MGR_j *is* the gender ratio of the mother's own sibship, MT_j is a dummy variable that takes a value of one if a male same-sex twin birth has occurred in family j, and FT_j is a dummy variable that takes a value of one if a female same-sex twin birth has occurred in family *j*.

[6] Not including the mother in the calculation of her own sibship gender ratio was done in order to conform with Tesfu and Gurmu (2013).

The predicted gender ratio gap values ($\widehat{r_j - d_j}$) are then used as instruments in the standard IV procedure. As long as the conditions listed above hold, this procedure will generate consistent estimates of the effect of gender ratio gap on education.

8. Results

The results obtained from LS regressions can be seen in Figure 3. None of the variables of interest are statistically significant at conventional levels. Given the downward bias that unobserved household characteristics may cause for both the gender ratio gap estimate and its interaction with the female dummy, this is not entirely surprising.[7]

Figure 2: Least Squares Results for school attendance

Variables			
Intercept	0.669***	0.232**	0.232**
	(0.016)	(0.118)	(0.110)
Child is female	0.022	0.016	0.016
	(0.0210)	(0.019)	(0.019)
Gender ratio gap	0.019	0.005	0.005
	(0.060)	(0.050)	(0.046)
Gender ratio gap*female	0.052	0.058	0.057
	(0.078)	(0.070)	(0.068)
Controlling for age		✓	✓
Controlling for household size		✓	✓
Controlling for birth order		✓	✓
Controlling for wealth		✓	✓
White's Correction			✓

*Note: Dependent variable is a dummy for school attendance, taking a value of 1 if the child is attending school. Dummy variables are employed to control for age, household size, birth order, and wealth. Standard errors are reported below the coefficient estimates. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels respectively.*

[7] See section 4 for a discussion of this downward bias.

In order to control for this potential endogeneity, I will now undertake the modified IV approach described in section six. The first stage results can be seen in Figure 4. The birth of a male twin and the birth of a female twin are both statistically significant at the 1% level. The gender ratio of the mother's own siblings is not statistically significant, but I have included it in the IV regression because theory dictates that it may have an effect.[8]

Figure 4: First Stage Results [Dependent Variable: Gender Ratio Gap]

Variables	Coefficient
Intercept	0.190***
	(0.067)
Gender ratio of the mother's siblings	0.003
	(0.019)
Birth of a female twin in the family	-0.168***
	(0.026)
Birth of a male twin in the family	0.159***
	(0.023)
Controlling for age	✓
Controlling for household size	✓
Controlling for birth order	✓
Controlling for wealth	✓

*Note: Dependent variable is the gender ratio gap. Dummy variables are employed to control for age, household size, birth order, and wealth. All controls are included in the regression. Standard errors are reported below the coefficient estimates. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels respectively.*

From this regression, predicted gender ratio gap values are generated. These values are then used as instruments in the traditional IV procedure. Results of this procedure can be seen in column one of Figure 5.

[8] See section 6 for a discussion.

Figure 5: Instrumental Variable Results for School Attendance

Variables	1 School Attendance	2 School Attendance - Rural
Intercept	0.264** (0.131)	0.260 (0.171)
Child is female	0.045 (0.050)	0.074 (0.061)
Gender ratio gap	-0.035 (0.237)	0.280 (0.318)
Gender ratio gap*female	0.759** (0.314)	0.687* (0.383)
Controlling for age	✓	✓
Controlling for household size	✓	✓
Controlling for birth order	✓	✓
Controlling for wealth	✓	✓
White's Heteroskedasticity Correction	✓	✓

*Note: Dependent variable is a dummy for school attendance, taking a value of 1 if the child is attending school. Dummy variables are employed to control for age, household size, birth order, and wealth. Standard errors are reported below the coefficient estimates. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels respectively.*

Again, the gender dummy variable alone has no statistically significant effect on a child's likelihood of being in school. Furthermore, the gender ratio gap does not affect a boy's chances of attending school. The gender ratio gap, however, does have a statistically significant effect on female children. The positive coefficient (0.759) indicates that an increase in the gender ratio gap will result in an increase in a girl's likelihood of attending school. As the motivation we have discussed primarily relates to rural households, I next subsample to examine only children from rural families, which represents 76% of the initial sample.[9] These results can be seen in column

[9] Rural was defined by the Ethiopian Central Statistical Agency, and was taken directly from the data.

two of Figure 5. Again, the gender ratio gap is only statistically significant for female children, with a positive coefficient of 0.687.

As the gender ratio gap is bound between -1 and 1, obtaining a practical interpretation of this coefficient requires some manipulation. One method of interpretation, suggested by early viewers of this research, can be seen in Figure 6. This interpretation employs the full-sample results from column one of Figure 5, but the rural subsample generates qualitatively consistent estimates.

Figure 6: Interpreting the IV Results

Variables	**1** **Boy 1**	**2** **Girl 1**	**3** **Boy 2**	**4** **Girl 2**	**5** **Boy 3**	**6** **Girl 3**
Age	10	10	10	10	10	10
Household Size	6	6	6	6	6	6
Birth Order	3	3	3	3	3	3
Wealth Quintile	3	3	3	3	3	3
Gender Ratio Gap	0	0	-0.25	-0.25	0.25	0.25
Predicted Probability Of Attending School	0.72	0.77	0.73	0.60	0.71	0.95

Note: All predictions generated using the full-sample IV estimates from column one of Figure 5.

Column one of Figure 6 describes a ten-year-old boy who is the third-born child in a family of four children, from the middle wealth quintile. This family has a gender ratio gap of zero, meaning that the actual gender distribution of the sibship is identical to the parents' desired gender distribution. The model predicts that this boy has a 72% probability of attending school. In column two, we see how the predicted probability would change if the same child had been born a girl; the girl's predicted probability of attending school is 77%. This comparison is primarily useful as a baseline case.

Column three describes a boy with identical characteristics to those described above, but born into a family with a gender ratio gap of -0.25. This negative gender ratio gap indicates that the family has proportionately fewer daughters than desired. This has little effect on the boy's chance of attending school; his predicted probability remains relatively stable at 73%. However, we see in column four that if the same child had been born a girl, the predicted probability of attending school decreases to 60%.

Columns five and six show a boy and girl child with identical characteristics to those in previous columns, but born into a family with a positive gender ratio gap of 0.25. A positive gender ratio gap implies that the parents have proportionately more daughters than they desired. Again, this gender ratio gap has little effect on the boy's predicted probability of attending school (73%), but it increases the predicted probability of the girl attending school to 95%.

9. Comparison to Previous Work

It is notable, but perhaps not surprising, that I obtain slightly different results than those generated by Tesfu and Gurmu (2013). While they find that gender ratio gap has a positive relationship with the likelihood of attending school for children of both sexes, I find this relationship to hold only for female children. This may be explained by the several differences between the scenario they examine and the one analyzed in this paper.

Tesfu and Gurmu work with pooled data from the 2000 and 2005 Ethiopian DHS surveys, while I used the 2011 survey. In the interim there were several changes in Ethiopia that may influence the relationship of interest. First, the legal marriage age increased from 15 to 18 in 2005 (Kodama, 2013). Given the prevalence of early marriage for girls, this change lowered the opportunity cost of educating a female child. Second, the Education Sector Development Program was instituted in 2002 by the Ethiopian government, with the intention of increasing

education rates both overall and in particular among women. The increased funding for education that accompanied this initiative lowered the cost of educating children of either sex. Finally, Ethiopia was at war with the neighbouring country of Eritrea from 1998 to 2000. This conflict may have affected the results of Tesfu and Gurmu, but likely had little bearing on my own.

Tesfu and Gurmu (2013) examine children from every household surveyed that had more than two school aged children. In contrast, my sample was restricted to children from families in which the parents are married and both reside in the household. I therefore avoid any differing family dynamics that may exist in single parent households, rooming houses, or other possible living arrangements.

I will not begin to postulate as to the possible mechanisms through which these factors may have shifted the relationship between the gender ratio gap and the education of male children. I merely want to illuminate some possible explanations for the differing conclusions reached in this paper and the work of Tesfu and Gurmu.

10. Conclusion

A gender ratio gap, or a difference between parents' desired sibship gender ratio and their realised gender ratio, affects female children's likelihood of attending school. A positive gender ratio gap, which occurs when parents have proportionately more girls than they desired, corresponds with increased school attendance rates for girls. A negative gender ratio gap, which occurs when parents have proportionately less girls than they desired, corresponds with decreased school attendance rates. Notably, neither a positive gender ratio gap nor a negative gender ratio gap affects a male child's likelihood of attending school. The fact that the effect of a gender ratio gap on a child's likelihood of attending school differs according to their sex has

potential policy implications. Existing initiatives such as the Education Sector Development Program should be continued and increased, with a goal of eliminating gender-related barriers to education. Information campaigns to educate families about the potential returns to educating their children, in particular their daughters, may serve to raise education rates for children of both sexes.

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