Gender Composition and Performance:

The effect of single-sex classes on exam scores

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Abstract: The literature in economics and education commonly argues that girls benefit from single-sex education and that there is no effect for boys. While theories of gender identity and peer-effects can explain why one would expect these results, estimating the causal effect of single-sex schooling is hard given issues of endogeneity. In this paper we use randomly assigned single-sex and mixed sex compulsory classes for first year students entering college to estimate the effect of single-sex education on the exam scores of girls and boys. We find that being in an all-girls class has a causal effect of increasing one's grade by 4 points; that result is robust to many controls and there is no effect for boys. The increase in the overall grade is primarily because girls assigned to all-girl groups do much better on the final exam; there is no evidence they do better on the coursework for the class. Attendance at classes plays a large role in the outcome: those that attend all classes score, on average, 23 points more on the overall course mark than those who do not attend any classes. Being assigned to an all-girls calls means a girl, on average, will attend 71% of classes compared to the 63% attended by a girl in a mixed gender group. The indirect increase in attendance of being assigned to an all-girls group can explain half of the overall increase in girls scores.

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Introduction

Educating girls in single-sex environments could have a positive effect on economically important outcomes such as competitive choices, risk attitudes, test scores that influence college placement, etc. Identifying the effect of single-sex education on particular outcomes has been challenging because of endogeneity issues surrounding what types of girls attend single-sex schools and the inability to randomly assign students to classes in many school systems. In this paper we will focus on grades of college-aged students and we will identify the effect of single-sex education by randomly assigning students to single-sex and mixed gender classes and following their progress over one academic year.

It is often argued that girls benefit academically from single-sex education, in part by achieving higher scores on standardized exams (see Campbell and Sanders (2002) for an overview of the empirical studies on single-sex education and its effects on girls). Two potential reasons for this effect have been discussed in the economics , education, and psychological literatures: (1) stereotype threat or identity concerns, and (2) peer effects.

Educational studies show that there may be more pressure for girls to maintain their gender identity in schools where boys are present than for boys when girls are present (Maccoby (1990, 1998); Brutsaert (1999)). If the girl believe that she is supposed to be meek and not outshine a male than she may not ask questions in class or put as much effort into preparing for an exam if boys are present. Stereotype threat could also be a cause for girls feeling pressure to conform to female ideals in a coed environment. Girls may feel not only the pressure of an exam but also burden of overcoming a stereotype that she believes that males in her cohort may have of her. The role of identity has also been explored in the economics literature Akerlof and Kranton (2000). Their work could be extended to this environment to examine the role of single-sex education; for instance girls may feel more conflict in their gender identity in a mixed gender setting than boys would since some traits of being 'feminine' may be at conflict with doing well in a class or asking questions.

When one is assigned to a single-sex environment her peers are going to be different than when she is assigned to a coed environment. Recent work in the economics of education literature has shown how peer-groups can effect ones performance in schools. For

instance, Duflo, Dupas, and Kremer (2010) show that being in similar peer-groups – with other high or low performing students – had a positive effect on a student's performance. These results are consistent with teachers being able to adjust their method of teaching to suit different groups. If boys and girls learn differently at college then, when segregating girls and boys into single-sex groups, both boys and girls should benefit because the teacher can adjust her method of teaching for the relevant group.

Given the potential for both girls and boys to improve their class grades – which are relevant for getting into graduate or professional schools, landing interviews at better firms, and in standing out compared to other potential individuals in the labor market – and the difficulty in identifying we will use a randomized identification technique to examine what causal effect, if any, single-sex education has on first year students entering college and we will provide evidence on what type of mechanism may be driving the effect.

Experimental Design

First year students in the economics department and the business school at the University of Essex are required to take a year-long introductory economics course. Economics students take EC111 and business school students take EC100. Each course consists of two lectures a week to all students enrolled in the course and one small class meeting with a graduate teaching assistant (GTA) from the economics department. Given the amount of material covered in the course and the number of students in the lectures (over 400 for each course) the classes are designed to allow students to ask specific questions and to provide more personalized instruction for the students. The classes meet 20 times over the course of the academic year and each graduate teaching assistant holds office hours that any student registered in the course can attend.

To examine the effect of single-sex education, students were randomly assigned to single-sex or mixed gender classes. Each class had, roughly, 17 students and the students stayed in the same class for the entire academic year and had the same GTA the entire time. No graduate teaching assistant taught only single-sex classes (that way GTA fixed effects could be used in the analysis) and each type of class and male and female GTAs teaching; other than those restrictions, GTAs were randomly assigned to classes by the timetabling office.

Other than intervening in the gender composition of the classes, no other changes were made to how the courses were taught or the requirements.

Students are required to attend all classes but failure to do so did not have a direct effect on a student's grade in the course. Students whose attendance record was inadequate had a letter sent to their parents informing the parents that failure to attend classes could lead to a student doing poorly in the course and, consequently, not earning the required grade to continue in the university. The classes are viewed as being vital for students to do well on exams and coursework.

Subjects

Subjects were first year students enrolled in the economics and business school at the University of Essex during the academic year 2010-2011. Students were, on average, 19 years old and roughly 34% came were born in the UK and 30% were born in the EU. The UK and EU students made up a much larger amount of the students in EC111 than in the business school; 70% to roughly 56%. Furthermore, in both courses, roughly 60% of students were male. Overall, the student body for both introductory courses did not vary much from previous years.

To examine the effect of the randomization and what differences, if any existed between students assigned to single-sex or coed groups we present a table of summary statistics below.

Table 1: Summary Statistics for single-sex and mixed classes for *Introduction to Economics*

	Girls			Boys		
	Mixed	Single-Sex	Diff	Mixed	Single-Sex	Diff
Final Exam Score	52.95	56.3	3.35	52.41	51.75	-0.66
Coursework Score	53.83	56.67	2.84	51.75	50.61	-1.14
Overall Course Grade	53.97	57.87	3.90*	52.98	53.39	0.41
Age	19.65	19.07	-0.58***	19.66	19.26	-0.40*
Class Size	18.49	20.15	1.66***	17.43	18.28	0.85***
Class Attendance (%)	0.64	0.71	0.07**	0.63	0.65	0.02
UK Born (%)	0.21	0.31	0.10*	0.34	0.31	-0.03
EU Born (%)	0.30	0.3	-0.00	0.25	0.24	-0.01
Chinese Born (%)	0.26	0.19	-0.07	0.17	0.24	0.07

The unconditional means for final exam and coursework scores show no differences between mixed and single-sex classes for boys or girls, however there is a difference for girls with regards to the overall course grade. These three variables will be dependent variables in our analysis below. The key variables that need to be discussed are age, class size, and if a student was born in the UK. For both boys and girls, the average number of students in the single-sex classes was larger than in the mixed gender classes. The maximum number of students in any class for EC100 was 25 and the maximum number per class for EC111 was 20 (EC111 is a much bigger class). The decrease in class size, to an average below the maximum number, is due to students dropping out of the university or switching departments. The data in the tables is made up of students who were enrolled in the course, stayed in the course, and took the final exam (thus receiving an overall course mark). If single-sex classes allowed students to do better overall in class and thus reduced their likelihood of dropping out, then it would not be correct to view the final class size in a course as exogenous. Thus to make sure our results in the next section are not picking up the effect of differential dropout rates instead of a direct effect on exam scores, we will

control for this variable. Likewise we will control for where a student was born and the age of a student.

Main Results

Table 2 below presents the main regressions results of the paper. It shows that only girls benefited from being in a single-sex environment and the benefit is robust to including the controls for variables that had significant differences above.

Table 2: Dependent Variable is overall mark in module

VARIABLES	[1]	[2]	[3]	[4]	[5]	[6]
Female (=1)	0.04	-0.02	-0.09	-0.64	-0.59	0.04
	[2.20]	[2.20]	[2.22]	[2.16]	[2.29]	[1.97]
All-Girls Class (=1)	3.89*	4.07*	4.01*	3.77*	3.99	3.89*
	[2.28]	[2.33]	[2.33]	[2.25]	[3.00]	[2.24]
All-Boys Class (=1)	0.36	0.26	0.32	0.51	-0.32	0.36
	[1.81]	[1.82]	[1.86]	[1.84]	[2.49]	[1.46]
EC 111 Module (=1)	2.83**	2.85**	2.68*	2.19	1.61	2.83**
	[1.41]	[1.42]	[1.44]	[1.44]	[5.52]	[1.33]
GTA Gender Control	NO	YES	NO	NO	NO	NO
Age Controls	NO	NO	YES	NO	NO	NO
Region of Birth Controls	NO	NO	NO	YES	NO	NO
Class Size * EC111	NO	NO	NO	NO	YES	NO
S.E. Clustered at Class Level	NO	NO	NO	NO	NO	YES
Constant	53.39***	53.56***	77.32***	52.79***	56.37***	53.39***
	[1.26]	[1.35]	[1.44]	[1.84]	[4.40]	[1.02]
Observations	570	570	570	570	570	570
R-squared	0.016	0.016	0.030	0.043	0.027	0.016

Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Colum [1] shows that being assigned to an single-sex class increased a girls overall grade in the course by 4 points. Given that the average grade for the course was 53 points, that would be a 7.5% increase in the average girls mark. Column [2] shows that when a GTA's gender is controlled for the point estimate stays roughly the same. Likewise adding age, as in column [3], or region of birth controls, as in column [4], to the regression does not change the point estimate significantly or cause the estimate to become insignificant. Controlling for class size was not straightforward. Since the two courses had different upper bounds on class sizes and EC100 was much larger than EC100, the class size dummies were correlated with the EC111 module dummy variable. Thus we approached this in two ways; first we added dummy variables for class size interacted with the EC111 dummy variable. This added 20 new controls to the regression equation and no variable other than the constant was significant because the standard errors got much larger. There are too few observations in each cell to have an accurate regression with that many dummy variables. What is worth noting is that the point estimate for the single-sex girls class has not changed. Column [5] deals with class size again; instead of adding fixed effects we cluster the standard errors of our regression in column [1] at the level of the class. When we do this the standard errors do not change much at all and the all-girls coefficient stay significant.

The results in table 2 show that there is a strong positive effect on the overall grade received by girls who are randomly assigned to single-sex classes but that there is no effect for boys. This evidence fits with the hypothesis that stereotype threat or issues of identity are playing a role but does not provide any evidence in support of the tracking outcomes observed in other studies looking at peer effects. By segregating boys and girls, teachers should be able to adjust their teaching so that they are able to teach to the mean student in each class better. Thus one would expect to see a positive effect for both boys and girls; however this is not the case. Given these results we now want to look at if we can identify what, if any mechanism may be playing a role in driving the positive effect.

Mechanism

The overall grade in EC111 and EC100 is calculated in the same manner as all other grades in the economics department; the final mark is either 50% of the exam score plus 50% of the coursework score or 100% of the exam mark – whichever is higher. Thus, the 4 point increase in the overall grade could be a cause of the treatment only effecting the exam score, only effecting the coursework score, or effecting both.

Insert Table 3 here

Column [1] shows the main regression from table 2 – that single-sex classes caused girls to do, on average, 4 points better in their overall grade for the course. Columns [2] and [3] show that effect on the two components of the overall grade: final exam score and coursework score. Girls in single-sex classes do about 4 points better on the final exam but there is no significant difference on the coursework mark. The 4 points is almost the same as the increase of the overall grade, which is not surprising since the exam score MUST be taken into account either way the final grade is calculated.

The design of EC111 and EC100 is such that attendance at the classes should give the student a better chance of passing the course. Columns [4]-[6] show the effect of attending class on the overall mark, exam score, and coursework mark. If student attends 100% of the courses she will get, on average, over 25 points higher on her overall grade, 26 points higher on her exam, and 31 points higher on her coursework than a girl who attends none of her classes. When attendance is included the effect of the all-girls coefficient drops by almost half in for overall mark and exam score – the two cases it was significant. Class attendance is not exogenous, thus we must analyze its effect and inclusion in the regression carefully. If a girls is assigned to an single-sex class she may feel more comfortable attending classes (because of less gender conflict, etc.). Since students were randomly assigned to class types than we can look at the effect of a girl being assigned to a single-sex class on her attendance. This result is shown in column [7]. On average a student attend 63% of her classes but a girl assigned to a single-sex class will attend 71% per cent of her classes. This 8 percentage point difference is significant and, given the size of the effect of attendance on one's overall mark, could explain a large part of the point estimate in the

overall grade. To consider this note that a 0.08 increase in attendance will effect one's overall mark by 0.08*25.47 (the point estimate from column [4]) which is an overall increase of 2.03 points in one's overall mark. Thus the indirect effect of attendance caused by being assigned to an all-girls group half of the increase in the overall mark. While this explains a large part of the overall effect it over half of the change is left unaccounted for. The evidence from Table 2 above seems to suggest that identity and stereotype threat could be playing a large role as well.

Conclusion

We identify the effect single-sex schooling on first-year undergraduates by randomly assigning the students two single-sex and mixed gender classes as part of the required, year-long introductory economics course at the University of Essex. We find a positive effect of single-sex education on girls and no effect on boys. Half of the effect can be explained through changes in attendance patterns for girls assigned to the single-sex classes.

The effect of single-sex education has been debated in the economics and education literature and issues of endogeneity have made it difficult to identify a causal effect. This paper shows that, consistent with standard theory, girls do benefit from single-sex education.

Bibliography

Akerlof, G., and R. Kranton (2000): .Economics and Identity,.*The Quarterly Journal of Economics*, 115, 715.753.

Brutsaert, H. (1999): .Coeducation and Gender Identity Formation: A Comparative Analysis of Schools in Belgium,.*Journal of Sociology of Education*, 20(3), 343.353.

Campbell, P., and J. Sanders (2002): .Challenging the System: Assumptions and Data Behind the Push for Single-Sex Schooling,.in *Gender in Policy and Practice: Perspectives on Single-Sex and Coeducational Schooling*, ed. by A. Datnow, and L. Hubbard, pp. 31.46. Routledge, New York.

Duflo, E., and P. Dupas, and M. Kremer (2010): Peer Effects, Teacher Incentives, and the Impact of Tracking, *American Economic Review (forthcoming)*

Table 3: Why overall differences may matter

VARIABLES	DEPENDENT VARIABLE						
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
	Overall Grade	Exam Score	Coursework	Overall Grade	Exam Score	Coursework	Attendence
Female (=1)	-0.02	-0.66	3.71*	-0.55	-1.21	3.06	0.02
	[2.20]	[2.37]	[2.25]	[2.02]	[2.20]	[1.98]	[0.03]
All-Girls Class (=1)	4.07*	4.70*	1.93	1.91	2.50	-0.71	0.08***
	[2.33]	[2.50]	[2.46]	[2.14]	[2.34]	[2.22]	[0.03]
All-Boys Class (=1)	0.26	0.09	-0.51	-0.27	-0.45	-1.17	0.02
	[1.82]	[1.96]	[1.88]	[1.68]	[1.83]	[1.68]	[0.03]
EC 111 Module (=1)	2.85**	3.87**	-3.69**	2.09	3.09**	-4.63***	0.03
	[1.42]	[1.54]	[1.45]	[1.32]	[1.44]	[1.29]	[0.02]
GTA Female (=1)	-0.50	-1.88	2.68*	-0.08	-1.45	3.20**	-0.02
	[1.51]	[1.66]	[1.55]	[1.42]	[1.59]	[1.40]	[0.02]
Attendence at Classes (0-1)				25.47***	26.01***	31.25***	
				[2.96]	[3.20]	[2.90]	
Constant	53.56***	51.59***	50.26***	37.55***	35.24***	30.61***	0.63***
	[1.35]	[1.47]	[1.37]	[2.36]	[2.54]	[2.35]	[0.02]
Observations	570	570	570	570	570	570	570
R-squared	0.016	0.019	0.044	0.151	0.138	0.231	0.030

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1