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# School Quality and the Gender Gap in Educational Achievement[†]

*By* David Autor, David Figlio, Krzysztof Karbownik, Jeffrey Roth, and Melanie Wasserman*

Women have surpassed men in educational attainment throughout the developed world. In 2011, the ratio of female to male college completion rates exceeded unity in 29 of 34 OECD countries, with just Chile, Japan, Luxembourg, Mexico, and Turkey having higher rates of male college completion. In the United States, the female high school graduation rate at present exceeds the male rate by 5 percentage points, and the female college graduation rate exceeds the male rate by 7 percentage points (Autor and Wasserman 2013).

What explains these gender gaps in educational attainment? Recent evidence indicates that boys and girls are differently affected by the quantity and quality of inputs received in childhood: Bertrand and Pan (2013) document that boys raised in single-parent families have twice the rates of behavioral and disciplinary issues as boys raised in two-parent families; Autor et al. (2015) demonstrate that while disadvantage is unrelated to the gender gap in neonatal health, the boy-girl gap in kindergarten readiness, test scores, truancy, disciplinary problems, disability, juvenile delinquency, and high school graduations is larger the more disadvantaged the family; Chetty and Hendren (2015) conclude that boys' economic mobility is differentially adversely affected by childhood residence in low-mobility communities; and Conti, Heckman, and Pinto (2015) find that intensive early childhood educational programs implemented in the 1960s and 1970s differentially improved boys' health.

While current literature focuses primarily on the effects of early childhood influences on the gender gap, much less is known about whether boys and girls are differentially affected by school quality. A limited body of evidence suggests that attributes of schools may affect boys and girls differently. Dee (2005) shows that students perform better with same-sex teachers; and since the majority of classroom teachers are female, this could contribute to gender differences in schooling outcomes. Machin and McNally (2008) document that focused teaching in literacy or numeracy in primary school differentially benefits the sex with weaker average performance—literacy among boys and numeracy among girls.

On the other hand, school choice lottery evidence from the Charlotte-Mecklenburg, North Carolina public school system indicates a differential benefit to girls in at least one measure of school quality. Hastings, Kane, and Staiger (2006) report that white females' test scores increase if they receive their first choice lottery school whereas white males' scores are unaffected. Building on this evidence, Deming et al. (2014) find that the postsecondary attainment benefits accruing from attending first-choice high schools are concentrated among girls rather than boys, and that girls make more use of the options available to them at more demanding high schools.

We complement this disparate evidence by providing powerful and tightly controlled estimates of the causal effect of school quality on the gender gap in test scores and behavioral outcomes. Using population-level matched birth and school administrative records for tens of thousands of sibling pairs attending thousands of Florida public schools, we contrast the outcomes of opposite-sex siblings who attend the

*Autor: MIT, 50 Memorial Drive, Cambridge, MA 02142, and NBER (e-mail: dautor@mit.edu); Figlio: Northwestern, 2040 Sheridan Road, Evanston, IL 60208, and NBER (e-mail: figlio@northwestern.edu); Karbownik: Northwestern, 2040 Sheridan Road, Evanston, IL 60208 (e-mail: krzysztof.karbownik@northwestern.edu); Roth: University of Florida, 1701 SW 16th Avenue, Gainesville, FL 32608 (e-mail: rothj@peds.ufl.edu); Wasserman: Massachusetts Institute of Technology, 50 Memorial Drive, Cambridge, MA 02142 (e-mail: mwass@mit.edu). The conclusions expressed in this paper are those of the authors and do not represent the positions of the Florida Departments of Education and Health or those of our funders.

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same sets of schools. This sibling level contrast purges unmeasured family heterogeneity while identifying the differential effect of school quality on boys relative to girls. Complementing this strategy, we contrast outcomes of siblings exposed to schools of differing quality levels due to family moves across Florida school catchment areas. Investigating both middle school academic and behavioral outcomes, we find that boys benefit more from cumulative exposure to higher-quality schools—measured using school level gain scores in reading and mathematics—than do their sisters.

## I. School Quality and Gender Gaps in Middle School Outcomes

We draw on data from the universe of birth certificates from Florida for years 1994 through 2002, sourced from the Florida Bureau of Vital Statistics, matched to public school records for academic years 1995–1996 through 2012–2013 from the Florida Department of Education Data Warehouse.[1] We focus on three outcomes observed for each student in grades six through eight: standardized math and reading scores from the Florida Comprehensive Assessment Test (FCAT); absenteeism rates; and the incidence of school suspension. We use school-level gain scores calculated by the Florida Department of Education—measuring schools' average contribution to student outcomes—to measure the quality of elementary and middle schools.[2]

For each school, we compute the average of the observed gain scores between 2002 and 2013, which we then convert into a percentile rank in the observed gains distribution across Florida schools. For each student, we construct the cumulative quality of schools attended from grade one forward, equal to a years-weighted average of the rank quality of all schools attended to that point. To limit the potential role of the endogeneity of school choices within families, we exclude from the sample the 20.8 percent of families in which children of elementary (middle) school age attend different elementary (middle) schools in the same academic year.

Panels A and B of Table 1 present summary statistics for academic and behavioral outcomes, and the gender gap in these outcomes, by quartiles of cumulative school quality. Academic outcomes are strongly positively correlated—and behavioral outcomes negatively correlated—with school quality, as expected. Panel C reports summary statistics for the family background characteristics that are included as regression controls. The quality of the schools a child attends is positively correlated with her family's socioeconomic status, including mother's education, mother's marital status, and income of neighborhood of residence at birth.

Figure 1 provides initial evidence suggesting a school quality gradient in the gender gap in schooling outcomes. Panel A plots average combined FCAT reading and math scores by sex against school quality percentile for the siblings in our sample. For both boys and girls, we observe a strong, positive linear relationship between the quality of schools attended and student academic achievement. This relationship is expected, given the strong correlation between school quality and student demographics reported in Table 1. More intriguingly, there is a modest but nevertheless pronounced female-favorable gap in test scores among students who attend the lowest quality schools, and this gap contracts to zero as one moves upward in the school quality distribution. This pattern is *not* directly predicted by the correlation between school quality and student demographics since demographics are balanced across genders within schools.[3]

Conversely, there is a steep negative relationship between school quality and suspensions (Figure 1, panel B), with an even more pronounced narrowing of the gender gap as one moves from a lower to a higher quality school. Among students who attended the lowest decile of school quality, roughly 45 percent of boys are suspended in an academic year, which exceeds

[1] Figlio et al. (2014) describe the matching process.

[2] We average the three gain score measures consistently produced over the entire period—percent making gains in reading, percent making gains in math, and percent of bottom quartile students making gains in reading—which are available for download at schoolgrades.fldoe.org. Results are similar if we also consider the proficiency-based measures used by the state.

[3] We confirm this fact in our data by regressing school quality measures on main effects and gender interactions for each of the demographic variables listed in Table 1. These interaction terms are individually and jointly insignificant.

Table 1—Summary Statistics

| | All | Quartiles of school quality | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| *Panel A. Outcomes* | | | | | |
| Math+Reading scores | 0.21 | −0.25 | 0.07 | 0.33 | 0.66 |
| | (0.86) | (0.83) | (0.82) | (0.78) | (0.75) |
| Suspension rate | 18.96 | 33.72 | 22.07 | 14.13 | 7.44 |
| | (39.20) | (47.28) | (41.47) | (34.83) | (26.25) |
| Absence rate | 4.57 | 5.77 | 4.95 | 4.20 | 3.52 |
| | (5.37) | (6.87) | (5.69) | (4.67) | (3.60) |
| *Panel B. Gender gap in outcomes* | | | | | |
| Math+Reading scores | −0.05 | −0.01 | −0.07 | −0.04 | −0.02 |
| | (0.00) | (0.01) | (0.01) | (0.01) | (0.01) |
| Suspension rate | 11.07 | 14.71 | 12.77 | 10.95 | 7.17 |
| | (0.18) | (0.45) | (0.40) | (0.33) | (0.24) |
| Absence rate | 0.47 | 0.90 | 0.48 | 0.34 | 0.27 |
| | (0.03) | (0.07) | (0.06) | (0.04) | (0.03) |
| *Panel C. Controls* | | | | | |
| Boy | 0.50 | 0.49 | 0.50 | 0.50 | 0.51 |
| White | 0.50 | 0.32 | 0.47 | 0.55 | 0.63 |
| Black | 0.19 | 0.44 | 0.21 | 0.09 | 0.04 |
| Hispanic | 0.10 | 0.07 | 0.01 | 0.11 | 0.10 |
| Immigrant | 0.22 | 0.17 | 0.21 | 0.25 | 0.23 |
| Mom high school dropout | 0.17 | 0.33 | 0.21 | 0.12 | 0.03 |
| Mom high school graduate | 0.60 | 0.61 | 0.66 | 0.64 | 0.51 |
| Mom college graduate | 0.23 | 0.05 | 0.13 | 0.24 | 0.46 |
| Unmarried: father absent | 0.12 | 0.27 | 0.14 | 0.07 | 0.02 |
| Unmarried: father present | 0.18 | 0.29 | 0.22 | 0.15 | 0.07 |
| Married | 0.70 | 0.43 | 0.63 | 0.78 | 0.91 |
| Bottom income tercile | 0.31 | 0.55 | 0.35 | 0.24 | 0.12 |
| Middle income tercile | 0.32 | 0.34 | 0.40 | 0.33 | 0.23 |
| Top income tercile | 0.37 | 0.11 | 0.25 | 0.43 | 0.65 |
| Observations | 247,050 | 59,801 | 60,174 | 61,594 | 65,481 |

*Notes:* Sample includes Florida siblings born between 1994 and 2002 whose public school outcomes are observed between school years 1995–1996 and 2012–2013 (2011–2012 for suspensions and absences). Siblings who were simultaneously of elementary (middle) school age but did not attend the same elementary (middle) school are excluded. Observations for math+reading scores, suspensions, and absences are 244,844, 176,434, and 175,686, respectively. Parentheses contain standard deviations (panel A) or standard errors (panel B). School quality is constructed as described in the text. Math+Reading is the average of the standardized FCAT scores for each child and testing year. Panel B reports mean boy minus girl differences for outcomes during grades 6 through 8. In panel C, race/ethnic categories are mutually exclusive. Income, maternal education, and marital status are measured at the time of birth, with income defined as the median income from the 2000 census for the mother's current zip code at the time of delivery.

the rate for girls by over 10 percentage points. Among students who attended schools with the highest gains scores, however, the male suspension rate is below 10 percent, and the gender gap in suspensions narrows to just a few percentage points.

## II. Estimating Causal Effects of School Quality Using Siblings

Since children who attend lower quality schools are disproportionately drawn from less affluent, less educated households, and non-married (often single-headed) households,

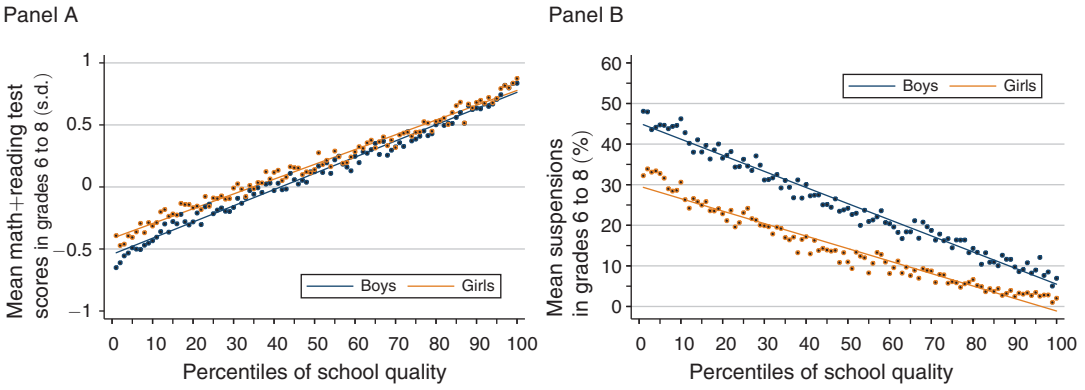


FIGURE 1. BOY-GIRL GAP IN STANDARDIZED MATH+READING SCORES (*Panel A*) AND SUSPENSION RATES (*Panel B*) IS SMALLER AT HIGHER QUALITY SCHOOLS

*Note:* See notes to Table 1 for sample and data construction.

we do not view the favorable relationship between school quality and middle school outcomes as causal.

Our primary interest instead is in the school quality gradient in the gender gap in schooling outcomes. Does this gradient reflect the fact that boys who attend lower-quality schools are already academically or behaviorally disadvantaged relative to girls with similar socio-economic backgrounds (Autor et al. 2015)? Alternatively, are outcomes of disadvantaged boys differentially sensitive to the academic and disciplinary environment of elementary and middle schools?

To isolate the causal effect of school quality on the gender gap in academic and behavioral outcomes from the numerous confounds visible in Table 1, we exploit cross-gender, within-family sibling comparisons. By contrasting the outcomes of brothers and sisters who *both* attend schools of lesser or superior quality, we purge the correlation between family background and schooling outcomes to identify the interaction between school quality and student gender. We fit the following OLS model,

$$(1)\quad Y_{ij} = \gamma_j + \beta_1 Boy_i + \beta_2 (Boy_i \times \mathbf{Q}_{ij}) + \beta_3 \mathbf{Q}_{ij} + \mathbf{F}_{ij}'\psi + \mathbf{X}_i'\lambda + e_{ij},$$

where $Y_{ij}$ represents an outcome for child $i$ born to mother $j$, $Boy_i$ is an indicator for whether the child is male, and $\mathbf{Q}_{ij}$ represents the average percentile rank of schools attended from grade one to the time of observation in middle school. The equation includes mother fixed effects $\gamma_j$, which account for time-invariant mother-specific factors that are constant across sibling births. The vector $\mathbf{F}_{ij}$ contains measures of at-birth maternal and family environment characteristics that may vary across births, including mother's education, marital status, age, and income tercile of neighborhood of residence. The vector $\mathbf{X}_i$ controls for time-invariant child-specific attributes, including birth order and month and year of birth. Because school quality is highly correlated with family background factors, we also interact $Boy_i$ with maternal race/ethnicity, neighborhood income, maternal education, and family structure, all observed on the child's birth certificate. These controls account for the differential gender gaps in grade-level outcomes exhibited by these demographic groups, as documented in Autor et al. (2015). We additionally include indicators for grades 7 and 8 and their interactions with gender. Standard errors are clustered at the mother level to account for within-child and within-family serial correlation in these outcomes.[4]

In order for $\beta_2$ to be an unbiased estimate of the effect of school quality on the gender gap in educational outcomes, it must be the case that the gender gap in potential middle school outcomes is uncorrelated with the quality of schools

[4] We restrict the sample to families in which all siblings have at least one valid observation of an academic or behavioral outcome during grades six through eight.

Table 2—The Effect of School Quality on the Gender Gap in Educational Outcomes

| | All siblings | | Family movers only | |
|---|---|---|---|---|
| | OLS (1) | FE (2) | OLS (3) | FE (4) |
| *Panel A. Math + reading scores* | | | | |
| Boy × School quality | 0.12*** | 0.12** | 0.06 | 0.19* |
| | (0.04) | (0.05) | (0.08) | (0.11) |
| Boy | −0.15*** | −0.13*** | −0.13*** | −0.17*** |
| | (0.03) | (0.03) | (0.05) | (0.07) |
| School quality | 0.98*** | 0.60*** | 1.13*** | 0.43*** |
| | (0.03) | (0.08) | (0.06) | (0.14) |
| Observations | 244,844 | 244,844 | 57,254 | 57,254 |
| *Panel B. Suspensions* | | | | |
| Boy × School quality | −9.81*** | −9.19*** | −12.37*** | −6.37 |
| | (1.75) | (2.47) | (4.22) | (6.06) |
| Boy | 23.38*** | 19.98*** | 26.03*** | 22.57*** |
| | (1.33) | (1.85) | (2.68) | (3.90) |
| School quality | −17.90*** | −4.24 | −21.36*** | −2.46 |
| | (1.12) | (4.58) | (2.82) | (8.47) |
| Observations | 176,434 | 176,434 | 43,017 | 43,017 |
| *Panel C. Absences* | | | | |
| Boy × School quality | −0.92*** | −0.75*** | −1.38* | 0.14 |
| | (0.28) | (0.28) | (0.72) | (0.67) |
| Boy | 1.78*** | 1.41*** | 2.43*** | 1.40*** |
| | (0.23) | (0.23) | (0.51) | (0.46) |
| School quality | −1.90*** | −0.60 | −2.74*** | −1.46 |
| | (0.20) | (0.55) | (0.46) | (1.02) |
| Observations | 175,686 | 175,686 | 42,759 | 42,759 |

*Notes:* Table presents estimates of equation (1). Columns 1 and 2 report results from the full sample of siblings, described in Table 1 notes. Columns 3 and 4 report results from the restricted sample of family movers. Each observation is a single score, absence rate, or suspension rate outcome. Each student can contribute up to three observations in the regression sample. Standard errors in parentheses are clustered at mother level.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

attended, conditional on family background and its interaction with sex. This assumption could be violated if, for example, families that invest more in their children prefer to send their sons (or daughters) to higher-performing schools relative to their daughters (or sons). As noted above, we drop families in which children of elementary (middle) school age attend different elementary (middle) schools in the same academic year. We further probe the possibility that within-family variation in school quality is correlated with child gender through a direct test. In results not tabulated here, we estimate a specification in which child gender is the dependent variable and the full set of controls, including mother fixed effects, are regressors. We find no evidence that child gender systematically varies with elementary or middle school quality, lending support to the identifying assumption that conditional on family background, child gender is as good as randomly assigned to school quality.

The first column of Table 2 reports estimates of equation (1), the relationship between school quality and outcomes in middle school, but excludes mother fixed effects $\gamma_j$. In all three cases, we observe that boys have substantially worse outcomes than girls in the lowest

performing schools, but that a sizable fraction of the gap is eliminated as measured school quality increases. For instance, in panel A (average test scores), the coefficient of −0.15 on $Boy_i$ implies that boys who attended the lowest quality schools perform on average one-seventh of a standard deviation below their female counterparts in reading and math.

Conversely, the coefficient on the interaction of $Boy_i$ and school quality percentile is highly positive and statistically significant, indicating that attending a higher quality school predicts a substantial narrowing of the female-favorable gender gap in academic achievement. Moving from the lowest to fiftieth percentile in middle school quality reduces the gender gap by 0.06 standard deviations, almost half of the initial gender gap. For both suspensions (panel B) and absences (panel C), a 50 percentile increment to school quality is estimated to close one-quarter of the boy-girl gap in adverse behaviors observed at the lowest quality schools. In the case of suspensions, this magnitude is economically quite large, corresponding to a 5 percentage point reduction in the probability of suspension in each academic year.

We include mother fixed effects in the second column, so identification now stems from within-sibling, cross-gender contrasts in outcomes. This step purges any potential unmeasured correlation between family and school quality that could bias our estimates. We observe that the boy disadvantage at the worst-quality schools shrinks when we compare brothers to their sisters, but still remains very pronounced, as does the interaction between $Boy_i$ and school quality. It is noteworthy that the main effect of school quality, $\beta_3$, falls in magnitude dramatically when we compare brothers to sisters, rather than comparing unrelated boys and girls. As our discussion above anticipates, this pattern confirms that unobserved family attributes affecting school outcomes are correlated with school quality.

We further refine our analysis by exploiting family moves as a means of introducing plausibly exogenous variation in exposure to schools of differing quality within families, following the approach used by Chetty and Hendren (2015) to estimate the causal effects of neighborhood quality. Variation in school quality across siblings will arise from differing exposure to schools due to the move, with the identifying assumption that the timing of family moves is not correlated with children's potential outcomes.

We implement this empirical strategy by estimating equation (1) for the restricted sample of families who move at least five miles.[5] While this identification strategy is especially valuable in estimating the main effect of school quality, $\beta_3$, it could also be helpful in eliminating any biases associated with the possibility that some siblings attend different elementary or middle schools within the same district (though never simultaneously per our sample restrictions), thereby biasing estimates of $\beta_2$.

The results of this analysis are presented in columns 3 and 4 of Table 2. Despite the 80 percent reduction in sample size and accompanying fall in precision, the movers models generally corroborate the primary findings. Point estimates for the impact of school quality on the gender gap in standardized test scores and suspensions are in all cases in the same ballpark as the estimates based on concordant school siblings, but we lack precision in the case of suspensions, and no interaction remains with regard to absences, in the maternal fixed effects model. These results broadly support the hypothesis that boys differentially benefit from higher quality primary and middle schools. Notably, the estimated main effects of school quality on academic and behavioral outcomes using the movers models are also reasonably comparable to those from the concordant school estimates (those using mother fixed effects), though they are quite imprecise in two of three cases.

## III. Discussion

We provide new evidence using matched birth and school administrative records to explore the degree to which school quality affects the gender gap in educational and behavioral outcomes. Cross-sectionally, we document a steep gradient between school quality and the educational outcomes of both boys and girls, and a shallower but economically meaningful and robust differential gradient by gender—specifically,

[5] Note that we do not observe physical moves, but rather observe school moves; we assume that when at least two siblings in a family move to a school that is a substantial distance away or in a different county, this likely reflects a family move.

the female-favorable gap in these outcomes is declining in school quality. Comparing within-family, between-sibling contrasts with conventional OLS estimates, we show that the cross-sectional relationship between school quality and student achievement overstates the causal effect of quality on both genders, but it does not overstate the effect of school quality on the gender gap. Using sibling contrasts, and focusing either on school-concordant siblings or family movers, we confirm that school quality is more consequential for boys than girls.

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