Born in the Family:
Preferences for Boys and the Gender Gap in Math[1]

Gaia Dossi, London School of Economics
David Figlio, Northwestern University and NBER
Paola Giuliano, UCLA and NBER
Paola Sapienza, Northwestern University and NBER

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Abstract

We study the effect of preferences for boys on the performance in mathematics of girls, using evidence from two different data sources. In our first set of results, we identify families with a preference for boys by using fertility stopping rules in a large population of households whose children attend public schools in Florida. Girls growing up in a boy-biased family score on average 3 percentage points lower on math tests when compared to girls raised in other types of families. In our second set of results, we find similar effects when we study the correlations between girls' performance in mathematics and maternal gender role attitudes, using evidence from the National Longitudinal Survey of Youth. We conclude that socialization at home can explain a non-trivial part of the observed gender disparities in mathematics performance and document that maternal gender attitudes correlate with those of their children, supporting the hypothesis that preferences transmitted through the family impact children behavior.

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Introduction

Boys tend to outperform girls in mathematics, especially in the upper tail of the distribution (Hyde and Mertz, 2009; Ellison and Swanson, 2010). These gender differences in math have potentially large consequences for gender gap in salaries. While there are many factors that bear on educational choices, underperformance in math is potentially a discouraging factor to enter STEM (Science, Technology, Engineering, and Math) fields (Card and Payne, 2017). Indeed, women are less likely to major in STEM subjects (National Science Foundation, 2015) and are underrepresented in STEM fields in both academic and private sector jobs (Altonji, Blom, & Meghir, 2012; Borghans & Groot, 1999; Carnevale, Smith, & Melton, 2011; Executive Office of the President, 2012; Joy, 2006). Evidence shows that STEM majors are good predictors of future occupation and lead to higher earnings (Altonji and Blank, 1999).[2]

Recent research, in the U.S. and around the world, has shown that the gender gap in mathematics is strongly correlated with women's emancipation and societal norms regarding women's role in society. Guiso et al. (2008) show correlations for a large set of countries. Nollenberger et al. (2016) replicate this result among second-generation immigrants in various destination countries and Pope and Sydnor (2010) find that this relationship also exists across states in the United States.

Several mechanisms might contribute to explain the correlation between gender role values and performance in mathematics. Possible non-exclusionary explanations include differences in opportunities in the labor market that induce lower investments in certain disciplines by female students, or psychological effects of stereotypes in schools (Carlana, 2019). Also, developmental psychologists have suggested that many stereotypical threats begin at home through parental transmission, as parents systematically treat girls and boys differently (Lytton and Romney, 1991; Block, 1976; and Hoffman, 1977).

Disentangling empirically these different mechanisms has been difficult due to lack of data. In this paper, we study whether socialization within the family can partially explain the gender gap in mathematics in the U.S., following the theoretical contribution of Bisin and Verdier (2001).

We exploit two different empirical strategies and datasets in order to investigate the link between family attitudes and girls' math performance. First, we measure gender biases inside the family by exploiting fertility patterns. Bharadwaj et al. (2015) and Dahl and Moretti (2008) found evidence of parental preferences for boys over girls by showing that the number of children in the U.S. is significantly higher in families when the firstborn is a girl. Following this literature, we investigate

[2] For causal evidence of the importance of math and STEM on earnings see Cortes et al. (2015), Goodman (2019), Joensen and Nielsen (2009, 2016), Kirkeboen et al. (2016) and Taylor (2014),

whether different fertility patterns correlate with girls' math performance. Using a unique dataset matching administrative data for public schools in Florida with birth certificates, we first define "boy-biased" families (those families with a fertility stopping rule biased towards sons) and then test whether performance in mathematics is indeed lower for girls raised in these families. We find that girls raised in gender-biased families have a three percentage point lower performance in standardized math tests than girls raised in other families.

Fertility stopping rules could be a noisy proxy for gender roles attitudes inside the family, as a specific fertility pattern could simply be a reflection of randomness. To limit this concern, our second strategy uses the National Longitudinal Survey of Youth 1979 (NLSY79) and test the existence of a correlation between test scores in mathematics and maternal measures of attitudes towards gender roles. The advantage of the NLSY is that preferences on gender roles are measured explicitly, unlike the Florida's sample. Indeed, for every family in our sample, we can directly link the individual gender role attitudes of the mother with the gender attitudes of their own children and their performance in mathematics. This strategy is a step forward vis-à-vis the existing literature (Guiso et al., 2008 and Pope and Snydor, 2010) which attributes to each individual average local societal gender attitudes.

We show that maternal attitudes regarding the role of women in society correlate with girls' test scores in mathematics but do not correlate with boys' performance in mathematics. We also confirm in this sample that maternal attitudes toward gender equality correlate with children's attitudes, an indication that gender role attitudes are transmitted inside the family from parents to children at an early age (Farre and Vella, 2013; Dhar et al., 2015).

1. Data and outcomes of interest

1.1. Florida Department of Education Data

For our first set of results, we employ a unique dataset containing demographic and school information on the universe of students born in Florida. The Florida Departments of Health and Education merged individual-level information from the Florida Bureau of Vital Statistics birth certificates with individual level public school records from the Florida Education Data Warehouse (FLDOE) for the purpose of this paper. Birth certificate data include all children born in Florida between 1994 and 2002, while the school data contain information on every K-12 student who attended Florida public schools between the academic year 2002-2003 and 2011-2012.[3] Overall, our

[3] The match between the school records and the birth certificates was implemented by the Florida agencies based on three dimensions: the first and last name, the date of birth, and the social security number; the agencies removed individual identifiers before providing the data for research purposes. The sample of birth records of children born in Florida from 1994 to 2002 consists of 2,047,633 observations. Of these individuals, 1,652,333 were present in Florida public school

sample contains information for nine birth cohorts born between 1994 and 2002 and attending public schools between 2002-2003 and 2011-2012.

The Florida birth certificate data permit us to measure a household's fertility structure and to obtain information on a large set of socio-economic characteristics of the mother (such as level of education, marital status, year and month of birth, and the zip code at the time of birth). Birth certificates also contain information on the number of older siblings (but not their gender) and a unique identifier for the mother, which allows us to reconstruct the household siblings' composition. The FLDOE data contain information on standardized test scores in mathematics (the Florida Comprehensive Assessment Test, or FCAT) from third through tenth grade, in addition to children's individual and family characteristics including age in month and gender, receipt of reduced or free lunch, and whether the child participates in a special education program.[4] More details about each variable are contained in the Online Appendix.

We conduct two sets of analyses using the Florida data. First, using observations at the family level, we replicate in our sample the fertility results of Dahl and Moretti (2008) and confirm that in Florida, like in the rest of the U.S., fertility is higher, conditional on having a girl as a first child. Second, having classified families according to their gender preferences as implied by fertility patterns, we use student-year level observations to test whether girls' test scores in mathematics vary based on these family parental preferences for boys versus girls.

Sample for fertility regressions. We estimate the fertility relationship at the family level. We restrict our sample to those families for which the first child was born after 1994, the first year for which we have access to birth certificate data that permits sibling identification. This restriction is necessary because birth certificates report the number of older siblings, but not their gender, therefore the only way to have the gender composition of the entire family is to have the birth certificate for each child. We remove all the families for which we cannot reconstruct the fertility history and the gender of all children due to missing birth certificates and families who have children from an unknown father. Given that fertility decisions are different for first generation immigrants (Blau, 1992) and that gender preferences differ across countries (Guiso et al., 2008), we also eliminate from our sample families

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data. The match rate of 81% is consistent with the percentage of children who are born in Florida, reside there until school age, and attend public school, as calculated from the Census and the American Community Survey for the corresponding years. More details on the match are provided in Figlio et al. (2014). We further restrict the sample to children who were in the Florida public school system between 2002 and 2011. This leaves us with 1,596,753 observations.

[4] The FCAT (Florida Comprehensive Assessment Test) is the state's high-stakes criterion-referenced test. Students enrolled in public school in grades 3 through 10 are required to take the math portion every year. Students are also tested in reading, but we focus on math because of the broad-based public discussion of women and STEM. Categories for special education include mentally handicapped, orthopedically, speech, language, or visually impaired, deaf or hard of hearing. It also includes students with emotional or behavioral disabilities, with autistic spectrum disorder and other forms of serious disabilities (such as students with traumatic brain injuries).

that have an international background (families whose mothers are born outside the United States and families where at least one child does not speak English at home). This reduces the likelihood that our results are driven by families engaging in selective abortion in favor of sons, as Almond and Edlund (2008) find evidence of sex-selection among certain groups of migrants to the U.S., but not among US-born. However, our results are robust if we did not exclude students with an international background. We also drop from our sample mothers who had their first child when they were still teenagers (younger than 15 years old): at that age fertility is likely to be unplanned; in addition, it is likely that these mothers will complete their fertility outside of our time window. Finally, we drop from the sample families with twins (it is difficult to define birth order) and those observations for which the birth order is not reported or for which there is an inconsistency between the reported birth order and the year of birth of the child based on the birth certificate. More details on the data construction are provided in the Appendix.

The main challenge for the reconstruction of the completed fertility is due to the fact that we can observe the maternal fertility history only up to 2002 (the last year of our birth certificates data). Thus, we cannot rule out that the mothers in our sample have additional children born after 2002. To address this issue, we use a probabilistic methodology based on national fertility patterns estimated from the American Community Survey (ACS) and we attribute to each woman in our sample a probability that she has completed her fertility by 2002.

More specifically, our methodology is the following: We attribute to each mother in the Florida dataset a probability that her fertility is completed. We calculate this probability empirically using information on completed fertility of mothers with similar characteristics (number of children and age at which she had each child) in the ACS. We then keep only those observations for which the probability that the mother has completed her fertility exceeds 90 percent. The details of the procedure with some examples of corresponding probabilities and the robustness to different probability thresholds for completed fertility are reported in the Online Appendix (Table A1 and A2). Using these restrictions, the number of families left in the sample is 129,686. The details of the construction of the sample are provided in section 1.1 of the Appendix. It is worth noting that the final sample contains more affluent families than the overall Florida's population of public school kids. Descriptive statistics at the family level are reported in Table 1, Panel A.

Sample for test score regressions. The test score regressions are estimated at the student-year level. We start with all students belonging to one of the families in our fertility sample. We then limit our attention to children/years for which we observe a math score and who attended sixth grade or higher, as the literature shows that the gender gap in mathematics starts appearing during junior high school

(Fryer and Levitt, 2010). Because the math tests have changed over time, we standardize test scores to zero mean and unit variance at the grade/year level across the sample of all students who attend public schools in Florida. Details on the way this standardization is done is described in the appendix.

Our goal is to identify biases in the family using the "differential stopping" fertility behavior. Thus, following Bharadwaj et al. (2015), we build a measure of son preference based on household's fertility decisions. Boy-biased families are families where all children are girls except for the last born. For example, for a family with two children, a boy-biased family has a girl as first born and a boy as second born; for a family with three children, a boy-biased family has two girls as first two children and the last child is a boy, and so on. To illustrate the construction of our variable and our identification strategy, Section 3 in the Appendix, describes the different fertility patterns of the families classified as boy-biased and the observations included in the regressions. We compare the performance of girls from boy-biased families with the performance of girls from any other type of family. In the regressions the lastborn is always excluded, as there are no lastborn girls in a boy-biased family (our results are robust to the inclusion of the last born as shown in Table A3). The sample statistics at the student level are contained in Table 1, Panel B.

Because our initial sample of families was selected by excluding mothers with teen pregnancies and families with unknown fathers, this sample is highly selected and contains more affluent families compared to the overall population of students in public school. Indeed, the average math score is 0.40 and only 27% are entitled to free lunch. This type of selection is not an issue when we use the NLSY, in the second part of the paper, because gender biases are not calculated based on fertility patterns.

1.2 National Longitudinal Survey of Youth (NLSY79)

We use the 1979 National Longitudinal Survey of Youth (NLSY79) to expand our analysis and test directly the importance of cultural transmission. As discussed above, fertility stopping rules have some limitations when used as a proxy for gender role attitudes. While the NLSY79 sample is too small to define gender biases using fertility stopping rules, it contains survey-based information on gender role attitudes for all the mothers and children in the sample, as well as performance in mathematics for the children, nicely complementing our previous analysis. Performance in mathematics in the NLSY79 is measured using the Peabody Individual Achievement Test (PIAT), a test administered to children aged five and over. It is among the most widely used brief assessments of academic achievement, with demonstrably high test-retest reliability and concurrent validity. We study whether maternal attitudes about gender roles correlate with performance in mathematics for boys and girls. As evidence of cultural transmission, we correlate maternal gender roles attitudes and those of their children. We only examine the importance of maternal (and not paternal) gender roles on performance in mathematics because the NLSY79 follows the offspring of women, but not the ones of men.

Maternal gender role attitudes. The original NLSY79 sample contains data on 12,686 young individuals aged between 14 and 22 interviewed between 1979 and 2014 (yearly interviews until 1994 and biennially after). From the original sample, we focus on the 4,934 women who had at least one child during the survey period. For this sample, we obtain data on maternal gender roles attitudes, measured using the following three questions: 1) A woman's place is in the home, not in the office or shop; 2) It is much better for everyone concerned if the man is the achiever outside the home and the woman takes care of the home and family; 3) Women are much happier if they stay at home and take care of their children. For each statement, respondents were asked if they strongly disagreed, disagreed, agreed, or strongly agreed (on a range from 1 to 4). We only keep the women who have non-missing values for all of the three questions in at least 1987 or 2004.[5] We consistently coded the questions so that a higher number indicates more traditional gender roles and calculated the principal component of all the variables. We also use the following control variables in our regressions: birth year, age at birth of each child, income, education, race, relationship status and the Census macro region of residence.

Sample for test score regressions. Starting from 1986, and every two years, two separate surveys, the NLSY Children and the NLSY Young Adults, were administered to the children of the original 1979 NLSY79 sample for two different age ranges (between the age of 10 and 14, and older than 14). We use these surveys to obtain data on test scores in mathematics, along with information on gender, age, birth order, and grade attended, and link these observations to maternal gender roles attitudes. We keep all the student-year observations (unbalanced panel) for which we have scores in mathematics in any grade from 6th to 10th, parallel to the analysis performed with the FLDOE dataset. Our sample consists of 8,328 year-grade observations, corresponding to 6,185 students (3,065 boys and 3,120 girls). The descriptive statistics for this sample are presented in Table 1, Panel C.

Sample for intergenerational transmission in gender roles attitudes. We also use the Children and Young Adults Sample to link maternal gender roles to the gender roles of their children. Gender role attitudes are measured in a different way in the Children and Young Adults Sample[6].

[5] While some of these questions were asked also in 1979 and 1982, we excluded those years since at that time the youngest women in the sample were, respectively, 15 and 18 years old and we think that at that age gender role preferences may not be completely formed.
[6] Starting from 2002, gender role questions were asked also to children between 14 and 16. We drop children older than 14 to be consistent with the earlier sample (in the earlier waves, these questions are asked only to 10-14 year-olds). However, for robustness, we also run regressions with the complete sample.

In the Children Sample, gender role attitudes are measured using answers to the following six questions: 1) Girls and boys should be treated the same in school; 2) A girl should not let a boy know she is smarter than he is; 3) Competing with boys in school would make a girl unpopular with boys; 4) A girl should pay her own way on dates; 5) If there is not enough money for all the children in a family to go to college, the boys should get to go instead of the girls; 6) It is perfectly okay for a girl to ask a boy for a date, even if he has never asked her.[7] For each statement, the children were asked if they strongly agreed, agreed, disagreed, or strongly disagreed. We recoded the questions so that a higher score always means a more gender biased answer. We combined all the questions using a principal component analysis. In the Young Adults Sample, gender roles attitudes are measured through the same questions asked to their mothers. For each child and for each year, we compute a measure of gender role attitudes through principal component analysis (like we did with the mothers' sample).

The children sample consists of 8,433 observations (4,126 boys and 4,307 girls) corresponding to 5,380 children (2,668 boys and 2,712 girls). We present the descriptive statistics in Table 1, Panel D. The sample of young adults consists of 13,502 observations (6,536 boys and 6,966 girls), corresponding to 6,644 children (3,335 boys and 3,309 girls). Descriptive statistics for this sub-sample are shown in Table 1, Panel D.

2. Results

2.1 Florida evidence: Demand for boys

Using Census data, Dahl and Moretti (2008) present evidence consistent with the notion that parents in the U.S. favor boys by observing the ex-post stopping fertility decisions of U.S. families. Before we conduct our main analysis, we want to confirm whether these results hold in the Florida sample. We use the same intuition of Dahl and Moretti (2008) and identify higher preferences for boys by testing whether fertility is higher for those families where the firstborn is a girl.

In Table 2, we investigate the effect of having a girl as a firstborn on various fertility outcomes. In the first column, we regress the total number of children in the household on a dummy variable which is equal to one if the firstborn child is a girl.[8] The coefficient is positive, statistically and

[7] For every year in which such questions are asked, we include only observations for which we have non-missing answers on all the questions.

[8] All the models control for a vector of households' characteristics: race dummies (including a dummy for whether the family is a mixed race family), a dummy for whether any child in the household is enrolled in a special education program, two proxies for family income (whether any of the children in the household has ever received free or reduced lunch, and median income in zip code of residence at birth*10,000 averaged across all children in the household), dummies for maternal education (whether the mother has graduated from high school, has attended some college, has graduated from

economically significant: compared to a family where the firstborn is a boy, the total number of children in the household increases by 4.2 percent. In columns 2-4, we regress the probability of having, respectively, two or more, three or more, or four or more children on having a firstborn daughter; each probability increases between 2.5 and 3.4 percent with a firstborn daughter.

2.2 Florida evidence: Family gender bias and girls' performance in mathematics

Given that we confirm a bias for boys in the Florida sample, our next step is to establish whether girls raised in a "boy biased" household have lower math performance than do other similar girls not raised in such families. Table 3 reports different specifications of girls' performance in mathematics from sixth to tenth grade. As discussed previously, in all columns we drop the last born because we do not have a comparison group for last born girls in boy-biased families (as, by construction, the last born is always a boy in a boy-biased family).

All our regressions contain a large set of controls, including age in months, race dummies, a measure of low-income status (measured by a dummy equal to one if the student is eligible to receive free or reduced lunch or attends a "provision 2" school), the median income of the zip-code at birth and a measure for whether the student has some special educational needs. We also control for maternal characteristics (educational attainment, marital status at time of birth, age at time of birth), birth order, grade, school and year fixed effects. [9]

In column (1) of Table 3, we use the largest sample. We then split the sample by family income (columns 2 and 3) and maternal education (columns 4 and 5). To proxy for income, we distinguish between families with children enrolled in the free or reduced lunch program for at least one year (column 2) and families where no child is ever enrolled in the free or reduced lunch program (column 3). For the maternal education sub-samples, we focus on those families where the mother at most obtained a high school diploma (column 4), or attended at least one year of college (column 5). We find that girls in "boy biased" families have around three percent of a standard deviation lower math test scores than do those raised in other families. To put this figure in perspective, this coefficient is around one-fourth the size of the difference between children of high school graduate mothers and those of high school dropout mothers. When we split the sample by socio-economic status or maternal

college), maternal age at first birth (in addition to the linear term, we include a squared and a cubic term for maternal age), a dummy for whether the mother was married when she had her first child.

[9] To qualify for free or reduced lunch, the family income has to be respectively below 185% and 130% of the federal income poverty. For details on provision 2 schools see http://www.fns.usda.gov/school-meals/provisions-1-2-and-3. Categories for special education include mentally handicapped, orthopedically, speech, language, or visually impaired, deaf or hard of hearing. It also includes students with emotional or behavioral disabilities, with autistic spectrum disorder and other forms of serious disabilities (such as students with traumatic brain injuries. For maternal education, we define dummies for high school completion, some years of college, and four or more years of college. In the regressions the excluded dummy is high school dropout mothers.

education, the coefficient is larger for the relatively advantaged families, but there is insufficient power to statistically differentiate the coefficients between the two groups. These results are consistent with other findings in the literature. Reardon et al. (2018) find that the gender gap in mathematics is more pronounced in socioeconomically advantaged school districts. The same authors find that socioeconomic variables do not explain the gender gap in reading. Fryer and Levitt (2010) also find that girls fall behind boys in math relatively more in families with higher maternal education.

As a placebo exercise, in the Appendix, we perform a parallel analysis in which we compare the math performance of boys raised in "girl-biased" families with those raised in other types of families (sample statistics and results are presented in Tables A4 and A5). The measure of "girl-biased" is symmetric to "boy-biased": a dummy equal to 1 if all children are boys with the exception of the last born, and equal to 0 for all the other families. Counter to the estimated effects of "boy bias" on girls' math performance, we observe no effect of growing up in "girl-biased" families on boys' math performance.

There are various limitations of this analysis that derive directly from the way a boy-biased family has been defined. The first one is noise. Consider the case of a family with a preference for boys. In the data, only if the last child turns out to be a boy, the family is coded as "boy-biased," but if the first born is a boy and the family has a second child, boy or girl, the family will not be classified as boy-biased. .

The second limitation is due to the fact that the sibling composition of "boy-biased" families is mechanically very different than the other families. It is possible that in boy-biased families the presence of mostly older girls in the family (except the last born) may prevent girls to learn from their older brothers, who typically do better in mathematics, perhaps due to biases originated outside the family, in the classroom or society at large. [10] To address the possibility that the results are driven by lack of learning, in columns (6) to (10) of Table 3 we estimate the same model specifications as in columns (1) to (5), but restrict the sample to only firstborn girls, who cannot learn from their older siblings anyway. The patterns and magnitudes of the findings are very similar regardless of whether we limit to firstborn versus all daughters in the family.

Moreover, the mere presence of boys may induce girls to underperform because girls with a brother acquire more traditional gender norms (Brenoe, 2018 and Cools and Patacchini, 2017). In our analysis, it is possible that the coefficient of boy-bias captures the presence of a brother because in "boy-biased" families, by construction, girls have always a brother. To rule out this possibility, we re-

[10] A body of evidence in literature also shows how birth order affects educational and life outcomes (for instance, Breining et al., forthcoming). In our setting, this potential effect is less of an issue due to the inclusion of birth order fixed effects in all our regressions.

run our specification excluding all the families with all girls. In this way, girls in boy-biased families are compared to girls growing up with at least one brother. The results, available from the authors, are substantially unchanged. This finding is also consistent with the literature on family composition: Brenoe (2018) finds that girls are less likely to choose a STEM field if they grow up with a brother, but this result is due to different preferences and not academic performance in mathematics (she finds that mathematical achievement is not affected by the presence of a brother).

Finally, the bias could arise from "equal treatment, unequal outcomes" behavior: as we have shown that fertility is higher conditional on having a first born girl, one concern is that girls from boy-biased families (which by definition have a firstborn daughter) will come from larger households. Girls could therefore be disadvantaged even if the parental inputs were equally allocated among daughters and sons. To address this possibility, in Table 4 we run a version of Table 3 which includes family size fixed effects (and exclude birth order fixed effects) for both the overall sample and also limiting the sample to firstborn children. The results are very similar to the ones shown in Table 3.

Our analysis using the NLSY overcomes these limitations because gender biases are directly measured with survey questions and therefore are not confounded with sibling composition effects.

2.3 NLSY evidence: Gender role attitudes and math performance

The National Longitudinal Survey of Youth 1979 gives us the opportunity to directly test the correlation between maternal gender role attitudes and children's math performance. We turn now to this analysis.

Table 5 shows the correlation between maternal gender attitudes and children's performance in mathematics for children in sixth through tenth grades.[11] In column (1) we look at the correlation for the overall sample of boys and girls. In this regression, the female dummy is always negative and significant, indicating the presence of a strong gender gap in mathematics: girls' scores in math are 14 percent lower than boys' scores. More conservative gender role attitudes are associated with lower math performance overall, but the relationship is not statistically significant at conventional levels. That said, as might be expected given our Florida results, conservative gender role attitudes should have different consequences for girls versus boys. Indeed, in column (2) and (3) when we split the sample by gender we confirm that girls' and boys' performances are differentially affected by maternal gender roles: for girls, one standard deviation increase in the conservatism of the mother's gender attitudes leads to a decrease of four percent of the sample standard deviation in math scores, but we

[11] All regressions include the following controls: log of net family income, dummies for maternal education (whether the mother has graduated from high school, has attended some college, has graduated from college), grade FE, survey year FE, race dummies, macro-region dummies (along with a dummy for missing macro-region), age of the child (in months), age of the mother at time of birth (in years), a dummy for whether the mother was in a relationship at the time of the survey, child's birth order. Column 1 also includes a female dummy.

observe no relationship in the case of boys. The size of this effect is fairly similar to the effect found in the Florida Department of Education data – one-third the size of the difference between children of high school graduate mothers and those of high school dropout mothers.[12]

Thus far, we have established a correlation between traditional gender roles (measured using fertility stopping rules or subjective measures of gender roles) and girls' math performance. The NLSY allows us to test directly the cultural transmission mechanism within the family. If parents transmit traditional gender roles to their children, these differences in beliefs can in turn have an effect on girls' performance in mathematics.

In Table 6, we further investigate the potential importance of cultural transmission by estimating the relationship between maternal gender role attitudes and gender role attitudes among children aged 10 to 14 (columns 1 and 2) and among children older than 14 (columns 3 and 4). The results suggest an intergenerational transmission mechanism. After controlling for a number of family characteristics, we find a positive and strongly statistically significant relationship between maternal gender role attitudes and children's gender role attitudes, of similar magnitudes for both boys and girls[13]. Moreover, this correlation apparently strengthens as children age: among younger children, a one standard deviation increase in the conservatism of mother's attitudes corresponds to 3.4 percent of a standard deviation of daughters' attitudes and 5.5 percent of a standard deviation of sons' attitudes. Among older children, these relationships grow to 14.6 percent and 15.5 percent of a standard deviation, respectively. However, this result may be due to the fact that gender attitudes are measured with different questions among younger children. In sum, it appears that both sons and daughters of mothers with conservative gender role attitudes maintain those gender role attitudes in childhood and especially later in adolescence. These results are consistent with Farre and Vella (2013) who find correlations between mothers and children's attitudes towards working women and subsequent labor market participation of their daughters, and their sons' wives.

[12] Other papers have studied the impact of gender attitudes on a variety of female outcomes. Nollenberger et al. (2016) find that one standard deviation increase in the gender equality index is associated with a reduction of 29% of the standard deviation in the math gender gap across countries of ancestry. Olivetti, Patacchini and Zenou (2020) find that one standard deviation increase in the average number of hours worked by mothers' of the students in the same school and same cohort translates into an additional 1/20th of a standard deviation in women's weekly hours worked in their late twenties. Finally, Fernández (2007) finds that an increase of one standard deviation in the female labor force participation of parents' source country is associated with an increase of 8% standard deviation in second-generation immigrant women's hours worked in the US.

[13] In all regression specification, we control for log of net family income, dummies for maternal education (whether the mother has graduated from high school, has attended some college, has graduated from college), a dummy for whether the mother was in a relationship at the time of the survey, mother birth year FE, survey year FE, race FE, macro-region FE, age of child (in years) FE.

3. Discussion

So far, we have shown a correlation between two proxies of gender biases and math performance of girls. There are at least two non-exclusionary potential mechanisms that could explain why girls growing up in gender biased families underperform in math. First, boy-biased parents could invest less in girls (and more in boys) for all educational activities. In other settings, Deaton (1989) and Bharadwaj and Nelson (2012) find evidence that parents invest differentially in their children, depending on the gender. Second, boy-biased parents could still invest equally but may direct girls away from STEM and other traditionally male dominated activities either because they believe that girls do not have the skills to succeed or because they have a preference for seeing their daughters succeeding in female fields.

We do not observe parental investments or the interaction with their children to test these hypotheses. However, we can test whether there is a difference in performance in reading, an activity where traditionally girls over perform boys. If the parents are underinvesting in girls' overall education, we should find that girls in boy biased families would also underperform in reading (relatively to other girls). We test this hypothesis in both samples and find indication of underinvestment in girls, consistent with Deaton (1989) and Bharadwaj and Nelson (2012). In the FLDOE data, girls raised in boy-biased families underperform other girls in reading (the beta coefficient is -0.014), while on average they over perform boys. We find similar results in the NLSY but with a smaller beta coefficient of the gender role attitudes on reading performance, when compared to the results in mathematics (Table A6 and A7). This evidence is consistent with an overall underinvestment in education for girls in boy biased families, even though it does not rule out the existence of alternative channels.

Maternal gender attitudes could have an impact beyond the mere performance in mathematics and could affect other choices in life such as the willingness to enter STEM fields. Unfortunately we are not able to link fertility stopping rules to college decisions or labor market outcomes in the Florida dataset. We attempt this exercise in the NLSY where for each young adult, we calculate the fraction of years spent in college in a stem field. Similarly to results in mathematics we find that maternal gender role attitudes are negatively correlated with going into a stem field in college (Table A8).

All the results reported in the paper are correlational in nature. They are unlikely to be driven by reverse causality, since performance in mathematics is observed after fertility choices had been made in the Florida dataset. Similarly in the NLSY we always look at the correlation between performance in mathematics and maternal gender roles prior to the time in which children took their standardized test scores. Omitted variables could however still be a concern. Our regressions include a large set of controls at the school, family and individual level. One potential channel which do not directly test in our baseline specification is the possibility that the results are driven by transmission of abilities. If gender role attitudes are proxies for maternal specialization in STEM, our results could potentially capture the effect of this variable. We do not find that this is the case. When we run a specification, controlling for maternal specialization in STEM, the coefficient on gender role attitudes stays virtually the same.[14]

4. Conclusion

Gaining a better understanding of the reasons behind the emergence of the gap in math skills is of first-order importance to explain the enduring gender differences in readiness for science, technology, engineering, and math (STEM) and the underrepresentation of women in these highly profitable fields. Several papers have established a correlation between cultural norms and gender gap in mathematics. These correlations could be driven by cultural transmission of parents to children, institutional differences across countries, and potentially teachers' biases.

We empirically explore the relevance of parental transmission on mathematics achievement, using a variety of evidence.

We use nine birth cohorts of Florida-native children to study the correlation of family gender norms and attitudes and girls' performance in mathematics. First, in line with the results of Dahl and Moretti (2008) for the United States, we confirm the existence of a higher preference for sons over girls in the Florida population: parents who desire to have one male child continue having children until a boy is born. Following Bharadwaj et al. (2015) we then identify families with a preference for boys as those who display a fertility stopping behavior in favor of sons. We find that girls born in such families perform worse on average in standardized tests in mathematics, compared to girls from other types of families.

Using fertility stopping rules can have some limitations. Our proxy of boys' preferences is noisy. Moreover, the specific stopping rule could be a proxy for different sibling composition, which in turn could drive the results. In addition, even though some parents may not have a fertility bias for boys, they might decide nonetheless to allocate inputs differentially between daughters and sons.

To address these limitations and provide corroborating evidence, we resort to an alternative sample, data, and model to test more directly for the relevance of gender roles inside the family and to investigate whether cultural transmission could be an important potential mechanism behind our findings. Using NLSY data, we test whether parental gender norms might help explain the differential

[14] The results are available from the authors. Note also that if our results were capturing differences in innate ability we should have expected an effect for both boys and girls and not only for girls.

performance among girls and, more generally, the male-female gap in math. Consistent with this hypothesis, we find evidence that, indeed, gender role attitudes of mothers and children are correlated, and that biased maternal attitudes are associated with worse performance in math of daughters, but not of sons.

Taken together, our findings suggest that gender-biased attitudes within the family play a significant role in the origination of the male-female gap in mathematics. While parental transmission could be optimal from the parents' perspective, as it expresses the desire of parents to raise children according to their traditions, it may have an impact on perpetuating certain societal biases.

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Table 1: Descriptive Statistics, Panel A

	PANEL A		
	(1)	(2)	(3)
	Mean	Std. Dev.	Obs.
Total number of children	1.424	0.621	129,686
Two or more children	0.362	0.481	129,686
Three or more children	0.055	0.227	129,686
Four or more children	0.007	0.083	129,686
Firstborn is a girl	0.491	0.500	129,686
Median income in zipcode of birth (USD)	46,964	13,384	129,686
Family Free Lunch	0.503	0.500	129,686
Mother married at first birth	0.643	0.469	129,686
Maternal age at first birth	26.800	6.591	129,686
Family Special Education	0.265	0.441	129,686
Mother graduated high school	0.349	0.462	129,686
Mother attended some college	0.267	0.429	129,686
Mother graduated from college	0.235	0.419	129,686

Notes. The table reports descriptive statistics for the Florida sample used in Table 2. The unit of observation is a family with children born in Florida between 1994 and 2002, and for whom we were able to reconstruct the fertility history without any gap. "Total number of children" is the number of children in the family. "Two or more children" is a dummy variable equal to 1 if the family has two or more children, equal to zero otherwise. "Three or more children" is a dummy variable equal to 1 if the family has three or more children, equal to zero otherwise. "Four or more children" is a dummy variable equal to 1, if the family has four or more children, equal to zero otherwise. "Firstborn is a girl" is a dummy variable equal to 1 if the firstborn in the family is a girl, equal to zero otherwise. The variable "Median income in zipcode of birth (USD)" is taken from the 1999 US Census, and it was calculated as the average across all children in a given family. "Family Free Lunch" and "Family Special Education" are dummy variables equal to 1, if at least one of the siblings in the family is enrolled in the given program in at least one year (in our data). "Mother graduated high school", "Mother attended some college", "Mother graduated from college" are dummy variables with excluded category "Mother is a high school dropout".

Table 1: Descriptive Statistics, Panel B

	PANEL B		
	(1)	(2)	(3)
	Mean	Std. Dev.	Obs.
Math score	0.407	0.830	65,114
Boy bias	0.481	0.500	65,114
Median income in zipcode of birth*100,000 (USD)	0.487	0.138	65,114
Free Lunch	0.274	0.446	65,114
Mother married at birth	0.835	0.371	65,114
Maternal age at birth	27.125	5.364	65,114
Special Education	0.060	0.238	65,114
Mother graduated high school	0.306	0.461	65,114
Mother attended some college	0.280	0.449	65,114
Mother graduated from college	0.324	0.468	65,114
Age (in months)	157.213	15.919	65,114

Notes. The table reports descriptive statistics for the Florida sample used in Table 3. The unit of observation is a student-year. The sample includes all students born in Florida between 1994 and 2002, from a family where we were able to reconstruct the fertility history without any gap, and for whom we have a score in mathematics. We exclude students from families where at least one of the children has unknown father. Here, we look only at female students, and we exclude the lastborn child in each family (only children are therefore not included, by definition). "Math score" measures students' Florida Comprehensive Assessment Test math score (standardized to have mean 0 and standard deviation 1 by test grade level/year across the sample of children enrolled in public school in Florida for whom we are able to reconstruct the fertility history and who took the math test of a level corresponding to the grade they are enrolled in, the first time that they are enrolled in that grade). "Boy bias" is a dummy variable equal to 1 if the last born in the family is a boy, and all the older children are girls, 0 otherwise. "Median income in zipcode of birth (USD)" is taken from the 1999 US Census, and it refers to the time of birth of the child. "Free Lunch" is a dummy equal to 1 if the student is enrolled in the Free lunch program in the given academic year. "Mother married at birth" is a dummy variable equal to 1 if the mother was married when the child was born. "Special Education" is a dummy equal to 1 if the student is enrolled in the special education program in the given academic year. "Mother graduated high school", "Mother attended some college", "Mother graduated from college" are dummy variables with excluded category "Mother is a high school dropout".

Table 1: Descriptive Statistics, Panel C

	PANEL C		
	(1)	(2)	(3)
	Mean	Std. Dev.	Obs.
Math score (standardized)	0.001	0.986	8,328
Maternal gender role attitudes	-0.088	1.447	8,328
Female	0.508	0.500	8,328
Income, USD	54,157	72,184	8,328
Income (log), USD	10.240	1.704	8,328
Mother in a relationship	0.669	0.470	8,328
Mother high school graduate	0.437	0.496	8,328
Mother attended some college	0.247	0.432	8,328
Mother college graduate	0.167	0.373	8,328
Maternal age at birth	25.855	6.171	8,328
Birth order	1.961	1.153	8,328
Age of child (in months)	157.500	12.777	8,328

Notes. The table reports sample statistics for the NLSY sample used in Table 6. The unit of observation is a child-year. The sample includes children enrolled in grade 6th to 10th, and within the sample, a child may appear in multiple years. The variable "Math score (standardized)" is the child's test score in the math PIAT test, standardized by survey-year and grade to have population mean 0 and population standard deviation 1. The variable "Maternal gender role attitudes" was built based through a principal component analysis on the answers to the following question, asked to each child's mother in 1987 and 2004: How much do you agree or disagree with the following statements: 1) A woman's place is in the home, not in the office or shop; 2) It is much better for everyone concerned if the man is the achiever outside the home and the woman takes care of the home and family; 3) Women are much happier if they stay at home and take care of their children. The menu of answers to this question was the following: 1: strongly disagree, 2: disagree, 3: agree, 4: strongly agree. A higher value corresponds to a more gender biased family (we recode the answers to the 2004 survey as in that wave the scale was inverted). If at least one answer was missing in 1987 (2004), and none were missing in 2004 (1987), the resulting variable is calculated using the three questions in 2004 (1987). If none of the answers were missing in 1987 nor in 2004, the final variable was computed using the answers in 1987 and 2004. If both in 1987 and 2004 there is at least one answer that is missing, the final variable was assigned a missing value. "Female" is a dummy variable (NLSY variable CSEX). "Income, USD" corresponds to net family income (NLSY variable TNFI). "Income (log), USD" was calculated as log(1+Income, USD). "Mother in a relationship" refers to the status at the time of the survey (built from NLSY variable RELSPPTR). Maternal education dummies ("Mother high school graduate", "Mother college dropout", "Mother college graduate", with "Mother high school dropout" as the excluded category) were built starting from NLSY variable HGCREV. "Birth order" corresponds to the NLSY variable BTHORDR. "Age of the child (in months)" corresponds to the NLSY variable CSAGE.

Table 1: Descriptive Statistics, Panel D

	10 to 14 years old			Over 14 years old		
	(1)	(2)	(3)	(4)	(5)	(6)
	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.
Maternal gender role attitudes	-0.003	1.271	8,433	0.002	0.136	13,502
Gender role attitudes (10 to 14 yrs old)	-0.091	1.460	8,433	-	-	-
Gender role attitudes (over 14 yrs old)	-	-	-	-0.070	0.144	13,502
Female	0.511	0.500	8,433	0.516	0.500	13,502
Income, USD	56,377	70,276	8,433	55,156	60,536	13,502
Income (log), USD	10.305	1.751	8,433	0.607	0.488	13,502
Mother in a relationship	0.688	0.463	8,433	10.117	2.190	13,502
Mother high school graduate	0.424	0.494	8,433	0.460	0.498	13,502
Mother attended some college	0.267	0.442	8,433	0.262	0.440	13,502
Mother college graduate	0.186	0.389	8,433	0.133	0.340	13,502

Notes. The table reports sample statistics for the NLSY sample used in Table 6. The unit of observation is a child-year. The sample in columns (1) to (3) includes children aged 10 to 14 years old. The sample used in columns (4) to (6) includes children older than 14 years old. Within a given sample, some children may appear in multiple years. This happens if they were asked the corresponding survey question more than once, in different years. "Gender role attitudes (10 to 14 yrs old)" is a categorical variable constructed from a set of questions asked to children aged 10 to 14 years old, in survey waves from 1994 until 2014 (over this period the surveys were administered once every 2 years). It is constructed through principal component analysis through the answers to the following questions: How much do you agree or disagree with the following statements? 1) Girls and boys should be treated the same in school; 2) A girl should not let a boy know she is smarter than he is; 3) Competing with boys in school would make a girl unpopular with boys; 4) A girl should pay her own way on dates; 5) If there is not enough money for all the children in a family to go to college the boys should get to go instead of the girls; 6) It is perfectly okay for a girl to ask a boy for a date, even if he has never asked her. The menu of answers to this question was the following: 1: strongly agree, 2: agree, 3: disagree, 4: strongly disagree. For questions 2, 3 and 4 we inverted the scale. The final value was calculated through principal component analysis of the questions of interests in a given year. A higher value corresponds to higher bias. "Gender role attitudes (over 14 years old)" is a categorical variable constructed from a set of questions asked to young adults once every 2 years, from 1994 to 2010. It is built from the answers to the following question: How much do you agree or disagree with the following statements? 1) A woman's place is in the home, not the office or shop; 2) It is much better for everyone concerned if the man is the achiever outside the home and the woman takes care of the home and family; 3) Women are much happier if they stay at home and take care of their children. The menu of answers to this question included the following: 1: strongly disagree, 2: disagree, 3: agree, 4: strongly agree. A higher value of the variable corresponds to higher bias. The final value was calculated through principal component analysis of the questions of interests in a given year. The remaining variables are described in Table 1 Panel C.

Table 2
Fertility Regressions
Florida Department of Education

	(1) Total number of children	(2) Two or more children	(3) Three or more children	(4) Four or more children
Firstborn is a girl	0.026***	0.016***	0.008***	0.002***
	(0.003)	(0.003)	(0.001)	(0.000)
Firstborn girl (beta)	0.021	0.016	0.017	0.014
Observations	129,686	129,686	129,686	129,686
R-squared	0.136	0.139	0.058	0.026
Firstborn is a girl (mean)	0.491	0.491	0.491	0.491
Firstborn is a girl (sd)	0.500	0.500	0.500	0.500
Dep. Variable (mean)	1.424	0.362	0.055	0.007

Notes. This table reports OLS estimates, with robust standard errors. The unit of observation is a family. Descriptive statistics for this sample are shown in Table 1, Panel A. In column (1), the dependent variable is the total number of children in a given family. In column (2), the dependent variable is a dummy equal to 1 if the family had two children or more, 0 otherwise. The dependent variables in columns (3) and (4) are dummy variables defined similarly. In all columns, the set of controls includes "Family Special Education", "Family Free Lunch", "Median income in zipcode of birth, USD" (averaged across the children in the family), mother education dummies ("Mother high school graduate", "Mother attended some college", "Mother high school graduate", "Mother high school dropout" is the omitted category), "Maternal age at first birth" (with quadratic and cubic term), "Mother married at time of first birth", family race dummies ("White", "Black", "Asian", "Race: Other", "Mixed Race Family"). Here there is no excluded group because we allow for overlap in the case of families with children of different ethnicities. ***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Table 3
Performance in mathematics of girls in families with preferences for boys
Florida Department of Education

						Only firstborns				
	All families	Only families with FRL	Excluding families with FRL	Mother attended HS	Mother attended college	All families	Only families with FRL	Excluding families with FRL	Mother attended HS	Mother attended college
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
			Math score					Math score		
Boy bias	-0.025**	-0.017	-0.035**	-0.018	-0.030**	-0.027***	-0.012	-0.039***	-0.014	-0.034**
	(0.010)	(0.016)	(0.014)	(0.016)	(0.013)	(0.010)	(0.016)	(0.014)	(0.017)	(0.014)
Median income in zipcode	0.256***	0.209***	0.232***	0.297***	0.220***	0.249***	0.210**	0.218***	0.287***	0.209***
of birth*100,000 (USD)	(0.045)	(0.078)	(0.054)	(0.084)	(0.052)	(0.047)	(0.084)	(0.057)	(0.088)	(0.054)
Free Lunch	-0.163***	-0.084***		-0.117***	-0.200***	-0.161***	-0.083***		-0.114***	-0.202***
	(0.012)	(0.013)		(0.016)	(0.019)	(0.012)	(0.014)		(0.016)	(0.020)
Mother high school grad	0.118***	0.100***	0.160***	0.104***		0.114***	0.091***	0.161***	0.099***	
	(0.021)	(0.023)	(0.049)	(0.022)		(0.022)	(0.025)	(0.050)	(0.023)	
Mother college dropout	0.230***	0.214***	0.247***		-0.234***	0.230***	0.203***	0.256***		-0.234***
	(0.022)	(0.027)	(0.049)		(0.014)	(0.024)	(0.029)	(0.050)		(0.014)
Mother college graduate	0.457***	0.414***	0.466***			0.456***	0.405***	0.476***		
	(0.024)	(0.034)	(0.049)			(0.025)	(0.037)	(0.050)		
Mother married at birth	0.025	0.001	0.072**	0.020	0.030	0.022	-0.007	0.076**	0.012	0.037
	(0.015)	(0.019)	(0.031)	(0.020)	(0.027)	(0.016)	(0.020)	(0.031)	(0.021)	(0.028)
Maternal age at birth	0.008***	0.006***	0.007***	0.010***	0.006***	0.007***	0.006***	0.006***	0.010***	0.004**
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Special Education	-0.759***	-0.734***	-0.772***	-0.749***	-0.758***	-0.757***	-0.719***	-0.784***	-0.738***	-0.767***
	(0.024)	(0.033)	(0.035)	(0.035)	(0.034)	(0.025)	(0.034)	(0.035)	(0.037)	(0.036)
Age (in months)	-0.017***	-0.022***	-0.009***	-0.022***	-0.010***	-0.017***	-0.023***	-0.009***	-0.023***	-0.010***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Birth order FE	YES	YES	YES	YES	YES	-	-	-	-	-
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Grade FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
School FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Race FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Boy bias (standardized beta)	-0.015	-0.010	-0.023	-0.011	-0.020	-0.017	-0.007	-0.026	-0.009	-0.022
Observations	65,114	28,997	36,117	25,775	39,339	59,592	25,856	33,736	23,445	36,147
R-squared	0.330	0.319	0.238	0.330	0.260	0.328	0.324	0.242	0.336	0.261

Notes. This table reports OLS estimates, with robust standard errors clustered by student and school. The unit of observation is a student-year. The sample includes all students born in Florida between 1994 and 2002 from a family for whom we were able to reconstruct the fertility history without any gap, and where none of the siblings has unknown father. From these families we keep students enrolled in grades 6th to 10th for whom we have a mathematics score. In this table we look only at female students, and we exclude the lastborn child in each family (only children are therefore not included, by definition). Sample statistics for this sample are reported in Table 1, Panel B. In Columns (6) to (10), we run the same specifications as in columns (1) to (5), but we restrict the sample to the firstborn in each family. In Columns (2) and (7), we restrict the sample to families with at least one child enrolled in the Free Lunch program, in at least one year in our sample. In Columns (3) and (8), we restrict the sample to those students who come from families where no child was ever enrolled in the Free Lunch program in any year. In Columns (4) and (9) we restrict the sample to children for whom "Mother high school dropout" or "Mother high school graduate" is equal to 1. In Columns (5) and (10) we restrict the sample to those children with "Mother attended some college" equal to 1, or "Mother college graduate college" equal to 1. The dependent variable is the Florida Comprehensive Assessment Test Math score (standardized to have mean 0 and standard deviation 1 by test grade level/year across the sample of children enrolled in public school in Florida for whom we are able to reconstruct the fertility history and who took the math test of a level corresponding to the grade they are enrolled in, the first time that they are enrolled in that grade). "Boy bias" is a dummy variable equal to 1 if the last born in the family is a boy, and all the older children are girls, 0 otherwise. "Median income in zipcode of birth (USD)" is taken from the 1999 US Census, and it refers to the time of birth of the child. "Free Lunch" is a dummy variable equal to 1 if the student is enrolled in the Free lunch program in the given academic year. "Mother married at birth" is a dummy variable equal to 1 if the mother was married when the child was born. "Special Education" is a dummy equal to 1 if the student is enrolled in the special education program in the given academic year. Columns (1) to (5) include birth order FE. All columns include year FE, grade FE, school FE, race FE. ***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Table 4
Robustness to the inclusion of family size fixed effects
Florida Department of Education

	All families	Only families with FRL	Excluding families with FRL	Mother attended HS	Mother attended college	All families	Only families with FRL	Excluding families with FRL	Mother attended HS	Mother attended college
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
			Math score					Math score		
Boy bias	-0.021**	-0.014	-0.029**	-0.014	-0.026**	-0.023**	-0.011	-0.033**	-0.011	-0.029**
	(0.010)	(0.016)	(0.014)	(0.016)	(0.013)	(0.010)	(0.017)	(0.014)	(0.017)	(0.014)
Median income in zipcode	0.254***	0.208***	0.229***	0.296***	0.217***	0.248***	0.209**	0.217***	0.284***	0.209***
of birth*100,000 (USD)	(0.045)	(0.078)	(0.054)	(0.084)	(0.052)	(0.047)	(0.084)	(0.057)	(0.088)	(0.054)
Free Lunch	-0.166***	-0.084***		-0.118***	-0.203***	-0.163***	-0.083***		-0.116***	-0.204***
	(0.011)	(0.013)		(0.016)	(0.019)	(0.012)	(0.014)		(0.016)	(0.020)
Mother married at birth	0.021	-0.004	0.068**	0.018	0.026	0.022	-0.007	0.075**	0.013	0.035
	(0.015)	(0.019)	(0.031)	(0.020)	(0.027)	(0.016)	(0.020)	(0.031)	(0.021)	(0.028)
Maternal age at birth	0.009***	0.006***	0.008***	0.011***	0.006***	0.007***	0.006***	0.006***	0.010***	0.005***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Special Education	-0.760***	-0.734***	-0.772***	-0.748***	-0.759***	-0.757***	-0.719***	-0.783***	-0.736***	-0.767***
	(0.024)	(0.033)	(0.035)	(0.035)	(0.034)	(0.025)	(0.034)	(0.035)	(0.036)	(0.036)
Age (in months)	-0.016***	-0.021***	-0.008***	-0.022***	-0.010***	-0.017***	-0.023***	-0.009***	-0.023***	-0.010***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Family size FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Grade FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
School FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Maternal Education FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Race FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Boy bias (standardized beta)	-0.013	-0.009	-0.019	-0.009	-0.017	-0.014	-0.007	-0.022	-0.007	-0.019
Observations	65,114	28,997	36,117	25,775	39,339	59,592	25,856	33,736	23,445	36,147
R-squared	0.330	0.319	0.238	0.331	0.260	0.328	0.324	0.243	0.336	0.261

Notes. This table reports OLS estimates, with robust standard errors clustered by student and school. The unit of observation is a student-year. This is the equivalent to Table 3, but it also includes family size fixed effects (i.e., total number of siblings in the family) instead of birth order fixed effects in columns (1) to (10). In Column (1), the sample includes all girls, excluding lastborns. In Columns (6) to (10), we run the same specifications as in columns (1) to (5), but we restrict the sample to the firstborn child in each family. In Columns (2) and (7), we restrict the sample to families with at least one child enrolled in the Free Lunch program, in at least one year in our sample. In Columns (3) and (8), we restrict the sample to those students who come from families where no child was ever enrolled in the Free Lunch program in any year. In Columns (4) and (9) we restrict the sample to children for whom "Mother high school dropout" or "Mother high school graduate" are equal to 1. In Columns (5) and (10) we restrict the sample to those children with "Mother attended some college" equal to 1, or "Mother graduated from college" equal to 1. The dependent variable is the students' Florida Comprehensive Assessment Test Math score (standardized to have mean 0 and standard deviation 1 by test grade level/year across the sample of children enrolled in public school in Florida for whom we are able to reconstruct the fertility history and who took the math test of a level corresponding to the grade they are enrolled in, the first time that they are enrolled in that grade). "Boy bias" is a dummy variable equal to 1 if the last born in the family is a boy, and all the older children are girls, 0 otherwise. All columns include year FE, grade FE, school FE, maternal education FE, and race FE. ***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Table 5
Performance in mathematics and maternal gender role attitudes
National Longitudinal Survey of Youth

	All	Girls	Boys
	(1)	(2)	(3)
		Math score (standardized)	
Maternal gender role attitudes	-0.008	-0.029**	0.013
	(0.009)	(0.012)	(0.009)
Female	-0.140***		
	(0.018)		
Income (log)	0.032***	0.038***	0.027***
	(0.007)	(0.014)	(0.004)
Mother in a relationship	0.093***	0.105***	0.078***
	(0.018)	(0.024)	(0.028)
Mother high school graduate	0.250***	0.239***	0.262***
	(0.029)	(0.029)	(0.053)
Mother some college	0.396***	0.364***	0.428***
	(0.031)	(0.032)	(0.070)
Mother college graduate	0.653***	0.632***	0.663***
	(0.039)	(0.075)	(0.098)
Maternal age at birth	0.019***	0.025***	0.014***
	(0.003)	(0.005)	(0.004)
Birth order	-0.086***	-0.069***	-0.103***
	(0.011)	(0.009)	(0.017)
Age of child (in months)	-0.005*	-0.006**	-0.005
	(0.003)	(0.002)	(0.004)
Grade FE	YES	YES	YES
Macro-region FE	YES	YES	YES
Survey year FE	YES	YES	YES
Race FE	YES	YES	YES
Maternal gender role attitudes (standardized beta)	-0.012	-0.044	0.018
Observations	8,328	4,232	4,096
R-squared	0.179	0.175	0.185

Notes. The table reports OLS estimates, with robust standard errors double-clustered at the child and grade level. The unit of observation is a child-year. The sample includes children from NLSY enrolled in grade 6th to 10th, and within the sample, a child may appear in multiple years. In Column (1), the sample includes both girls and boys. Sample statistic for this sample are presented in Table 1, Panel C. In Columns (2) and (3), the sample is restricted respectively to the subset of girls, and to the subset of boys. The dependent variable "Math score (standardized)" is the child's test score in the math PIAT test, standardized by survey-year and grade to have mean 0 standard deviation 1 in our sample. The variable "Maternal gender role attitudes" was built based on the answers to the following question, asked to each child's mother in 1987 and 2004: How much do you agree or disagree with the following statements: 1) A woman's place is in the home, not in the office or shop; 2) It is much better for everyone concerned if the man is the achiever outside the home and the woman takes care of the home and family; 3) Women are much happier if they stay at home and take care of their children. The menu of answers to this question was the following: 1: strongly disagree, 2: disagree, 3: agree, 4: strongly agree. A higher value corresponds to a more gender biased family (we recode the answers to the 2004 survey as in that wave the scale was inverted). If at least one answer was missing in 1987 (2004), and none were missing in 2004 (1987), the resulting variable was constructed through the principal component analysis of the three questions in 2004 (1987). If none of the answers were missing in 1987 nor in 2004, the final variable was constructed through the principal component analysis of the answers in 1987 and 2004. If both in 1987 and 2004 there is at least one answer that is missing, the final variable was assigned a missing value. "Female" is a dummy variable (NLSY variable CSEX). "Income, USD" corresponds to net family income (NLSY variable TNFI). "Income (log), USD" was calculated as log(1+Income, USD). "Mother in a relationship" refers to the status at the time of the survey (built from NLSY variable RELSPPTR). Maternal education dummies are built from NLSY variable HGCREV. "Birth order" corresponds to the NLSY variable BTHORDR. "Age of the child (in months)" corresponds to the NLSY variable CSAGE. All regressions include survey year FE, grade FE, macro-region FE, race FE. ***, **, and * indicate significance at the 1%, 5%, and 10% levels.

Table 6
Cultural transmission of gender role attitudes
National Longitudinal Survey of Youth

	Girls	Boys	Girls	Boys
	(1)	(2)	(3)	(4)
	Gender role attitudes (10 to 14 years old)		Gender role attitudes (over 14 years old)	
Maternal gender role attitudes	0.027**	0.050***	0.139***	0.138***
	(0.013)	(0.016)	(0.016)	(0.015)
Income (log)	-0.017	-0.028*	-0.030***	-0.042***
	(0.012)	(0.016)	(0.009)	(0.009)
Mother in a relationship	0.022	-0.072	0.032	-0.005
	(0.044)	(0.055)	(0.041)	(0.042)
Mother high school graduate	-0.198***	-0.251***	-0.334***	-0.356***
	(0.072)	(0.075)	(0.066)	(0.063)
Mother some college	-0.240***	-0.408***	-0.584***	-0.620***
	(0.075)	(0.080)	(0.069)	(0.070)
Mother college graduate	-0.389***	-0.278***	-0.679***	-0.624***
	(0.083)	(0.092)	(0.083)	(0.080)
Child age FE	YES	YES	YES	YES
Survey year FE	YES	YES	YES	YES
Macro-region FE	YES	YES	YES	YES
Maternal birth year FE	YES	YES	YES	YES
Race FE	YES	YES	YES	YES
Maternal gender role attitudes (standardized beta)	0.034	0.055	0.146	0.151
Observations	4,307	4,126	6,966	6,536
R-squared	0.057	0.064	0.078	0.095

Notes. The table reports OLS estimates, with robust standard errors clustered at the child level. The unit of observation is a child-year. The sample in columns (1) to (2) includes children aged 10 to 14 years old. The sample used in columns (3) to (4) includes children older than 14 years old. Sample statistics for the two samples are shown in Table 1, Panel D. In Columns (1) and (2), the dependent variable is built through principal component analysis from a set of questions asked to children aged 10 to 14 in the survey waves from 1994 until 2014 (over this period the surveys were administered once every 2 years). It is constructed through a principal component analysis of the answers to the following questions: How much do you agree or disagree with the following statements? 1) Girls and boys should be treated the same in school; 2) A girl should not let a boy know she is smarter than he is; 3) Competing with boys in school would make a girl unpopular with boys; 4) A girl should pay her own way on dates; 5) If there is not enough money for all the children in a family to go to college the boys should get to go instead of the girls; 6) It is perfectly okay for a girl to ask a boy for a date, even if he has never asked her. The menu of answers included the following: 1: strongly agree, 2: agree, 3: disagree, 4: strongly disagree. For questions 2, 3 and 4 the scale was reversed. The final value was calculated through a principal component analyses on the questions of interest in a given year. A higher value corresponds to higher bias. In Column (3) and (4), the dependent variable is a categorical variable constructed from a set of questions asked to young adults once every 2 years, from 1994 to 2010. It is constructed through a principal component analysis of the answers to the following question: How much do you agree or disagree with the following statements? 1) A woman's place is in the home, not the office or shop; 2) It is much better for everyone concerned if the man is the achiever outside the home and the woman takes care of the home and family; 3) Women are much happier if they stay at home and take care of their children. The menu of answers to this question was the following: 1: strongly disagree, 2: disagree, 3: agree, 4: strongly agree. A higher value of the variable corresponds to higher bias. The final value was calculated through principal component analysis of the questions of interests in a given year. The variable "Maternal gender role attitudes" was built based on the answers to the following question asked to each child's mother in 1987 and 2004: How much do you agree or disagree with the following statements: 1) A woman's place is in the home, not in the office or shop; 2) It is much better for everyone concerned if the man is the achiever outside the home and the woman takes care of the home and family; 3) Women are much happier if they stay at home and take care of their children. The menu of answers to this question was the following: 1: strongly disagree, 2: disagree, 3: agree, 4: strongly agree. A higher value corresponds to a more gender biased family (we recode the answers to the 2004 survey as in that wave the scale was inverted). If at least one answer was missing in 1987 (2004), and none were missing in 2004 (1987), the resulting variable is constructed through the principal component analysis of the three questions in 2004 (1987). If none of the answers were missing in 1987 nor in 2004, we computed the final variable though a principal component analysis of the answers in 1987 and 2004. If both in 1987 and 2004 there is at least one answer that is missing, the final variable was assigned a missing value. The remaining variables are defined as in Table 5. All regressions include child age FE, survey year FE, macro-region FE, maternal birth year FE, race FE. ***, **, and * indicate significance at the 1%, 5%, and 10% levels.