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Susanne Link

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Abstract

To obtain reliable estimates of the effects of single-sex education, I exploit the random assignment of students to single-sex and coeducational schools in South Korea. The results suggest that single-sex schooling is beneficial for girls in math, but has no effects for boys. Moreover, comparisons within and across gender reveal that girls with low supporting parental backgrounds at coeducational schools fall behind their peers which is partly explained by a rougher classroom climate at mixed schools. Several robustness checks confirm these results.

JEL Code: I20, I24, J16.
Keywords: Single-sex education, student performance, random assignment, peer effects.

Susanne Link
Ifo Institute – Leibniz Institute
for Economic Research
at the University of Munich
Poschingerstr. 5
81679 Munich, Germany
Phone: +49(0)89/9224-1698
link@ifo.de

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1 Introduction

Underrepresentation of women in both high-paying and science-related fields is well documented. Explanations include gender-stereotype sorting, as well as differences in individual preferences, in non-cognitive behavior or in cognitive skills between men and women. Differences in the distribution of quantitative skills between boys and girls partly explain the sorting of men and women into high-paying and low-paying fields.[1] However, variation across cultures suggests that this gap is due to the social environment rather than inherent gender traits (Guiso et al., 2008).[2] Thus, raising girls' interest and achievement in math and sciences is a goal of policy aimed at reducing gender-based disparities. In this context, single-sex schooling has gained particular attention. For example, in the United States, single-sex classrooms are a growing phenomenon and amendments to Title IX that explicitly allow single-sex public schools and classes have set off a pedagogical dispute over whether sex-segregation improves educational achievement (Cohen, 2012; Whitmore, 2005).[3]

This paper exploits the random assignment procedure of students to South Korean (hereafter Korean) middle schools to investigate the effects of single-sex schooling on academic achievement in two stereotypically male subjects, namely, math and science. Given that attendance at single-sex schools is orthogonal to student characteristics such as socioeconomic background and ability, the comparison between girls (boys) at coeducational schools and girls (boys) at single-sex schools should identify a reliable effect of single-sex schooling on student achievement. By using TIMSS data from 1999, that provide extensive background information, I am able to investigate potential channels.

I find positive effects of single-sex schooling for girls at middle schools in math, but not in science. The effects in math are not only highly statistically significant and non-negligible in their magnitude, but also highly relevant since math performance is consistently linked to future earnings (Paglin and Rufolo, 1990). In contrast, I do not find any effects for boys.[4] Several robustness checks confirm that the results are not driven by observable or unobservable differences in the types of students that attend single-sex and coeducational schools.

Comparisons within and across gender reveal that girls with non-supporting parental backgrounds at coeducational schools fall behind their peers, a finding partly explained by a rougher classroom atmosphere at mixed schools. Coleman (1961) was the first to

[1] Paglin and Rufolo (1990) show that there is a much higher proportion of men than women in the top intervals of mathematical reasoning ability, which is often a qualification in high-paying fields. Interestingly, women with high mathematical reasoning abilities also show high participation rates in the sciences.

[2] See, e.g., Fryer and Levitt (2010) for an analysis of the gender gap in mathematics for the United States. Booth et al. (2011) emphasize the importance of social learning rather than inherent gender traits for observed gender differences in risk behavior.

[3] For example, Billger (2009) studies the effects of single-sex schooling in the context of the increase in single-sex classes and schooling in the United States as a response to amendments to Title IX.

[4] This finding is in line with earlier research on the effects of single-sex education. For example, Jackson (2002) finds positive effects of all-girl classes but no effects for all-boy classes.

hypothesize that the presence of the opposite sex in the classroom is distracting and leads to lower educational achievement for both boys and girls. In line with this, single-sex schools are claimed to have more serious and studious classroom climates (Lee and Bryk, 1986). This might be especially beneficial for girls given that boys are more disruptive, restless, and dominant in class. In fact, larger shares of girls in class are found to be associated with higher academic achievement which can partly be explained by a lower level of classroom disruption and violence (Hoxby, 2000; Whitmore, 2005; Lavy and Schlosser, 2011).[5]

Despite a great deal of work on the subject, empirical evidence regarding the effects of single-sex schooling on student outcomes is inconclusive (Bigler and Signorella, 2011). Several studies report positive effects, especially for girls, on academic achievement, self-esteem, and other non-cognitive outcomes (e.g. Lee and Bryk, 1986; Riordan, 1990; Jackson, 2002; Eisenkopf et al., 2011). However, other studies find no significant differences between students at coeducational and single-sex schools (Marsh, 1989). Moreover, most of the literature is based on comparison of student outcomes at coeducational schools and single-sex schools. These results are likely to be biased by self-selection of students into single-sex schools, since attendance at single-sex-schools is usually correlated with unobservable, individual characteristics that also determine student achievement.[6]

In recent years, there has been a growing literature that addresses the selection issues as to isolate the causal effect of single-sex schooling on student outcomes. Jackson (2012) exploits the fact that assignment rules in Trinidad and Tobago create exogenous variation to remove selection bias. He shows that only girls with stated preferences for single-sex schooling actually perform better. However, for most students he finds no significant effects. Eisenkopf et al. (2011) report positive effects of single-sex education for girls at a Swiss high school where girls are randomly assigned to single-sex and coeducational classrooms. In a similar manner, Behrman et al. (2012) make use of a unique feature in the Korean education system, namely, the random allocation of students to high schools in Seoul. They show that attending a single-sex school is associated with higher test scores in Korean and English and a higher probability of attending a four-year college for both girls and boys.

This paper contributes to the growing quasi-experimental literature on the effects of single-sex schooling. The random assignment of students to Korean schools presents a nice opportunity to obtain unbiased estimates. In contrast to Behrman et al. (2012), I focus on middle schools which are compulsory and therefore represent the full population of eighth grade students. Moreover, investigating the effects of single-sex schooling on math and sciences is especially interesting given the discussion about the influence of gender stereotypes on student achievement and choice (Thompson, 2003; Joshi et al., 2010;

[5] However, Whitmore (2005) reports that the positive effects for boys are only found for low grade level.

[6] See, e.g., Lee and Bryk (1986) for an overview of reasons to choose single-sex schools over coeducational schools.

Favara, 2011). Further, employing data provided by TIMSS and PISA is advantageous. Using externally assessed test scores in contrast to teacher assessed grades reduces the risk that effects are driven by teacher discrimination against girls or boys or by grading relative to peer performance. Moreover, the rich background questionnaire used in this study allows me to investigate a broad set of potential channels, which is an additional contribution to the literature.

My in-depth analysis shows that the positive effects for girls are neither explained by differences in school and teacher characteristics at coeducational and single-sex schools nor by gender-tailored teaching practices or more positive attitudes toward math at single-sex schools. However, some of the effect can be attributed to a rougher classroom atmosphere at mixed schools. The fact that I cannot fully eliminate the positive effect of single-sex schooling suggests that girls with non-supporting family backgrounds somehow benefit from the absence of boys in class. The more general implication may be that in any school system, girls with a non-supporting background may be particularly influenced by less favorable peer characteristics.[7]

The remainder of the paper is organized as follows: Section 2 describes the random assignment process to Korean schools. Section 3 presents the data. Section 4 explains the empirical approach. Section 5 provides the main results, along with an analysis of potential channels and mechanisms. Section 6 details the results of several robustness checks. Section 7 summarizes and concludes.

2 The Random Assignment Process to Korean Schools

As a response to a fierce competition among students in the admission process to middle and high schools, an "Equalization Policy" (EP) was introduced in 1969 with the aim of creating equal education opportunities at middle schools and reducing the influence of social background on student educational achievement.[8] Under this policy, the competitive entrance examinations were replaced by a random allocation, via a lottery system, of students within each school district. In other words, all schools, regardless of whether they were public or private, could no longer select students themselves but instead were required to take all students assigned to them by the Ministry of Education via a district-wide lottery. Moreover, the policy required equalization of school resources and teachers in an effort to ensure that there were no differences in resources and instruction quality across schools (Kim and Lee, 2003). Curriculum and teacher qualifications became uniform and centrally regulated. The government even provided subsidies to financially weak private schools so that their teacher salaries would equal those of public schools. Furthermore, all

[7]The heterogeneity of peer effects across gender is also documented by Lavy et al. (2012) that show that only girls significantly benefit from the presence of academically strong peers, the presence of very academically bright peers.

[8]See, e.g., section 7 in the Appendix for more information and Kim and Lee (2003) for an overview of the Korean education system in general and education reforms in particular.

private schools were required to charge the same tuition and teach the central curriculum.[9]

The policy was first implemented in Seoul in 1969 and expanded to major cities and then throughout the entire country within the next two years. Differences in teacher quality and school resources between schools were quickly reduced and improvements in the physical and psychological development of children reported. However, now that the problem was solved at the middle school level, an even fiercer competition for prestigious high schools began. As a response, the government introduced the high school Equalization Policy in 1974 for general high schools.[10] Under the policy, entrance examinations for general high schools were abolished. After passing a screening process, applicants for general high schools were assigned by lottery to a school within their residential district. Again, the policy was first adopted in Seoul and Pusan, the two largest Korean cities. By 1980, the Equalization Policy had been expanded to cover most major Korean cities.

The original structure of the Equalization Policy has been maintained for the past 30 years, leaving its main guidelines unchanged. Even today, all middle school students are assigned by lottery to a school within their residential district (Lee, 2004; Kim and Lee, 2003). However, the high school Equalization Policy became the subject of discussion and critique during the 1990s. As a result, its implementation was slowed. Metropolitan cities continued to be required to follow the policy and assign their students to general high schools, but it was optional for smaller cities and rural school districts. In 2001, the high school EP covered all seven metropolitan areas and 11 provincial cities. This accounts for 51 percent of the country's 1,969 high schools and 65 percent of their 1.91 million total students (Kim et al., 2008). More recently, some school districts modified the Equalization Policy such that students are allowed to state their preferences and high schools may choose a fraction of their students.

3 Data

Secondary schooling in Korea is organized into lower and upper secondary education. After graduating from middle school, which ranges from Grade 7 to 9, students usually proceed to upper secondary education (ISCED 3) and attend either general or vocational high schools.[11] Graduates of vocational high schools are qualified for direct entry into the labor market. In contrast, general high schools are more academically oriented and

[9]Except for certain rights over personnel decisions and school facilities, there are no differences between private and public schools in Korea. Even essential features of private schools, such as selection of students, tuition fees, teacher salaries, and curriculum, are regulated. Because of their short history, private schools in Korea were less prestigious and most of them welcomed the financial support and assignment of better students.

[10]High schools in Korea are divided into general, more academically oriented high schools, and vocational high schools that qualify for direct entry into the labor market. Vocational high schools have always been excluded from the Equalization Policy. Applicants for vocational high schools are allowed to state their preferences and are then selected by schools based on entrance examinations or middle school results.

[11]There are also a few specialized schools which are not considered in this study.

qualify their graduates for tertiary education. Interestingly, Korea has a long-standing tradition of single-sex schooling, with about half the students attending single-sex schools in 2000. It was not until the 1980s that coeducational schools emerged and conversion of some single-sex schools followed. Since the Equalization Policy for middle schools was not modified subsequent to this development, students are randomly assigned within the boundaries of their school districts regardless of whether schools are single-sex schools or coeducational schools.

To give an overview of the population of students, I report summary statistics on the eighth grade students at middle school and the 15-year-old students at high school by using data provided by the Third International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA). TIMSS 1999 tested countries in the southern hemisphere between September and November 1998, while PISA 2000 tested the majority of students in April 2000. Since the Korean school year starts in March and ends in mid-February, I observe the same cohort of students at the end of Grade 8 at middle school and at the beginning of Grade 10 at high school by using the TIMSS 1999 and the PISA 2000 data.

Besides educational achievement indicators, both datasets provide extensive background information at the student level as well as information on school and teacher characteristics. To indicate the single-sex status of a school, I rely on information as to the number of girls and boys enrolled at a school.[12] I drop observations from villages or rural areas because those areas are likely to have only a limited number of schools to which students could be assigned. In other words, by restricting the sample to large towns and cities, I focus on areas where the average school district has several coeducational as well as several all-girl and all-boy schools. For instance, in a typical school district (Kangnam) within the capital of Seoul, there are 10 coeducational schools, seven all-boy schools and seven all-girl schools to which students can be assigned (Seoul Metropolitan Office of Education 2007). The resulting dataset totals 4,775 individual observations at middle schools and 4,390 individual observations at high schools.

Given that I am interested in the effect of single-sex schooling on student achievement, there are a number of reasons to focus on middle schools only. Most important, all students are assigned randomly to middle schools according to the Equalization Policy. In contrast, vocational schools are not targeted by the EP and general high schools are subject to a number of exceptions. Moreover, the TIMSS data comprise the full population of students attending the eightht grade. In contrast, students select themselves into either vocational or general high schools after graduating from middle school. Figure 1 shows that the proportions of girls and boys at middle schools are quite equal — presumably because middle school is compulsory — whereas the share of boys exceeds the share of girls at

[12]The number of boys and girls enrolled at school is only collected in TIMSS 1995 and 1999. Since about 30 percent of students at coeducational schools are taught in single-sex classes in TIMSS 1999, I do not infer single-sex school status by the share of girls in a class in more recent waves of TIMSS and use TIMSS 1999, only.

general high schools. This is due to the fact that a relatively large share of girls attends vocational high schools, which are less academically oriented, or even drops out of school after graduating from middle school.

Furthermore, students at middle schools are nearly equally divided between single-sex and coeducational schools. About one half of all girls and all boys attend all-girl or all-boy schools, respectively. The figures for high school and vocational school students, however, reveal a disproportionate distribution of students between single-sex and coeducational schools. This indicates that the number of all-girl, all-boy and coeducational high schools is not evenly distributed. In addition, I observe students at a later point in time in their middle school career. Assuming that a single-sex school effect needs some time to unfold, I am more likely to find any effects for students at the end of their second year at middle school compared to students at the beginning of their first year at high school.

Tables 1 and 2 report student characteristics separately by gender for single-sex and coeducational middle schools. This comparison is intended to provide a first indication of the extent of randomness in the allocation process to school types. If students are randomly assigned to schools, student characteristics should not differ across single-sex and coeducational schools. The figures by gender and school affiliation are very similar and differences are generally not statistically significant for conventional student background characteristics. Unfortunately, I cannot observe residential school districts, and the very few significant differences in student characteristics are possibly driven by differences in the location of schools. However, several robustness checks suggest that the results are not driven by differences in the population of students between single-sex and coeducational schools.

4 Empirical Strategy

In the literature, the effects of attending a single-sex school are mostly derived by comparing students at coeducational and single-sex schools while controlling for a rich set of background variables. However, these estimates are unbiased only if the variable of interest, attendance at a single-sex school, is not correlated with unobservable characteristics captured by the error term. To satisfy this assumption, recently a number of studies make use of quasi-experimental settings (Eisenkopf et al., 2011; Behrman et al., 2012; Jackson, 2012).

To obtain the effect of single-sex schooling on student performance, I estimate the following model

$$TS_{ic} = \alpha + \beta SS_c + \gamma' X_{ic} + \varepsilon_i + \eta_c. \tag{1}$$

TS_{ic} is student i's performance at school c in either math or science, while SS_c indicates if student i is attending a single-sex school (1, if single-sex). The dependent variable is normalized with a mean of 0 and a standard deviation of 1. X_{ic} denotes a large set of control variables at the individual, school, and teacher level, ε_i represents an idiosyncratic error term, and η_c the error component that varies at the school level. In all regressions, I cluster standard errors at the school level to account for the fact that students at the same school share similar background and identical school and teacher characteristics.

As mentioned above, the interpretation of β relies on the underlying assumption that attendance at single-sex schools is orthogonal to unobserved individual characteristics. Since all middle schools are covered by the Equalization Policy, all middle school students are randomly assigned to a school within their residential district and neither observables nor unobservable characteristics should bias my estimates. I run all regressions separately for girls and boys, implicitly comparing girls (boys) at single-sex schools with girls (boys) at coeducational schools. By gradually adding control variables, I check whether differences in student characteristics, family background, and school and teacher characteristics alter the estimates. Since the random assignment process should be reflected in very similar background characteristics, adding information on student's socioeconomic background should not reverse or fundamentally alter my estimates. In contrast, differences in school resources and teacher characteristics can be seen as potential channels through which single-sex schooling affects student achievement. Although the Equalization Policy aimed at the equalization of schools and the ultimate reduction of differences in school quality, there are small differences between single-sex and coeducational schools in standard school and teacher characteristics (see Table A.1 in the Appendix).

The baseline model is then extended. To investigate the underlying mechanisms, I account for differences in the disciplinary classroom climate, teaching practices, and student attitudes, all of which are often argued to be influential determinants in the public debate. Further, I check whether effects of single-sex education are heterogenous across student groups and divide my sample implicitly into students from *relatively supporting* and *relatively non-supporting* families. Finally, I compare students across gender to see how girls at single-sex and coeducational schools actually perform relative to their male peers.

5 The Effect of Single-Sex Schooling on Student Performance

5.1 Baseline Results

Table 3 reports OLS estimates on the effect of single-sex schooling for girls and boys at middle schools. I start with a univariate model with *attending a single-sex school* as the explanatory variable. The model is then — step by step — extended by controls on student and background characteristics, school characteristics, and teacher characteristics.[13] The variable of interest, attending a single-sex school, is positive and significant in math for girls at middle schools throughout all specifications. Neither adding individual control variables (Column 2) nor school (Column 3) and teacher variables (Column 4) alters magnitude and significance. In other words, the coefficient is robust to the inclusion of control variables, which in turn suggests that attendance at single-sex schools is not correlated with unobservables that affect both control variables and outcome. Overall, these results suggest that girls at single-sex schools outperform girls at coeducational schools by about 13.5 percent (Column 4). For science, I find a positive coefficient that is not significant at conventional levels throughout the specifications.

The lower part of Table 3 reports the results for boys. I find insignificant coefficients, which are mainly close to zero for all specifications and both subjects. This indicates that there are no beneficial effects of single-sex schooling for boys at middle schools.[14]

Since students start middle school in Grade 7 and I observe them at the end of Grade 8, the effects I find for girls in math are likely to be cumulative.[15] TIMSS tests elements of primary and secondary school curriculum (Hanushek and Woessmann, 2011).[16] Compared to science, which is not taught as a single subject at most schools in my sample, math achievement might be a better indicator of teacher instruction in class. Thus, if more studious classrooms allow teachers at all-girl schools to cover the curriculum more extensively, this might be reflected in the large, significant coefficients for math achievement. Moreover, math is a traditionally male subject. The positive effects at single-sex school might also be driven by less gender-stereotyped attitudes.

In the upcoming analysis, I investigate several issues raised in the discussion of my findings. First, I focus on channels that might explain the positive effects for girls at single-sex schools. Second, I investigate whether the effects are limited to a specific group of students and compare girls' achievement relative to that of boys.

5.2 Channels of the Effects of Single-Sex Schooling

Given the positive and large effects for girls in math, it is important to understand the mechanisms that drive these effects. In a larger sense, studies on single-sex schooling contribute to the literature on peer effects which deals with the effects of all sorts of peer characteristics, including gender, on academic achievement (Hoxby, 2000; Lavy and Schlosser, 2011). Thus, it is important to separate gender compositional effects from other peer effects, such as advantageous family backgrounds and environments. Even though students in Korea are randomly assigned to schools within their residential districts, it

[13] See Table A.2 for the complete model.

[14] Throughout the paper, I report estimation results using the first plausible value reported in the data. However, the results are robust to using other plausible values or the mean of all plausible values reported.

[15] See Heckman (2006) for evidence on life-cycle skill formation.

[16] For a comparison on international student assessment tests, see Neidorf et al. (2006).

is possible, but rather unlikely, that I observe only all-girl schools in better-off areas, whereas I observe coeducational schools in disadvantaged areas. If girls with advantageous family backgrounds are grouped within all-girl schools, the effects I find are not due to the absence of boys, but could be attributed to a better student composition at single-sex schools. For example, Jimenez and Lockheed (1989) attribute positive effects of single-sex schooling for girls in Thailand to favorable peer characteristics, rather than gender.

To make sure that it is the absence of boys in contrast to advantageous family background characteristics of female peers that drive the positive effects for girls, I account for the quality of a student's peers in the regression. This approach is especially comprehensive, since TIMSS tests complete classes in math. Thus, in Table 4, I control for the share of peers with a low socioeconomic background as measured by the books at home, the share of peers with high family resources as a proxy for wealth, the average family size of an individual's peers, the share of peers with at least one parent holding a university degree, the share of peers with mothers who hold an university degree, and the average amount of time spent studying by an individual's peers as a proxy for peer pressure. None of these controls change the estimate of single-sex schooling for girls or boys, suggesting that the effects are not due to selection, but to factors such as classroom interaction and climate that are different in single-sex schools.

Since the equalization of resources across schools is one part of the EP, the results should also not be driven by conventional school characteristics. Table 3 shows that controlling for conventional school characteristics does not change the estimates. However, single-sex and coeducational schools might differ in the atmosphere and organization within schools. Even though some of these dimensions are unobservable, I am able to compare coeducational and single-sex schools in three influential areas — teaching practices, student attitudes toward math, including self-perceived competence, and disciplinary climate — to check whether the positive effect of single-sex schools for girls can be explained by differences between single-sex and coeducational schools.

The most obvious reason why single-sex education might be especially beneficial for girls involves the relatively more restless and disruptive behavior of boys. A growing body of literature documents that a larger share of boys in a class is associated with lower academic achievement (Hoxby, 2000; Lavy and Schlosser, 2011). TIMSS reports students', teachers', and principals' perceptions on several aspects of the disciplinary climate of classrooms and schools. Table A.3 in the Appendix reveals that, according to teacher and principal reports, there are indeed differences in the disciplinary climate at coeducational, all-girl, and all-boy schools. Teachers are asked to what extent teaching is hindered by (1) disruptive students, (2) uninterested students, (3) a wide range of backgrounds, and (4) a wide range of academic abilities. Twenty-five to 28 percent of students at coeducational schools attend classrooms where "disruptive" and "uninterested" students are reported to be "a serious problem". These fractions are somewhat smaller for all-boy schools and about half the size at all-girl schools. Further, teachers at coeducational schools perceive "a wide range of backgrounds" and "a wide range of academic abilities" as a problem more often compared to teachers at single-sex schools. Moreover, at more than 60 percent of all-girl schools, the "injury of students" is "not a problem at all", but there are large fractions of coeducational and all-boy schools that report the it as "quite problematic". This indicates that the disciplinary climate, as reported by both teachers and principals, is rougher at coeducational schools, which might be especially detrimental to girls' achievement.

Another argument made in favor of single-sex education is that such schools offer the opportunity to tailor schooling to each sex's unique needs. Differences in the way students are taught, therefore, might account for the positive effects found for girls. On the one hand, supporters of single-sex education claim that brain differences between boys and girls require different teaching styles.[17] On the other hand, more studious classroom climates at all-girl schools might motivate teachers to give more homework or work more often in groups.[18] Table A.4 in the Appendix shows that students at both all-girl and all-boy schools more often report "copying notes from the board" compared to students at coeducational schools. Students from all-girl schools report that teachers "give homework more frequently" and that they "work more often in groups". However, the reported differences are quite small.

Student attitudes toward math present another possible channel and the one most closely related to the literature on gender stereotypes. The construction of gender identities at schools seems especially important with regard to the persisting gender test score gap in math (see, e.g., Guiso et al., 2008; Fryer and Levitt, 2010) and the low representation of women in math- or science- related fields.[19] The presence of the opposite sex at mixed schools may either deforce or reinforce gender-stereotyped attitudes and thereby influence the likelihood that boys (girls) engage in stereotypically female (male) subjects or fields.[20] Single-sex education may reduce gender stereotype attitudes, it may lead to gender-atypical educational choices, and it might increase girls' interest in math, which is likely to improve learning and achievement (e.g. Thompson, 2003; Joshi et al., 2010; Favara, 2011). Moreover, the presence of boys in the classroom could be especially intimidating for girls in a stereotypically male subject such as math. Given a predominant opinion that boys outperform girls in math, a girl at a coeducational school is more likely to assess herself poorly relative to her peers, which include girls **and** boys, compared to a girl at a single-sex school.[21] Table A.5 reports descriptive statistics on several indicators of student

[17] Neuroscientists have found only few differences and none of them have been linked to teaching practices.

[18] The fact that achievement gains can be driven by differences in teaching styles has been documented by Jürges and Schneider (2010) who attribute positive effects of central exit exams to the fact that students were required to work harder.

[19] The role of gender identities is based on Akerlof and Kranton (2000)

[20] For example, Favara (2011) confirms that subject choices of girls at single-sex schools are more similar to those of their male schoolmates. In contrast, Halpern et al. (2011) show that sex segregation increases gender stereotyping.

[21] Beyer and Bowden (1997) show that females' self-perceptions of performance were inaccurately low in male tasks.

attitudes toward math, their self-perceived competence in math, and their educational aspirations. Girls at coeducational schools seem to have a less positive attitude toward math compared to girls at single-sex schools; apart from that, however, there are only very small differences regarding their confidence, educational aspirations, and preferences for math.

Classroom climate, teaching practices, and student attitudes all have the potential to interact with student learning and — as discussed above — there are plausible reasons why those areas might differ between single-sex schools and coeducational schools. However, except for the disciplinary climate, the descriptive statistics report only very small — if any — differences between coeducational and single-sex schools. Nevertheless, I control for disciplinary climate, teaching practices, and student attitudes in the regressions. If the coefficient of interest, single-sex schooling, is capturing some of these differences, the coefficient should decrease in size and significance.

Table 5 shows the relationship between measures of teaching practices and student achievement. The frequency of "having tests" and "giving homework" seems to be positively associated with student learning, however, most of the other measures are insignificant. Most importantly, the coefficient on the variable *single-sex schooling* does not change in magnitude or significance for either girls or boys. This suggests that the effects of single-sex schooling are not driven by differences in teaching practices. Table 6 reports the association between several measures of student attitudes toward math and achievement. As expected, all the measures are positively and significantly associated with better math results for both, boys and girls. However, although student attitudes have strong explanatory power for student achievements, the positive effects of single-sex schooling remain significant and are not affected by differences in the attitude toward math.

The association between several measures of the disciplinary climate and student achievement is also set out in Table 7. If students "behave orderly and as told" in class, they show higher achievement. However, the coefficient of interest is not influenced by the measures reported by students. Interestingly, I find no significant association between the extent of "disruptive students" and male and female achievement. In line with this, the effect of single-sex schooling is unchanged in these specifications. Also, the coefficient of interest is not affected by the inclusion of the extent of "intimidation of students" at school. This is not surprising, since principal reports are very similar at coeducational and single-sex schools.

In contrast, Table 7 reveals a negative and strong association between teachers who report "uninterested students as a great problem" and student achievement for girls. The coefficient of single-sex schooling drops by one quarter and loses significance in the girls' regression. Similarly, the "injury of students" presents a larger problem at coeducational schools and reduces the estimate of single-sex schooling considerably in the girls' regression. Although some teachers report "differences in students' backgrounds as a problem", this is not reflected in lower achievement by students. However, teachers at coeducational schools more often report that "differences in the math abilities" of their students limit their teaching. This is also reflected in lower student achievement and reduces the estimate of single-sex schooling. Since students are randomly assigned to single-sex and coeducational schools, the variation in math ability at each type of school should initially be quite similar. One explanation for that observation, therefore, might be that achievement of students in general or of boys and girls in particular at coeducational schools has diverged over time. Alternatively, it might be that teachers of coeducational classes just perceive abilities as more diverse, possibly due to a predetermined opinion that boys outperform girls in math.

Overall, these results suggest that differences in teaching practices and student attitudes cannot explain the achievement gains for girls at single-sex schools. However, in reality, Table 7 suggests not that girls educated in a single-sex school do better, but that girls at coeducational schools do worse due to a rougher classroom atmosphere.

5.3 Heterogenous Effects of Single-Sex Schooling

In a next step, I investigate whether effects vary with student family background. Paying attention to students with relatively less supportive backgrounds is important for several reasons. First, it has been argued that either type of schooling might be more beneficial or harmful to some students than to others. For example, Riordan (1990) shows that the greatest gains in single-sex schooling are those experienced by Hispanic and African-American males and females at schools with large minority populations. One reason for this might be that students with low socioeconomic background typically receive less support at home in studying and, since their education depends more strongly on instruction received at school, respond more strongly to it. Another reason might be that students belonging to minorities — either ethnic or socioeconomic — are easily intimidated and need a great deal of attention or support. Paying attention to students from a low socioeconomic background is also politically relevant since those students are at a higher risk of dropping out of school or performing very poorly, which might come at a high cost for the society as a whole (OECD, 2009; Woessmann and Piopiunik, 2009).

The number of books at home is a strong predictor of academic achievement by both girls and boys, as Table A.2 in the Appendix reveals, and has often been used in the literature as a measure for socioeconomic background (see, e.g., Woessmann, 2003, 2008; Schütz et al., 2008). Thus, I divide the sample into two groups and classify students with less than 100 books at home as students with *relatively low socioeconomic background* and those with more than 100 books at home as students with *relatively high socioeconomic background*. I further generate a variable that takes the value 1 if students have relatively low educated parents since parental education is a strong indicator of parents' interest in their children's educational aspirations and development. Similarly, a variable indicating wether a student reports that his or her mother is not interested in his or her math achievement is generated. I then interact those measures with single-sex schooling and include them in the regression.

As expected, Table 8 shows that a low socioeconomic background, low educated parents, and uninterested mothers are strongly and negatively associated with girls' and boys' math achievement. Interestingly, the interaction of all three measures of a supportive background are positive and significant for girls. Moreover, positive effects of single-sex schooling only occur for girls with low socioeconomic or low educated family backgrounds, and the effects are even larger for girls who report that their mothers are not interested in their math achievement. Consistent with the previous results for boys, the effects of single-sex schooling remain insignificant and around zero and the coefficients on the interactions are not significant.

So far, the analysis compared girls (boys) at coeducational schools with girls (boys) at single-sex schools. The results suggest that girls from low parental support backgrounds at single-sex schools outperform girls from low parental support backgrounds at coeducational school, whereas there are no significant differences for boys. However, given the existence of a gender test score gap in math, it is also interesting how girls at single-sex and coeducational schools perform relative to boys. Table 9 shows a pooled regression divided by socioeconomic background. The coefficient on the female dummy can be interpreted as the gender test score gap in math. Without controlling for single-sex schools, there is no significant difference in math achievement between boys and girls in the full sample (Column 1). However, as soon as the regression controls for all-boy (coefficient on single-sex) and all-girl schools (coefficient on the interaction of single-sex and female), the coefficient on the female dummy turns negative and significant, revealing the famous female test score gap in math. In other words, Columns 1 and 2 show that there are no significant differences in math achievement between boys at either coeducational schools or single-sex schools and girls at single-sex schools. However, girls at coeducational schools underperform boys at both school types and girls at single-sex schools. Table 9 also reports the results for students with low and high socioeconomic background as measured by books at home (Columns 4 to 9). Interestingly, there is no test score gap in math between boys and girls from relatively high socioeconomic background (Column 7), not even after controlling for single-sex schools (Column 8). In contrast, the test score gap between boys and girls with low socioeconomic background at coeducational schools is especially large (Column 5). Interestingly, the test score gap for girls in math vanishes as soon as the regression additionally controls for "the extent of injuries", — which can be viewed as a proxy for disciplinary climate. Altogether, this in-depth analysis suggests that girls from less supportive backgrounds fall behind at coeducational schools and that the atmosphere in coeducational classrooms plays an important role in this result.

6 Robustness

My results suggest that single-sex schooling seems to be beneficial in regard to math achievement for girls from low parental support backgrounds in math, but does not have any effects for boys. The causal interpretation in an ordinary least squares approach is based on the assumption that attendance at single-sex schools is orthogonal to student characteristics such as socioeconomic background and ability, and since students in Korea are randomly assigned to schools, this is very likely the case. Tables 1 and 2 lend support to this assumption by reporting very small and mostly non-significant differences in a very rich set of observable student characteristics. Moreover, the robustness of the estimates to the inclusion of this extensive set of control variables further corroborates the assumption (see Table 3).

The few significant differences in student characteristics may very well be driven by differences in the location of schools but, unfortunately, I cannot observe residential school districts. Table 4 shows that controlling for peer quality as a proxy for neighborhood characteristics does not change the estimates. Furthermore, controlling for the background variables reported in Table 1 at the class-level leaves the estimate unchanged. Nevertheless, I perform propensity score analysis and compare students at single-sex and coeducational schools who have similar estimated propensities to attend single-sex schools based on observable characteristics. I perform two common matching techniques — namely kernel and nearest-neighbor — since, to date, no single method has been found to be superior in the matching literature.[22] However, both the OLS and propensity score estimates are biased and inconsistent if there are unobservable characteristics that directly affect student achievement and are also correlated with single-sex school attendance. Again, since students are randomly assigned to schools, differences in unobservable characteristics between students at single-sex and coeducational schools only emerge out of differences in school locations. In other words, I do not worry that students attending single-sex schools are in general more motivated or the like, but I cannot exclude the possibility that school districts with, for example, highly motivated citizens have more single-sex schools. Students in those highly-motivated school districts would then have a higher probability of attending single-sex schools. Given that this argument also applies to boys at single-sex schools, I am confident that differences in unobservable characteristics are not driving my results. Nevertheless, I follow a technique developed by Altonji et al. (2005) that attempts to obtain information on the degree of selection on unobservables based on the degree of selection on observables to evaluate the selection bias on the estimates of the effects of single-sex schooling.[23]

Table 10 reports the results from the propensity score analysis using kernel and five nearest-neighbor matching techniques. As expected given the small and few differences in

[22] I use the Stata command *psmatch2* (see Leuven and Sianesi, 2003) to calculate the propensity score estimates.

[23] See Altonji et al. (2005) for a detailed explanation of the technique.

student characteristics and the large overlap in estimated propensity scores (not shown), the point estimates are quite similar to the OLS estimates for both the conventional student background control set (see Table 1) and the extensive student background control set (see Tables 1 and 2). Overall, I find positive, significant effects for girls at single-sex schools, but no effects for boys in either OLS or propensity score analysis. The underlying crucial assumption is that after conditioning on observable characteristics, students do not differ in unobservable characteristics. The right-hand side of Table 10 therefore reports the OLS estimates along with the estimated selection bias due to unobservables. In practice, the relationship between single-sex schooling and the observable determinants of math achievement (individual background variables) is used to approximate the relationship between single-sex schooling and influential unobservable factors. The selection bias is then estimated based on the underlying assumption that the selection on observables and the selection on unobservables are of equal magnitude. Since observable background information, such as parents' education and number of books at home, is collected to reduce potential bias, the relationship between unobservable characteristics of student achievement and single-sex schooling is likely to be even less strong. Interestingly, the estimated selection bias is negative and ranges from -0.012 to -0.071, depending on the set of controls. The bias is larger for the set of controls that includes exclusively strong predictors of student achievement and is close to zero when a large number of background controls is added. Given these results, a substantial positive single-sex school effect for girls cannot be rejected. The OLS estimates even provide a lower bound of the single-sex schooling effect given the negative sign of the selection bias. The reported selection bias for boys is also negative and quite large, meaning that, I cannot rule out that there is a positive effect of single-sex schooling for boys, too.

7 Discussion and Conclusion

Empirical results on the effects of single-sex schooling are often inconclusive and do not account for potential selection issues. Recently, several studies have addressed these problems and attempt to pinpoint the causal effects of single-sex schooling. Nevertheless, it is necessary to understand the underlying mechanisms and channels of such effects before any policy recommendations can be offered.

This paper contributes to the growing quasi-experimental literature and investigates the effect of single-sex schooling in a particularly interesting setting. In the Korean education system, students are randomly assigned to secondary schools, which can be either single-sex or coeducational. Given that attendance at single-sex schools is orthogonal to student characteristics such as socioeconomic background and ability, the comparison between girls (boys) at coeducational schools and girls (boys) at single-sex schools should identify a reliable effect of single-sex schooling on student achievement. Although there may be confounding factors, several robustness checks suggest that the effects are not driven by observable and unobservable differences in the types of students who attend single-sex and coeducational schools. Moreover, the rich data-set I use allows me to investigate a large set of potential channels and features that are often associated with single-sex schooling in the public debate. Although arguments for and against single-sex education are well-developed, most empirical work stops after obtaining the reduced-form estimates of the effect of single-sex schooling.

I find substantial positive, significant effects of single-sex schooling for girls from low parental support backgrounds in Math, but no effects for boys. Differences in school and teacher characteristics, gender-tailored education practices, or reduced gender stereotypes at single-sex schools cannot explain the finding. Comparisons across gender reveal that the test score gender gap in math is especially large for girls from low parental support backgrounds who attend coeducational schools. This result suggests that these girls might be somehow harmed by the presence of boys when learning a stereotypically male subject such as math. Given that most Western countries report large gender test score gaps in math while educating their students in coeducational schools, this is an particular interesting finding (see also Guiso et al., 2008; Fryer and Levitt, 2010).

In this regard, it must be remembered that schooling tradition and culture in Korea obviously differs from that of Western societies. Moreover, the data I analyze relate to a point of time when gender equality levels, as measured by, for example, the gender gap index (GGI), were relatively low in Korea. Even though this raises concerns about the generalizability of the findings, this paper documents an interesting pattern that is consistent with earlier findings. The fact that the in-depth analysis cannot fully explain the positive effects for girls suggests that future research should focus more on classroom interactions when trying to understand the underlying mechanisms of the effects of single-sex schooling.

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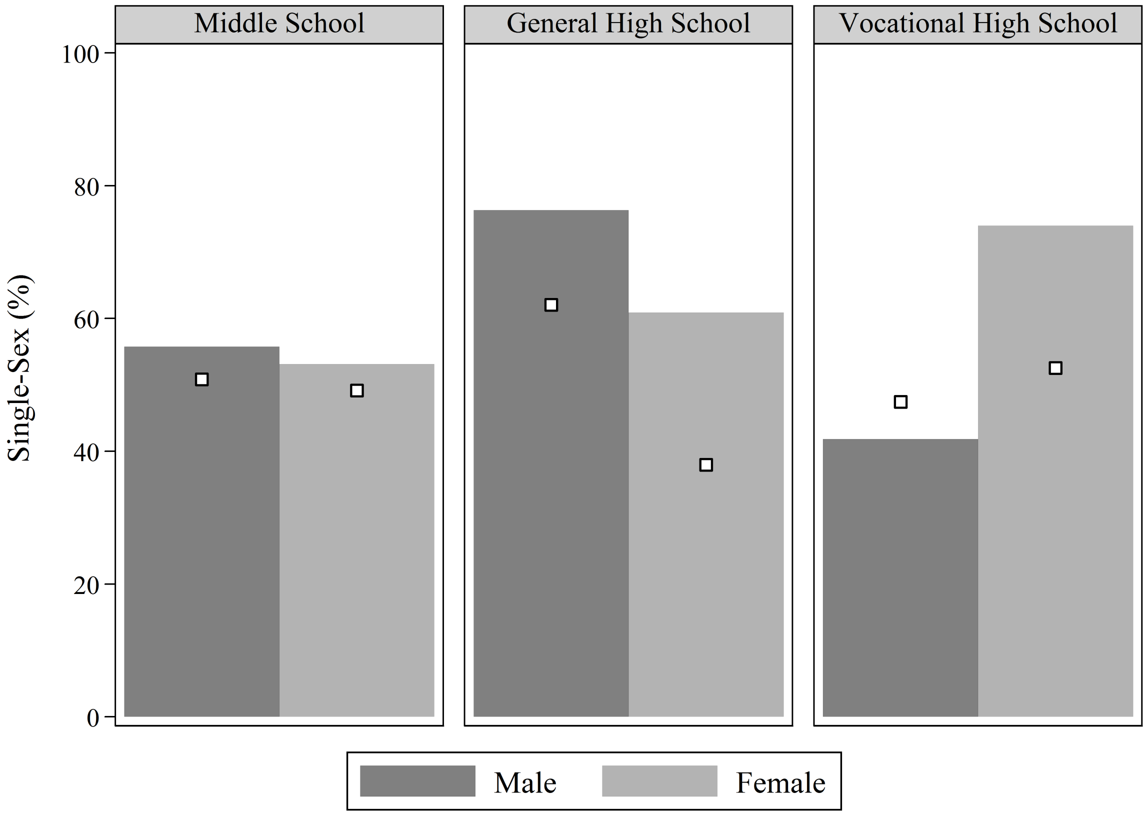
Figures and Tables

Figure 1. Student Population by School Type and Gender.



Notes: The white squares denote the share of girls and boys at each type of school. The bar denotes the share of girls and boys attending single-sex schools.

Table 1
Student Characteristics

	Female			Male		
	Coed	SS	Diff.	Coed	SS	Diff.
Age	14.45	14.42	-0.03 **	14.42	14.43	0.01
	(0.32)	(0.33)	(0.01)	(0.34)	(0.35)	(0.01)
None	0.04	0.04	0.00	0.03	0.05	0.02**
	(0.19)	(0.20)	(0.01)	(0.17)	(0.21)	(0.01)
Primary	0.13	0.13	0.00	0.12	0.13	0.02
	(0.34)	(0.34)	(0.01)	(0.32)	(0.34)	(0.01)
Secondary	0.47	0.55	0.08 ***	0.42	0.47	0.05**
	(0.50)	(0.50)	(0.02)	(0.49)	(0.50)	(0.02)
University	0.29	0.22	-0.07 ***	0.35	0.25	-0.10***
	(0.45)	(0.41)	(0.02)	(0.48)	(0.43)	(0.02)
0-10 Books	0.08	0.08	-0.00	0.08	0.11	0.03**
	(0.27)	(0.27)	(0.01)	(0.28)	(0.31)	(0.01)
11-25 Books	0.11	0.09	-0.02	0.09	0.11	0.02
	(0.31)	(0.29)	(0.01)	(0.29)	(0.31)	(0.01)
26-100 Books	0.35	0.37	0.02	0.35	0.35	-0.00
	(0.48)	(0.48)	(0.02)	(0.48)	(0.48)	(0.02)
101-200 Books	0.25	0.24	-0.00	0.24	0.22	-0.01
	(0.43)	(0.43)	(0.02)	(0.42)	(0.42)	(0.02)
> 200 Books	0.21	0.21	0.01	0.24	0.21	-0.03*
	(0.41)	(0.41)	(0.02)	(0.42)	(0.41)	(0.02)
Live w Parents	0.90	0.90	-0.00	0.90	0.90	-0.01
	(0.30)	(0.30)	(0.01)	(0.30)	(0.30)	(0.01)
Observations	1101	1247	1056	413	643	1056

Note: Individual observations are weighted by sampling probabilities. Standard deviations in parentheses. Data source: TIMSS 1999.

Table 2
Student Characteristics II

	Female			Male		
	Coed	SS	Diff.	Coed	SS	Diff.
Home resources						
Computer at home	0.63	0.63	0.00	0.77	0.68	-0.09***
	(0.48)	(0.48)	(0.02)	(0.42)	(0.47)	(0.02)
Observation	1099	1246	2345	1073	1351	2424
Internet at home	0.20	0.22	0.01	0.33	0.23	-0.10***
	(0.40)	(0.41)	(0.02)	(0.47)	(0.42)	(0.02)
Observation	1076	1207	2283	1049	1314	2363
Calculator at home	0.95	0.96	0.02*	0.97	0.96	-0.00
	(0.22)	(0.19)	(0.01)	(0.18)	(0.18)	(0.01)
Observation	1098	1246	2344	1072	1350	2422
Read a book						
about every day	0.22	0.22	0.00	0.28	0.25	-0.03
	(0.42)	(0.42)	(0.02)	(0.45)	(0.43)	(0.02)
about once a week	0.44	0.43	-0.01	0.38	0.38	0.00
	(0.50)	(0.50)	(0.02)	(0.49)	(0.49)	(0.02)
rarely/once a month	0.34	0.35	0.01	0.34	0.37	0.03
	(0.47)	(0.48)	(0.02)	(0.48)	(0.48)	(0.02)
Observation	1096	1244	2340	1063	1342	2405
Watch news or documentaries						
about every day	0.27	0.31	0.04**	0.30	0.30	0.00
	(0.44)	(0.46)	(0.02)	(0.46)	(0.46)	(0.02)
about once a week	0.33	0.35	0.03	0.34	0.36	0.02
	(0.47)	(0.48)	(0.02)	(0.47)	(0.48)	(0.02)
rarely/once a month	0.41	0.34	-0.06***	0.37	0.34	-0.03
	(0.49)	(0.47)	(0.02)	(0.48)	(0.47)	(0.02)
Observation	1093	1244	2337	1057	1335	2392
Go to the movies						
about every day/ once a week	0.03	0.03	0.00	0.04	0.06	0.02*
	(0.17)	(0.18)	(0.01)	(0.20)	(0.23)	(0.01)
about once a month	0.46	0.46	0.00	0.45	0.44	-0.01
	(0.50)	(0.50)	(0.02)	(0.50)	(0.50)	(0.02)
rarely	0.51	0.50	-0.01	0.51	0.50	-0.01
	(0.50)	(0.50)	(0.02)	(0.50)	(0.50)	(0.02)
Observation	1098	1244	2342	1063	1337	2400
Watch opera, ballet, classic music						
about every day/ once a week	0.06	0.06	-0.00	0.01	0.01	-0.01
	(0.24)	(0.24)	(0.01)	(0.12)	(0.09)	(0.00)
about once a month	0.18	0.17	-0.00	0.12	0.14	0.03**
	(0.38)	(0.38)	(0.02)	(0.32)	(0.35)	(0.01)
rarely	0.76	0.76	0.00	0.83	0.80	-0.03*
	(0.43)	(0.42)	(0.02)	(0.37)	(0.40)	(0.02)
Observation	1091	1245	2336	1055	1333	2388
Watch comedies						
about every day	0.53	0.52	-0.01	0.54	0.54	-0.01
	(0.50)	(0.50)	(0.02)	(0.50)	(0.50)	(0.02)
about once a week	0.34	0.35	0.01	0.34	0.34	0.00
	(0.48)	(0.48)	(0.02)	(0.47)	(0.47)	(0.02)
rarely/about once a month	0.13	0.13	0.00	0.07	0.07	0.00
	(0.33)	(0.34)	(0.01)	(0.25)	(0.26)	(0.01)
Observation	1097	1242	2339	1062	1338	2400

Note: Individual observations are weighted by sampling probabilities. Standard deviations in parentheses. Data source: TIMSS 1999.

Table 3
Effects of Single-Sex Education at Middle Schools

	Female							
	Math				Science			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Single-Sex	0.127**	0.144***	0.118**	0.135***	0.062	0.070	0.059	0.070
	(0.058)	(0.049)	(0.052)	(0.049)	(0.057)	(0.053)	(0.054)	(0.054)
Student Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
School Controls	No	No	Yes	Yes	No	No	Yes	Yes
Teacher Controls	No	No	No	Yes	No	No	No	Yes
Imputation Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Observations	2348	2348	2348	2348	2348	2348	2348	2348
Cluster	76	76	76	76	76	76	76	76
R^2	0.004	0.173	0.182	0.189	0.001	0.137	0.148	0.157
	Male							
	Math				Science			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Single-Sex	-0.087	-0.016	-0.002	-0.001	-0.092	-0.028	-0.030	-0.042
	(0.065)	(0.050)	(0.050)	(0.058)	(0.068)	(0.054)	(0.052)	(0.062)
Student Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
School Controls	No	No	Yes	Yes	No	No	Yes	Yes
Teacher Controls	No	No	No	Yes	No	No	No	Yes
Imputation Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Observations	2427	2427	2427	2427	2427	2427	2427	2427
Cluster	78	78	78	78	78	78	78	78
R^2	0.002	0.176	0.186	0.199	0.002	0.167	0.175	0.182
Data	TIMSS 1999				TIMSS 1999			

Notes: Individual student observations are weighted by sampling probabilities. Standard errors are clustered at the school level and reported in parentheses. Student controls include age, parent's education, books at home and living with mother and father. School controls include total enrollment, school location, student-teacher- and computer-student ratios, hiring and course autonomy. Teacher controls include teacher's age, gender, education and books at home for the teacher reported first if there are several. The regressions control for the fact that some students have several teachers in math and science. All regressions control for imputation. * p<0.10, ** p<0.05, *** p<0.01

Table 4

Effects of Single-Sex Education accounting for Peer Quality

	Female Math Test Score					
	Socioeconomic Background			University Degree		Peer Pressure
	Few Books	High Home Resources	Family Size	At least one Parent	Mother	Study Time
	(1)	(2)	(3)	(4)	(5)	(6)
Single-Sex	0.142***	0.140***	0.142***	0.149***	0.163***	0.151***
	(0.049)	(0.051)	(0.049)	(0.051)	(0.051)	(0.043)
Peers' Average	-0.176	0.126	-0.082	0.141	0.469*	0.732***
	(0.214)	(0.218)	(0.062)	(0.168)	(0.269)	(0.267)
Full Controls	Yes	Yes	Yes	Yes	Yes	Yes
Imputation Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2348	2346	2336	2348	2348	2281
Cluster	76	76	76	76	76	76
R^2	0.189	0.189	0.190	0.188	0.185	0.190

	Male Math Test Score					
	Socioeconomic Background			University Degree		Peer Pressure
	Few Books	High Home Resources	Family Size	At least one Parent	Mother	Study Time
	(1)	(2)	(3)	(4)	(5)	(6)
Single-Sex	0.018	0.016	-0.021	0.012	0.008	0.027
	(0.056)	(0.058)	(0.057)	(0.057)	(0.056)	(0.060)
Peers' Average	-0.463***	0.250	-0.082	0.232*	0.382**	0.513
	(0.147)	(0.170)	(0.062)	(0.138)	(0.168)	(0.367)
Full Controls	Yes	Yes	Yes	Yes	Yes	Yes
Imputation Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2427	2425	2397	2427	2427	2349
Cluster	78	78	78	78	78	78
R^2	0.202	0.201	0.200	0.200	0.201	0.196

Notes: Individual student observations are weighted by sampling probabilities. Standard errors are clustered at the school level and reported in parentheses. Student controls include age, parent's education, books at home and living with mother and father. School controls include total enrollment, school location, student-teacher- and computer-student ratios, hiring and course autonomy. Teacher controls include teacher's age, gender, education and books at home (for the teacher reported first if there are several). The regressions control for the fact that some students have several teachers in math and science. All regressions control for imputation.* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 5

Effects of Single-Sex Education accounting for Teaching Practices

	Math Test Score							
	Copying Notes		Having a Test/ Quiz		Giving Homework		Working in Groups	
	Female	Male	Female	Male	Female	Male	Female	Male
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Single-Sex	0.134***	0.015	0.151***	0.010	0.131***	0.007	0.137***	0.004
	(0.048)	(0.059)	(0.049)	(0.057)	(0.048)	(0.057)	(0.048)	(0.059)
Once in a while	0.095	0.033	0.213***	0.406***	0.191**	0.195**	-0.091**	-0.015
	(0.092)	(0.090)	(0.064)	(0.059)	(0.087)	(0.082)	(0.043)	(0.043)
Pretty often/ Always	0.100	-0.046	0.225***	0.365***	0.223**	0.104	0.051	0.034
	(0.088)	(0.095)	(0.082)	(0.067)	(0.088)	(0.089)	(0.062)	(0.064)
Full Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Imputation Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2348	2427	2348	2427	2348	2427	2348	2427
Cluster	76	78	76	78	76	78	76	78
R^2	0.190	0.199	0.195	0.218	0.191	0.200	0.191	0.197

Notes: Individual student observations are weighted by sampling probabilities. Standard errors are clustered at the school level and reported in parentheses. Student controls include age, parent's education, books at home and living with mother and father. School controls include total enrollment, school location, student-teacher- and computer-student ratios, hiring and course autonomy. Teacher controls include teacher's age, gender, education and books at home (for the teacher reported first if there are several). The regressions control for the fact that some students have several teachers in math and science. All regressions control for imputation.* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 6

Effects of Single-Sex Education accounting for Students' Attitudes

	Female Math Test Score				
	Like Math	Positive Attitude	Important for myself	Confidence	Educational Aspirations
	(1)	(2)	(3)	(4)	(5)
Single-Sex	0.132***	0.112**	0.112**	0.142***	0.130***
	(0.044)	(0.046)	(0.048)	(0.046)	(0.044)
Medium	0.598***	0.363***	0.297***	0.723***	0.504***
	(0.040)	(0.045)	(0.081)	(0.078)	(0.074)
High	0.974***	0.924***	0.529***	1.377***	1.032***
	(0.050)	(0.060)	(0.082)	(0.097)	(0.055)
Full Controls	Yes	Yes	Yes	Yes	Yes
Imputation Controls	Yes	Yes	Yes	Yes	Yes
Observations	2342	2339	2341	2342	2342
Cluster	76	76	76	76	76
R^2	0.305	0.247	0.211	0.251	0.286
	Male Math Test Score				
	Like Math	Positive Attitude	Important for myself	Confidence	Educational Aspirations
	(1)	(2)	(3)	(4)	(5)
Single-Sex	0.014	0.013	0.014	0.016	0.011
	(0.048)	(0.055)	(0.054)	(0.052)	(0.052)
Medium	0.615***	0.322***	0.388***	0.586***	0.410***
	(0.037)	(0.042)	(0.063)	(0.087)	(0.084)
High	0.838***	0.731***	0.536***	1.167***	0.900***
	(0.053)	(0.072)	(0.061)	(0.091)	(0.058)
Full Controls	Yes	Yes	Yes	Yes	Yes
Imputation Controls	Yes	Yes	Yes	Yes	Yes
Observations	2414	2413	2416	2412	2416
Cluster	78	78	78	78	78
R^2	0.305	0.237	0.221	0.246	0.282

Notes: Individual student observations are weighted by sampling probabilities. Standard errors are clustered at the school level and reported in parentheses. Student controls include age, parent's education, books at home and living with mother and father. School controls include total enrollment, school location, student-teacher- and computer-student ratios, hiring and course autonomy. Teacher controls include teacher's age, gender, education and books at home (for the teacher reported first if there are several). The regressions control for the fact that some students have several teachers in math and science. All regressions control for imputation.* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 7

Effects of Single-Sex Education accounting for Disciplinary Classroom Climate

	Female Math Test Score							
	Limits to Teaching						Behavior presents Problem	
	Students' Behavior		Students		Wide Range of		Students get	
	Orderly	As told	Disruptive	Uninterested	Backgrounds	Acad. Abilities	Intimidated	Injured
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Single-Sex	0.121**	0.134***	0.126**	0.095*	0.142***	0.083*	0.114**	0.077
	(0.049)	(0.048)	(0.050)	(0.051)	(0.051)	(0.048)	(0.052)	(0.048)
Medium	0.018	0.219**	-0.009	-0.051	0.078	-0.200***	-0.016	-0.137***
	(0.077)	(0.097)	(0.062)	(0.067)	(0.068)	(0.075)	(0.067)	(0.052)
High	0.191**	0.211**	0.023	-0.202**	-0.001	-0.087	-0.179**	-0.111
	(0.091)	(0.098)	(0.082)	(0.101)	(0.117)	(0.074)	(0.075)	(0.078)
Full Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Imputation Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2348	2348	2281	2281	2281	2327	2249	2249
Clusters	76	76	74	74	74	75	73	73
R^2	0.195	0.191	0.191	0.194	0.192	0.193	0.189	0.190

	Male Math Test Score							
	Limits to Teaching						Behavior presents Problem	
	Students' Behavior		Students		Wide Range of		Students get	
	Orderly	As told	Disruptive	Uninterested	Backgrounds	Acad. Abilities	Intimidated	Injured
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Single-Sex	0.004	0.006	-0.022	-0.009	0.016	-0.008	-0.001	-0.008
	(0.057)	(0.058)	(0.061)	(0.066)	(0.055)	(0.060)	(0.058)	(0.055)
Medium	0.128**	0.145**	0.021	-0.043	0.106**	0.009	-0.019	0.010
	(0.062)	(0.064)	(0.066)	(0.080)	(0.053)	(0.061)	(0.053)	(0.053)
High	0.105	0.081	-0.098	-0.069	0.075	-0.064	-0.038	0.111
	(0.069)	(0.072)	(0.073)	(0.073)	(0.070)	(0.117)	(0.093)	(0.080)
Full Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Imputation Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2427	2427	2401	2401	2401	2401	2411	2411
Clusters	76	76	74	74	74	75	73	73
R^2	0.199	0.199	0.200	0.199	0.200	0.199	0.197	0.198
Reported by	Students		Teachers				Principals	

Notes: Individual student observations are weighted by sampling probabilities. Standard errors are clustered at the school level and reported in parentheses. Student controls include age, parent's education, books at home and living with mother and father. School controls include total enrollment, school location, student-teacher- and computer-student ratios, hiring and course autonomy. Teacher controls include teacher's age, gender, education and books at home (for the teacher reported first if there are several). The regressions control for the fact that some students have several teachers in math and science. All regressions control for imputation.* p<0.10, ** p<0.05, *** p<0.01

Table 8
Heterogenous Effects of Single-Sex Education

	Test Score Math					
	Female			Male		
	(1)	(2)	(3)	(4)	(5)	(6)
Single-Sex	0.051	0.041	0.093*	-0.020	-0.032	0.019
	(0.059)	(0.047)	(0.049)	(0.070)	(0.066)	(0.054)
Low Socioeconomic	-0.550***			-0.435***		
	(0.058)			(0.054)		
Low∗Single-Sex	0.177**			0.022		
	(0.074)			(0.079)		
Low-educated		-0.370***			-0.329***	
		(0.055)			(0.059)	
Low-educated∗Single-Sex		0.230***			0.082	
		(0.070)			(0.084)	
Math not important for Mother			-0.708***			-0.780***
			(0.177)			(0.135)
NotImp∗Single-Sex			0.547**			0.071
			(0.221)			(0.180)
Full Controls	Yes	Yes	Yes	Yes	Yes	Yes
Imputation Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2348	2348	2335	2427	2427	2406
Cluster	76	76	76	78	78	78
R^2	0.162	0.163	0.195	0.162	0.176	0.224

Notes: Individual student observations are weighted by sampling probabilities. Standard errors are clustered at the school level and reported in parentheses. Student controls include age, parent's education, books at home and living with mother and father. School controls include total enrollment, school location, student-teacher- and computer-student ratios, hiring and course autonomy. Teacher controls include teacher's age, gender, education and books at home (for the teacher reported first if there are several). The regressions control for the fact that some students have several teachers in math. All regressions control for imputation.* p<0.10, ** p<0.05, *** p<0.01

Table 9

Single-Sex Education and the Test Score Gap in Math

	Math								
	Socioeconomic Background								
	All			Low			High		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Female	-0.040	-0.086**	-0.029	-0.071	-0.166***	-0.079	0.012	0.014	0.053
	(0.034)	(0.040)	(0.052)	(0.046)	(0.051)	(0.070)	(0.038)	(0.049)	(0.064)
Single-Sex		0.051	0.039		0.063	0.053		0.040	0.028
		(0.047)	(0.052)		(0.061)	(0.069)		(0.065)	(0.070)
Single-Sex*Female		0.079	0.062		0.156*	0.131		-0.006	-0.020
		(0.066)	(0.070)		(0.086)	(0.089)		(0.079)	(0.084)
injured2			0.036			0.021			0.053
			(0.049)			(0.061)			(0.069)
injured3			0.045			0.074			0.055
			(0.062)			(0.091)			(0.083)
injured2*Female			-0.125*			-0.166*			-0.096
			(0.067)			(0.089)			(0.086)
injured3*Female			-0.066			-0.170			-0.009
			(0.074)			(0.106)			(0.111)
Full Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Imputation Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4775	4775	4660	2575	2575	2500	2200	2200	2160
Cluster	116	116	113	116	116	113	116	116	113
R^2	0.181	0.183	0.182	0.124	0.129	0.130	0.110	0.110	0.112

Notes: Individual student observations are weighted by sampling probabilities. Standard errors are clustered at the school level and reported in parentheses. Student controls include age, parent's education, books at home and living with mother and father. School controls include total enrollment, school location, student-teacher- and computer-student ratios, hiring and course autonomy. Teacher controls include teacher's age, gender, education and books at home (for the teacher reported first if there are several). The regressions control for the fact that some students have several teachers in math and science. All regressions control for imputation.* p<0.10, ** p<0.05, *** p<0.01

Table 10

Robustness: Matching Estimates and Selection Bias

	Female							
	Propensity Score Matching				Bias in OLS			
	Kernel		Near.Neighbor		OLS Estimate		Estimated Bias	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Single-Sex	0.117***	0.107**	0.086	0.104**	0.143***	0.125**	−0.071	−0.012
	(0.042)	(0.043)	(0.054)	(0.046)	(0.049)	(0.048)	(0.025)	(0.020)
Student Background Variables								
Set 1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Set 2	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2348	2260	2348	2260	2348	2260	2348	2260
LR-chi2	37.71	59.69	37.71	59.69	0.171	0.212	0.171	0.212
	Male							
	Propensity Score Matching				Bias in OLS			
	Kernel		Near.Neighbor		OLS Estimate		Estimated Bias	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Single-Sex	−0.033	0.007	−0.023	0.001	−0.016	0.014	−0.372	−0.342
	(0.042)	(0.043)	(0.048)	(0.046)	(0.050)	(0.054)	(0.063)	(0.050)
Student Background Variables								
Set 1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Set 2	No	Yes	No	Yes	No	Yes	No	Yes
Observations	2427	2310	2427	2310	2427	2310	2427	2310
LR-chi2	47.80	2310	47.80	91.92	0.164	0.238	0.164	0.238

Notes: This table reports propensity score matching results and ordinary least square results along with the estimated selection bias based on Altonji et al. (2005). Student control set 1 includes age, mothers and fathers education, books at home and living with mother and father. Student control set 2 includes computer at home, internet at home, calculator at home, frequency of reading a book at home, frequency of watching news or documentaries at home, frequency of going to the movies, frequency of watching opera, ballet, frequency of watching comedies. Standard deviations in parentheses. Data source: TIMSS 1999.

Historical Background

As a response to very low enrollment rates after the Japanese liberalization, primary schooling in Korea became universal and compulsory in 1951. Although school facilities and resources were limited after the 3-year Korean War, enrollment rates for elementary schooling increased remarkably and rose steadily (Kim and Lee, 2003). Since most resources were invested in the primary education sector, the capacity of public secondary schools was not much increased. As a result, the provision of secondary school facilities lagged behind the rapid growth of the student population and resulted in a fierce competition among students in the admission process to middle and high schools. Consequently, all middle and high schools selected their students through competitive entrance examinations. However, the selection of students based on entrance examinations resulted in an advantage for wealthy families that were able to better support their children, particularly by paying for private tutoring. At that time, the Korean education system was characterized by an excess demand for secondary schools, substantial quality differences across schools, and overall unequal education opportunities. As a response, an "Equalization Policy" (EP) was introduced in 1969 with the aim of creating equal education opportunities at middle schools and reducing the influence of social background on student educational achievement.

Table A.1
School Characteristics Middle Schools

	Middle Schools			
	Coed	Single-Sex Schools		
	All	All	Female	Male
Total enrollment	1317.98	1178.80	1204.79	1155.09
	(482.17)	(338.10)	(310.60)	(359.84)
Outskirts of a city	0.52	0.34	0.33	0.34
	(0.50)	(0.47)	(0.47)	(0.47)
Center of a city	0.48	0.66	0.67	0.66
	(0.50)	(0.47)	(0.47)	(0.47)
Student-Teacher-Ratio	25.35	24.79	24.55	25.00
	(5.67)	(4.06)	(3.06)	(4.78)
Student-Computer-Ratio	39.25	61.92	49.68	73.08
	(37.92)	(152.53)	(54.68)	(203.74)
Share Teacher > 5 years	14.15	22.88	26.59	19.51
	(26.02)	(34.36)	(38.06)	(30.21)
Hiring Autonomy	0.27	0.42	0.46	0.40
	(0.42)	(0.49)	(0.49)	(0.49)
Course Autonomy	0.92	0.94	0.95	0.94
	(0.26)	(0.24)	(0.22)	(0.24)
Low socioeconomic background	0.53	0.55	0.54	0.57
	(0.50)	(0.50)	(0.50)	(0.50)
Female Teacher	0.64	0.60	0.79	0.42
	(0.48)	(0.49)	(0.41)	(0.49)
Teaching Experience	12.35	13.17	10.64	15.48
	(8.61)	(9.33)	(7.66)	(10.08)
Under 30	0.292	0.129	0.160	0.102
	(0.455)	(0.336)	(0.367)	(0.302)
30-50	0.620	0.695	0.782	0.616
	(0.486)	(0.460)	(0.413)	(0.486)
> 50	0.088	0.175	0.058	0.282
	(0.283)	(0.380)	(0.235)	(0.450)
Master/ Phd	0.14	0.12	0.11	0.13
	(0.35)	(0.32)	(0.31)	(0.33)
Up to 1 bookcase	0.256	0.378	0.311	0.439
	(0.436)	(0.485)	(0.463)	(0.496)
2 bookcases	0.269	0.308	0.349	0.272
	(0.444)	(0.462)	(0.477)	(0.445)
3 bookcases	0.475	0.314	0.341	0.289
	(0.499)	(0.464)	(0.474)	(0.453)
N	2175.00	2600.00	1247.00	1353.00

Note: TIMSS 1999. Individual observations weighted by sampling probabilities. Standard deviations in parentheses. Students with less than 100 books at home are classified as students with low socioeconomic background.

Table A.2

Effects of Single-Sex Education at Middle Schools

	Female		Male	
	Math	Science	Math	Science
	(1)	(2)	(3)	(4)
Single-Sex	0.135***	0.062	0.004	-0.017
	(0.049)	(0.050)	(0.058)	(0.053)
Age	0.048	0.157***	0.010	0.067
	(0.048)	(0.054)	(0.051)	(0.060)
None	0.309**	0.249	0.515***	0.545***
	(0.146)	(0.150)	(0.121)	(0.096)
Primary	0.338***	0.398***	0.379***	0.310***
	(0.111)	(0.108)	(0.084)	(0.075)
Secondary	0.379***	0.429***	0.446***	0.422***
	(0.096)	(0.097)	(0.074)	(0.069)
University	0.756***	0.684***	0.698***	0.636***
	(0.100)	(0.100)	(0.076)	(0.074)
11-25 books	0.343***	0.256***	0.237**	0.206**
	(0.107)	(0.088)	(0.095)	(0.083)
26-100 books	0.607***	0.521***	0.602***	0.508***
	(0.092)	(0.092)	(0.067)	(0.049)
101-200 books	0.858***	0.731***	0.756***	0.678***
	(0.096)	(0.094)	(0.071)	(0.060)
> 200 books	1.037***	1.007***	0.985***	0.939***
	(0.088)	(0.085)	(0.078)	(0.061)
Live w parents	0.138*	-0.064	0.205***	0.095
	(0.071)	(0.065)	(0.063)	(0.062)
Total enrollment	0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Center of a city	0.077	0.046	0.077	0.114**
	(0.056)	(0.054)	(0.060)	(0.054)
Student-teacher-ratio	-0.014*	-0.011	-0.004	0.009
	(0.008)	(0.008)	(0.006)	(0.006)
Student-computer-ratio	-0.001**	-0.000	0.000	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)
Share teacher > 5 years	-0.001	-0.002**	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Autonomy to hire	0.102	0.001	0.008	-0.049
	(0.063)	(0.050)	(0.047)	(0.059)
Autonomy over courses	-0.044	0.057	0.262***	0.247**
	(0.104)	(0.095)	(0.080)	(0.105)
Female teacher	-0.108	-0.009	0.019	0.065
	(0.075)	(0.063)	(0.066)	(0.060)
Teacher age: 30-50	0.032	0.291***	-0.145	-0.070
	(0.082)	(0.073)	(0.094)	(0.103)
Teacher age: > 50	-0.340	0.628***	-0.438**	-0.130
	(0.215)	(0.170)	(0.186)	(0.222)
Master/ Phd	-0.037	0.088	0.115	0.036
	(0.099)	(0.055)	(0.116)	(0.067)
Teaching experience	-0.000	-0.022***	0.007	0.004
	(0.006)	(0.005)	(0.006)	(0.007)

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	Female		Male	
	Math	Science	Math	Science
Teacher books: 2 bookcases	0.013	-0.135**	-0.060	-0.019
	(0.079)	(0.062)	(0.078)	(0.066)
Teacher books: 3-4 bookcases	0.060	-0.123*	-0.128	0.009
	(0.062)	(0.064)	(0.081)	(0.053)
Several teacher	0.093	-0.016	-0.320*	-0.028
	(0.120)	(0.057)	(0.173)	(0.066)
Constant	-1.686**	-3.056***	-1.473*	-2.383***
	(0.735)	(0.784)	(0.776)	(0.885)
Imputation control	Yes	Yes	Yes	Yes
Observations	2348	2348	2427	2427
R-sq	0.189	0.157	0.199	0.177

Notes: Individual student observations are weighted by sampling probabilities. Standard errors are clustered at the school level and reported in parentheses. Reference category for parent's education is "do not know", for

Table A.3

Descriptives: Disciplinary Climate

	Behave Not Orderly			Behave Not as Told			Students Disruptive			Students Uninterested		
	Coed	All-girls	All-Boys	Coed	All-girls	All-Boys	Coed	All-girls	All-Boys	Coed	All-girls	All-Boys
Not a Problem	0.279	0.401	0.274	0.399	0.513	0.421	0.208	0.380	0.238	0.287	0.428	0.368
	(0.446)	(0.489)	(0.444)	(0.487)	(0.499)	(0.491)	(0.406)	(0.486)	(0.426)	(0.452)	(0.495)	(0.482)
Minor Problem	0.592	0.508	0.594	0.520	0.428	0.492	0.539	0.490	0.568	0.436	0.426	0.470
	(0.489)	(0.499)	(0.488)	(0.496)	(0.493)	(0.497)	(0.499)	(0.500)	(0.496)	(0.496)	(0.495)	(0.499)
Serious Problem	0.129	0.091	0.132	0.081	0.059	0.086	0.253	0.130	0.194	0.277	0.146	0.162
	(0.333)	(0.286)	(0.336)	(0.271)	(0.235)	(0.279)	(0.435)	(0.337)	(0.396)	(0.448)	(0.353)	(0.369)
Observations	2175	1247	1353	2175	1247	1353	2128	1201	1353	2128	1201	1353
	Wide range of Backgrounds			Wide range of Academic Abilities			Intimidation of Students			Injury of Students		
	Coed	All-girls	All-Boys	Coed	All-girls	All-Boys	Coed	All-girls	All-Boys	Coed	All-girls	All-Boys
Not a Problem	0.278	0.508	0.488	0.185	0.480	0.573	0.337	0.362	0.371	0.419	0.698	0.370
	(0.448)	(0.500)	(0.500)	(0.388)	(0.500)	(0.495)	(0.473)	(0.481)	(0.483)	(0.493)	(0.459)	(0.483)
Minor Problem	0.575	0.409	0.435	0.627	0.401	0.355	0.508	0.540	0.536	0.502	0.229	0.507
	(0.494)	(0.492)	(0.496)	(0.484)	(0.490)	(0.479)	(0.500)	(0.499)	(0.499)	(0.500)	(0.420)	(0.500)
Serious Problem	0.146	0.083	0.078	0.189	0.119	0.071	0.155	0.098	0.093	0.079	0.073	0.123
	(0.354)	(0.276)	(0.268)	(0.391)	(0.324)	(0.258)	(0.362)	(0.298)	(0.290)	(0.270)	(0.260)	(0.328)
Observations	2175	1247	1353	2175	1247	1353	2128	1201	1353	2128	1201	1353

Notes: This table reports descriptive statistics on the disciplinary climate. Individual observations are weighted by sampling probabilities. Standard deviations in parentheses. Data source: TIMSS 1999.

Table A.4
Descriptives: Teaching Practice

	Teaching Practice											
	Copying Notes			Having a Quiz/ Test			Giving Homework			Working in Groups		
	Coed	All-girls	All-Boys	Coed	All-girls	All-Boys	Coed	All-girls	All-Boys	Coed	All-girls	All-Boys
Never	0.096	0.057	0.060	0.167	0.174	0.201	0.088	0.039	0.082	0.524	0.417	0.634
	(0.294)	(0.233)	(0.237)	(0.372)	(0.378)	(0.400)	(0.282)	(0.195)	(0.274)	(0.499)	(0.493)	(0.480)
Once in a while	0.426	0.350	0.304	0.572	0.587	0.558	0.451	0.489	0.418	0.312	0.370	0.254
	(0.494)	(0.477)	(0.459)	(0.494)	(0.492)	(0.495)	(0.497)	(0.500)	(0.492)	(0.462)	(0.483)	(0.434)
Pretty often/ always	0.479	0.593	0.636	0.261	0.240	0.241	0.462	0.472	0.500	0.165	0.213	0.112
	(0.499)	(0.491)	(0.481)	(0.439)	(0.427)	(0.427)	(0.498)	(0.499)	(0.499)	(0.371)	(0.409)	(0.314)
Observations	2175	1247	1353	2175	1247	1353	2175	1247	1353	2175	1247	1353

Notes: This table reports descriptive statistics on teaching practices. Individual observations are weighted by sampling probabilities. Data source: TIMSS 1999.

Table A.5
Descriptives: Attitude towards Math

	Attitude											
	Like Math				Positive Attitude towards Math				Math Important for myself			
	Female		Male		Female		Male		Female		Male	
	Coed	Single-Sex	Coed	Single-Sex	Coed	Single-Sex	Coed	Single-Sex	Coed	Single-Sex	Coed	Single-Sex
Low	0.480	0.449	0.429	0.446	0.312	0.270	0.245	0.253	0.091	0.092	0.106	0.105
	(0.500)	(0.498)	(0.495)	(0.497)	(0.463)	(0.444)	(0.430)	(0.435)	(0.288)	(0.289)	(0.308)	(0.307)
Medium	0.417	0.435	0.416	0.415	0.610	0.646	0.647	0.651	0.540	0.495	0.497	0.536
	(0.493)	(0.496)	(0.493)	(0.493)	(0.488)	(0.478)	(0.478)	(0.477)	(0.499)	(0.500)	(0.500)	(0.499)
High	0.103	0.115	0.154	0.139	0.079	0.084	0.108	0.096	0.368	0.413	0.397	0.359
	(0.304)	(0.319)	(0.361)	(0.346)	(0.269)	(0.277)	(0.311)	(0.295)	(0.483)	(0.493)	(0.489)	(0.480)
Observations	1099.000	1243.000	1069.000	1345.000	1093.000	1246.000	1071.000	1342.000	1096.000	1245.000	1071.000	1345.000

	Confidence in Math					Educational Aspiration			
	Female		Male			Female		Male	
	Coed	Single-Sex	Coed	Single-Sex		Coed	Single-Sex	Coed	Single-Sex
Low	0.060	0.051	0.039	0.041	Secondary Education	0.040	0.033	0.045	0.046
	(0.238)	(0.221)	(0.193)	(0.197)		(0.197)	(0.178)	(0.208)	(0.210)
Medium	0.850	0.871	0.833	0.845	Vocational Education	0.069	0.059	0.078	0.094
	(0.358)	(0.335)	(0.373)	(0.362)		(0.254)	(0.237)	(0.269)	(0.292)
High	0.090	0.078	0.128	0.114	Tertiary Education	0.795	0.802	0.769	0.747
	(0.287)	(0.268)	(0.335)	(0.318)		(0.404)	(0.398)	(0.422)	(0.435)
Observations	1096.000	1246.000	1071.000	1341.000		1095.000	1247.000	1067.000	1349.000

Notes: This table reports descriptive statistics on students' attitudes towards math. Individual observations are weighted by sampling probabilities. Standard deviations in parentheses. Data source: TIMSS 1999.

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