Gender Peer Effects: Evidence from the Transition from Single-sex to Coeducational High Schools (Boy Meets Girl)

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Whether single-sex schooling can deliver better educational outcomes than coeducational schooling is a public concern. Parents are concerned about their children's academic performance. Education policy makers are keen to find ways to improve student outcomes, and changing the gender composition of schools might be a cost-effective option.[1]

To understand students' academic performance in coeducational schools, we must understand the gender peer effect—the manner in which students interact with their opposite-sex peers. An ideal setting for identifying the effect would be an experiment in which we randomly assign students to single-sex or coeducational schools. This opportunity is rarely available; in the United States in particular, where most single-sex schools are private or Catholic, students self-select into those schools (Halpern et al. 2011). Thus, previous studies estimating the gender peer effect exploit marginal changes of gender composition naturally occurring across adjacent cohorts (Hoxby 2000; Lavy and Schlosser 2011) or rely on accidental variation created by a policy experiment (Whitmore 2005).

In this study, we exploit two unique institutional features of the high school system in Seoul, South Korea to estimate the causal gender effect. First, because of Seoul's Levelling Policy that

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[1] In the United States, the 2006 reform to Title IX of the Educational Amendments of 1972 started to permit public single-sex education, albeit to a limited degree.

commenced in 1974, middle school graduates are randomly assigned to high schools within a school district (Park et al. 2012). Parents might increase the probability that their children are assigned to their preferred school by moving closer to it, but the formula used for assigning students is not clearly known to the public and a degree of uncertainty about the process exists.

Second, we exploit a quasi-natural experiment in Seoul where several single sex high schools were changed to coeducational schools during the late 1990s and early 2000s. The transitions were led by the Seoul superintendent (In Jong Yoo, 1996–2004) under the Coeducational School Expansion Policy that started in 1998. The influx of opposite-sex students, who are randomly selected by the Levelling Policy, should be exogenous to incumbent students who entered their school shortly before the transition began. Although some students (or parents) might have preferred single-sex schools, they could not easily avoid their schools' transition even on anticipating it. Students are not allowed to transfer to another school within the same school district, making school transfer costly. Even if they move into a different district, they are again subject to the Levelling Policy. Indeed the data show that significant transfer-outs did not occur during the transition period. Further, even if non-random selection occurred, it would bias our estimates toward zero because students expecting to perform worse in a coeducational school would transfer out. In sum, we have a unique opportunity to examine the effects of exogenous changes in the gender composition at the school level on students' academic achievement. To our knowledge, our study is the first to identify the gender peer effect off transitions from single-sex to coeducational schools.

I. Data and Empirical Strategy

We use administrative data on Korean college entrance examination scores for all students who graduated from high schools in Seoul. We focus on the Coeducational School Expansion Policy period, and in particular, on the 1998–2003 period, since test scores in this period are standardized and comparable. We examine three high-stake subjects: Math, English, and Korean. Test scores are standardized each year at the national level with mean 50 and standard deviation 10. We exclude vocational or specialty high school graduates and repeated test takers. The sample consists of about 90,000–100,000 students per year from about 180 schools. During the sample period, seven schools were changed from all-boys (BOYS) to coeducational schools (COED), while only one all-girls school was changed. For this reason, we focus on boys and identify the gender peer effect of within-school variation in gender composition arising when schools transition from BOYS to COED.

Table 1 illustrates the manner in which different school cohorts undergo their school's transition. Suppose that a school commenced admitting girls at year τ.[2] Then, we can define three distinct cohort groups. The first group comprises students who entered the school before the transition, that is, at $(\tau - 3)$ or earlier and spent all of their three years of high school at BOYS. The second group consists of those who entered the school during the transition, that is, between $(\tau - 2)$ and $(\tau + 1)$. This transition group can be separated into two different subgroups. The first subgroup comprises boys who entered the school at $(\tau - 2)$ and $(\tau - 1)$: they entered BOYS, but when they were in the second and third year respectively, the school

[2] Throughout the paper, a year indicates the year that the test was held. In Korea, an academic year is from March to February and the second semester ends in December. The national college entrance examination is held only once a year in November, and all the students should appear for it on the same day.

started to admit girls to the first grade. The second comprises boys who entered the school at τ and $(\tau+1)$: they entered COED, but the transition was not complete. The last group includes those who entered the school at $(\tau+2)$ or later, after the transition was complete.

Table 1. Transition from All-boys to Coeducational School

				Beginning to admit girls				
Cohort (entrance year)	$\tau-3$	$\tau-2$	$\tau-1$	τ	$\tau+1$	$\tau+2$	$\tau+3$	$\tau+4$
Before transition $(\tau-3)$	B1	B2	B3					
During transition $(\tau-2)$		B1	B2	B3				
During transition $(\tau-1)$			B1	B2	B3			
During transition (τ)				C1	C2	C3		
During transition $(\tau+1)$					C1	C2	C3	
After transition $(\tau+2)$						C1	C2	C3

Notes: The vertical years represent high school entrance years. The horizontal years represent years around the transition from all-boys to coeducational schooling. At year τ, a high school begins to admit girls. B represents boys who entered the school before τ. C represents boys who entered the school at τ or later. The numbers next to B and C represent grades. For example, B3 indicates boys currently in the third grade who entered the school before τ. Students appear for college entrance examinations when they are in the third grade of high school.

Table 2 presents average test scores of transition school students (boys) by school entrance cohort, corresponding to Table 1. In the last column, we calculate the average share of girls at the school level for each cohort. For example, for students in the $(\tau-2)$ cohort, if the cohort size is constant and exactly half of the first year students are girls, then the share of girls is zero in the first and second years and one-sixth in the third year. Thus, the average share of girls is about 0.055. The sample average is a bit lower at 0.048. The results in Table 1 suggest that the gender peer effect could be nonlinear. We find that boys perform worse when girls start entering their school but, as the number of girls increases, boys' test scores start to improve. When the gender composition at the school is almost balanced, average scores recover to almost the pre-transition level.

Table 2. Transition School Students' Average Test Scores and Girls Ratio by School Entrance Cohort

	Math	English	Korean	Average Girls Ratio
[1] Boys before transition, $(\tau - 3)$ or earlier	52.09	52.23	52.59	0.00
	(9.10)	(7.87)	(7.36)	
	5,346	5,341	5,348	
[2] Boys during transition, $(\tau - 2)$	51.01	50.84	50.83	0.05
	(8.82)	(8.15)	(7.91)	
	2,671	2,671	2,675	
[3] Boys during transition, $(\tau - 1)$	49.30	48.82	48.98	0.14
	(9.28)	(8.84)	(9.16)	
	3,608	3,607	3,609	
[4] Boys during transition, τ	49.67	49.27	49.48	0.27
	(9.19)	(8.98)	(8.91)	
	2,336	2,335	2,337	
[5] Boys during transition, $(\tau + 1)$	49.95	49.19	49.19	0.37
	(9.31)	(9.33)	(8.88)	
	2,186	2,185	2,189	
[6] Boys after transition, $(\tau + 2)$ or later	50.90	50.78	50.63	0.44
	(9.53)	(9.09)	(9.12)	
	2,298	2,297	2,299	

Notes: Average scores of boys who graduated from transition schools by high school entrance cohort. The average girls ratio is the high school three-year average of the share of girls in the school for each cohort. Standard deviations are presented in parentheses. The number of observations is presented below the standard deviations.

To check if the results from the unconditional mean comparison in Table 2 hold with control variables, we conduct regression analysis by estimating the following equation:

$$Y_{ijzt} = \sum_{k=-2}^{2} \beta_k D_{ijzt}^{k} + \alpha_j + \mu_{zt} + \epsilon_{ijzt}$$

where Y_{ijzt} is the standardized test score of student i from high school j in school district z, who appeared for the test in year t. Let τ_j denote the year when school j commenced admitting girls. The dummy variable D_{ijzt}^k is the indicator of whether the student attends a transition school and belongs to a $(\tau_j + k)$ cohort, except for D_{ijzt}^2, which includes cohorts $(\tau_j + 2)$ or later.[3] The omitted comparison group includes those who entered at $(\tau_j - 3)$ or earlier, prior to the transition. We control for school fixed effects (α_j) and school district-specific nonlinear time trends in Seoul students' average scores by school district-year fixed effects (μ_{zt}).

Table 3. Gender Peer Effects on Boys' College Entrance Examination Scores

	Math	**English**	**Korean**
Omitted group: Cohorts $(\tau - 3)$ or earlier			
Cohort $(\tau - 2)$	-0.222	-0.552	-0.814*
	(0.490)	(0.376)	(0.438)
Cohort $(\tau - 1)$	-2.045***	-2.228***	-2.431***
	(0.534)	(0.643)	(0.792)
Cohort τ	-0.714	-0.897	-1.085
	(0.678)	(0.736)	(0.719)
Cohort $(\tau + 1)$	-0.851***	-0.776*	-0.848*
	(0.279)	(0.412)	(0.481)
Cohorts $(\tau + 2)$ or later	-0.477	-0.316	-0.157
	(0.390)	(0.506)	(0.534)
Constant	49.481***	50.398***	47.122***
	(0.380)	(0.306)	(0.359)
School Fixed Effect	Yes	Yes	Yes
School District-Year Fixed Effect	Yes	Yes	Yes
Observations	332,073	331,822	332,274
Adjusted R-squared	0.068	0.091	0.067

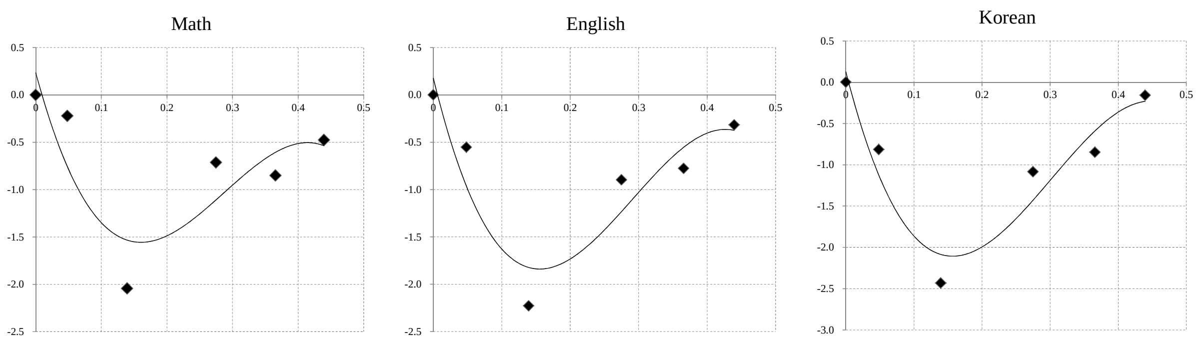
Notes: Robust standard errors, clustered by school, are presented in parentheses. *** Significant at the 1% level. * Significant at the 10% level. The dependent variable is the standardized national college entrance examination score with mean 50 and standard deviation 10.

[3] One might think that the cohorts entering after the transition began are endogenous in that they chose to enter COED. Although this is unlikely because of the Levelling Policy and other restrictions on school choice, we re-estimate our equation without those cohorts and find qualitatively same results.

II. Estimation Results

Table 3 presents the regression results for the three subjects separately. The results are consistent across subjects. Boys' test scores decrease early in the transition. In particular, the influx of girls significantly lowers the test scores of cohort $(\tau - 1)$ by about 2 points (0.2 standard deviation). However, as the number of girls entering schools increases, boys' academic performance improves. In fact, when the transition is complete, for cohorts $(\tau + 2)$ or later, average test scores are only slightly lower than the pre-transition average test scores.

Figure 1. Nonlinear Gender Peer Effects



Notes: The horizontal axis represents the average share of girls, and the vertical axis represents the estimated peer effect presented in Table 3. The curve is the fitted cubic function.

The results in Table 3 show that the gender peer effect is nonlinear. In Figure 1, we plot the relationships between the gender peer effect as shown in Table 3 and the average share of girls as shown in Table 2 and find a U-shaped relationship. It seems that boys perform worst when girls comprise 10–20 percent of the total student population. When the proportion of girls is close to 50 percent, boys perform as well as they do when there are only boys in their school.

Our findings of nonlinear gender peer effects are consistent with those of Hoxby (2000), who exploits random variation in the gender composition of school cohorts, measured by unexpected deviations from within-school cohort-to-cohort gender composition trends. Specifically, she finds that an increase in the share of girls decreases boys' test scores when the share is lower than 1/3, while it significantly increases boys' scores when the share is higher than 2/3. She finds that a change in the share of girls has a small positive impact or no impact when the share is between 1/3 and 2/3 of the total students. These patterns are similar to what we found in Figure 1.

The insignificant difference in average scores before and after the transition is also consistent with recent papers that carefully control for selectivity bias. Lavy and Schlosser (2011), using the same identification strategy of Hoxby (2000), find that a change in gender composition of cohort does not significantly change individual behavior and conclude that the observed positive effects of girls are driven by compositional change. Jackson (2012) exploits a quasi-natural experiment arising from the institutional rule of assigning students to secondary schools in Trinidad and Tobago. He finds no benefit of attending single-sex schools. We do find significant benefits for all three subjects using the Korean data set by controlling for school district-year fixed effects, without school-specific fixed effects. In this study, we control for both fixed effects exploiting transition schools and find no significant benefit. As long as transition schools are not peculiar, our findings suggest that the observed benefits of single-sex schools are due to students' selection into schools.

Lastly, we examine heterogeneous peer effects by estimating a linear probability model after replacing the dependent variable with the indicator of whether the student's score is higher than 60, one standard deviation above the national average. We also estimate the probability that a student's score is lower than 40 to examine the effect at a lower tail. The results are quite consistent with Figure 1. We find that boys at both tails are negatively affected by the influx of girls. In addition, we find that the impact is larger at a lower tail. For cohort $(\tau - 1)$ where the effect is the greatest, the probability of a student scoring higher than 60 drops by 3–4 percentage points while that of a student scoring lower than 40 increases by 5–8 percentage points.[4]

III. Conclusion

To circumvent the self-selection of students into single-sex and coeducational schools, we relied on school-level variation in the proportion of girls in the total student population owing to the transition from all-boys to coeducational schools. The influx of girls caused a decrease in boys' scores on college entrance examinations in three high-stake subjects, Math, English, and Korean. However, this gender peer effect was nonlinear. Analysis results reveal that the presence of a relatively small proportion of girls causes a substantial decrease in boys' test scores, whereas these scores improve as the gender composition becomes more balanced. An unbalanced gender composition of students, particularly when boys outnumber girls, might cause boys – especially those at a lower tail – to indulge in disruptive behavior or lose focus on their studies. The gender peer effect could work through various channels. For example, an unbalanced gender composition might affect students' performance indirectly via its impacts on teachers or school policies. Definitely further evidence on mechanisms of the gender peer effect would have practical implications for current debate about single-sex versus coeducational schooling.

[4] For transition schools before transition, the sample average share of students scoring higher than 60 is 14–21 percent, and that of students lower than 40 is 6–8 percent. The number of students per school is on average 594.

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